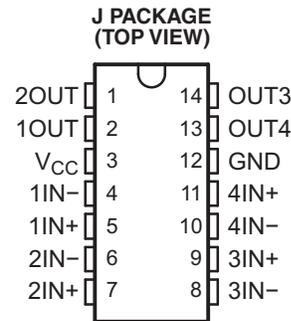


## QUAD DIFFERENTIAL COMPARATOR

 Check for Samples: [LM139-SP](#), [LM139A-SP](#)

### FEATURES

- QML-V Qualified, SMD 5962-7700801VCA, 5962-9673802VCA and 5962-9673802V9B
  - Rad-Tolerant: 40 kRad/sec (Si) TID (5962-9673802VCA and 5962-9673802V9B) <sup>(1)</sup>
    - TID Dose Rate = 0.01 rad/sec (Si)
  - Wide Supply Ranges
    - Single Supply: 2 V to 36 V (Tested to 30 V)
    - Dual Supplies:  $\pm 1$  V to  $\pm 18$  V (Tested to  $\pm 15$  V)
  - Low Supply-Current Drain Independent of Supply Voltage: 0.8 mA (Typ)
  - Low Input Bias Current: 25 nA (Typ)
  - Low Input Offset Current: 3 nA (Typ) (LM139)
  - Low Input Offset Voltage: 2 mV (Typ)
- Common-Mode Input Voltage Range Includes Ground
  - Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage:  $\pm 36$  V
  - Low Output Saturation Voltage
  - Output Compatible With TTL, MOS, and CMOS



(1) Radiation tolerance is a typical value based upon initial device qualification with dose rate = 0.01 rad/sec. Radiation lot acceptance testing is available - contact factory for details.

### DESCRIPTION/ORDERING INFORMATION

These devices consist of four independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies also is possible, as long as the difference between the two supplies is 2 V to 36 V, and  $V_{CC}$  is at least 1.5 V more positive than the input common-mode voltage. Current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

The LM139 and LM139A are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

Table 1. ORDERING INFORMATION <sup>(1)</sup>

$T_A$	$V_{IOmax}$ AT $25^{\circ}\text{C}$	MAX $V_{CC}$	PACKAGE <sup>(2)</sup>	ORDERABLE PART NUMBER		TOP-SIDE MARKING
$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$	5 mV	30 V	J	LM139	5962-7700801VCA	5962-7700801VCA
	2 mV	30 V		LM139A	5962-9673802VCA <sup>(3)</sup>	5962-9673802VCA
	2 mV	30 V	KGD	5962-9673802V9B <sup>(3)</sup>		N/A

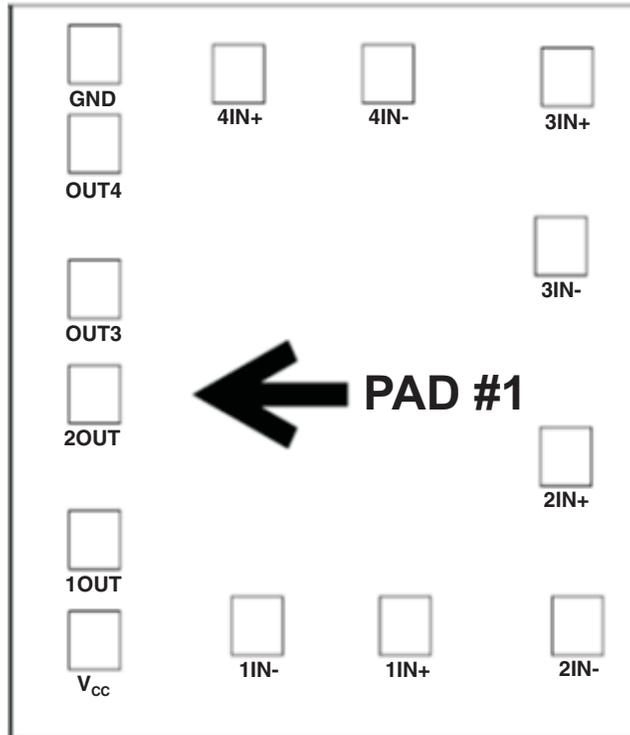
- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).
- (2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).
- (3) Radiation tolerant



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**BARE DIE INFORMATION**

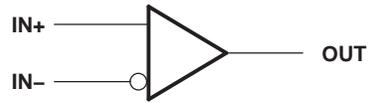
DIE THICKNESS	BACKSIDE FINISH	BACKSIDE POTENTIAL	BON PAD METALLIZATION COMPOSITION	BOND PAD THICKNESS
15 mils	Silicon with backgrind	Floating	AlCu (0.5%)	0.055 mils



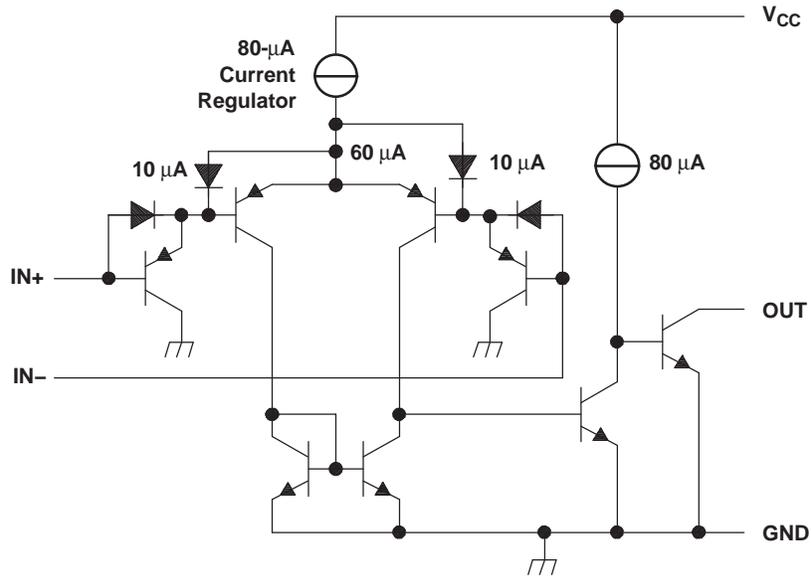
**Table 2. Bond Pad Coordinates in Microns**

DISCRIPTION	PAD NUMBER	Xmin	Ymin	Xmax	Ymax
2OUT	1	22.86	455.93	124.46	557.53
1OUT	2	22.86	203.2	124.46	304.8
Vcc	3	22.86	27.94	124.46	129.54
1IN-	4	345.44	53.34	447.04	154.94
1IN+	5	640.08	53.34	741.68	154.94
2IN-	6	981.71	53.34	1083.31	154.94
2IN+	7	958.85	347.98	1060.45	449.58
3IN-	8	948.69	713.74	1050.29	815.34
3IN+	9	961.39	1008.38	1062.99	1109.98
4IN-	10	605.79	1013.46	707.39	1115.06
4IN+	11	308.61	1013.46	410.21	1115.06
GND	12	22.86	1047.75	124.46	1149.35
OUT4	13	22.86	891.54	124.46	993.14
OUT3	14	22.86	638.81	124.46	740.41

**SYMBOL (EACH COMPARATOR)**



**SCHEMATIC (EACH COMPARATOR)**



All current values shown are nominal.

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage <sup>(2)</sup>			36	V
V <sub>ID</sub>	Differential input voltage <sup>(3)</sup>			±36	V
V <sub>I</sub>	Input voltage range (either input)		-0.3	36	V
V <sub>O</sub>	Output voltage			36	V
I <sub>O</sub>	Output current			20	mA
	Duration of output short circuit to ground <sup>(4)</sup>			Unlimited	
θ <sub>JC</sub>	Package thermal impedance, junction to case <sup>(5) (6)</sup>	J package		15.05	°C/W
T <sub>J</sub>	Operating virtual-junction temperature			150	°C
	Lead temperature 1,6 mm (1/16 in) from case for 60 s	J package		300	°C
T <sub>stg</sub>	Storage temperature range		-65	150	°C

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, except differential voltages, are with respect to network ground.
- (3) Differential voltages are at IN+ with respect to IN-.
- (4) Short circuits from outputs to V<sub>CC</sub> can cause excessive heating and eventual destruction.
- (5) Maximum power dissipation is a function of T<sub>J</sub> (max), θ<sub>JC</sub>, and T<sub>C</sub>. The maximum allowable power dissipation at any allowable case temperature is  $P_D = (T_J(\text{max}) - T_C)/\theta_{JC}$ . Operating at the absolute maximum T<sub>J</sub> of 150°C can affect reliability.
- (6) The package thermal impedance is calculated in accordance with MIL-STD-883.

**ELECTRICAL CHARACTERISTICS FOR LM139**

 at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS <sup>(1)</sup>		$T_A$ <sup>(2)</sup>	MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage	$V_{CC} = 5\text{ V to }30\text{ V}$ , $V_{IC} = V_{ICR\text{ min}}$ , $V_O = 1.4\text{ V}$		25°C	1			mV
				Full range	4			
$I_{IO}$	Input offset current	$V_O = 1.4\text{ V}$		25°C	3	25		nA
				Full range	100			
$I_{IB}$	Input bias current	$V_O = 1.4\text{ V}$		25°C	-25	-100		nA
				Full range	-300			
$V_{ICR}$	Common-mode input-voltage range <sup>(3)</sup>			25°C	0 to $V_{CC} - 1.5$			V
				Full range	0 to $V_{CC} - 2$			
$A_{VD}$	Large-signal differential-voltage amplification	$V_{CC+} = \pm 7.5\text{ V}$ , $V_O = -5\text{ V to }5\text{ V}$		25°C	50	200		V/mV
$I_{OH}$	High-level output current	$V_{ID} = 1\text{ V}$	$V_{OH} = 5\text{ V}$	25°C	0.1			nA
			$V_{OH} = 30\text{ V}$	Full range	1			μA
$V_{OL}$	Low-level output voltage	$V_{ID} = -1\text{ V}$ ,	$I_{OL} = 4\text{ mA}$	25°C	150	400		mV
				Full range	700			
$I_{OL}$	Low-level output current	$V_{ID} = -1\text{ V}$ ,	$V_{OL} = 1.5\text{ V}$	25°C	6	16		mA
$I_{CC}$	Supply current (four comparators)	$V_O = 2.5\text{ V}$ ,	No load	25°C	0.8		2	mA

- (1) All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
- (2) Full range (MIN to MAX) for LM139 and LM139A is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ . All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
- (3) The voltage at either input or common-mode should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is  $V_{CC+} - 1.5\text{ V}$ ; however, one input can exceed  $V_{CC+}$ , and the comparator will provide a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to 30 V without damage.

## ELECTRICAL CHARACTERISTICS FOR LM139A

at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS <sup>(1)</sup>	$T_A$ <sup>(2)</sup>	MIN	TYP <sup>(3)</sup>	MAX	UNIT
$I_{CC}$	Supply current	$R_L = \infty$ , $V_+ = 30\text{ V}$	Full range			2	mA
$I_{CEX}$	Output leakage current	$V_+ = 30\text{ V}$ , $V_{OUT} = 30\text{ V}$	Full range			1	$\mu\text{A}$
$V_{SAT}$	Saturation voltage	$I_{SINK} = 4\text{ mA}$	25°C			400	mV
			Full range			700	
$I_{SINK}$	Output sink current	$V_{OUT} = 1.5\text{ V}$	25°C		6		mA
$V_{IO}$	Input offset voltage	$V_+ = 5\text{ V}$ , $V_{CM} = 0\text{ V}$	25°C			$\pm 2$	mV
			Full range			$\pm 4$	
		$V_+ = 30\text{ V}$ , $V_{CM} = 0\text{ V}$	25°C			$\pm 2$	mV
			Full range			$\pm 4$	
		$V_+ = 30\text{ V}$ , $V_{CM} = 28.5\text{ V}$ , $V_{OUT} = 1.5\text{ V}$	25°C			$\pm 2$	mV
$V_+ = 30\text{ V}$ , $V_{CM} = 28\text{ V}$ , $V_{OUT} = 1.5\text{ V}$	Full range			$\pm 4$	mV		
$I_{IB}$	Input bias current	$V_{OUT} = 1.5\text{ V}$	25°C	-100		-1	nA
			Full range	-300		-1	
$I_{IO}$	Input offset current	$V_{OUT} = 1.5\text{ V}$	25°C			$\pm 25$	nA
			Full range			$\pm 100$	
PSRR	Power supply rejection ratio	$V_+ = 5\text{ V}$ to $30\text{ V}$	25°C	60		100	dB
CMRR	Common-mode rejection ratio	$V_+ = 30\text{ V}$ , $V_{CM} = 0\text{ V}$ to $28.5\text{ V}$	25°C	60			dB
$A_V$	Voltage gain	$V_+ = 15\text{ V}$ , $R_L \geq 15\text{ k}\Omega$ , $V_{OUT} = 1\text{ V}$ to $11\text{ V}$	25°C	50			V/mV
$V_{CM}$ <sup>(4)</sup>	Common mode voltage range	$V_+ = 30\text{ V}$	25°C	0		$V_+ - 1.5$	V
			Full range	0		$V_+ - 2$	
$V_{DIFF}$ <sup>(5)</sup>	Differential input voltage	$V_+ = 30\text{ V}$ , $V_- = 0\text{ V}$ , $V_{IN+} = 36\text{ V}$ , $V_{IN-} = 0\text{ V}$	Full range			500	nA
		$V_+ = 30\text{ V}$ , $V_- = 0\text{ V}$ , $V_{IN+} = 0\text{ V}$ , $V_{IN-} = 36\text{ V}$				500	
$t_{RLH}$	Response time	$V_{OD}$ (overdrive) = $5\text{ mV}$	25°C			5	$\mu\text{s}$
		$V_{OD}$ (overdrive) = $50\text{ mV}$				0.8	
$t_{RHL}$	Response time	$V_{OD}$ (overdrive) = $5\text{ mV}$	25°C			2.5	$\mu\text{s}$
		$V_{OD}$ (overdrive) = $50\text{ mV}$				0.8	

- (1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX  $V_{CC}$  for testing purposes is  $30\text{ V}$ .
- (2) Full range is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for LM139A.
- (3) All typical values are at  $T_A = 25^\circ\text{C}$ .
- (4) The input common mode voltage or either input signal voltage should not be allowed to go negative by more than  $0.3\text{ V}$ . The upper end of the common mode voltage range is  $V_+ - 1.5\text{ V}$  for  $T_A = 25^\circ\text{C}$  or  $V_+ - 2.0\text{ V}$  for  $T_A = \text{Full range}$ , but either or both inputs can go to  $+30\text{ V}$  dc without damage independent of the magnitude of  $V_+$ .
- (5) Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common mode range, the comparator will provide a proper output state. The low input voltage state must not be less than  $-0.3\text{ V}$  dc or  $0.3\text{ V}$  dc below the magnitude of the negative power supply, if used.

## SWITCHING CHARACTERISTICS

 $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ 

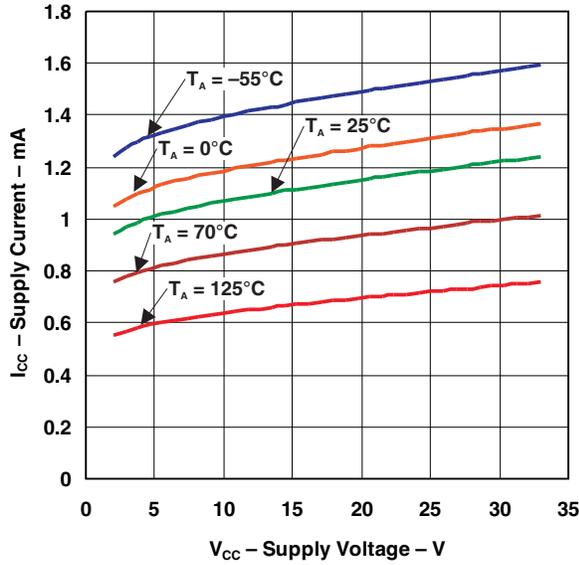
PARAMETER	TEST CONDITIONS	TYP	UNIT
Response time	$R_L$ connected to 5 V through 5.1 k $\Omega$ , $C_L = 15\text{ pF}^{(1)}\text{ }^{(2)}$	100-mV input step with 5-mV overdrive	1.3
		TTL-level input step	0.3

(1)  $C_L$  includes probe and jig capacitance.

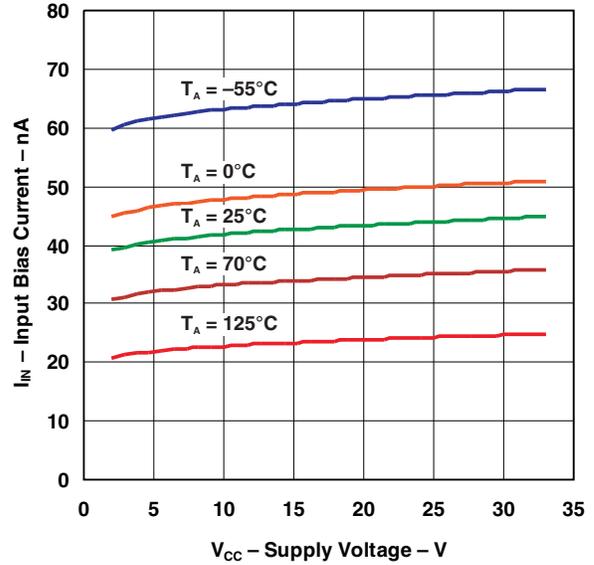
(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

**TYPICAL CHARACTERISTICS**

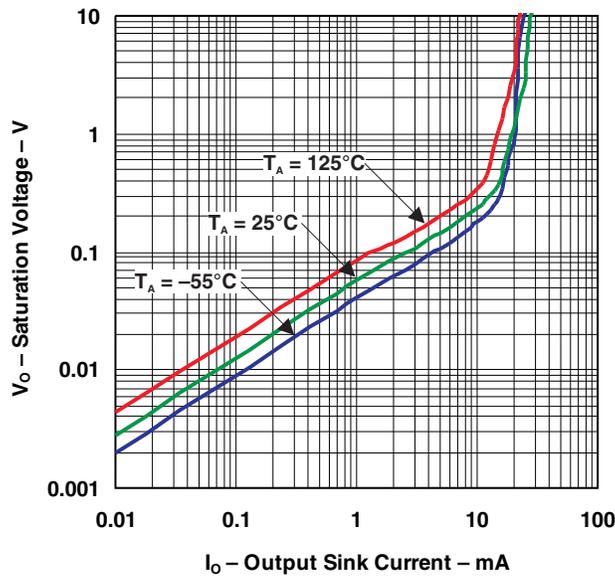
**SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE**



**INPUT BIAS CURRENT  
vs  
SUPPLY VOLTAGE**

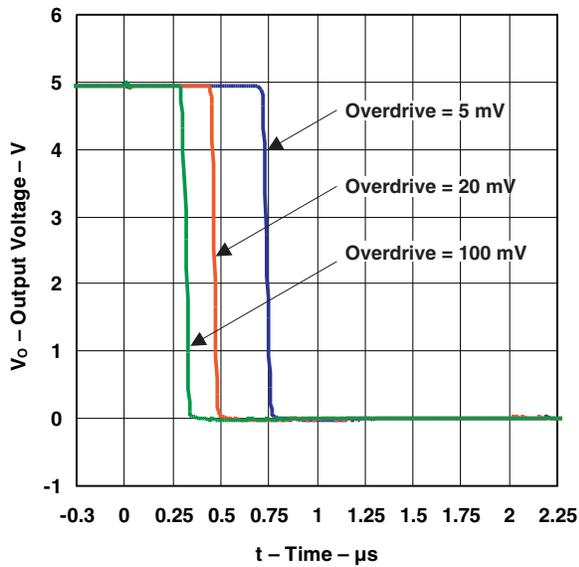


**OUTPUT SATURATION VOLTAGE**

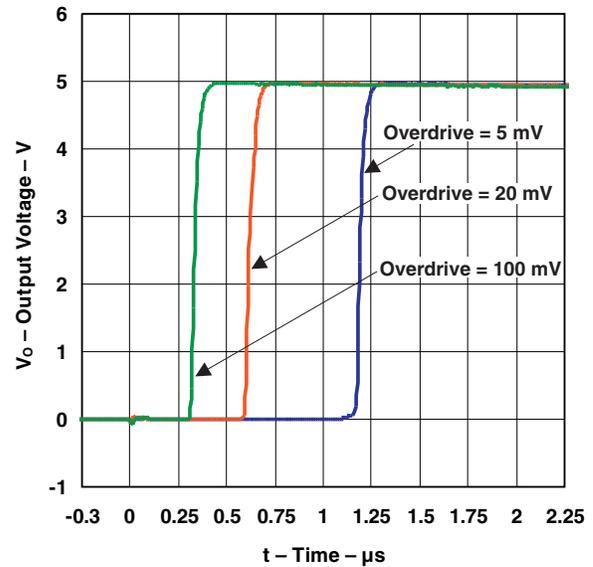


TYPICAL CHARACTERISTICS (continued)

RESPONSE TIME FOR VARIOUS OVERDRIVES  
NEGATIVE TRANSITION



RESPONSE TIME FOR VARIOUS OVERDRIVES  
POSITIVE TRANSITION



**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">5962-7700801VCA</a>	Active	Production	CDIP (J)   14	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-7700801VC A LM139JQMLV
5962-7700801VCA.A	Active	Production	CDIP (J)   14	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-7700801VC A LM139JQMLV
5962-9673802V9B	Active	Production	XCEPT (KGD)   0	100   BULK	Yes	Call TI	N/A for Pkg Type	-55 to 125	
5962-9673802V9B.A	Active	Production	XCEPT (KGD)   0	100   BULK	Yes	Call TI	N/A for Pkg Type	-55 to 125	
<a href="#">5962-9673802VCA</a>	Active	Production	CDIP (J)   14	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9673802VC A LM139AJQMLV
5962-9673802VCA.A	Active	Production	CDIP (J)   14	25   TUBE	No	SNPB	N/A for Pkg Type	-55 to 125	5962-9673802VC A LM139AJQMLV

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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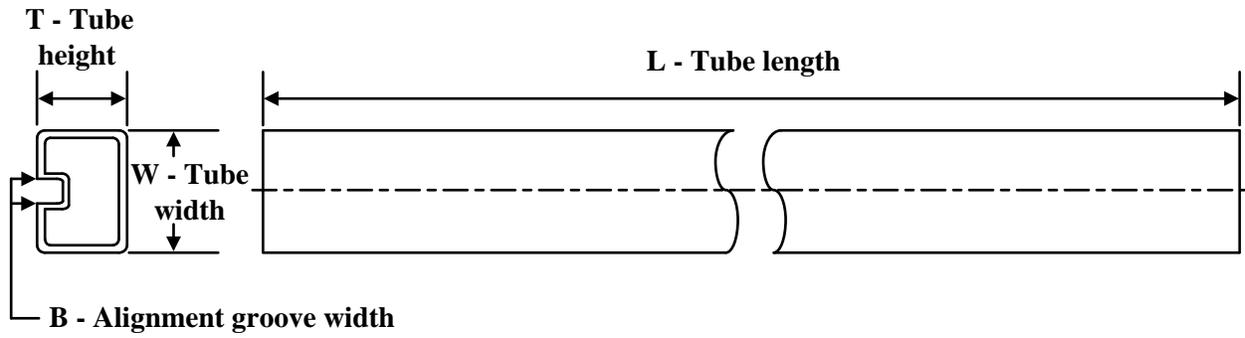
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM139-SP :**

- Catalog : [LM139](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

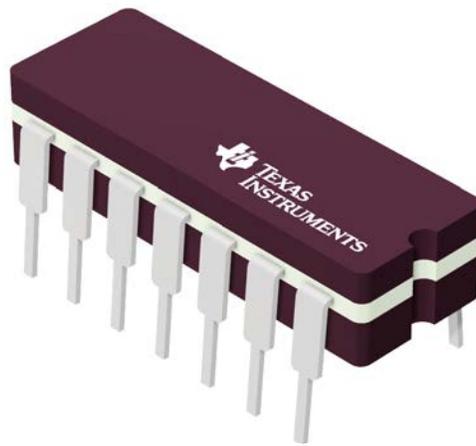
**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
5962-9673802VCA	J	CDIP	14	25	506.98	15.24	13440	NA
5962-9673802VCA.A	J	CDIP	14	25	506.98	15.24	13440	NA

J 14

**GENERIC PACKAGE VIEW**  
**CDIP - 5.08 mm max height**  
CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4040083-5/G

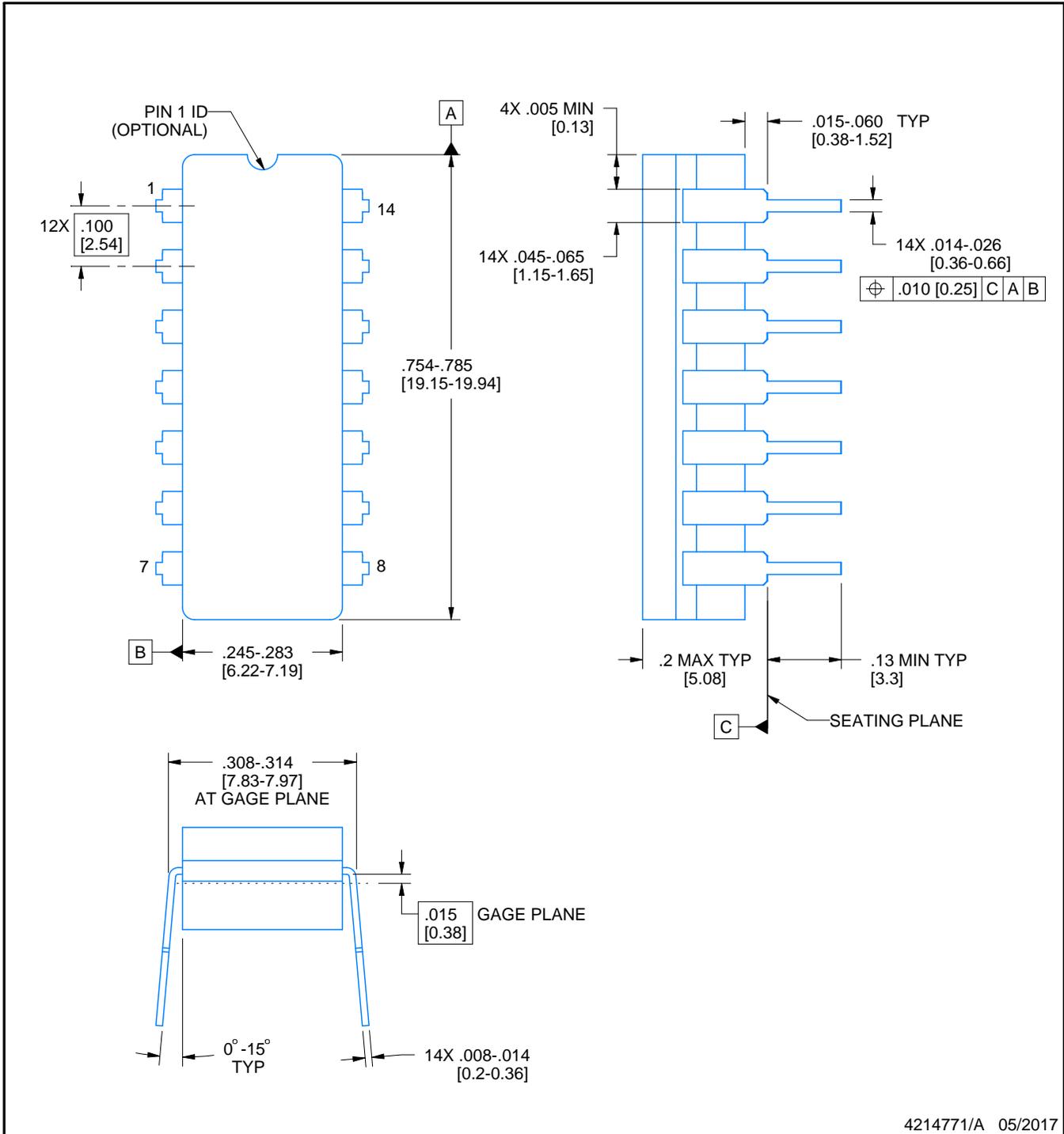
J0014A



# PACKAGE OUTLINE

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



4214771/A 05/2017

NOTES:

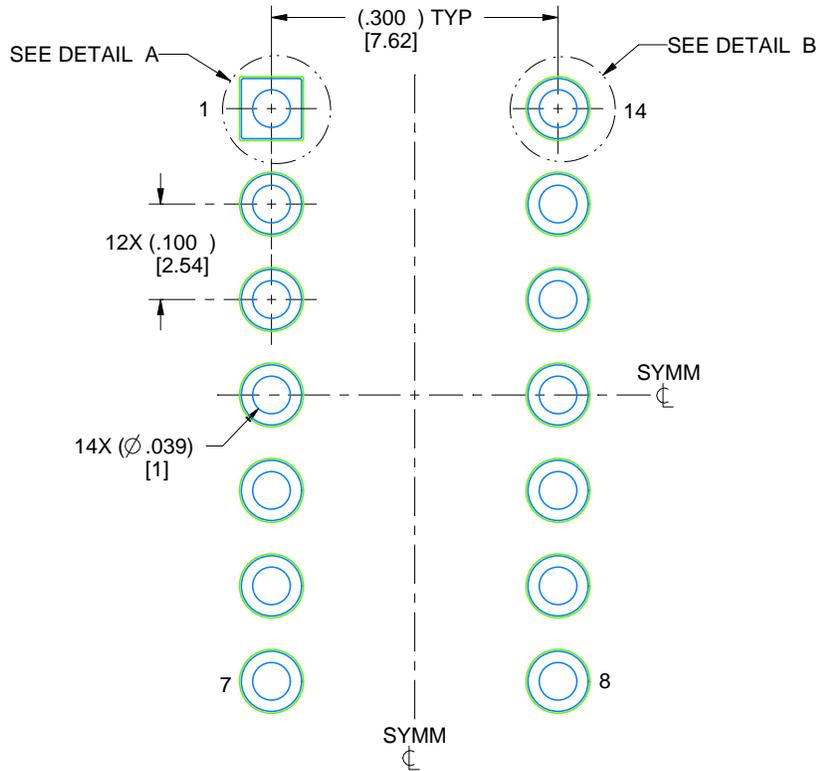
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.

# EXAMPLE BOARD LAYOUT

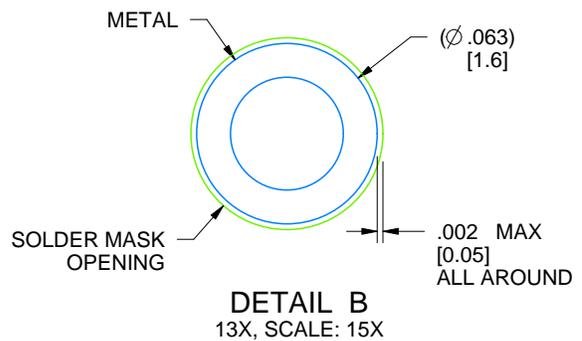
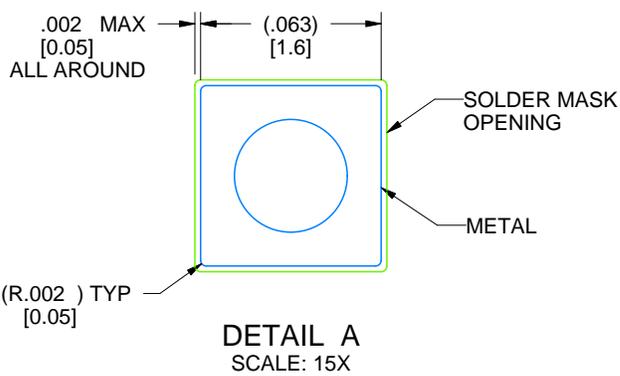
J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



LAND PATTERN EXAMPLE  
NON-SOLDER MASK DEFINED  
SCALE: 5X



4214771/A 05/2017

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