QUAD DIFFERENTIAL COMPARATOR

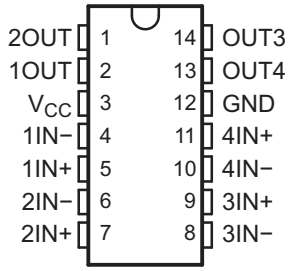
Check for Samples: LM139-SP, LM139A-SP

FEATURES

- **QML-V Qualified, SMD 5962-7700801VCA, 5962-9673802VCA and 5962-9673802V9B**
- **Rad-Tolerant: 40 kRad/sec (Si) TID (5962-9673802VCA and 5962-9673802V9B)** (1)
  - **TID Dose Rate = 0.01 rad/sec (Si)**
- **Wide Supply Ranges**
  - **Single Supply: 2 V to 36 V (Tested to 30 V)**
  - **Dual Supplies: ±1 V to ±18 V (Tested to ±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: ±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.

J PACKAGE
(TOP VIEW)



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°C to 125°C.

Table 1. ORDERING INFORMATION(1)

T_A	V_{IO}max AT 25°C	MAX V_{CC}	PACKAGE(2)	ORDERABLE PART NUMBER		TOP-SIDE MARKING
–55°C to 125°C	5 mV	30 V	J	LM139	5962-7700801VCA	5962-7700801VCA
	2 mV	30 V		LM139A	5962-9673802VCA(3)	5962-9673802VCA
	2 mV	30 V	KGD	5962-9673802V9B(3)		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.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(3) Radiation tolerant

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

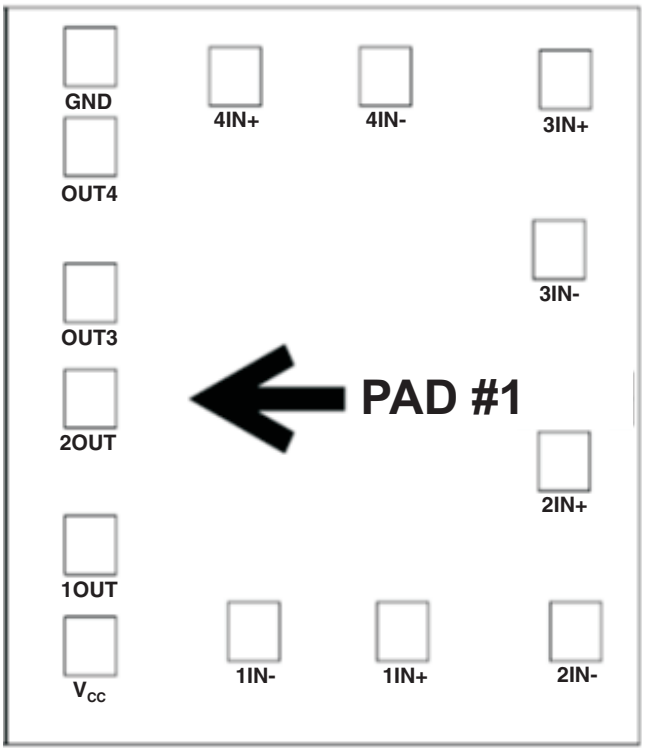
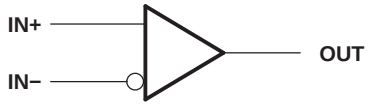


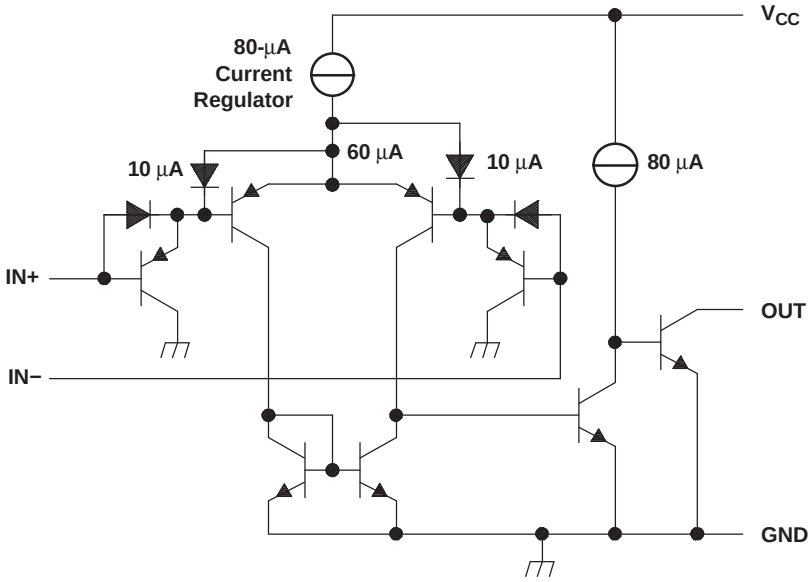
Table 2. Bond Pad Coordinates in Microns

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(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage(2)			36	V
V_{ID}	Differential input voltage(3)			±36	V
V_I	Input voltage range (either input)		–0.3	36	V
V_O	Output voltage			36	V
I_O	Output current			20	mA
	Duration of output short circuit to ground(4)			Unlimited	
θ_{JC}	Package thermal impedance, junction to case(5) (6)	J package		15.05	°C/W
T_J	Operating virtual-junction temperature			150	°C
	Lead temperature 1,6 mm (1/16 in) from case for 60 s	J package		300	°C
T_{stg}	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_{CC} can cause excessive heating and eventual destruction.
(5) Maximum power dissipation is a function of T_J (max), θ_{JC}, and T_C. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_J (max) – T_C)/\theta_{JC}$. Operating at the absolute maximum T_J 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 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)		T_A (2)	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, $V_{IC} = V_{ICR}$ min, V_O = 1.4 V		25°C		1		mV
				Full range			4	
I_{IO}	Input offset current	V_O = 1.4 V		25°C		3	25	nA
				Full range			100	
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–25	–100	nA
				Full range			–300	
V_{ICR}	Common-mode input-voltage range(3)			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+} = ±7.5 V, V_O = –5 V to 5 V		25°C	50	200		V/mV
I_{OH}	High-level output current	V_{ID} = 1 V	V_{OH} = 5 V	25°C		0.1		nA
			V_{OH} = 30 V	Full range			1	µA
V_{OL}	Low-level output voltage	V_{ID} = –1 V,	I_{OL} = 4 mA	25°C		150	400	mV
				Full range			700	
I_{OL}	Low-level output current	V_{ID} = –1 V,	V_{OL} = 1.5 V	25°C	6	16		mA
I_{CC}	Supply current (four comparators)	V_O = 2.5 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°C to 125°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 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 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)	T_A(2)	MIN	TYP(3)	MAX	UNIT
I_{CC}	Supply current	R_L = ∞, V+ = 30 V	Full range			2	mA
I_{CEX}	Output leakage current	V+ = 30 V, V_{OUT} = 30 V	Full range			1	µA
V_{SAT}	Saturation voltage	I_{SINK} = 4 mA	25°C			400	mV
			Full range			700	
I_{SINK}	Output sink current	V_{OUT} = 1.5 V	25°C		6		mA
V_{IO}	Input offset voltage	V+ = 5 V, V_{CM} = 0 V	25°C			±2	mV
			Full range			±4	
		V+ = 30 V, V_{CM} = 0 V	25°C			±2	mV
			Full range			±4	
		V+ = 30 V, V_{CM} = 28.5 V, V_{OUT} = 1.5 V	25°C			±2	mV
		V+ = 30 V, V_{CM} = 28 V, V_{OUT} = 1.5 V	Full range			±4	mV
I_{IB}	Input bias current	V_{OUT} = 1.5 V	25°C	-100		-1	nA
			Full range	-300		-1	
I_{IO}	Input offset current	V_{OUT} = 1.5 V	25°C			±25	nA
			Full range			±100	
PSRR	Power supply rejection ratio	V+ = 5 V to 30 V	25°C	60		100	dB
CMRR	Common-mode rejection ratio	V+ = 30 V, V_{CM} = 0 V to 28.5 V	25°C	60			dB
A_V	Voltage gain	V+ = 15 V, R_L ≥ 15 kΩ, V_{OUT} = 1 V to 11 V	25°C	50			V/mV
V_{CM}(4)	Common mode voltage range	V+ = 30 V	25°C	0		V+ - 1.5	V
			Full range	0		V+ - 2	
V_{DIFF}(5)	Differential input voltage	V+ = 30 V, V- = 0 V, V_{IN+} = 36 V, V_{IN-} = 0 V	Full range			500	nA
		V+ = 30 V, V- = 0 V, V_{IN+} = 0 V, V_{IN-} = 36 V				500	
t_{RLH}	Response time	V_{OD} (overdrive) = 5 mV	25°C			5	µs
		V_{OD} (overdrive) = 50 mV				0.8	
t_{RHL}	Response time	V_{OD} (overdrive) = 5 mV	25°C			2.5	µs
		V_{OD} (overdrive) = 50 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 V.
(2) Full range is −55°C to 125°C for LM139A.
(3) All typical values are at T_A = 25°C.
(4) The input common mode voltage or either input signal voltage should not be allowed to go negative by more that 0.3 V. The upper end of the common mode voltage range is V+ -1.5 V for T_A = 25°C or V+ -2.0 V for T_A = Full range, but either or both inputs can go to +30 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 V dc or 0.3 V dc below the magnitude of the negative power supply, if used.

SWITCHING CHARACTERISTICS

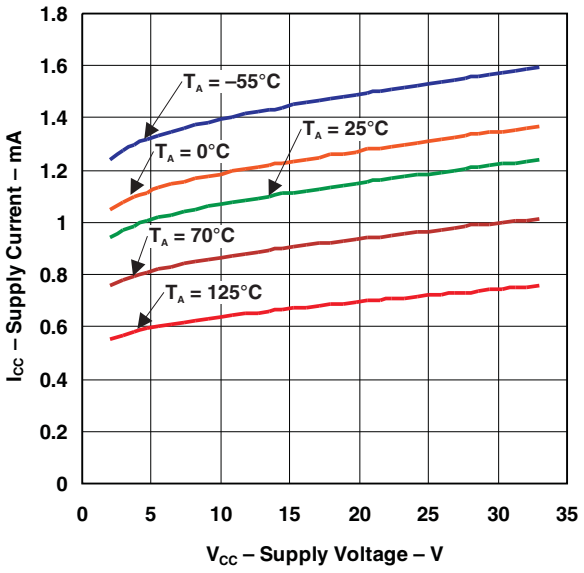
V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS		TYP	UNIT
Response time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF(1) (2)	100-mV input step with 5-mV overdrive	1.3	µs
		TTL-level input step	0.3	

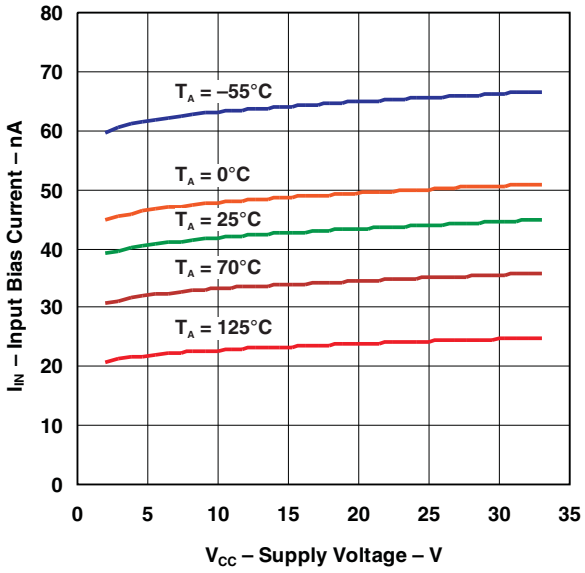
(1) C_L includes probe and jig capacitance.
(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

TYPICAL CHARACTERISTICS

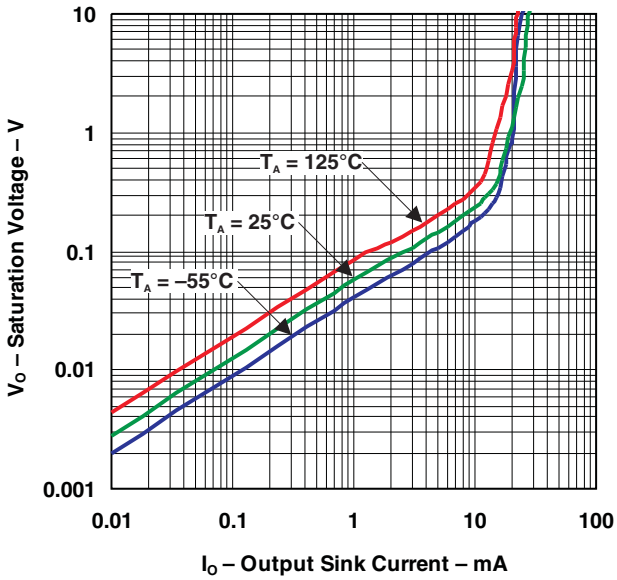
SUPPLY CURRENT vs SUPPLY VOLTAGE



INPUT BIAS CURRENT vs SUPPLY VOLTAGE

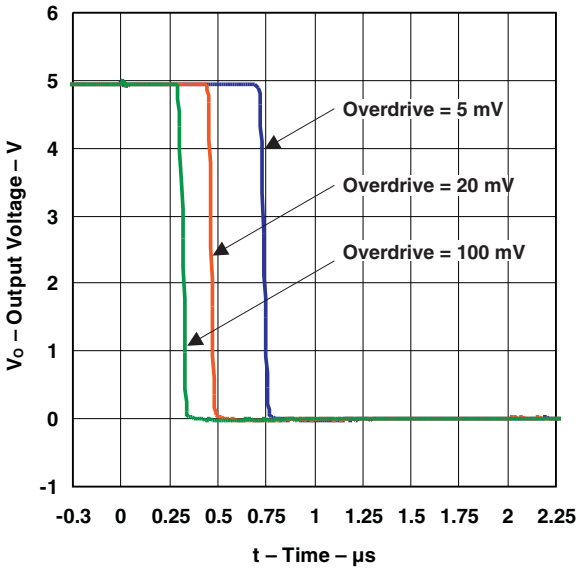


OUTPUT SATURATION VOLTAGE

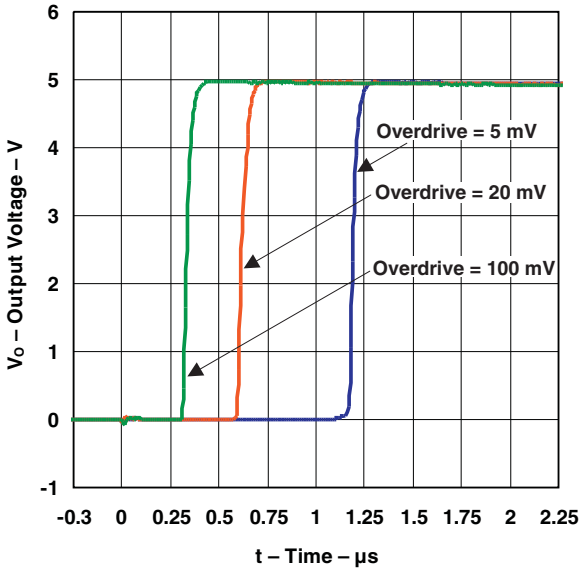


TYPICAL CHARACTERISTICS (continued)

RESPONSE TIME FOR VARIOUS OVERDRIVES NEGATIVE TRANSITION



RESPONSE TIME FOR VARIOUS OVERDRIVES POSITIVE TRANSITION



PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-7700801VCA	ACTIVE	CDIP	J	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-7700801VCA LM139JQMLV	Samples
5962-9673802V9B	ACTIVE	XCEPT	KGD	0	100	RoHS & Green	Call TI	N / A for Pkg Type	-55 to 125		Samples
5962-9673802VCA	ACTIVE	CDIP	J	14	1	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	5962-9673802VCA LM139AJQMLV	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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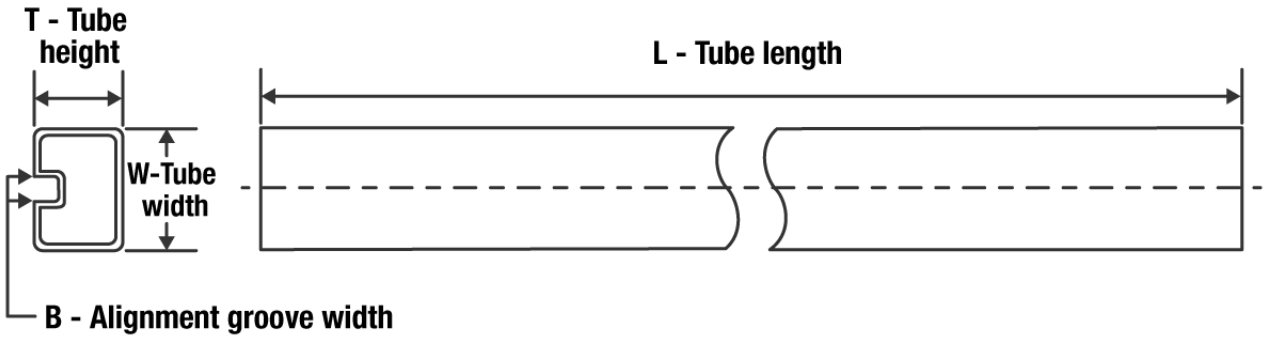
OTHER QUALIFIED VERSIONS OF LM139-SP :

- Catalog: LM139

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TUBE



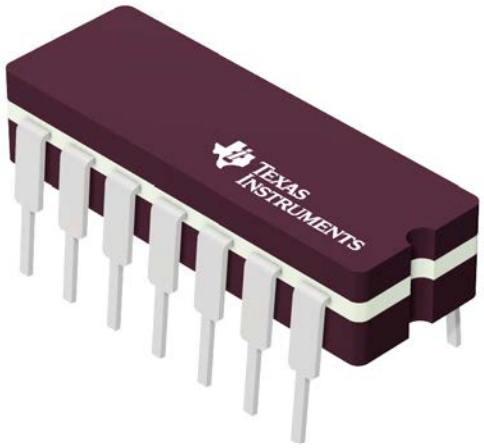
*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
5962-9673802VCA	J	CDIP	14	1	506.98	15.24	13440	NA

GENERIC PACKAGE VIEW

J 14 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.

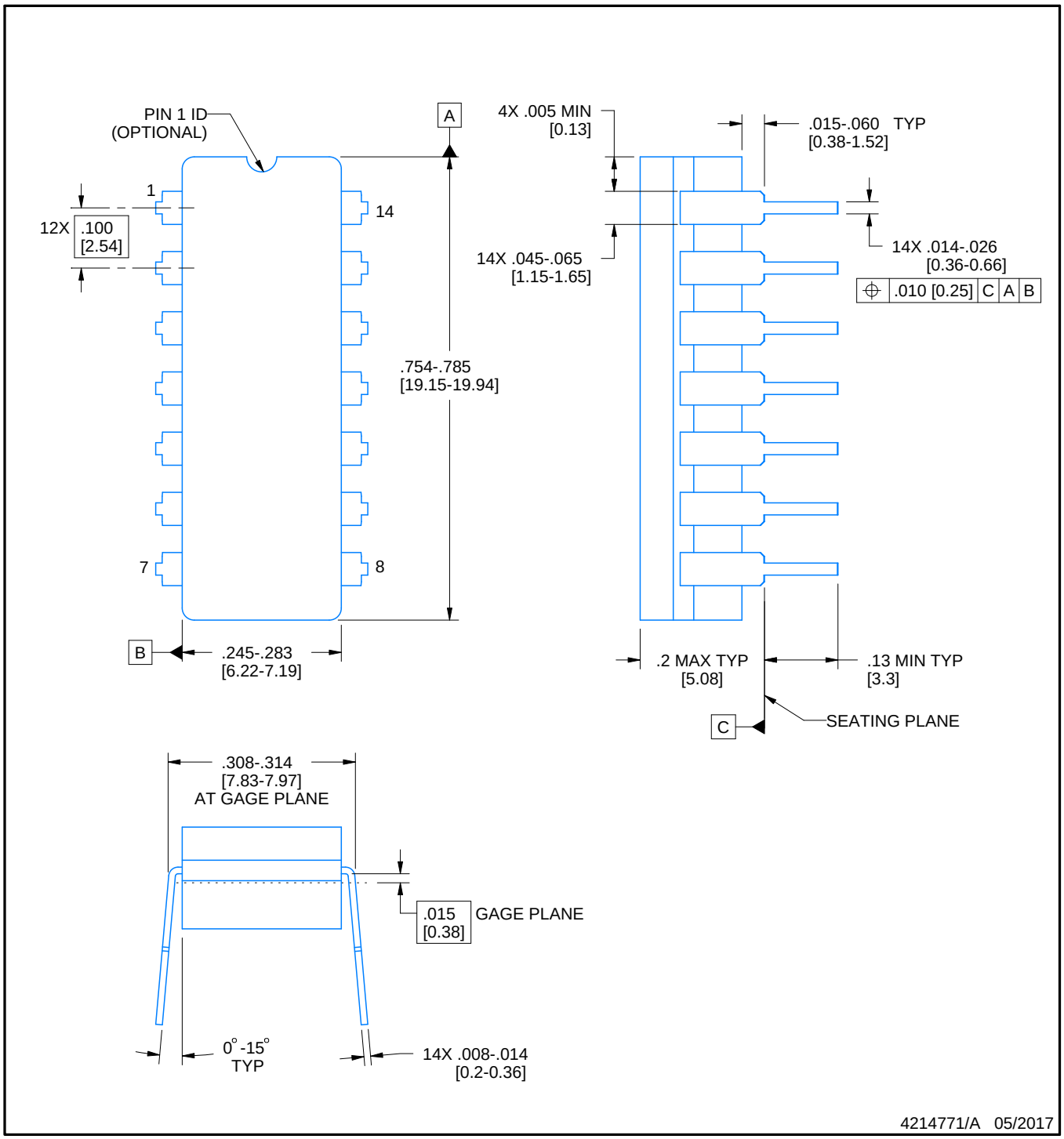
4040083-5/G

PACKAGE OUTLINE

J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



NOTES:

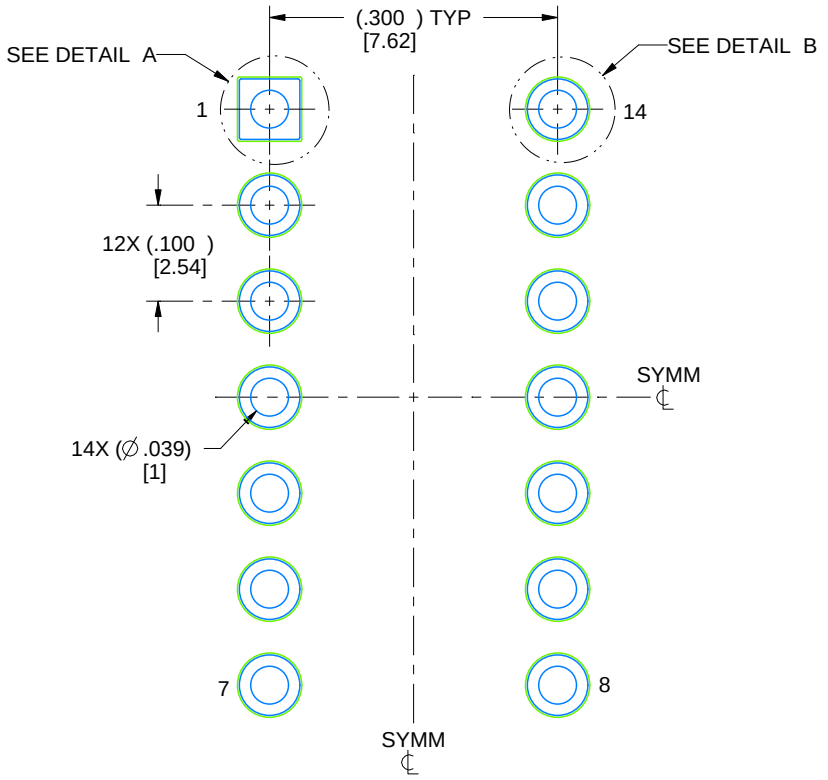
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermitically sealed with 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

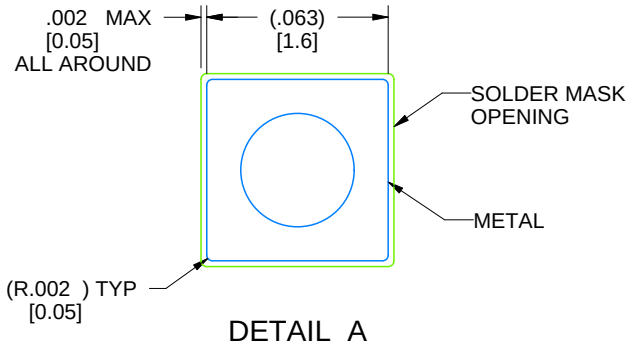
J0014A

CDIP - 5.08 mm max height

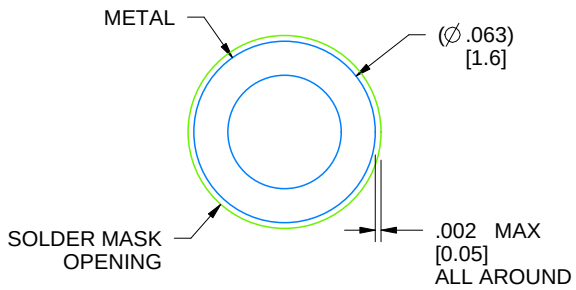
CERAMIC DUAL IN LINE PACKAGE



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



DETAIL A
SCALE: 15X



DETAIL B
13X, SCALE: 15X

4214771/A 05/2017

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