LM111-N/LM211-N/LM311-N Voltage Comparator

Check for Samples: LM111-N, LM211-N, LM311-N

FEATURES

- **Operates From Single 5V Supply**
- **Input Current: 150 nA Max. Over Temperature**
- **Offset Current: 20 nA Max. Over Temperature**
- **Differential Input Voltage Range: ±30V**
- **Power Consumption: 135 mW at ±15V**

DESCRIPTION

The LM111-N, LM211-N and LM311-N are voltage comparators that have input currents nearly a thousand times lower than devices like the LM106 or LM710. They are also designed to operate over a wider range of supply voltages: from standard ±15V op amp supplies down to the single 5V supply used for IC logic. Their output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, they can drive lamps or relays, switching voltages up to 50V at currents as high as 50 mA.

Both the inputs and the outputs of the LM111-N, LM211-N or the LM311-N can be isolated from system ground, and the output can drive loads referred to ground, the positive supply or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire OR'ed. Although slower than the LM106 and LM710 (200 ns response time vs 40 ns) the devices are also much less prone to spurious oscillations. The LM111-N has the same pin configuration as the LM106 and LM710.

The LM211-N is identical to the LM111-N, except that its performance is specified over a −25°C to +85°C temperature range instead of −55°C to +125°C. The LM311-N has a temperature range of 0°C to +70°C.

Typical Applications

NOTE

Pin connections shown in Schematic Diagram and Typical Applications are for the LMC TO-99 package.

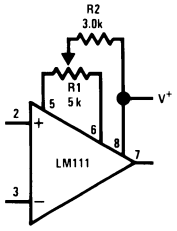
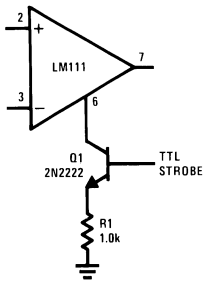


Figure 1. Offset Balancing



Do Not Ground Strobe Pin. Output is turned off when current is pulled from Strobe Pin.

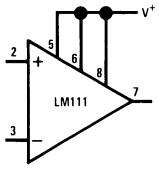
Figure 2. Strobing

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Increases typical common mode slew from 7.0V/µs to 18V/µs.

Figure 3. Increasing Input Stage Current

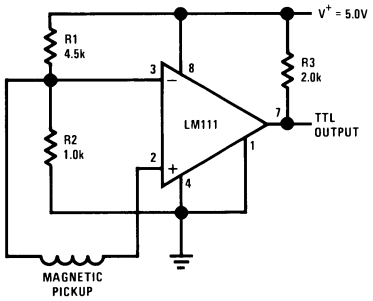


Figure 4. Detector for Magnetic Transducer

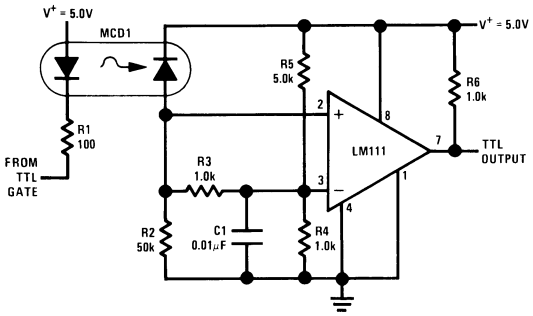
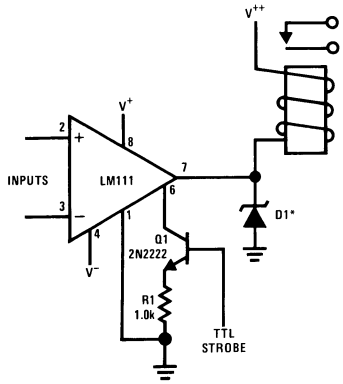
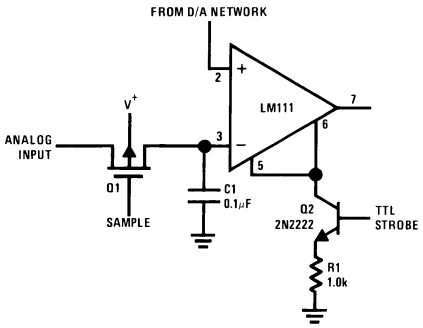


Figure 5. Digital Transmission Isolator



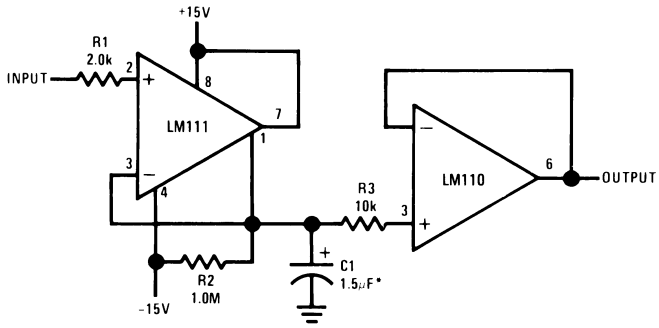
*Absorbs inductive kickback of relay and protects IC from severe voltage transients on V^{++} line.
Do Not Ground Strobe Pin.

Figure 6. Relay Driver with Strobe



Do Not Ground Strobe Pin.
Typical input current is 50 pA with inputs strobed off.
Pin connections shown in Schematic Diagram and Typical Applications are for the LMC TO-99 package.

Figure 7. Strobing off Both Input and Output Stages



*Solid tantalum

Figure 8. Positive Peak Detector

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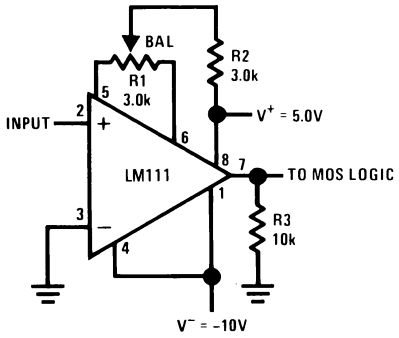


Figure 9. Zero Crossing Detector Driving MOS Logic

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings for the LM111-N/LM211-N[1][2]

Total Supply Voltage (V_{84})			36V
Output to Negative Supply Voltage (V_{74})			50V
Ground to Negative Supply Voltage (V_{14})			30V
Differential Input Voltage			±30V
Input Voltage[3]			±15V
Output Short Circuit Duration			10 sec
Operating Temperature Range		LM111-N	−55°C to 125°C
		LM211-N	−25°C to 85°C
Lead Temperature (Soldering, 10 sec)			260°C
Voltage at Strobe Pin			V^+−5V
Soldering Information	Dual-In-Line Package	Soldering (10 seconds)	260°C
	Small Outline Package	Vapor Phase (60 seconds)	215°C
		Infrared (15 seconds)	220°C
ESD Rating[4]			300V

(1) Refer to RETS111X for the LM111H, LM111J and LM111J-8 military specifications.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(3) This rating applies for ±15 supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.
(4) Human body model, 1.5 kΩ in series with 100 pF.

Electrical Characteristics[1] for the LM111-N and LM211-N

Parameter	Conditions	Min	Typ	Max	Units
Input Offset Voltage[2]	T_A=25°C, R_S≤50k		0.7	3.0	mV
Input Offset Current	T_A=25°C		4.0	10	nA
Input Bias Current	T_A=25°C		60	100	nA
Voltage Gain	T_A=25°C	40	200		V/mV
Response Time[3]	T_A=25°C		200		ns
Saturation Voltage	V_{IN}≤−5 mV, I_{OUT}=50 mA T_A=25°C		0.75	1.5	V
Strobe ON Current[4]	T_A=25°C		2.0	5.0	mA
Output Leakage Current	V_{IN}≥5 mV, V_{OUT}=35V, T_A=25°C, I_{STROBE}=3 mA		0.2	10	nA
Input Offset Voltage[2]	R_S≤50 k			4.0	mV
Input Offset Current[2]				20	nA
Input Bias Current				150	nA
Input Voltage Range	V^+=15V, V^-=−15V, Pin 7 Pull-Up May Go To 5V	−14.5	13.8-14.7	13.0	V
Saturation Voltage	V^+≥4.5V, V^-=0, V_{IN}≤−6 mV, I_{OUT}≤8 mA		0.23	0.4	V
Output Leakage Current	V_{IN}≥5 mV, V_{OUT}=35V		0.1	0.5	µA
Positive Supply Current	T_A=25°C		5.1	6.0	mA
Negative Supply Current	T_A=25°C		4.1	5.0	mA

(1) These specifications apply for V_S=±15V and Ground pin at ground, and −55°C≤T_A≤+125°C, unless otherwise stated. With the LM211-N, however, all temperature specifications are limited to −25°C≤T_A≤+85°C. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to ±15V supplies.
(2) The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with a 1 mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and R_S.
(3) The response time specified (see definitions) is for a 100 mV input step with 5 mV overdrive.
(4) This specification gives the range of current which must be drawn from the strobe pin to ensure the output is properly disabled. Do not short the strobe pin to ground; it should be current driven at 3 to 5 mA.

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Absolute Maximum Ratings for the LM311-N[1][2]

Total Supply Voltage (V_{84})			36V
Output to Negative Supply Voltage (V_{74})			40V
Ground to Negative Supply Voltage (V_{14})			30V
Differential Input Voltage			±30V
Input Voltage[3]			±15V
Power Dissipation[4]			500 mW
ESD Rating[5]			300V
Output Short Circuit Duration			10 sec
Operating Temperature Range			0° to 70°C
Storage Temperature Range			−65°C to 150°C
Lead Temperature (soldering, 10 sec)			260°C
Voltage at Strobe Pin			V^+−5V
Soldering Information	Dual-In-Line Package	Soldering (10 seconds)	260°C
	Small Outline Package	Vapor Phase (60 seconds)	215°C
		Infrared (15 seconds)	220°C

(1) "Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits."
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
(3) This rating applies for ±15V supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.
(4) The maximum junction temperature of the LM311-N is 110°C. For operating at elevated temperature, devices in the LMC package must be derated based on a thermal resistance of 165°C/W, junction to ambient, or 20°C/W, junction to case. The thermal resistance of the dual-in-line package is 100°C/W, junction to ambient.
(5) Human body model, 1.5 kΩ in series with 100 pF.

Electrical Characteristics [1] for the LM311-N

Parameter	Conditions	Min	Typ	Max	Units
Input Offset Voltage[2]	T_A=25°C, R_S≤50k		2.0	7.5	mV
Input Offset Current[2]	T_A=25°C		6.0	50	nA
Input Bias Current	T_A=25°C		100	250	nA
Voltage Gain	T_A=25°C	40	200		V/mV
Response Time[3]	T_A=25°C		200		ns
Saturation Voltage	V_{IN}≤−10 mV, I_{OUT}=50 mA , T_A=25°C		0.75	1.5	V
Strobe ON Current[4]	T_A=25°C		2.0	5.0	mA
Output Leakage Current	V_{IN}≥10 mV, V_{OUT}=35V T_A=25°C, I_{STROBE}=3 mA V^- = Pin 1 = −5V		0.2	50	nA
Input Offset Voltage[2]	R_S≤50K			10	mV
Input Offset Current[2]				70	nA
Input Bias Current				300	nA
Input Voltage Range		−14.5	13.8,−14.7	13.0	V
Saturation Voltage	V^+≥4.5V, V^-=0, V_{IN}≤−10 mV, I_{OUT}≤8 mA		0.23	0.4	V
Positive Supply Current	T_A=25°C		5.1	7.5	mA
Negative Supply Current	T_A=25°C		4.1	5.0	mA

(1) These specifications apply for V_S=±15V and Pin 1 at ground, and 0°C < T_A < +70°C, unless otherwise specified. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to ±15V supplies.
(2) The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with 1 mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and R_S.
(3) The response time specified (see definitions) is for a 100 mV input step with 5 mV overdrive.
(4) This specification gives the range of current which must be drawn from the strobe pin to ensure the output is properly disabled. Do not short the strobe pin to ground; it should be current driven at 3 to 5 mA.

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Typical Performance Characteristics LM111-N/LM211-N

Input Bias Current

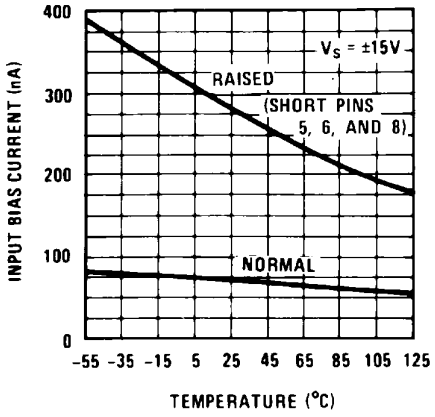


Figure 10.

Input Bias Current

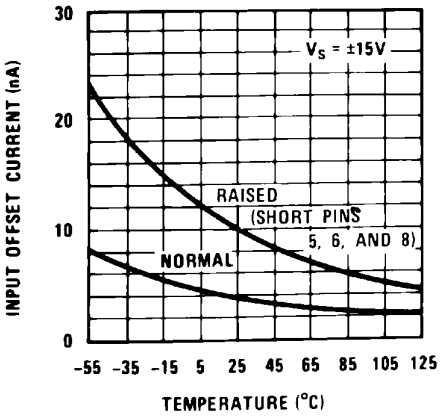


Figure 11.

Input Bias Current

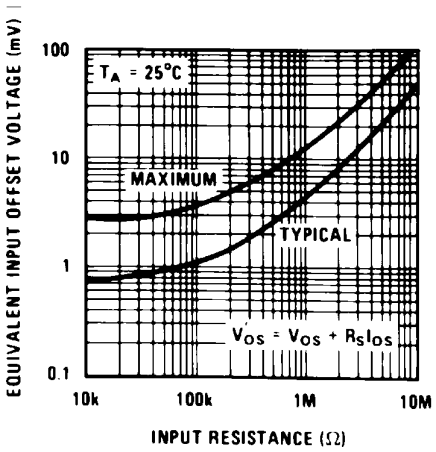


Figure 12.

Input Bias Current

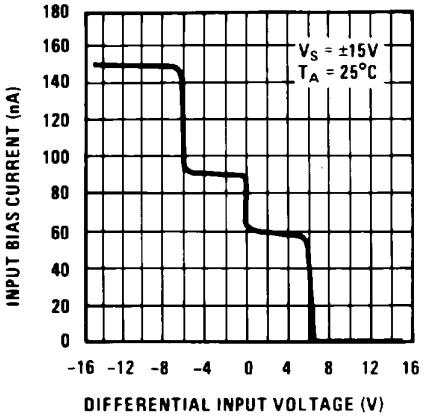


Figure 13.

Input Bias Current

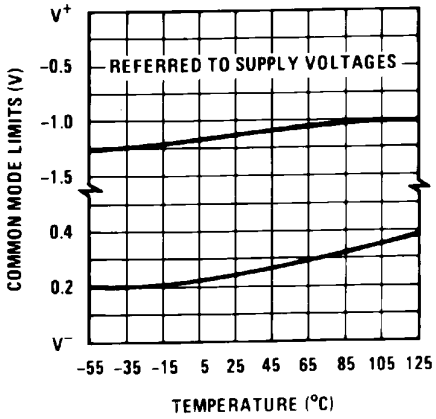


Figure 14.

Input Bias Current

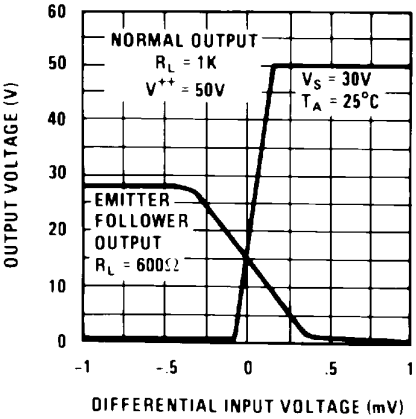


Figure 15.

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Typical Performance Characteristics LM111-N/LM211-N (continued)

Input Bias Current
Input Overdrives

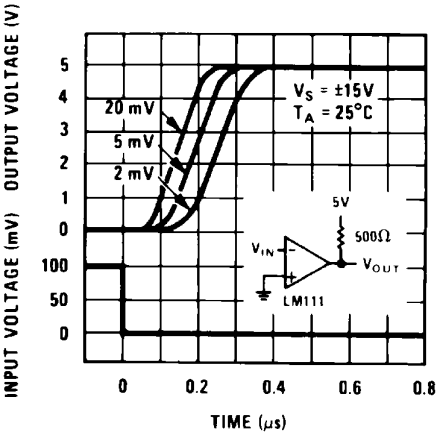


Figure 16.

Input Bias Current
Input Overdrives

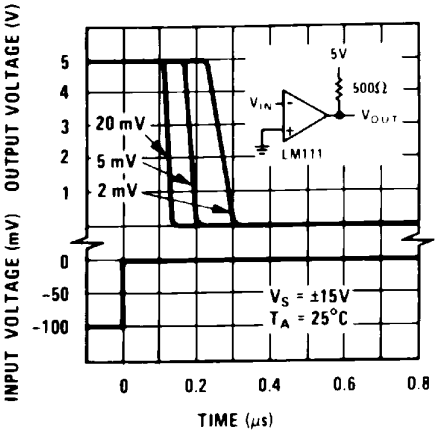


Figure 17.

Input Bias Current

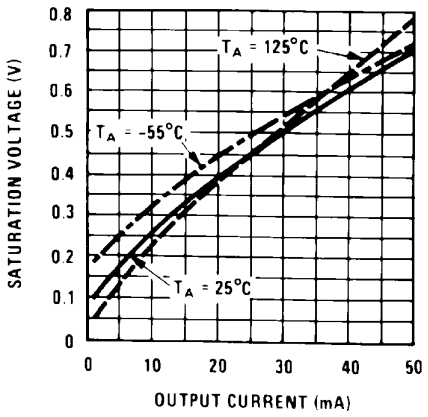


Figure 18.

Response Time for Various
Input Overdrives

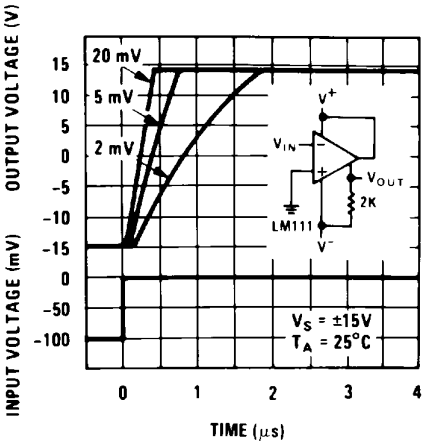


Figure 19.

Response Time for Various
Input Overdrives

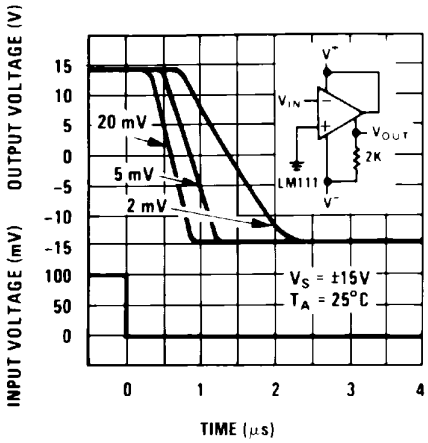


Figure 20.

Output Limiting Characteristics

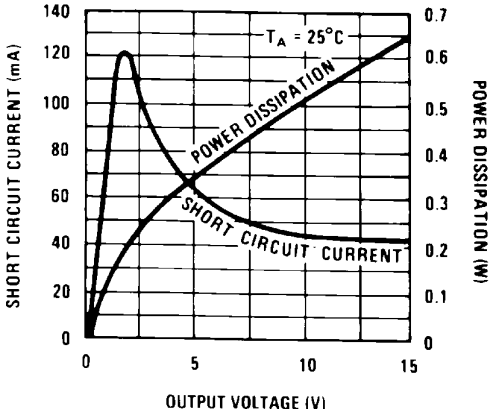


Figure 21.

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Typical Performance Characteristics LM111-N/LM211-N (continued)

Supply Current

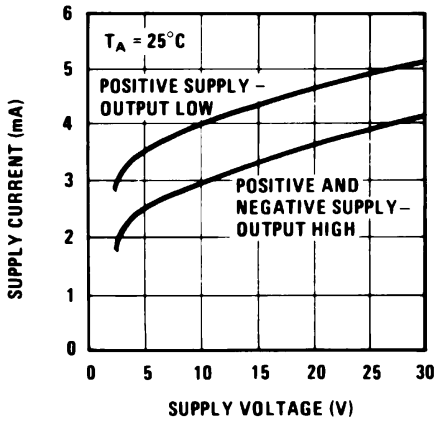


Figure 22.

Supply Current

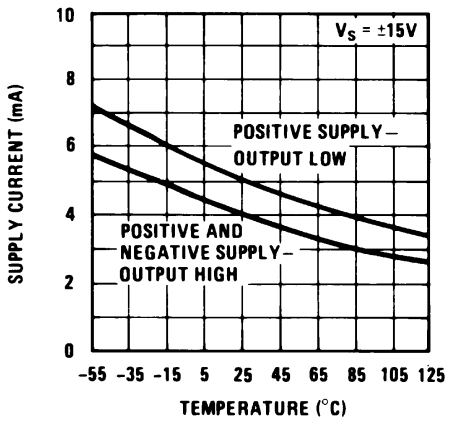


Figure 23.

Leakage Currents

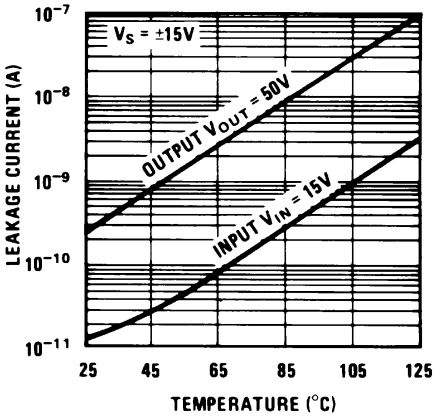


Figure 24.

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Typical Performance Characteristics LM311-N

Input Bias Current

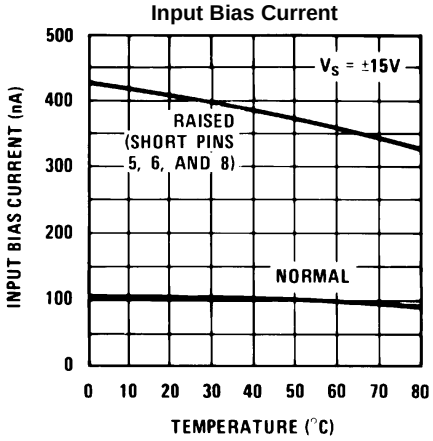


Figure 25.

Input Offset Current

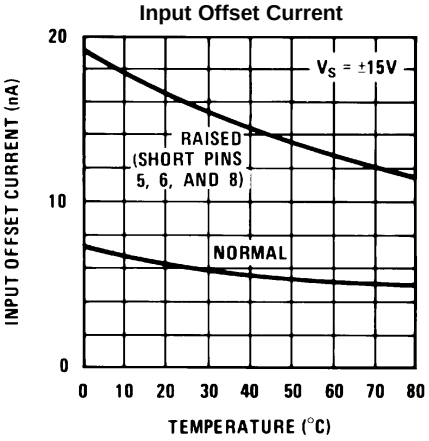


Figure 26.

Offset Error

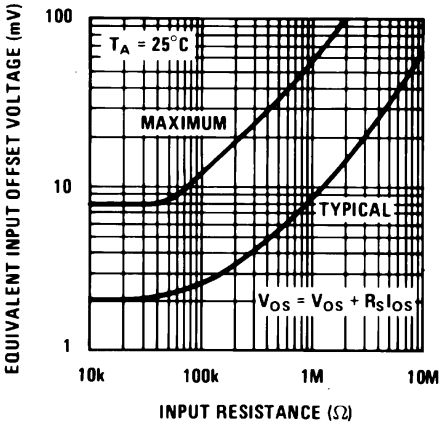


Figure 27.

Input Characteristics

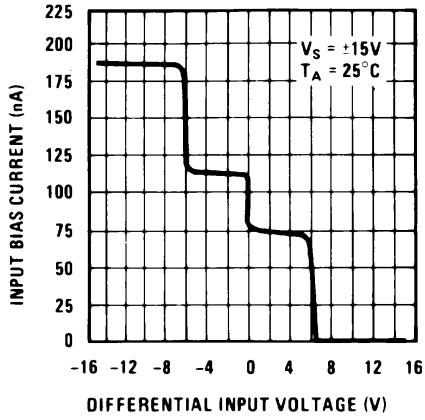


Figure 28.

Common Mode Limits

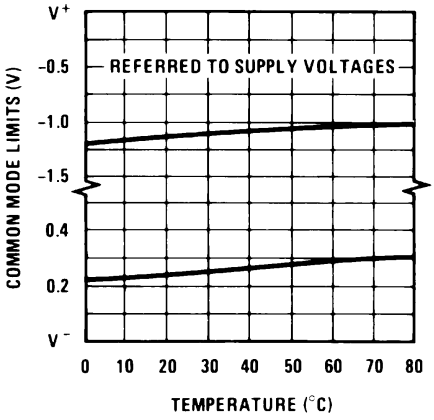


Figure 29.

Transfer Function

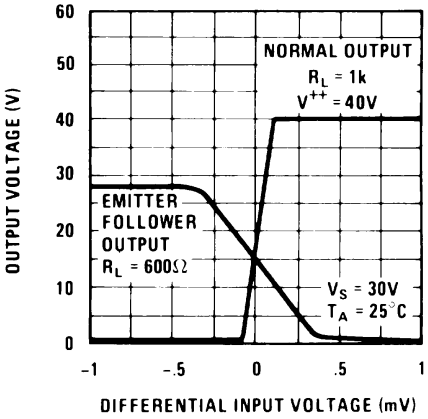


Figure 30.

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Typical Performance Characteristics LM311-N (continued)

Response Time for Various Input Overdrives

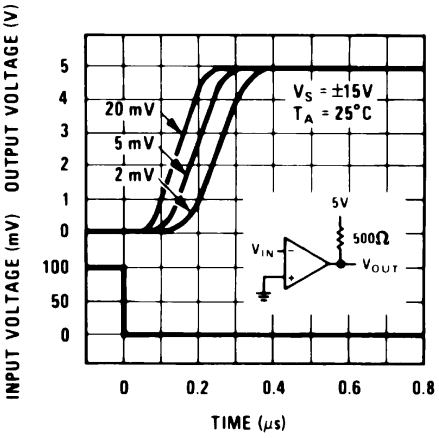


Figure 31.

Response Time for Various Input Overdrives

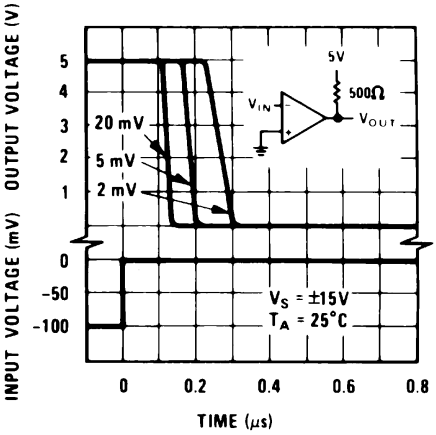


Figure 32.

Output Saturation Voltage

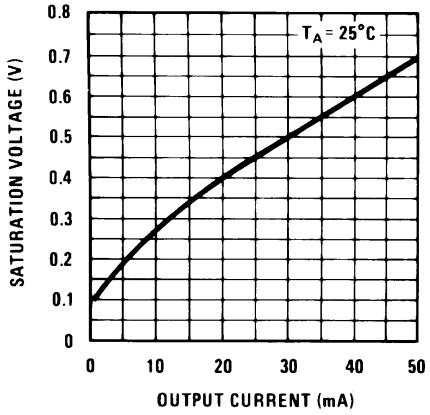


Figure 33.

Response Time for Various Input Overdrives

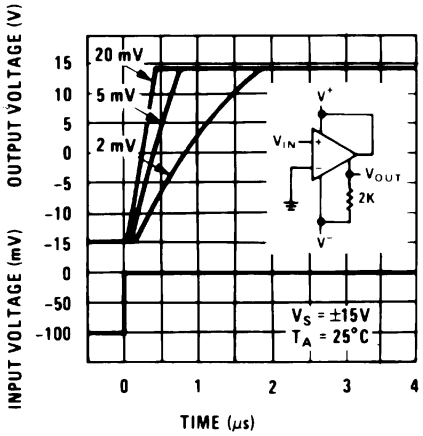


Figure 34.

Response Time for Various Input Overdrives

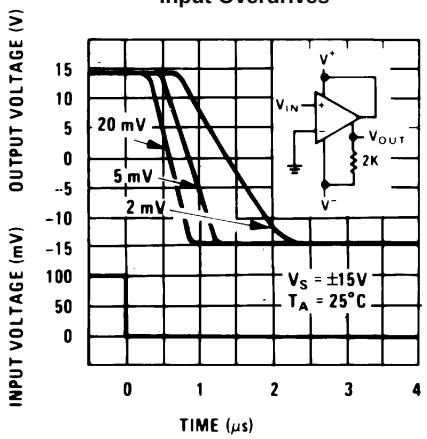


Figure 35.

Output Limiting Characteristics

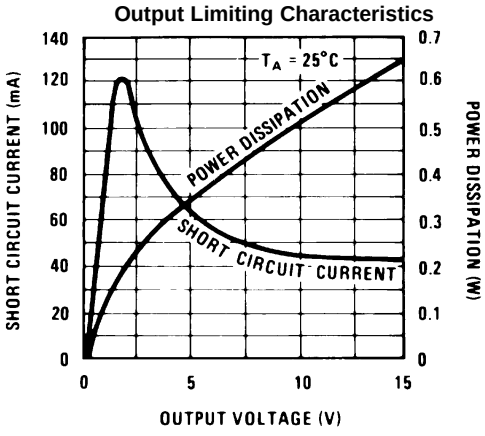


Figure 36.

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Typical Performance Characteristics LM311-N (continued)

Supply Current

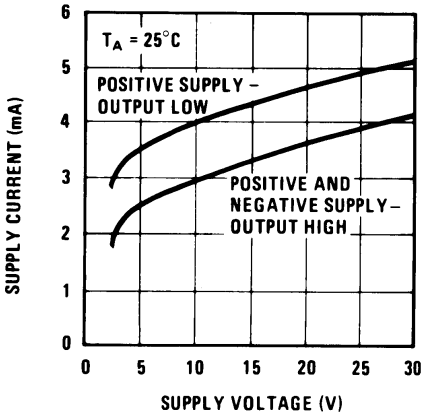


Figure 37.

Supply Current

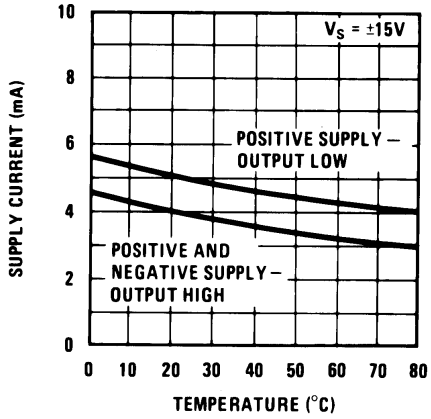


Figure 38.

Leakage Currents

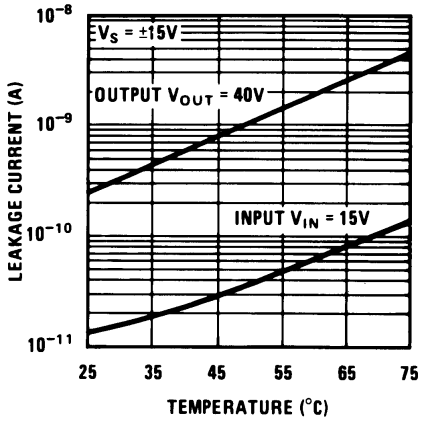


Figure 39.

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APPLICATION HINTS

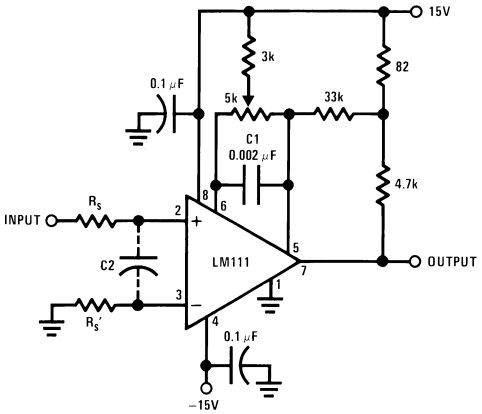
CIRCUIT TECHNIQUES FOR AVOIDING OSCILLATIONS IN COMPARATOR APPLICATIONS

When a high-speed comparator such as the LM111-N is used with fast input signals and low source impedances, the output response will normally be fast and stable, assuming that the power supplies have been bypassed (with 0.1 µF disc capacitors), and that the output signal is routed well away from the inputs (pins 2 and 3) and also away from pins 5 and 6.

However, when the input signal is a voltage ramp or a slow sine wave, or if the signal source impedance is high (1 kΩ to 100 kΩ), the comparator may burst into oscillation near the crossing-point. This is due to the high gain and wide bandwidth of comparators like the LM111-N. To avoid oscillation or instability in such a usage, several precautions are recommended, as shown in Figure 40 below.

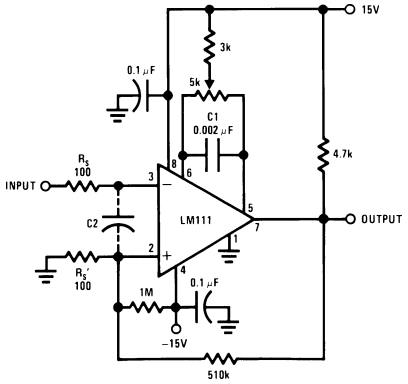
1. The trim pins (pins 5 and 6) act as unwanted auxiliary inputs. If these pins are not connected to a trim-pot, they should be shorted together. If they are connected to a trim-pot, a 0.01 µF capacitor C1 between pins 5 and 6 will minimize the susceptibility to AC coupling. A smaller capacitor is used if pin 5 is used for positive feedback as in Figure 40.
2. Certain sources will produce a cleaner comparator output waveform if a 100 pF to 1000 pF capacitor C2 is connected directly across the input pins.
3. When the signal source is applied through a resistive network, R_S, it is usually advantageous to choose an R_S' of substantially the same value, both for DC and for dynamic (AC) considerations. Carbon, tin-oxide, and metal-film resistors have all been used successfully in comparator input circuitry. Inductive wirewound resistors are not suitable.
4. When comparator circuits use input resistors (eg. summing resistors), their value and placement are particularly important. In all cases the body of the resistor should be close to the device or socket. In other words there should be very little lead length or printed-circuit foil run between comparator and resistor to radiate or pick up signals. The same applies to capacitors, pots, etc. For example, if R_S=10 kΩ, as little as 5 inches of lead between the resistors and the input pins can result in oscillations that are very hard to damp. Twisting these input leads tightly is the only (second best) alternative to placing resistors close to the comparator.
5. Since feedback to almost any pin of a comparator can result in oscillation, the printed-circuit layout should be engineered thoughtfully. Preferably there should be a groundplane under the LM111-N circuitry, for example, one side of a double-layer circuit card. Ground foil (or, positive supply or negative supply foil) should extend between the output and the inputs, to act as a guard. The foil connections for the inputs should be as small and compact as possible, and should be essentially surrounded by ground foil on all sides, to guard against capacitive coupling from any high-level signals (such as the output). If pins 5 and 6 are not used, they should be shorted together. If they are connected to a trim-pot, the trim-pot should be located, at most, a few inches away from the LM111-N, and the 0.01 µF capacitor should be installed. If this capacitor cannot be used, a shielding printed-circuit foil may be advisable between pins 6 and 7. The power supply bypass capacitors should be located within a couple inches of the LM111-N. (Some other comparators require the power-supply bypass to be located immediately adjacent to the comparator.)
6. It is a standard procedure to use hysteresis (positive feedback) around a comparator, to prevent oscillation, and to avoid excessive noise on the output because the comparator is a good amplifier for its own noise. In the circuit of Figure 41, the feedback from the output to the positive input will cause about 3 mV of hysteresis. However, if R_S is larger than 100Ω, such as 50 kΩ, it would not be reasonable to simply increase the value of the positive feedback resistor above 510 kΩ. The circuit of Figure 42 could be used, but it is rather awkward. See the notes in paragraph 7 below.
7. When both inputs of the LM111-N are connected to active signals, or if a high-impedance signal is driving the positive input of the LM111-N so that positive feedback would be disruptive, the circuit of Figure 40 is ideal. The positive feedback is to pin 5 (one of the offset adjustment pins). It is sufficient to cause 1 to 2 mV hysteresis and sharp transitions with input triangle waves from a few Hz to hundreds of kHz. The positive-feedback signal across the 82Ω resistor swings 240 mV below the positive supply. This signal is centered around the nominal voltage at pin 5, so this feedback does not add to the V_{OS} of the comparator. As much as 8 mV of V_{OS} can be trimmed out, using the 5 kΩ pot and 3 kΩ resistor as shown.
8. These application notes apply specifically to the LM111-N, LM211-N, LM311-N, and LF111 families of comparators, and are applicable to all high-speed comparators in general, (with the exception that not all comparators have trim pins).

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Pin connections shown are for LM111H in the LMC hermetic package.

Figure 40. Improved Positive Feedback



Pin connections shown are for LM111H in the LMC hermetic package.

Figure 41. Conventional Positive Feedback

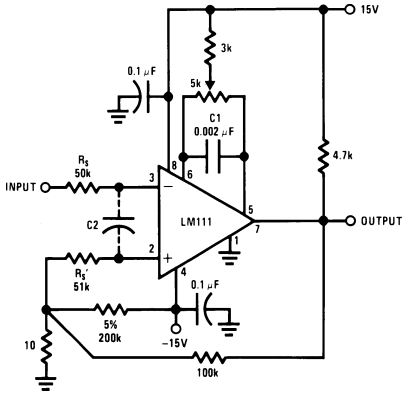


Figure 42. Positive Feedback with High Source Resistance

Typical Applications

(Pin numbers refer to LMC package)

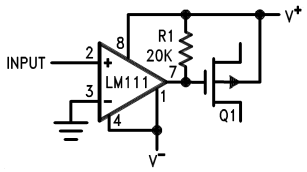
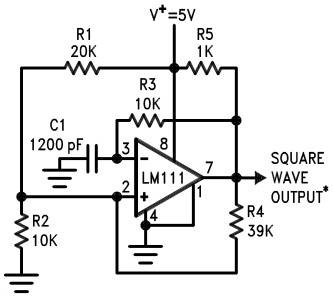
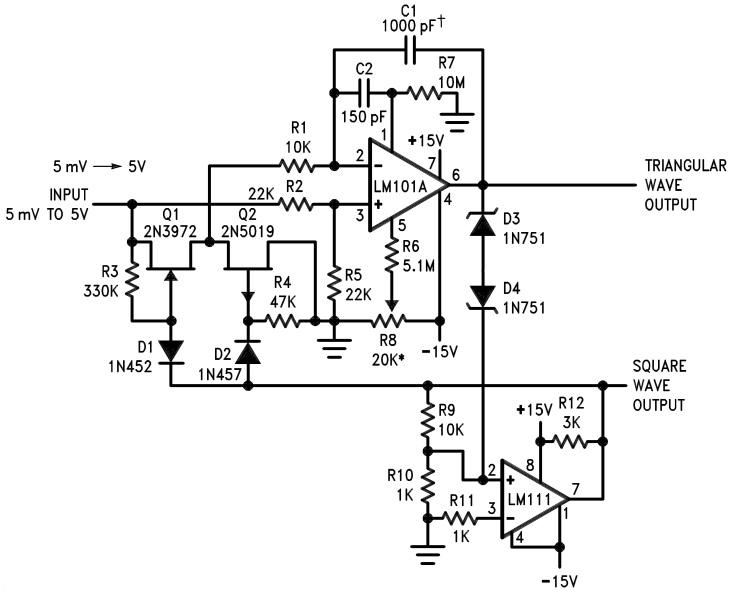


Figure 43. Zero Crossing Detector Driving MOS Switch



*TTL or DTL fanout of two

Figure 44. 100 kHz Free Running Multivibrator

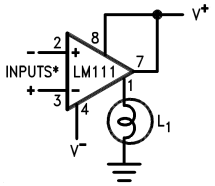


*Adjust for symmetrical square wave time when V_{IN} = 5 mV

†Minimum capacitance 20 pF Maximum frequency 50 kHz

Figure 45. 10 Hz to 10 kHz Voltage Controlled Oscillator

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*Input polarity is reversed when using pin 1 as output.

Figure 46. Driving Ground-Referred Load

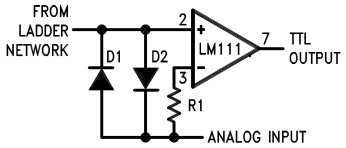
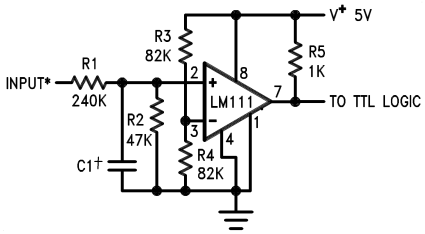


Figure 47. Using Clamp Diodes to Improve Response



*Values shown are for a 0 to 30V logic swing and a 15V threshold.

†May be added to control speed and reduce susceptibility to noise spikes.

Figure 48. TTL Interface with High Level Logic

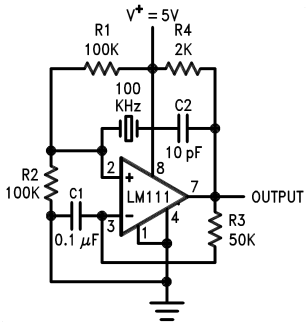


Figure 49. Crystal Oscillator

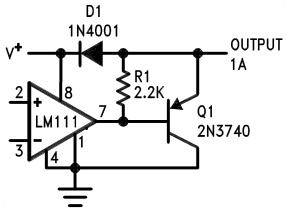
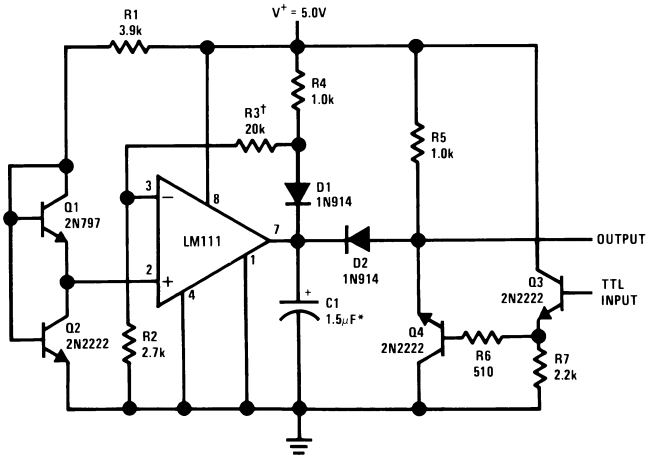


Figure 50. Comparator and Solenoid Driver

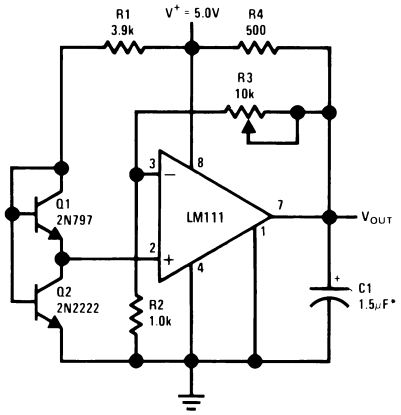
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*Solid tantalum

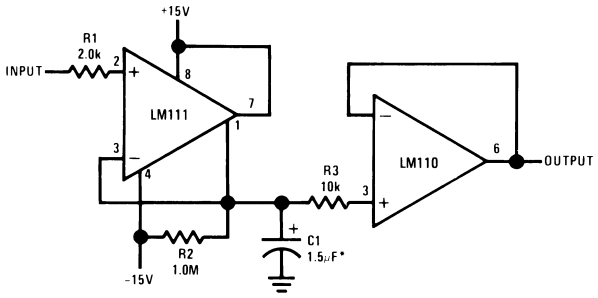
†Adjust to set clamp level

Figure 51. Precision Squarer



*Solid tantalum

Figure 52. Low-Voltage Adjustable Reference Supply



*Solid tantalum

Figure 53. Positive Peak Detector

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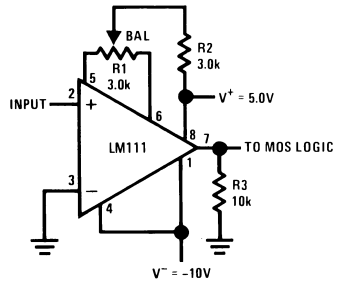
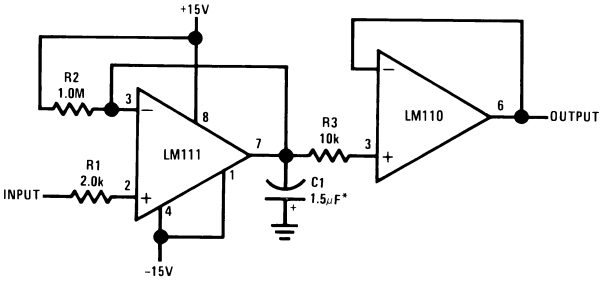
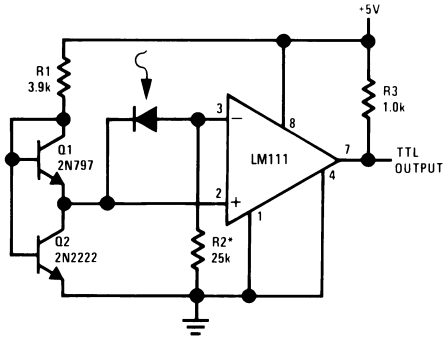


Figure 54. Zero Crossing Detector Driving MOS Logic



*Solid tantalum

Figure 55. Negative Peak Detector



*R2 sets the comparison level. At comparison, the photodiode has less than 5 mV across it, decreasing leakages by an order of magnitude.

Figure 56. Precision Photodiode Comparator

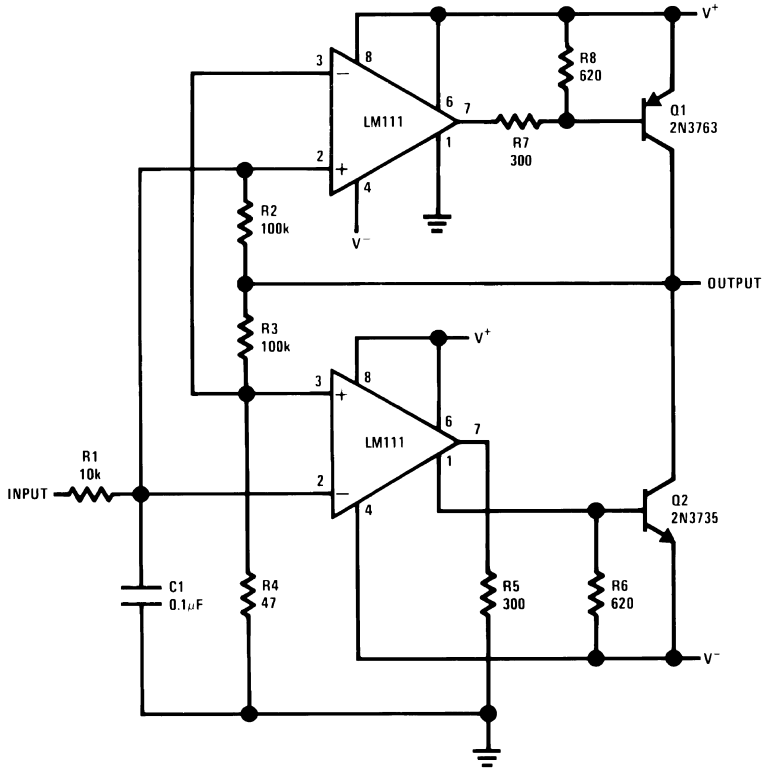


Figure 57. Switching Power Amplifier

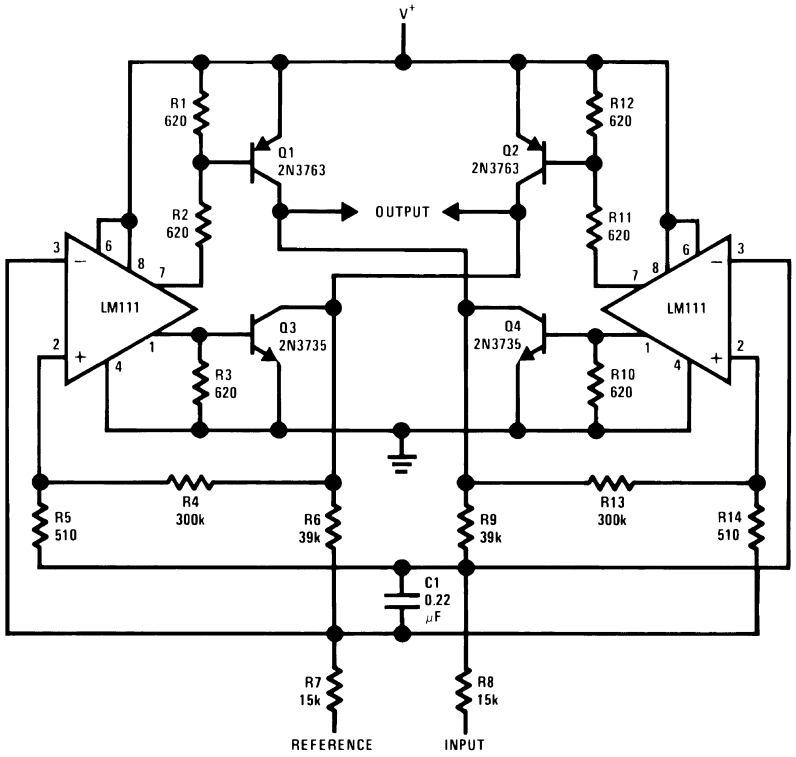


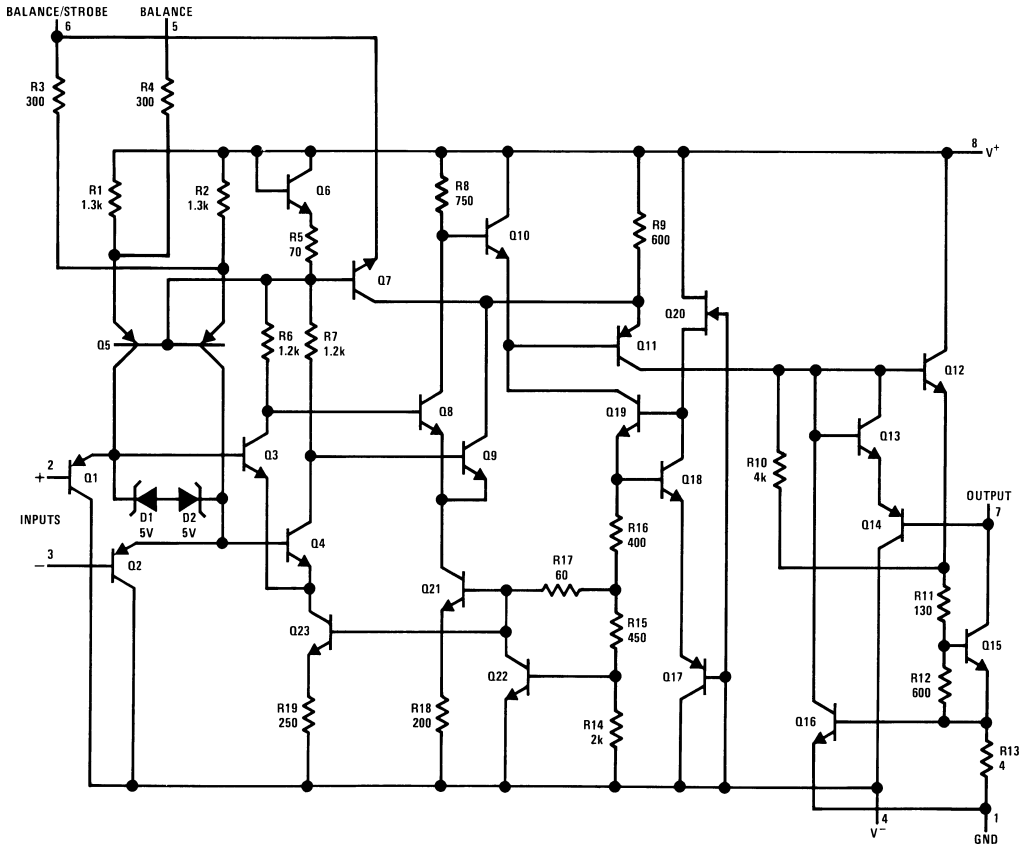
Figure 58. Switching Power Amplifier

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Schematic Diagram

NOTE

Pin connections shown in the schematic diagram are for the LMC package.



Pin Diagrams

Top View

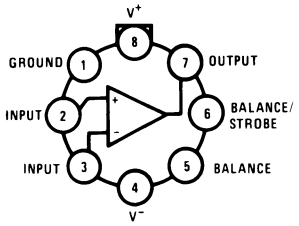


Figure 59. 8-Pin TO-99
See LMC Package

Top View

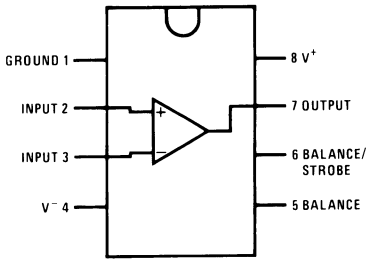


Figure 60. 8-Pin CDIP (See NAB Package)
8-Pin SOIC (See D Package)
8-Pin PDIP (See P Package)

Top View

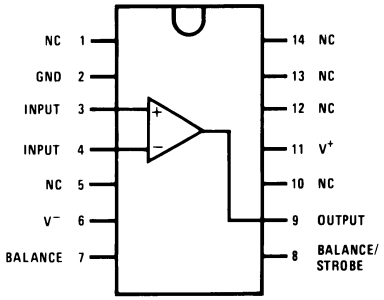


Figure 61. 14-Pin CDIP (See J Package)
14-Pin PDIP (See NFF Package)

Top View

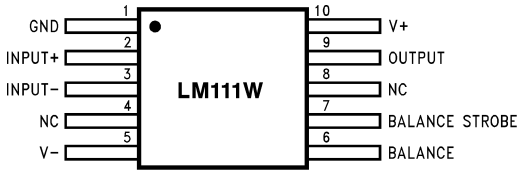


Figure 62. LM111W/883, LM111WG/883
10-Pin CLGA (See NAD Package)
10-Pin CLGA (See NAC Package)

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REVISION HISTORY

Changes from Revision D (March 2013) to Revision E	Page
• Changed layout of National Data Sheet to TI format	20

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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)
LM111 MW8	Active	Production	WAFERSALE (YS) | 0	1 | NOT REQUIRED	-	Call TI	Level-1-NA-UNLIM	-55 to 125	
LM111H	Active	Production	TO-99 (LMC) | 8	500 | OTHER	No	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM111H, LM111H)
LM111H/NOPB	Active	Production	TO-99 (LMC) | 8	500 | OTHER	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM111H, LM111H)
LM111J-8	Active	Production	CDIP (NAB) | 8	40 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM111J-8
LM311-MWC	Active	Production	WAFERSALE (YS) | 0	1 | NOT REQUIRED	-	Call TI	Level-1-NA-UNLIM	-40 to 85	
LM311H	Active	Production	TO-99 (LMC) | 8	500 | TRAY NON-STD	No	Call TI	Level-1-NA-UNLIM	0 to 70	(LM311H, LM311H)
LM311H/NOPB	Active	Production	TO-99 (LMC) | 8	500 | OTHER	Yes	Call TI	Level-1-NA-UNLIM	0 to 70	(LM311H, LM311H)
LM311M	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	0 to 70	LM 311M
LM311M/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 311M
LM311M/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 311M
LM311MX	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	0 to 70	LM 311M
LM311MX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 311M
LM311MX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 311M
LM311N/NOPB	Active	Production	PDIP (P) | 8	40 | TUBE	Yes	NIPDAU	Level-1-NA-UNLIM	0 to 70	LM 311N
LM311N/NOPB.B	Active	Production	PDIP (P) | 8	40 | TUBE	Yes	NIPDAU	Level-1-NA-UNLIM	0 to 70	LM 311N

(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.

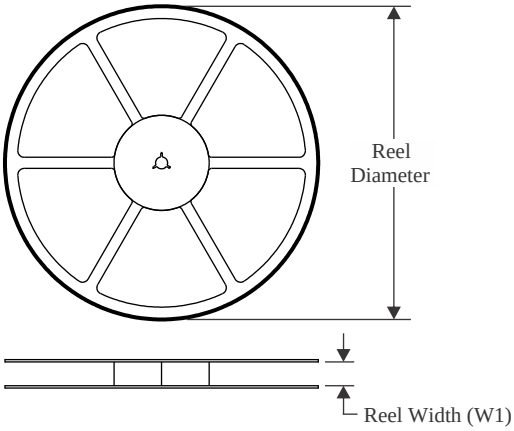
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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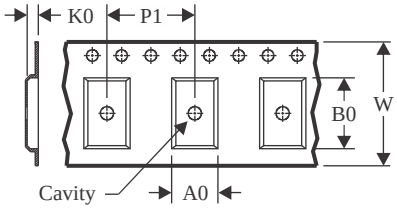
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

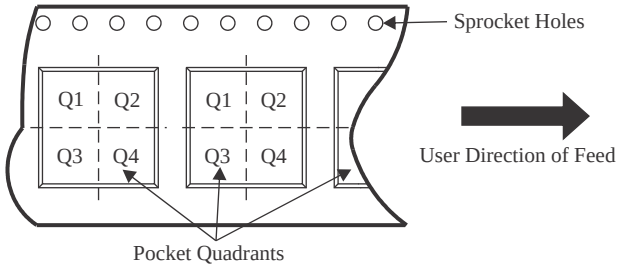


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

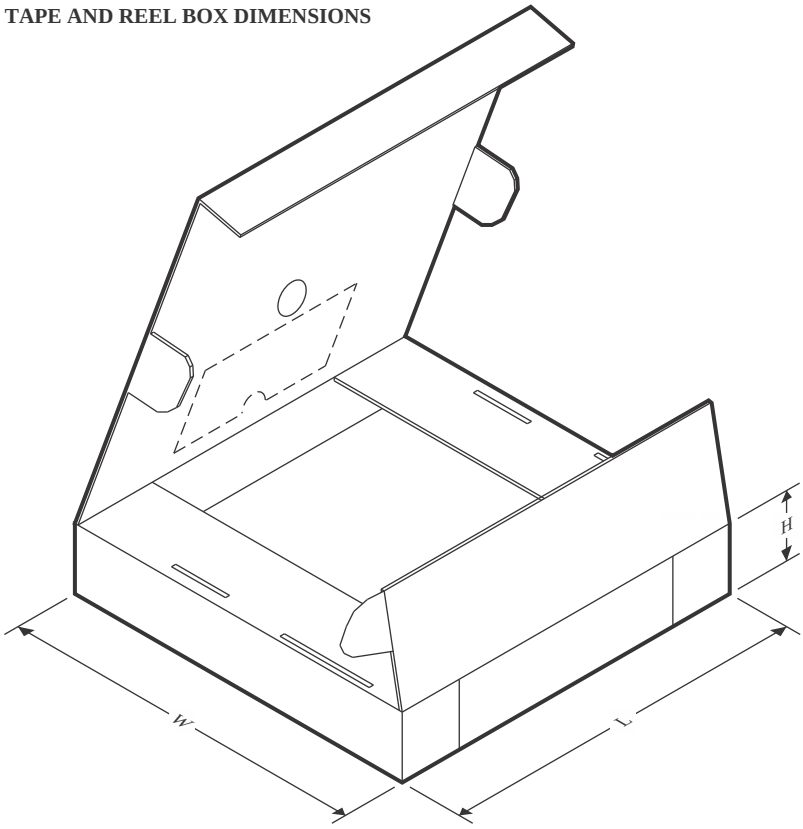
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM311MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

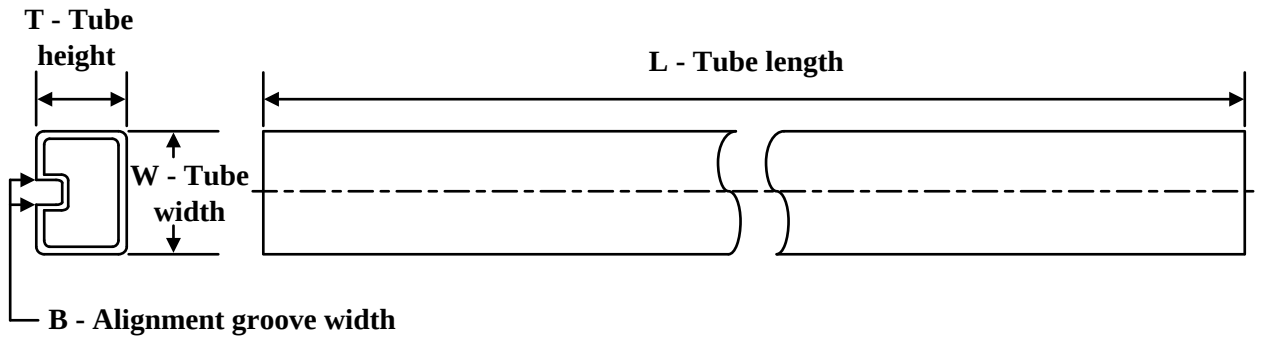
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM311MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

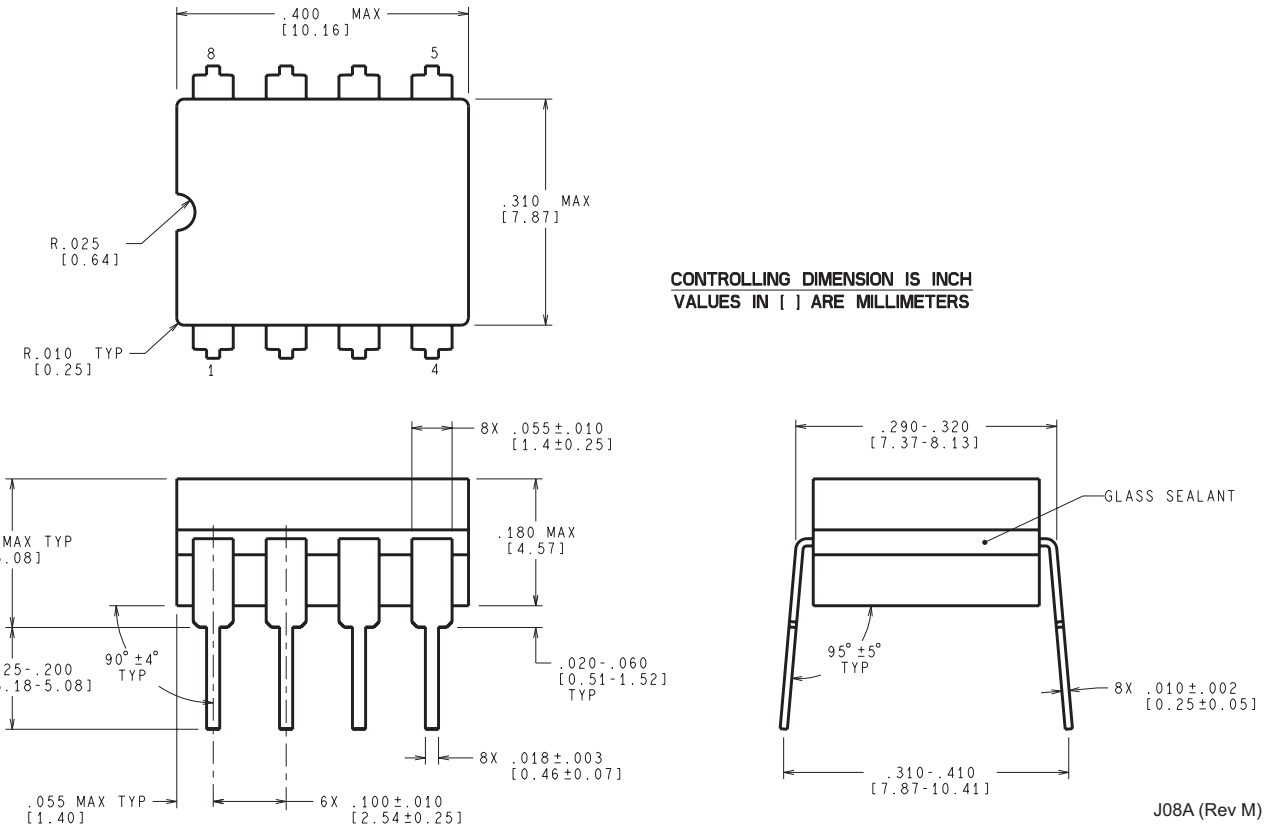
TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM111J-8	NAB	CDIP	8	40	502	14	11938	4.32
LM311M/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM311M/NOPB.B	D	SOIC	8	95	495	8	4064	3.05
LM311N/NOPB	P	PDIP	8	40	502	14	11938	4.32
LM311N/NOPB.B	P	PDIP	8	40	502	14	11938	4.32

NAB0008A

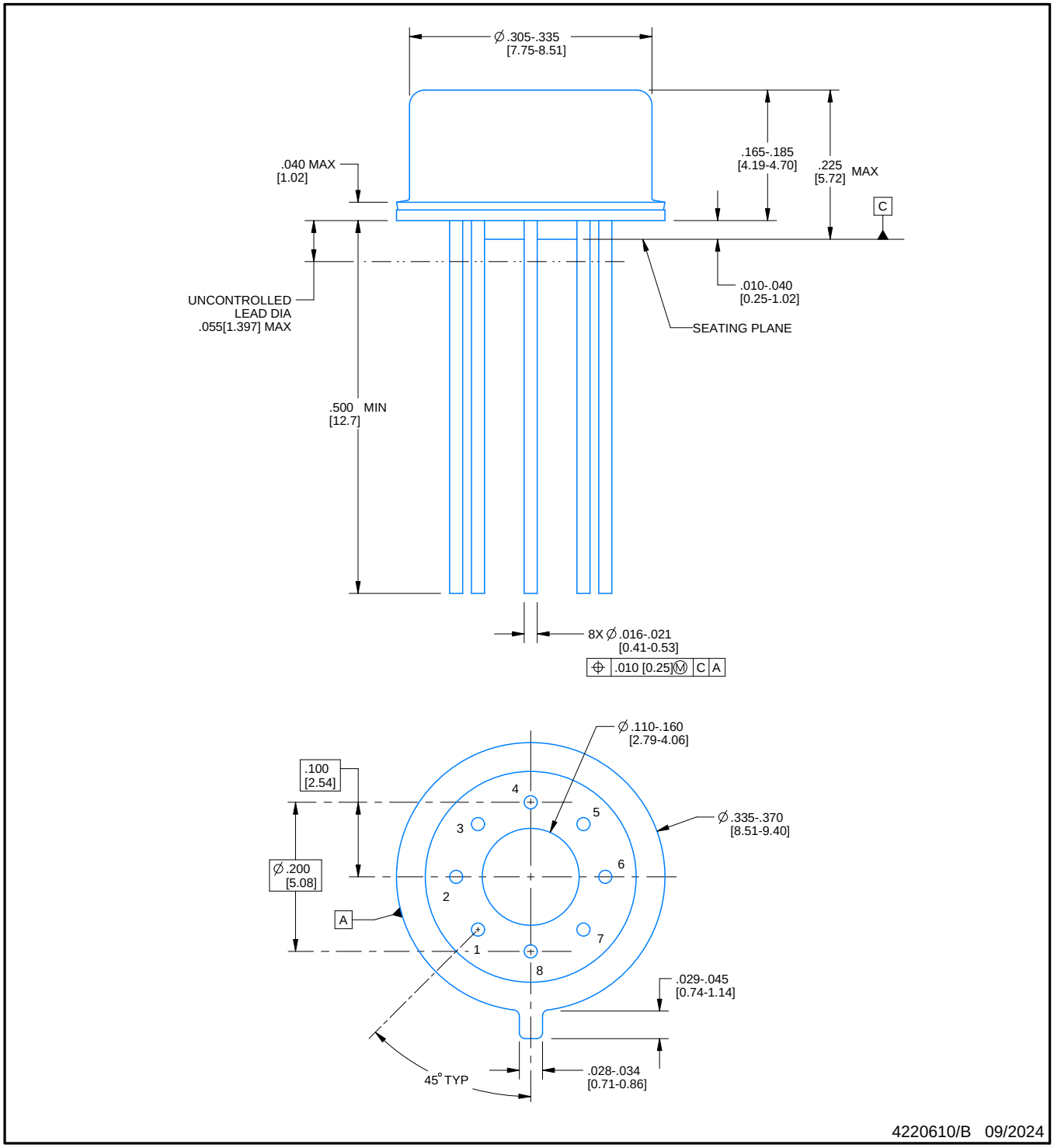

.400 MAX
[10.16]
8
5
.310 MAX
[7.87]
R.025
[0.64]
R.010 TYP
[0.25]
1
4
CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS
8X .055±.010
[1.4±0.25]
.200 MAX TYP
[5.08]
.180 MAX
[4.57]
8X .125-.200
[3.18-5.08]
90° ±4°
TYP
.020-.060
[0.51-1.52]
TYP
8X .018±.003
[0.46±0.07]
.055 MAX TYP
[1.40]
6X .100±.010
[2.54±0.25]
.290-.320
[7.37-8.13]
GLASS SEALANT
95° ±5°
TYP
8X .010±.002
[0.25±0.05]
.310-.410
[7.87-10.41]
J08A (Rev M)

PACKAGE OUTLINE

LMC0008A

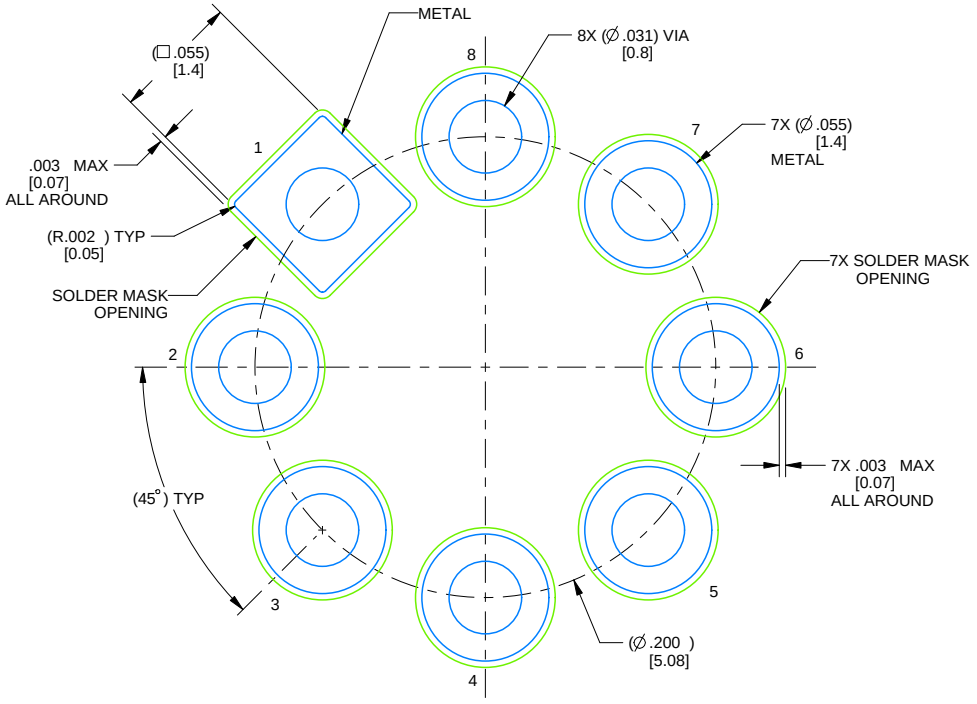
TO-CAN - 5.72 mm max height

TRANSISTOR OUTLINE



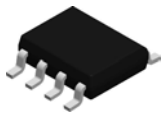
NOTES:

1. All linear dimensions are in inches [millimeters]. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Pin numbers shown for reference only. Numbers may not be marked on package.
4. Reference JEDEC registration MO-002/TO-99.



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE: 12X

4220610/B 09/2024

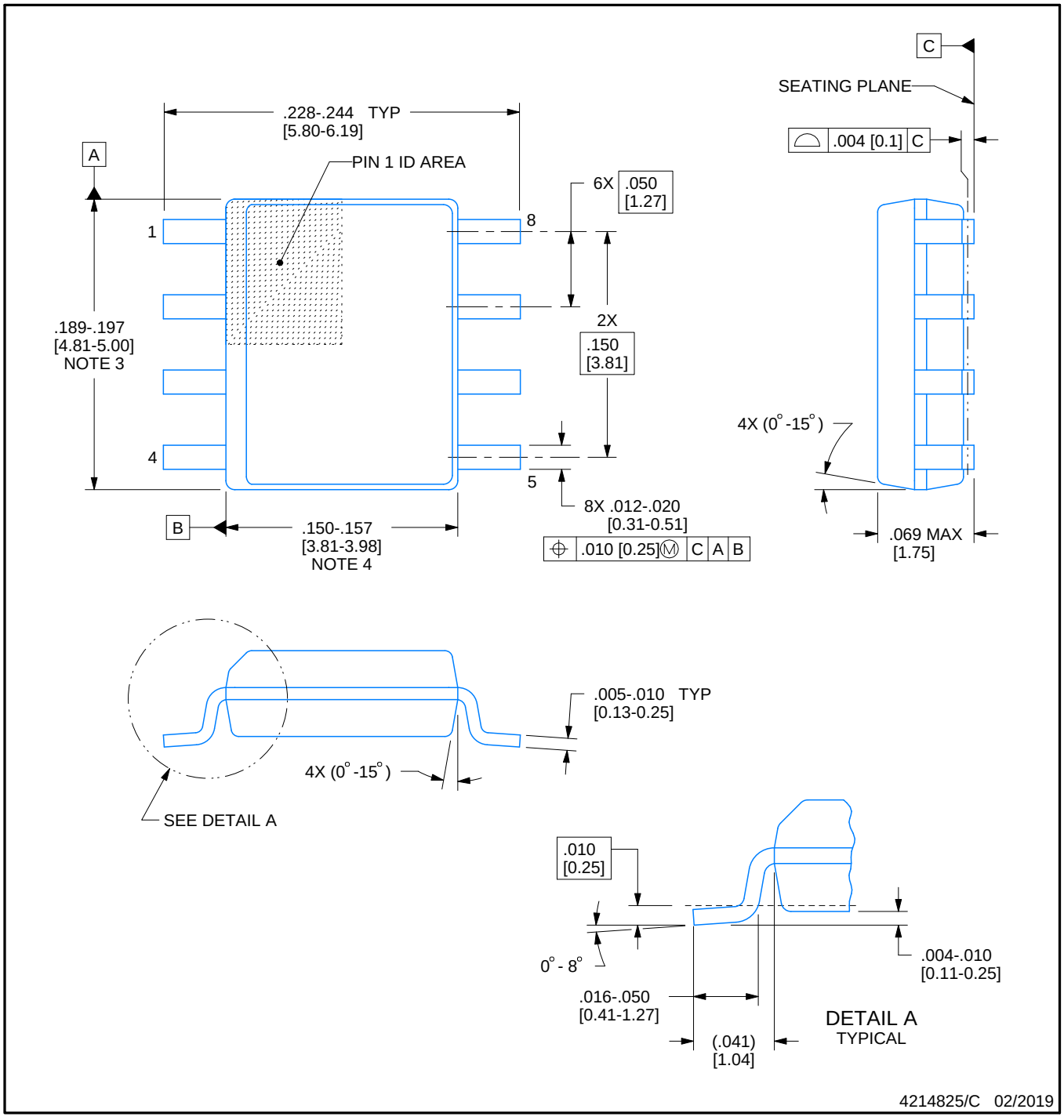


PACKAGE OUTLINE

D0008A

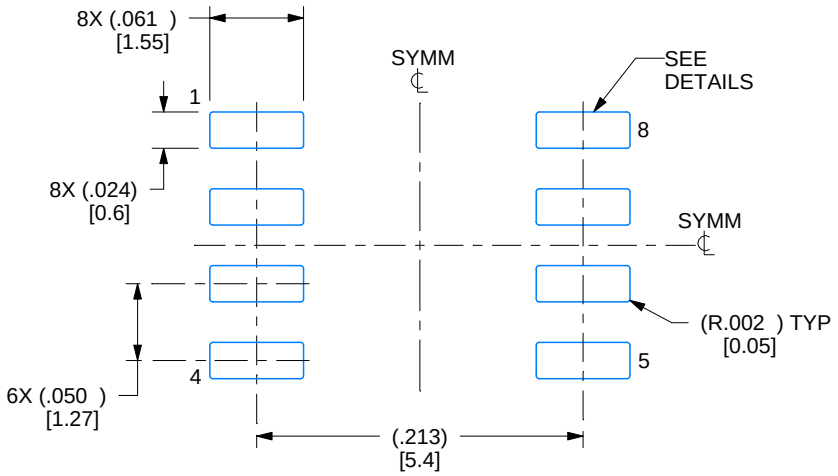
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

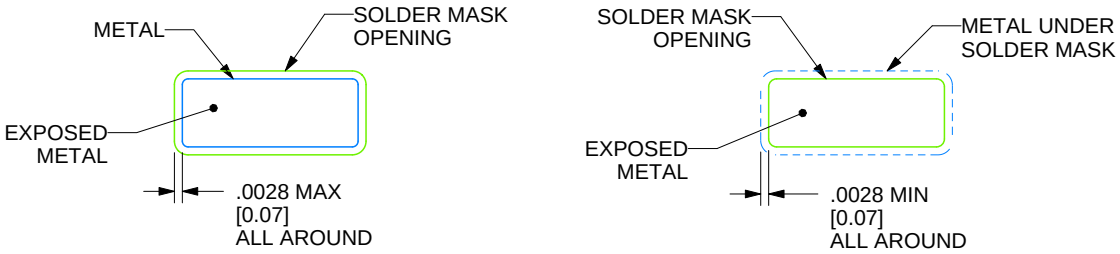


NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

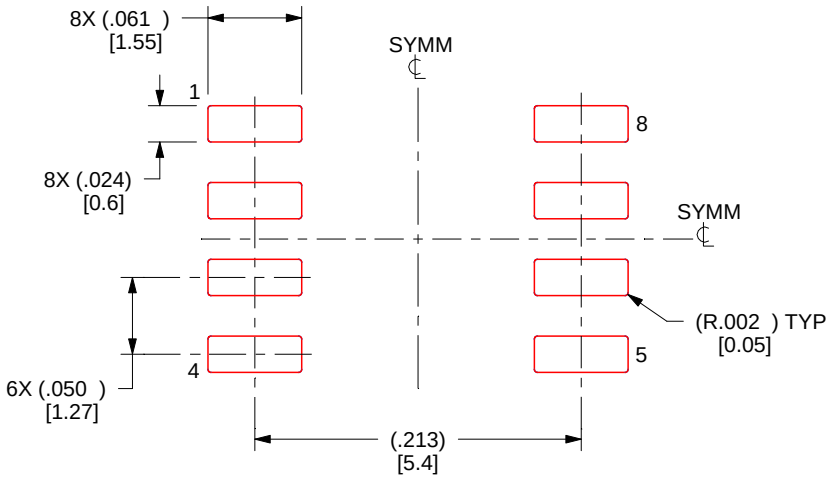
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



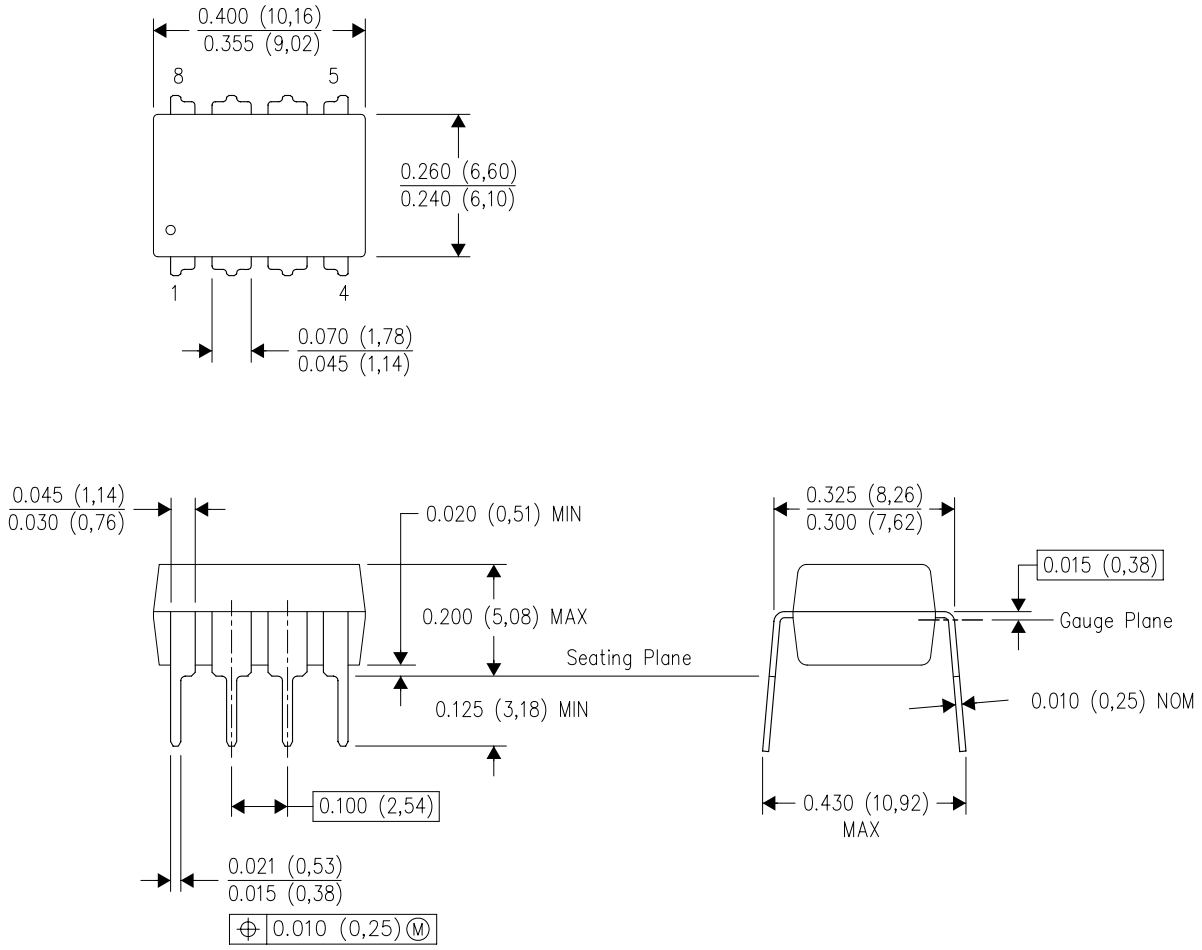
SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

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