LM2931-N Series Low Dropout Regulators

Check for Samples: LM2931-N

FEATURES

- **Very Low Quiescent Current**
- **Output Current in Excess of 100 mA**
- **Input-output Differential Less than 0.6V**
- **Reverse Battery Protection**
- **60V Load Dump Protection**
- **−50V Reverse Transient Protection**
- **Short Circuit Protection**
- **Internal Thermal Overload Protection**
- **Mirror-image Insertion Protection**
- **Available in TO-220, TO-92, TO-263, or SOIC-8 Packages**
- **Available as Adjustable with TTL Compatible Switch**

DESCRIPTION

The LM2931-N positive voltage regulator features a very low quiescent current of 1mA or less when supplying 10mA loads. This unique characteristic and the extremely low input-output differential required for proper regulation (0.2V for output currents of 10mA) make the LM2931-N the ideal regulator for standby power systems. Applications include memory standby circuits, CMOS and other low power processor power supplies as well as systems demanding as much as 100mA of output current.

Designed originally for automotive applications, the LM2931-N and all regulated circuitry are protected from reverse battery installations or 2 battery jumps. During line transients, such as a load dump (60V) when the input voltage to the regulator can momentarily exceed the specified maximum operating voltage, the regulator will automatically shut down to protect both internal circuits and the load. The LM2931-N cannot be harmed by temporary mirror-image insertion. Familiar regulator features such as short circuit and thermal overload protection are also provided.

The LM2931-N family includes a fixed 5V output (±3.8% tolerance for A grade) or an adjustable output with ON/OFF pin. Both versions are available in a TO-220 power package, DDPAK/TO-263 surface mount package, and an 8-lead SOIC package. The fixed output version is also available in the TO-92 plastic package.

Connection Diagrams

FIXED VOLTAGE OUTPUT

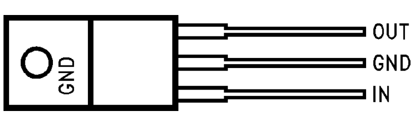


Figure 1. TO-220 3-Lead Power Package Front View

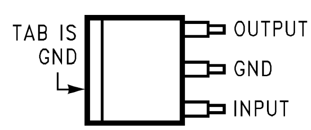
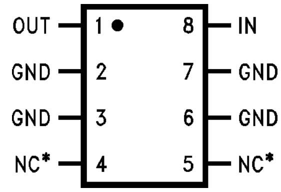


Figure 2. DDPAK/TO-263 Surface-Mount Package Top View

Figure 3. Side View



*NC = Not internally connected. Must be electrically isolated from the rest of the circuit for the DSBGA package.

**Figure 4. 8-Pin SOIC
Top View**

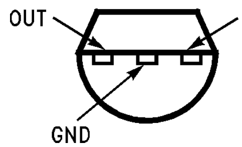


**Figure 5. TO-92 Plastic Package
Bottom View**

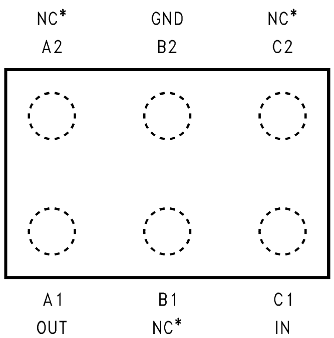


**Figure 6. 6-Bump DSBGA
Top View
(Bump Side Down)**

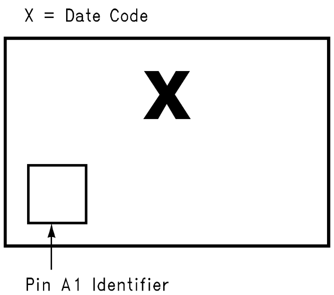


Figure 7. DSBGA Laser Mark

ADJUSTABLE OUTPUT VOLTAGE

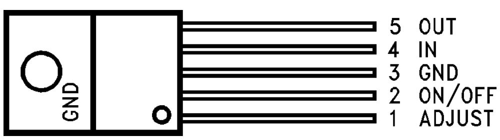


**Figure 8. TO-220 5-Lead Power Package
Front View**

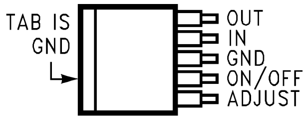


**Figure 9. DDPAK/TO-263
5-Lead Surface-Mount Package
Top View**

Figure 10. Side View

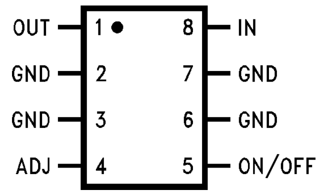
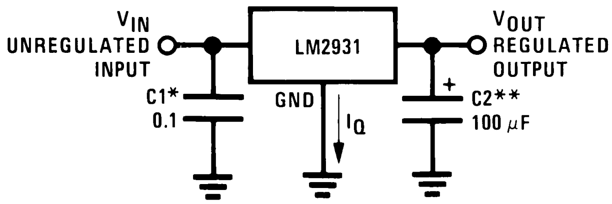


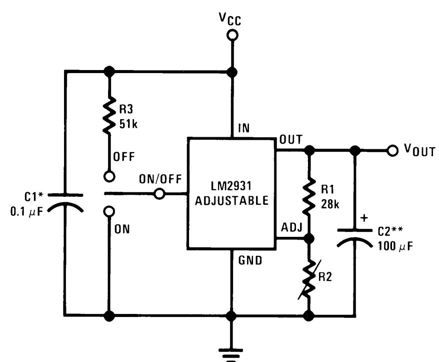
Figure 11. 8-Pin SOIC Top View

Typical Applications



*Required if regulator is located far from power supply filter.
**C2 must be at least 100 μF to maintain stability. May be increased without bound to maintain regulation during transients. Locate as close as possible to the regulator. This capacitor must be rated over the same operating temperature range as the regulator. The equivalent series resistance (ESR) of this capacitor is critical; see curve.

Figure 12. LM2931-N Fixed Output



$$V_{OUT} = \text{Reference Voltage} \times \frac{R1 + R2}{R1}$$

Note: Using 27k for R1 will automatically compensate for errors in V_{OUT} due to the input bias current of the ADJ pin (approximately 1 μA).

Figure 13. LM2931-N Adjustable Output

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[1][2]

Input Voltage	
Operating Range	26V
Overvoltage Protection	
LM2931A, LM2931C (Adjustable)	60V
LM2931-N	50V
Internal Power Dissipation	
[3] [4]	Internally Limited
Operating Ambient Temperature	
Range	−40°C to +85°C
Maximum Junction Temperature	125°C
Storage Temperature Range	−65°C to +150°C
Lead Temp. (Soldering, 10 seconds)	230°C
ESD Tolerance [5]	2000V

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its rated operating conditions.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
(3) See circuit in Typical Applications. To ensure constant junction temperature, low duty cycle pulse testing is used.
(4) The maximum power dissipation is a function of maximum junction temperature T_{Jmax}, total thermal resistance θ_{JA}, and ambient temperature T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{Jmax} - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2931-N will go into thermal shutdown. For the LM2931-N in the TO-92 package, θ_{JA} is 195°C/W; in the SOIC-8 package, θ_{JA} is 160°C/W, and in the TO-220 package, θ_{JA} is 50°C/W; in the DDPAK/TO-263 package, θ_{JA} is 73°C/W; and in the 6-Bump DSBGA package θ_{JA} is 290°C/W. If the TO-220 package is used with a heat sink, θ_{JA} is the sum of the package thermal resistance junction-to-case of 3°C/W and the thermal resistance added by the heat sink and thermal interface.If the TO-263 package is used, the thermal resistance can be reduced by increasing the P.C. board copper area thermally connected to the package: Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W.
(5) Human body model, 100 pF discharged through 1.5 kΩ.

ELECTRICAL CHARACTERISTICS FOR FIXED 3.3V VERSION

V_{IN} = 14V, I_O = 10mA, T_J = 25°C, C_2 = 100µF (unless otherwise specified) [1]

Parameter	Conditions	LM2931-N-3.3		Units
		Typ	Limit [2]	
Output Voltage		3.3	3.465 3.135	V_{MAX} V_{MIN}
	4V ≤ V_{IN} ≤ 26V, I_O = 100 mA −40°C ≤ T_J ≤ 125°C		**3.630** **2.970**	V_{MAX} V_{MIN}
Line Regulation	4V ≤ V_{IN} ≤ 26V	4	33	mV_{MAX}
Load Regulation	5mA ≤ I_O ≤ 100mA	10	50	mV_{MAX}
Output Impedance	100mA$_{DC}$ and 10mA$_{rms}$, 100Hz - 10kHz	200		mΩ
Quiescent Current	I_O ≤ 10mA, 4V ≤ V_{IN} ≤ 26V −40°C ≤ T_J ≤ 125°C	0.4	**1.0**	mA_{MAX}
	I_O = 100mA, V_{IN} = 14V, T_J = 25°C	15		mA
Output Noise Voltage	10Hz -100kHz, C_{OUT} = 100µF	330		µV$_{rms}$
Long Term Stability		13		mV/1000 hr
Ripple Rejection	f_O = 120Hz	80		dB

(1) See circuit in Typical Applications. To ensure constant junction temperature, low duty cycle pulse testing is used.
(2) All limits are specified for T_J = 25°C (standard type face) or over the full operating junction temperature range of −40°C to +125°C (bold type face).

ELECTRICAL CHARACTERISTICS FOR FIXED 3.3V VERSION (continued)

V_{IN} = 14V, I_O = 10mA, T_J = 25°C, C_2 = 100µF (unless otherwise specified) (1)

Parameter	Conditions	LM2931-N-3.3 Typ	LM2931-N-3.3 Limit (2)	Units
Dropout Voltage	I_O = 10mA I_O = 100mA	0.05 0.30	0.2 0.6	V_{MAX}
Maximum Operational Input Voltage		33	26	V_{MIN}
Maximum Line Transient	R_L = 500Ω, V_O ≤ 5.5V, T = 1ms, τ ≤ 100ms	70	50	V_{MIN}
Reverse Polarity Input Voltage, DC	V_O ≥ −0.3V, R_L = 500Ω	−30	−15	V_{MIN}
Reverse Polarity Input Voltage, Transient	T = 1ms, τ ≤ 100ms, R_L = 500Ω	−80	−50	V_{MIN}

ELECTRICAL CHARACTERISTICS FOR FIXED 5V VERSION

V_{IN} = 14V, I_O = 10mA, T_J = 25°C, C2 = 100 µF (unless otherwise specified) (1)

Parameter	Conditions	LM2931A-5.0 Typ	LM2931A-5.0 Limit (2)	LM2931-N-5.0 Typ	LM2931-N-5.0 Limit (2)	Units
Output Voltage		5	5.19 4.81	5	5.25 4.75	V_{MAX} V_{MIN}
	6.0V ≤ V_{IN} ≤ 26V, I_O = 100mA −40°C ≤ T_J ≤ 125°C		**5.25** **4.75**		**5.5** **4.5**	V_{MAX} V_{MIN}
Line Regulation	9V ≤ V_{IN} ≤ 16V 6V ≤ V_{IN} ≤ 26V	2 4	10 30	2 4	10 30	mV_{MAX}
Load Regulation	5 mA ≤ I_O ≤ 100mA	14	50	14	50	mV_{MAX}
Output Impedance	100mA$_{DC}$ and 10mA$_{rms}$, 100Hz -10kHz	200		200		mΩ
Quiescent Current	I_O ≤ 10mA, 6V ≤ V_{IN} ≤ 26V −40°C ≤ T_J ≤ 125°C	0.4	**1.0**	0.4	**1.0**	mA_{MAX}
	I_O = 100mA, V_{IN} = 14V, T_J = 25°C	15	30	15		mA_{MAX}
Output Noise Voltage	10Hz -100kHz, C_{OUT} = 100µF	500		500		$µV_{rms}$
Long Term Stability		20		20		mV/1000 hr
Ripple Rejection	f_O = 120 Hz	80	**55**	80		dB_{MIN}
Dropout Voltage	I_O = 10mA I_O = 100mA	0.05 0.3	0.2 0.6	0.05 0.3	0.2 0.6	V_{MAX}
Maximum Operational Input Voltage		33	26	33	26	V_{MIN}
Maximum Line Transient	R_L = 500Ω, V_O ≤ 5.5V, T = 1ms, τ ≤ 100ms	70	60	70	50	V_{MIN}
Reverse Polarity Input Voltage, DC	V_O ≥ −0.3V, R_L = 500Ω	−30	−15	−30	−15	V_{MIN}
Reverse Polarity Input Voltage, Transient	T = 1ms, τ ≤ 100ms, R_L = 500Ω	−80	−50	−80	−50	V_{MIN}

(1) See circuit in Typical Applications. To ensure constant junction temperature, low duty cycle pulse testing is used.
(2) All limits are specified for T_J = 25°C (standard type face) or over the full operating junction temperature range of −40°C to +125°C (bold type face).

ELECTRICAL CHARACTERISTICS FOR ADJUSTABLE VERSION

V_{IN} = 14V, V_{OUT} = 3V, I_O = 10 mA, T_J = 25°C, R1 = 27k, C2 = 100 µF (unless otherwise specified) [(1)]

Parameter	Conditions	Typ	Limit	Units Limit
Reference Voltage		1.20	1.26	V_{MAX}
			1.14	V_{MIN}
	I_O ≤ 100 mA, −40°C ≤ T_j ≤ 125°C, R1 = 27k		**1.32**	V_{MAX}
	Measured from V_{OUT} to Adjust Pin		**1.08**	V_{MIN}
Output Voltage Range			24	V_{MAX}
			3	V_{MIN}
Line Regulation	V_{OUT} + 0.6V ≤ V_{IN} ≤ 26V	0.2	1.5	mV/V_{MAX}
Load Regulation	5 mA ≤ I_O ≤ 100 mA	0.3	1	$\%_{MAX}$
Output Impedance	100 mA_{DC} and 10 mA_{rms}, 100 Hz–10 kHz	40		mΩ/V
Quiescent Current	I_O = 10 mA	0.4	1	mA_{MAX}
	I_O = 100 mA	15		mA
	During Shutdown R_L = 500Ω	0.8	1	mA_{MAX}
Output Noise Voltage	10 Hz–100 kHz	100		µV_{rms}/V
Long Term Stability		0.4		%/1000 hr
Ripple Rejection	f_O = 120 Hz	0.02		%/V
Dropout Voltage	I_O ≤ 10 mA	0.05	0.2	V_{MAX}
	I_O = 100 mA	0.3	0.6	V_{MAX}
Maximum Operational Input				
Voltage		33	26	V_{MIN}
Maximum Line Transient	I_O = 10 mA, Reference Voltage ≤ 1.5V	70	60	V_{MIN}
	T = 1 ms, τ ≤ 100 ms			
Reverse Polarity Input	V_O ≥ −0.3V, R_L = 500Ω			
Voltage, DC		−30	−15	V_{MIN}
Reverse Polarity Input	T = 1 ms, τ ≤ 100 ms, R_L = 500Ω			
Voltage, Transient		−80	−50	V_{MIN}
On/Off Threshold Voltage	V_O=3V			
On		2.0	1.2	V_{MAX}
Off		2.2	3.25	V_{MIN}
On/Off Threshold Current		20	50	µA_{MAX}

(1) See circuit in Typical Applications. To ensure constant junction temperature, low duty cycle pulse testing is used.

TYPICAL PERFORMANCE CHARACTERISTICS

Dropout Voltage

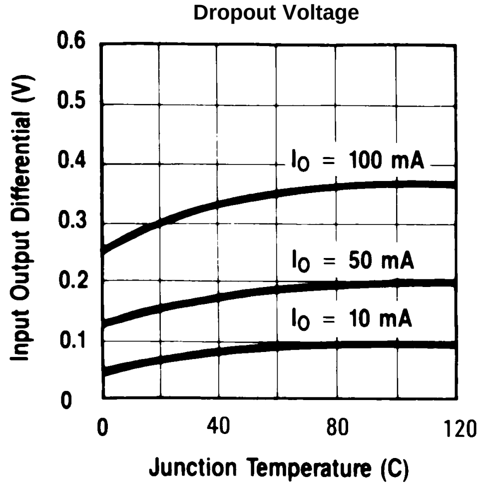


Figure 14.

Dropout Voltage

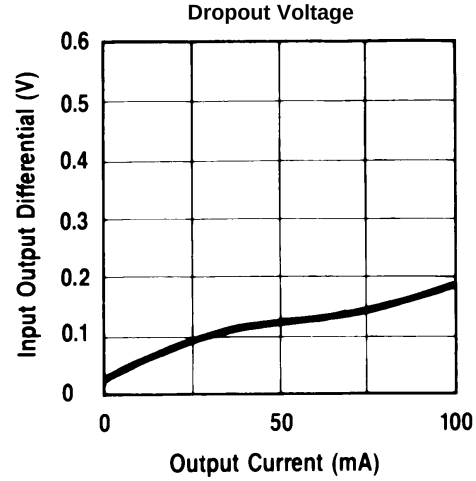


Figure 15.

Low Voltage Behavior

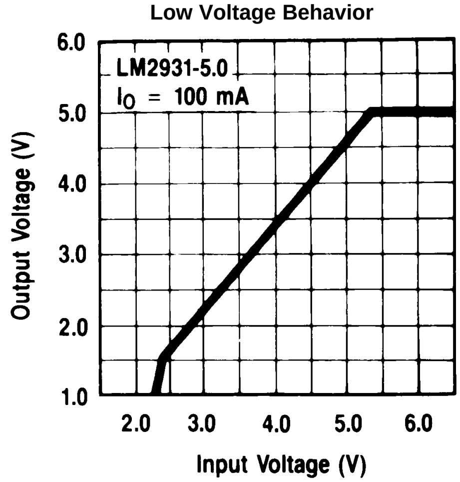


Figure 16.

Output at Voltage Extremes

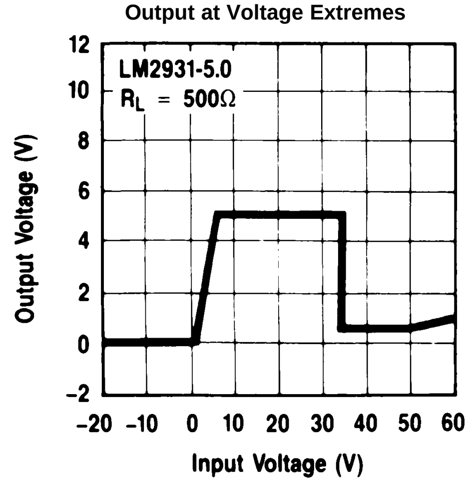


Figure 17.

Line Transient Response

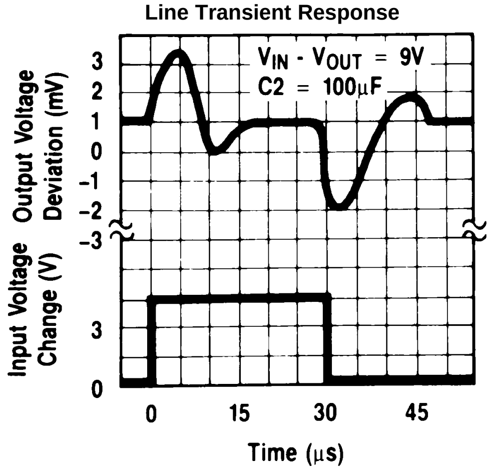


Figure 18.

Load Transient Response

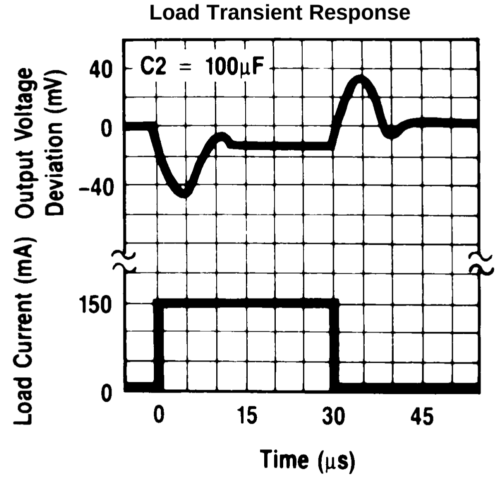


Figure 19.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Peak Output Current

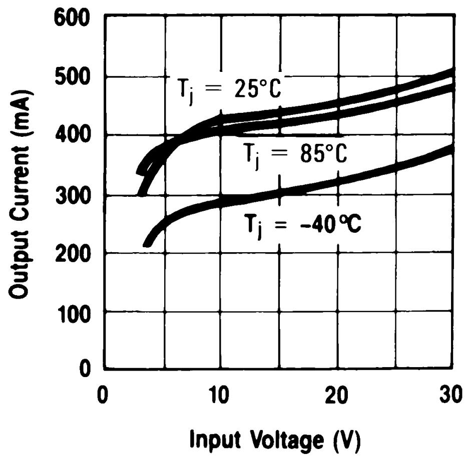


Figure 20.

Quiescent Current

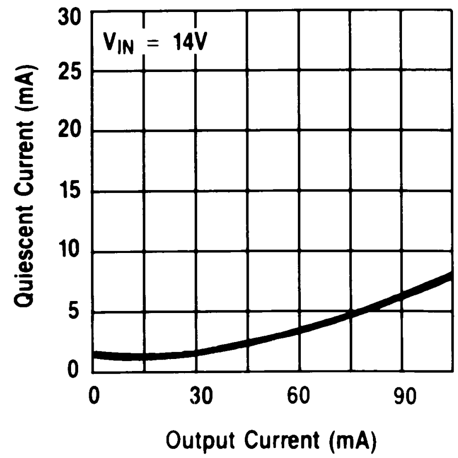


Figure 21.

Quiescent Current

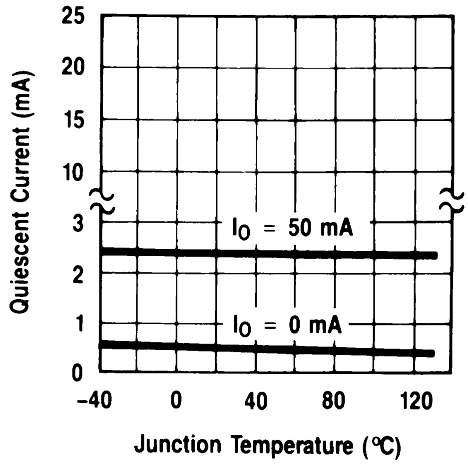


Figure 22.

Quiescent Current

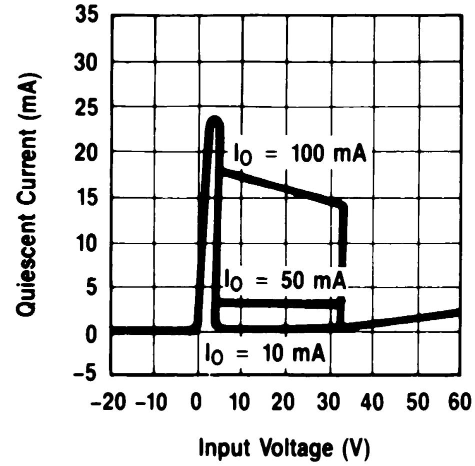


Figure 23.

Ripple Rejection

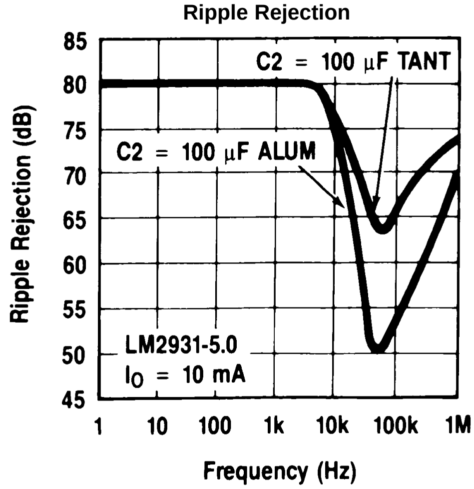


Figure 24.

Ripple Rejection

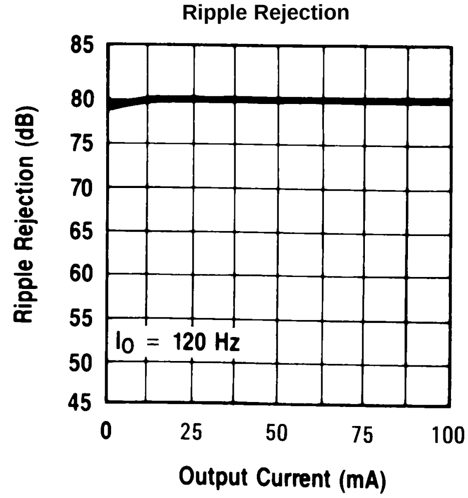


Figure 25.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Output Impedance

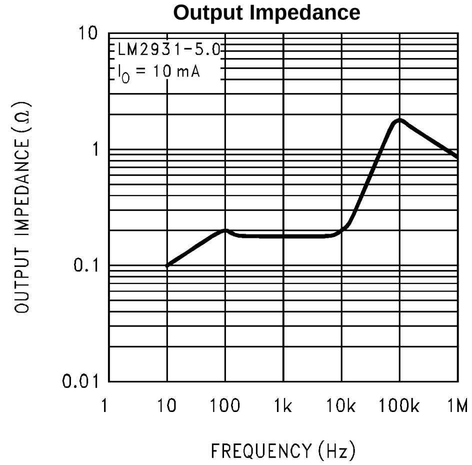


Figure 26.

Operation During Load Dump

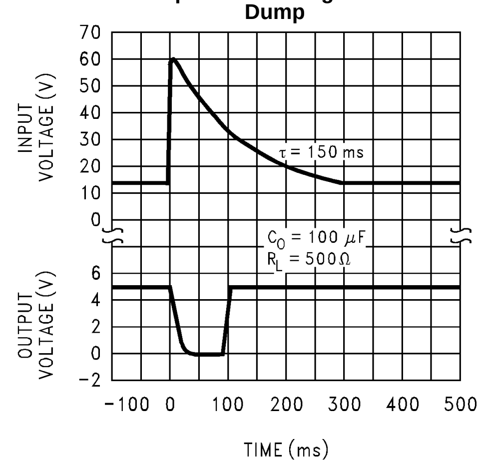


Figure 27.

Reference Voltage

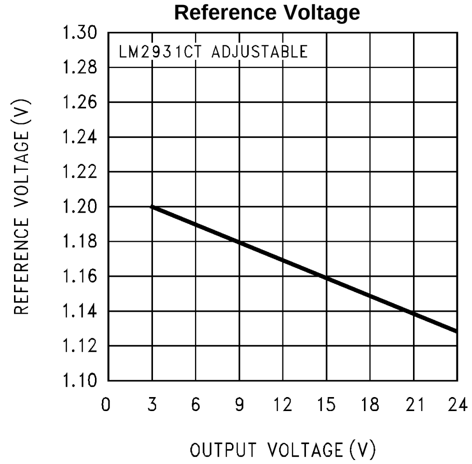


Figure 28.

Maximum Power Dissipation (SOIC-8)

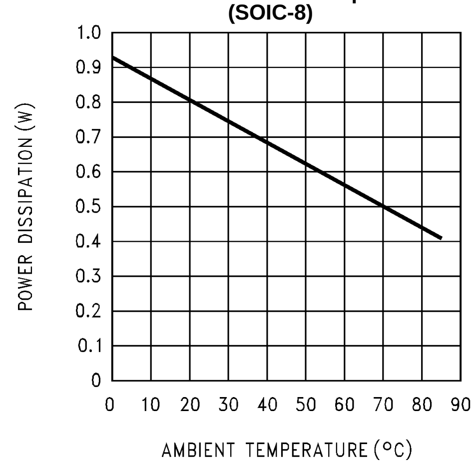


Figure 29.

Maximum Power Dissipation (TO-220)

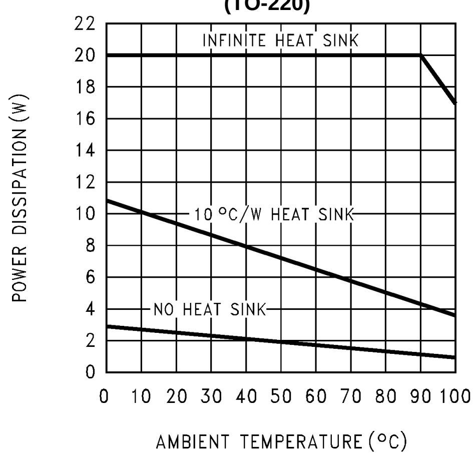


Figure 30.

Maximum Power Dissipation (TO-92)

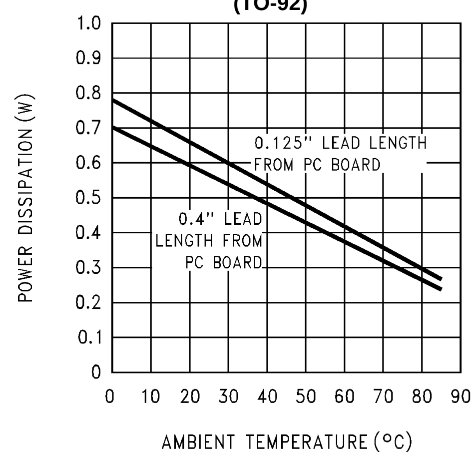


Figure 31.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Maximum Power Dissipation (TO-263) (1)

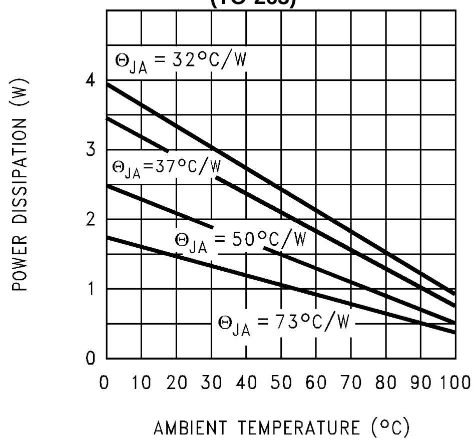


Figure 32.

On/Off Threshold

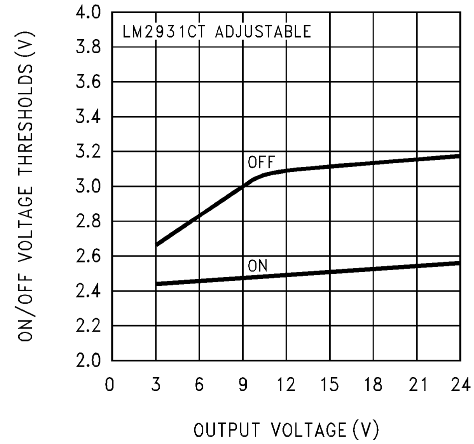


Figure 33.

Output Capacitor ESR

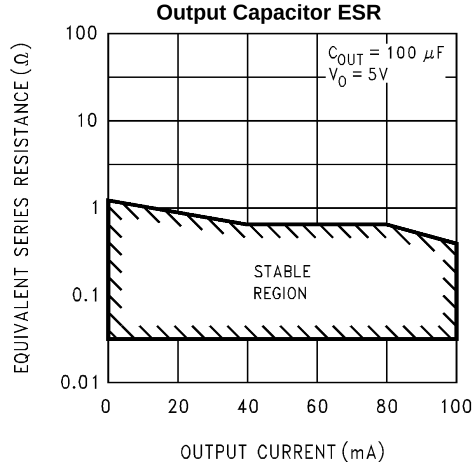
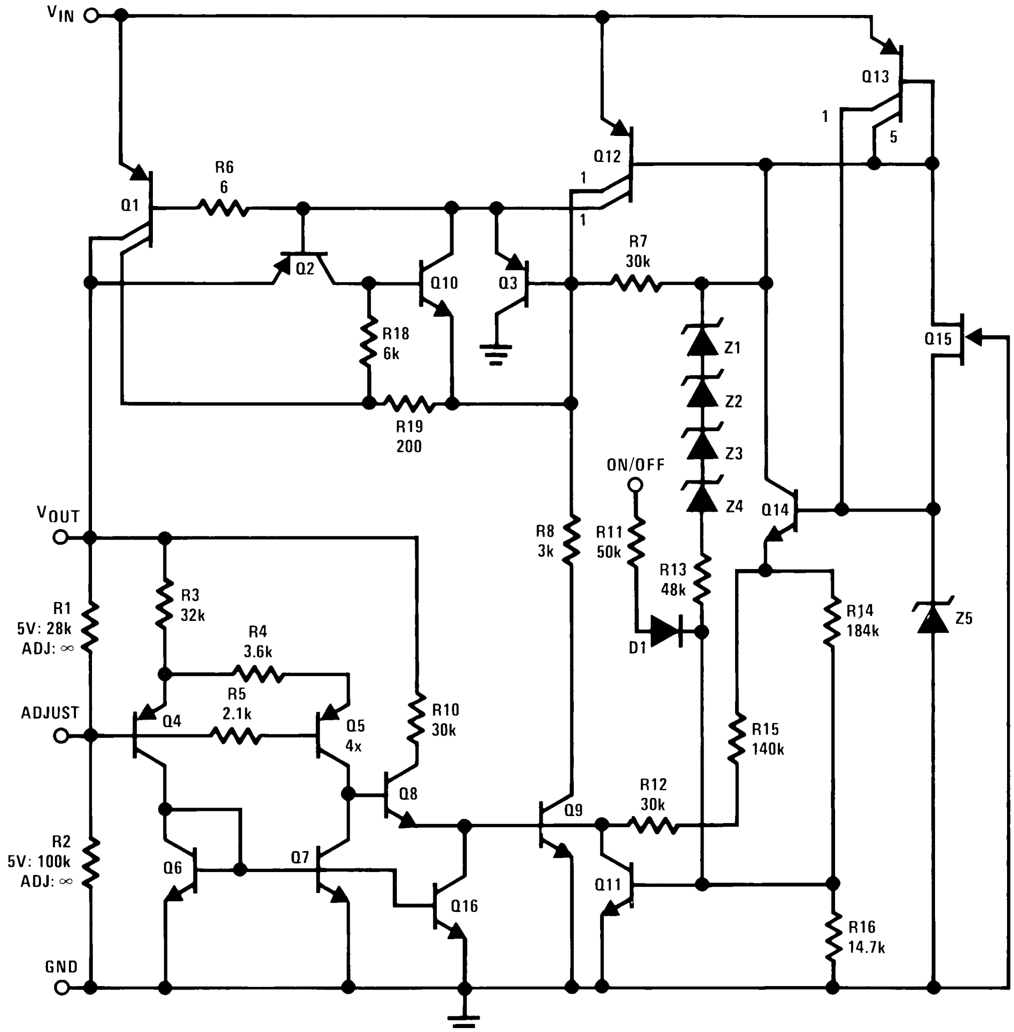


Figure 34.

(1) The maximum power dissipation is a function of maximum junction temperature T_{Jmax}, total thermal resistance θ_{JA}, and ambient temperature T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{Jmax} - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2931-N will go into thermal shutdown. For the LM2931-N in the TO-92 package, θ_{JA} is 195°C/W; in the SOIC-8 package, θ_{JA} is 160°C/W, and in the TO-220 package, θ_{JA} is 50°C/W; in the DDPAK/TO-263 package, θ_{JA} is 73°C/W; and in the 6-Bump DSBGA package θ_{JA} is 290°C/W. If the TO-220 package is used with a heat sink, θ_{JA} is the sum of the package thermal resistance junction-to-case of 3°C/W and the thermal resistance added by the heat sink and thermal interface.If the TO-263 package is used, the thermal resistance can be reduced by increasing the P.C. board copper area thermally connected to the package: Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W.

SCHEMATIC DIAGRAM



APPLICATION HINTS

One of the distinguishing factors of the LM2931-N series regulators is the requirement of an output capacitor for device stability. The value required varies greatly depending upon the application circuit and other factors. Thus some comments on the characteristics of both capacitors and the regulator are in order.

High frequency characteristics of electrolytic capacitors depend greatly on the type and even the manufacturer. As a result, a value of capacitance that works well with the LM2931-N for one brand or type may not necessary be sufficient with an electrolytic of different origin. Sometimes actual bench testing, as described later, will be the only means to determine the proper capacitor type and value. Experience has shown that, as a rule of thumb, the more expensive and higher quality electrolytics generally allow a smaller value for regulator stability. As an example, while a high-quality 100 µF aluminum electrolytic covers all general application circuits, similar stability can be obtained with a tantalum electrolytic of only 47µF. This factor of two can generally be applied to any special application circuit also.

Another critical characteristic of electrolytics is their performance over temperature. While the LM2931-N is designed to operate to −40°C, the same is not always true with all electrolytics (hot is generally not a problem). The electrolyte in many aluminum types will freeze around −30°C, reducing their effective value to zero. Since the capacitance is needed for regulator stability, the natural result is oscillation (and lots of it) at the regulator output. For all application circuits where cold operation is necessary, the output capacitor must be rated to operate at the minimum temperature. By coincidence, worst-case stability for the LM2931-N also occurs at minimum temperatures. As a result, in applications where the regulator junction temperature will never be less than 25°C, the output capacitor can be reduced approximately by a factor of two over the value needed for the entire temperature range. To continue our example with the tantalum electrolytic, a value of only 22µF would probably thus suffice. For high-quality aluminum, 47µF would be adequate in such an application.

Another regulator characteristic that is noteworthy is that stability decreases with higher output currents. This sensible fact has important connotations. In many applications, the LM2931-N is operated at only a few milliamps of output current or less. In such a circuit, the output capacitor can be further reduced in value. As a rough estimation, a circuit that is required to deliver a maximum of 10mA of output current from the regulator would need an output capacitor of only half the value compared to the same regulator required to deliver the full output current of 100mA. If the example of the tantalum capacitor in the circuit rated at 25°C junction temperature and above were continued to include a maximum of 10mA of output current, then the 22µF output capacitor could be reduced to only 10µF.

In the case of the LM2931CT adjustable regulator, the minimum value of output capacitance is a function of the output voltage. As a general rule, the value decreases with higher output voltages, since internal loop gain is reduced.

At this point, the procedure for bench testing the minimum value of an output capacitor in a special application circuit should be clear. Since worst-case occurs at minimum operating temperatures and maximum operating currents, the entire circuit, including the electrolytic, should be cooled to the minimum temperature. The input voltage to the regulator should be maintained at 0.6V above the output to keep internal power dissipation and die heating to a minimum. Worst-case occurs just after input power is applied and before the die has had a chance to heat up. Once the minimum value of capacitance has been found for the brand and type of electrolytic in question, the value should be doubled for actual use to account for production variations both in the capacitor and the regulator. (All the values in this section and the remainder of the data sheet were determined in this fashion.)

LM2931-N DSBGA Light Sensitivity

When the LM2931-N DSBGA package is exposed to bright sunlight, normal office fluorescent light, and other LED's, it operates within the limits specified in the electrical characteristic table.

Definition of Terms

Dropout Voltage: The input-output voltage differential at which the circuit ceases to regulate against further reduction in input voltage. Measured when the output voltage has dropped 100 mV from the nominal value obtained at 14V input, dropout voltage is dependent upon load current and junction temperature.

Input Voltage: The DC voltage applied to the input terminals with respect to ground.

Input-Output Differential: The voltage difference between the unregulated input voltage and the regulated output voltage for which the regulator will operate.

Line Regulation: The change in output voltage for a change in the input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that the average chip temperature is not significantly affected.

Load Regulation: The change in output voltage for a change in load current at constant chip temperature.

Long Term Stability: Output voltage stability under accelerated life-test conditions after 1000 hours with maximum rated voltage and junction temperature.

Output Noise Voltage: The rms AC voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

Quiescent Current: That part of the positive input current that does not contribute to the positive load current. The regulator ground lead current.

Ripple Rejection: The ratio of the peak-to-peak input ripple voltage to the peak-to-peak output ripple voltage at a specified frequency.

Temperature Stability of V_O: The percentage change in output voltage for a thermal variation from room temperature to either temperature extreme.

REVISION HISTORY

Changes from Revision F (April 2013) to Revision G	Page
• Changed layout of National Data Sheet to TI format	13

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM2931AM-5.0	NRND	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	2931A M-5.0	
LM2931AM-5.0/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	2931A M-5.0	Samples
LM2931AMX-5.0	NRND	SOIC	D	8		TBD	Call TI	Call TI	-40 to 85	2931A M-5.0	
LM2931AMX-5.0/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	2931A M-5.0	Samples
LM2931AS-5.0	NRND	DDPAK/ TO-263	KTT	3	45	TBD	Call TI	Call TI	-40 to 85	LM2931 AS5.0	
LM2931AS-5.0/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 85	LM2931 AS5.0	Samples
LM2931ASX-5.0	NRND	DDPAK/ TO-263	KTT	3	500	TBD	Call TI	Call TI	-40 to 85	LM2931 AS5.0	
LM2931ASX-5.0/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 85	LM2931 AS5.0	Samples
LM2931AT-5.0	NRND	TO-220	NDE	3	45	TBD	Call TI	Call TI	-40 to 85	LM2931 AT5.0	
LM2931AT-5.0/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	-40 to 85	LM2931 AT5.0	Samples
LM2931AZ-5.0/LFT1	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type		LM293 1AZ-5	Samples
LM2931AZ-5.0/LFT3	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type		LM293 1AZ-5	Samples
LM2931AZ-5.0/LFT4	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type		LM293 1AZ-5	Samples
LM2931AZ-5.0/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-40 to 85	LM293 1AZ-5	Samples
LM2931CM	NRND	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	LM29 31CM	
LM2931CM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM29 31CM	Samples
LM2931CMX	NRND	SOIC	D	8	2500	TBD	Call TI	Call TI	-40 to 85	LM29 31CM	

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM2931CMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LM29 31CM	Samples
LM2931CS	NRND	DDPAK/ TO-263	KTT	5	45	TBD	Call TI	Call TI	-40 to 85	LM2931CS	
LM2931CS/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 85	LM2931CS	Samples
LM2931CT/NOPB	ACTIVE	TO-220	KC	5	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	-40 to 85	LM2931CT	Samples
LM2931M-5.0	NRND	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	2931 M-5.0	
LM2931M-5.0/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	2931 M-5.0	Samples
LM2931MX-5.0	NRND	SOIC	D	8	2500	TBD	Call TI	Call TI	-40 to 85	2931 M-5.0	
LM2931MX-5.0/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	2931 M-5.0	Samples
LM2931S-5.0/NOPB	ACTIVE	DDPAK/ TO-263	KTT	3	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	-40 to 85	LM2931S 5.0	Samples
LM2931T-5.0	NRND	TO-220	NDE	3		TBD	Call TI	Call TI	-40 to 85	LM2931T 5.0	
LM2931T-5.0/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	-40 to 85	LM2931T 5.0	Samples
LM2931Z-5.0/LFT1	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type		LM293 1Z-5	Samples
LM2931Z-5.0/LFT2	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type		LM293 1Z-5	Samples
LM2931Z-5.0/NOPB	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-40 to 85	LM293 1Z-5	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] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

[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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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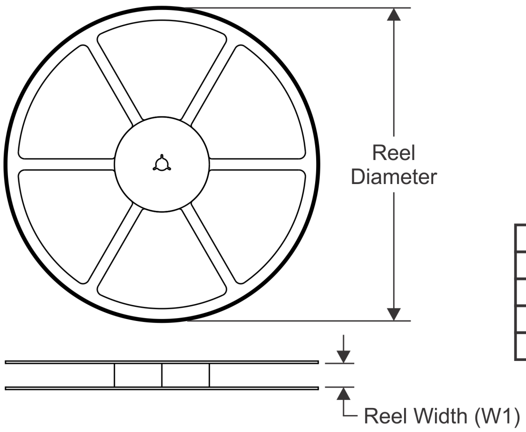
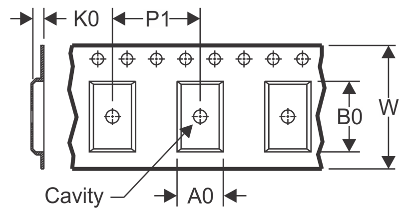
TAPE AND REEL INFORMATION

REEL DIMENSIONS

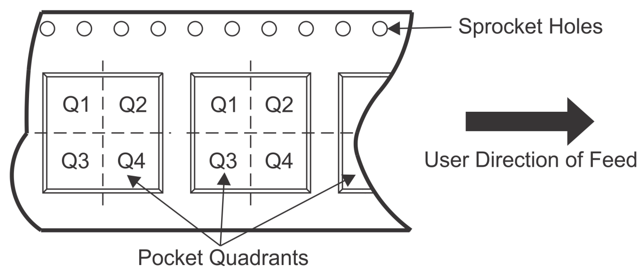


TAPE DIMENSIONS



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

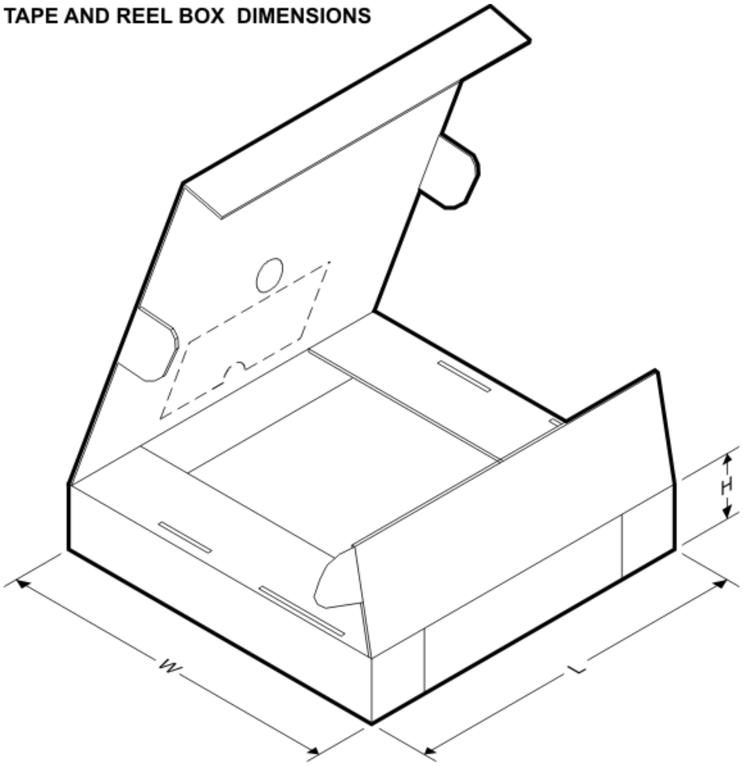
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM2931AMX-5.0/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM2931ASX-5.0	DDPAK/ TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2931ASX-5.0/NOPB	DDPAK/ TO-263	KTT	3	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2931CMX	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM2931CMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM2931MX-5.0	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM2931MX-5.0/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

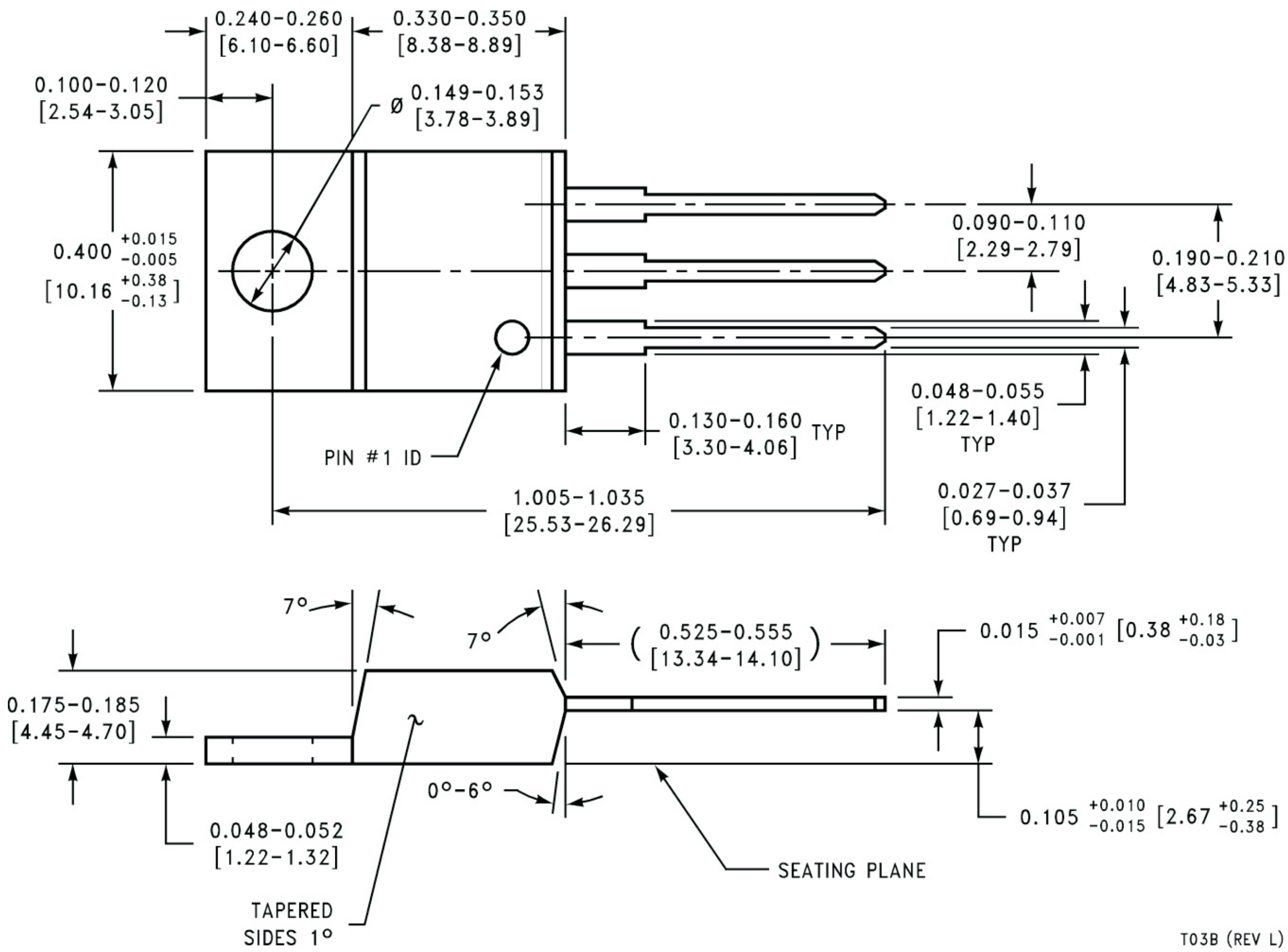
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

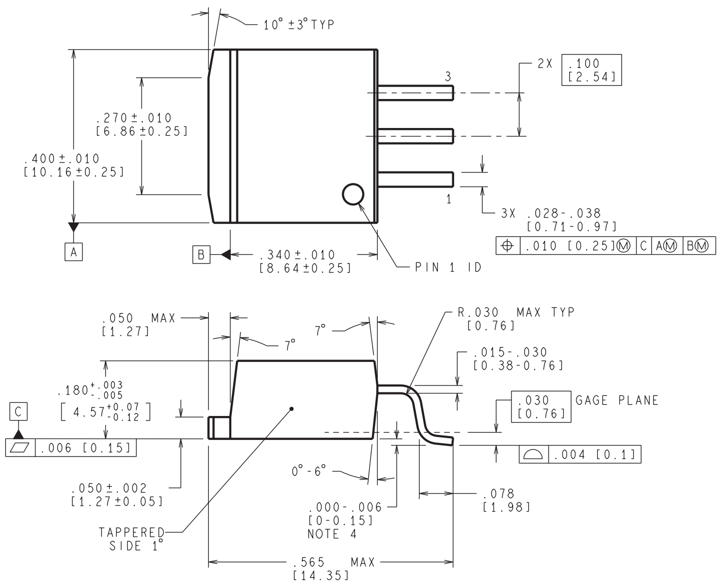
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2931AMX-5.0/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM2931ASX-5.0	DDPAK/TO-263	KTT	3	500	367.0	367.0	45.0
LM2931ASX-5.0/NOPB	DDPAK/TO-263	KTT	3	500	367.0	367.0	45.0
LM2931CMX	SOIC	D	8	2500	367.0	367.0	35.0
LM2931CMX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM2931MX-5.0	SOIC	D	8	2500	367.0	367.0	35.0
LM2931MX-5.0/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

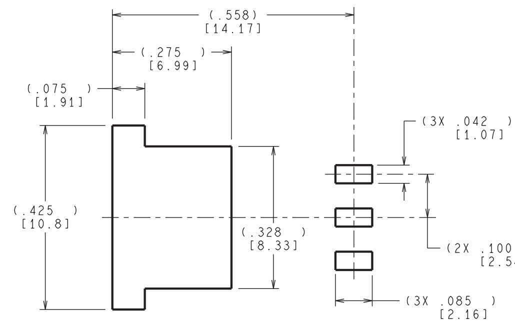
NDE0003B



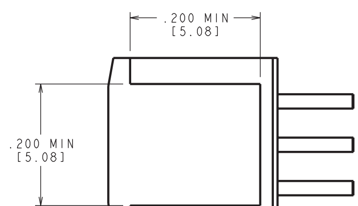
0.240–0.260
[6.10–6.60]
0.330–0.350
[8.38–8.89]
0.100–0.120
[2.54–3.05]
Ø 0.149–0.153
[3.78–3.89]
0.400 +0.015 −0.005
[10.16 +0.38 −0.13]
0.090–0.110
[2.29–2.79]
0.190–0.210
[4.83–5.33]
0.048–0.055
[1.22–1.40]
TYP
0.130–0.160 TYP
[3.30–4.06]
PIN #1 ID
1.005–1.035
[25.53–26.29]
0.027–0.037
[0.69–0.94]
TYP
7°
7°
(0.525–0.555)
[13.34–14.10]
0.015 +0.007 −0.001 [0.38 +0.18 −0.03]
0.175–0.185
[4.45–4.70]
0°–6°
0.105 +0.010 −0.015 [2.67 +0.25 −0.38]
0.048–0.052
[1.22–1.32]
SEATING PLANE
TAPERED
SIDES 1°
T03B (REV L)

KTT0003B





LAND PATTERN RECOMMENDATION



CONTROLLING DIMENSION IS INCH
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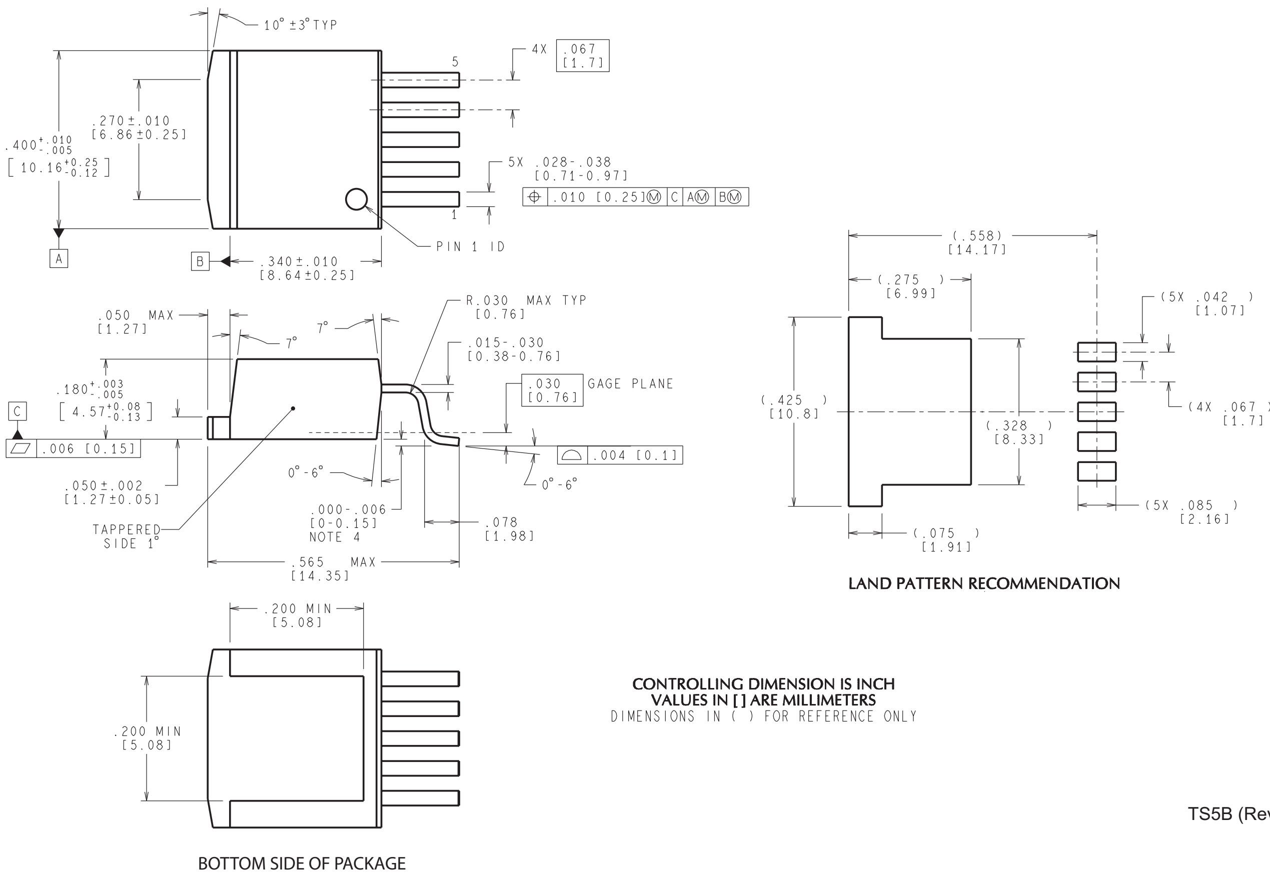
DIMENSIONS IN ( ) FOR REFERENCE ONLY

BOTTOM SIDE OF PACKAGE

TS3B (Rev F)

KTT0005B



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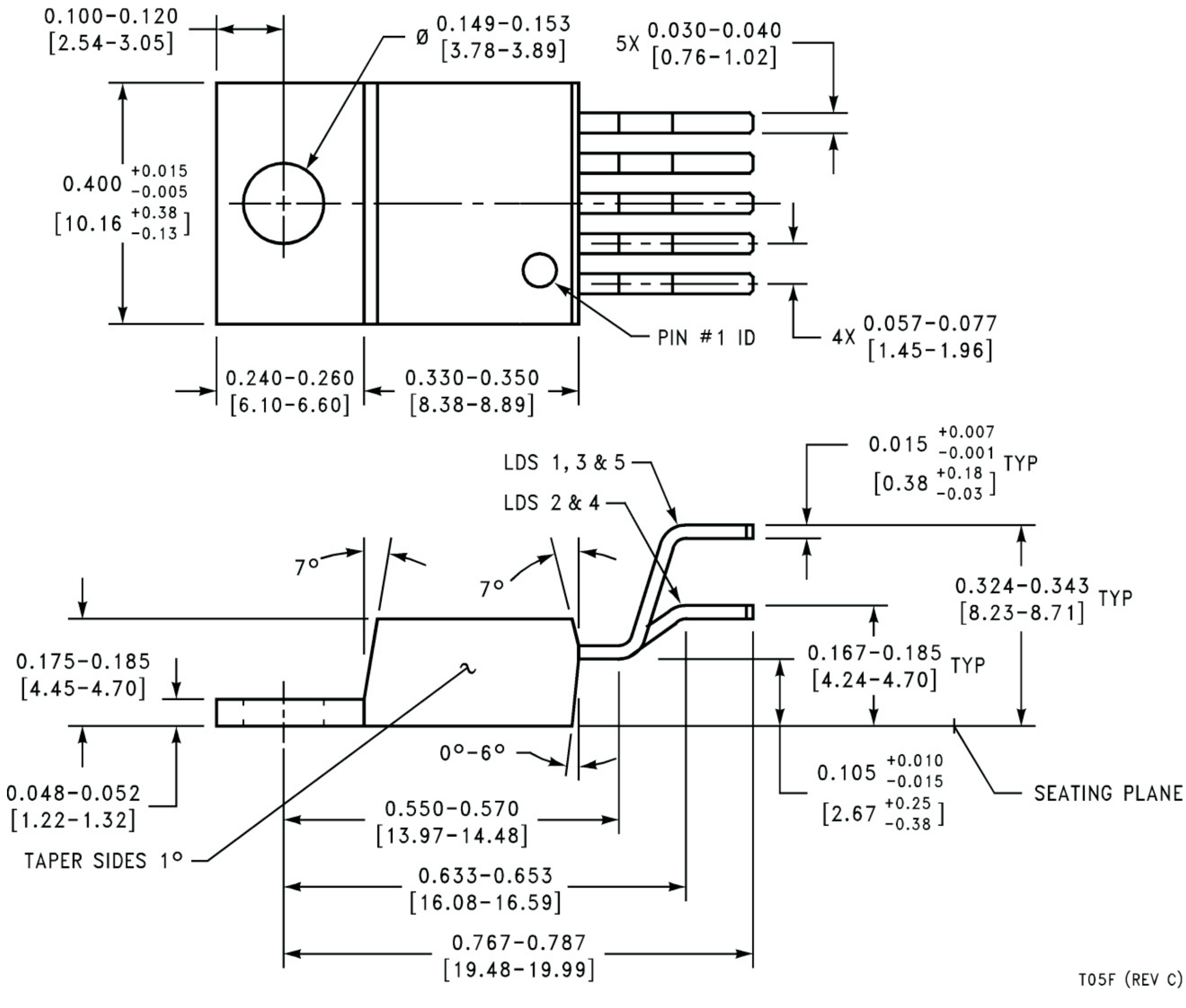
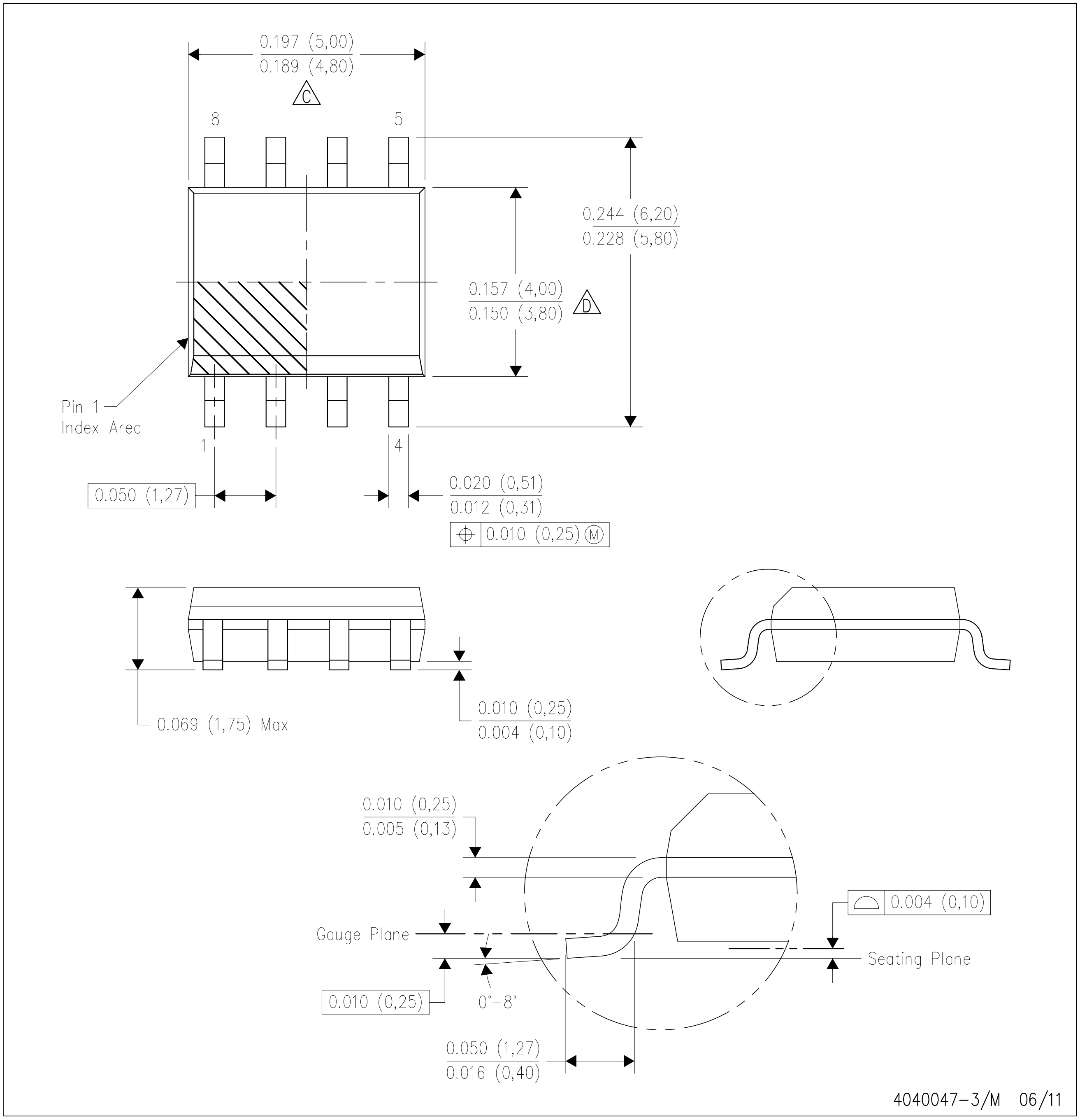
TS5B (Rev D)

NEB0005F

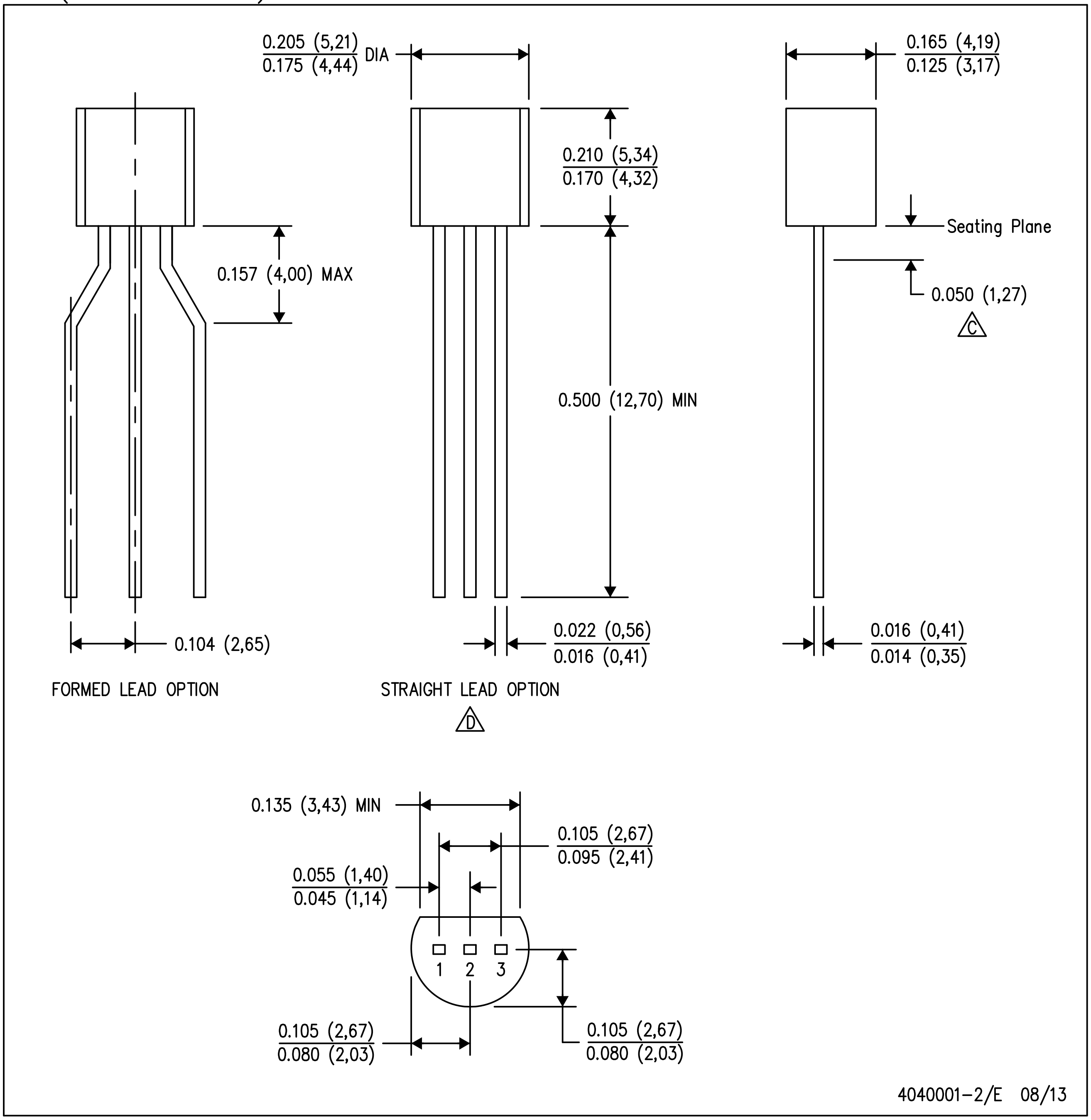

0.100–0.120
[2.54–3.05]
Ø 0.149–0.153
[3.78–3.89]
5X 0.030–0.040
[0.76–1.02]
0.400 +0.015 −0.005
[10.16 +0.38 −0.13]
PIN #1 ID
4X 0.057–0.077
[1.45–1.96]
0.240–0.260
[6.10–6.60]
0.330–0.350
[8.38–8.89]
LDS 1, 3 & 5
LDS 2 & 4
0.015 +0.007 −0.001
[0.38 +0.18 −0.03] TYP
7°
7°
0.324–0.343
[8.23–8.71] TYP
0.175–0.185
[4.45–4.70]
0.167–0.185
[4.24–4.70] TYP
0°–6°
0.048–0.052
[1.22–1.32]
0.105 +0.010 −0.015
[2.67 +0.25 −0.38]
SEATING PLANE
0.550–0.570
[13.97–14.48]
TAPER SIDES 1°
0.633–0.653
[16.08–16.59]
0.767–0.787
[19.48–19.99]
T05F (REV C)

D (R-PDSO-G8) PLASTIC SMALL OUTLINE



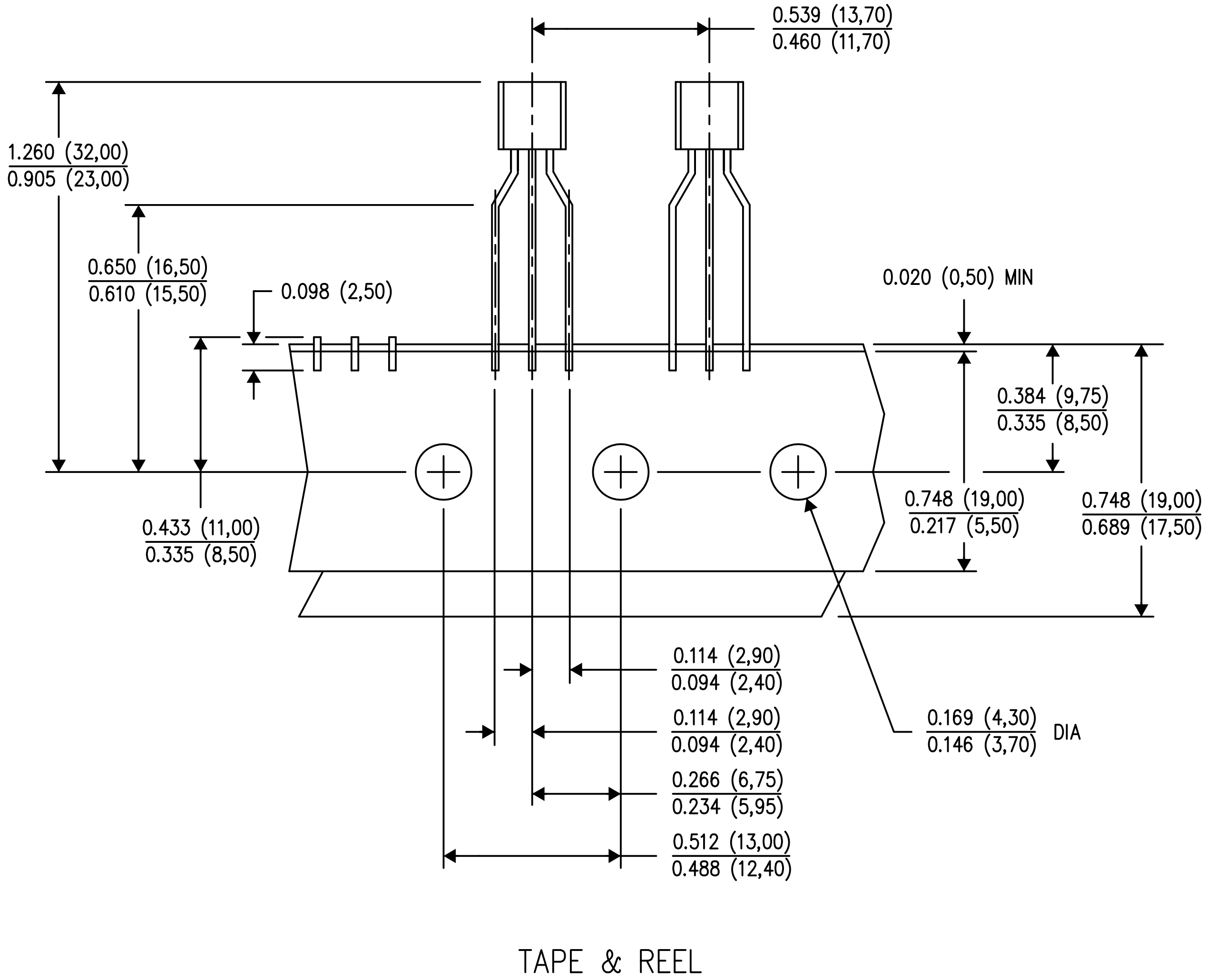
NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AA.

LP (O-PBCY-W3) PLASTIC CYLINDRICAL PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Lead dimensions are not controlled within this area.
D. Falls within JEDEC TO-226 Variation AA (TO-226 replaces TO-92).
E. Shipping Method:
Straight lead option available in bulk pack only.
Formed lead option available in tape & reel or ammo pack.
Specific products can be offered in limited combinations of shipping mediums and lead options.
Consult product folder for more information on available options.

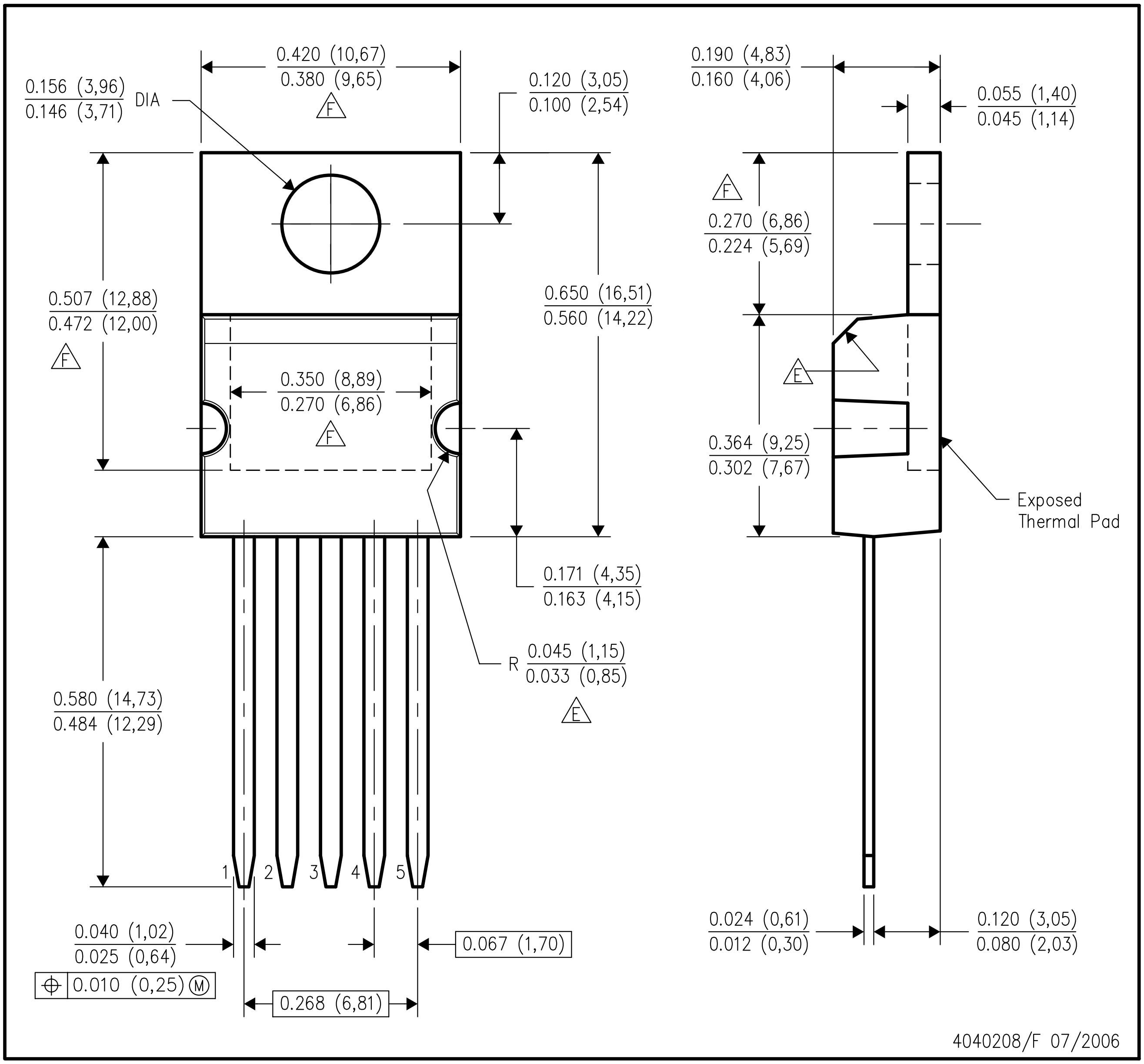
LP (O-PBCY-W3) PLASTIC CYLINDRICAL PACKAGE



4040001-3/E 08/13

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Tape and Reel information for the Formed Lead Option package.

KC (R-PSFM-T5) PLASTIC FLANGE-MOUNT PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. All lead dimensions apply before solder dip.
D. The center lead is in electrical contact with the mounting tab.
E. These features are optional.
F. Thermal pad contour optional within these dimensions.