Advanced Monolithic Systems

AMS2931

100mA LOW DROPOUT VOLTAGE REGULATOR

RoHS compliant

FEATURES

- **Fixed and Ajustable Versions Available**
- **Output Current in excess of 100mA**
- **Very Low Quiescent Current**
- **Reverse Battery Protection**
- **Input-output Differential less than 0.6V**
- **Short Circuit protection**
- **Internal Thermal Overload Protection**
- **60V Load Dump Protection**
- **-50V Reverse Transient Protection**
- **Mirror Image Insertion Protection**

APPLICATIONS

- **Battery Powered Systems**
- **Portable Consumer Equipment**
- **Cordless Telephones**
- **Portable (Notebook) Computers**
- **Portable Instrumentation**
- **Radio Control Systems**
- **Automotive Electronics**

GENERAL DESCRIPTION

The AMS2931 series consists of positive fixed and adjustable voltage regulators ideally suited for use in battery-powered systems. These devices feature 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 AMS2931 ideal to use for standby power systems.

Originally designed for automotive applications, the AMS2931 and all regulated circuitry are protected from input fault conditions caused by reverse battery installation or two battery jump starts. During line transients, such as 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 AMS2931 series also includes internal current limiting, thermal shutdown, and is able to withstand temporary power-up with mirror-image insertion.

The AMS2931 is offered in the 3-pin TO-92 package, 8-pin plastic SOIC, TO-220 and TO-263 packages.

ORDERING INFORMATION

OUTPUT VOLTAGE	PACKAGE TYPE				OPER. TEMP RANGE
	TO-92	8 LEAD SOIC	TO-220	TO-263	
FIXED*	AMS2931AN-X	AMS2931AS-X	AMS2931AT-X	AMS2931AM-X	-40ºC to +85ºc
	AMS2931N-X	AMS2931S-X	AMS2931T-X	AMS2931M-X	-40ºC to +85ºc
ADJ.		AMS2931CS			-40ºC to +85ºc

X = 2.0V, 2.5V, 3.0V, 3.3V, 3.5V, 4.0V, 5.0V

*For additional available fixed voltages contact factory

ABSOLUTE MAXIMUM RATINGS (Note 1)

Overvoltage Protection	
AMS2931A-X, AMS2931C	60V
AMS2931-X	50V
Maximum Input Voltage	22V
Internal Power Dissipation (Note 4)	Internally Limited
Storage Temperature	-65°C to +150°C

OPERATING CONDITIONS (Note1)

Input voltage range	4V to 22V
Junction Temperature	+125°C
Lead Temperature (Soldering 25 sec)	265°C
ESD	2000V

ELECTRICAL CHARACTERISTICS

Electrical Characteristics at V_{IN} =14V, I_O =10mA, T_J=25°C, C2 = 100µF unless otherwise specified.

PARAMETER	CONDITIONS	AMS2931A-X Min.	AMS2931A-X Typ.	AMS2931A-X Max.	AMS2931-X Min.	AMS2931-X Typ.	AMS2931-X Max.	Units
Fixed Output voltage Versions								
Output Voltage		-1.0		+1.0	-3.0		+3.0	%
	6V ≤ V_{IN} ≤26V, I_O=100 mA -40°C ≤ T_J ≤125°C	**- 3.0**		**+ 3.0**		**± 5.0**		%
Line Regulation	9V ≤ V_{IN} ≤ 16V 6V ≤ V_{IN} ≤ 26V		2 4	10 30		2 4	10 30	mV mV
Load Regulation	5mA ≤ I_O ≤ 100 mA		14	50		14	50	mV
Dropout Voltage	I_O = 10 mA I_O = 100 mA		50 300	200 600		50 300	200 600	mV mV
Quiescent Current	I_O ≤ 10 mA, 6V ≤ V_{IN} ≤ 26V -40°C ≤ T_J ≤ 125°C		0.4	**1.0**		0.4	**1.0**	mA
	I_O = 100 mA, V_{IN} = 14V, T_J = 25°C	5	15	30		15		mA
Output Noise Voltage	10Hz-100kHz, C_{OUT} = 100µA		500			500		µV rms
Output Impedance	100mA$_{DC}$ and 10mA$_{rms}$,100Hz=10kHz			200			200	mΩ
Long Term Stability	T =1000hr		20			20		mV
Ripple Rejection	f_O =120Hz	**55**	80			80		dB
Maximum Line Transient	R_L = 500Ω, V_O ≤ 5.5V T = 1ms, τ ≤100ms	60	70		50	70		V
Reverse Polarity Input Voltage, D/C		-15	-30		-15	-30		V
Reverse Polarity Input Voltage, Transient	R_L = 500Ω, T = 1ms, τ ≤100ms	-50	-80		-50	-80		V

ELECTRICAL CHARACTERISTICS

Electrical Characteristics at V_{IN} =14V, V_{OUT} =3V I_O =10mA, T_J=25°C, R1 =27k, C2 = 100µF unless otherwise specified.

PARAMETER	CONDITIONS (Note 2)	Min.	AMS2931C Typ.	Max.	Units
Adjustable Version					
Reference Voltage		1.14	1.20	1.26	V
	$I_O \leq$ 100 mA, -40°C ≤ $T_J \leq$ 125°C, R1=27k, Measured from V_{OUT} to Adjust Pin	**1.08**		**1.32**	V
Output Voltage Range		3	24		V
Line Regulation	V_{OUT} + 0.6V ≤ $V_{IN} \leq$ 26V		.02	1.5	mV/V
Load Regulation	5mA ≤ $I_O \leq$ 100 mA		0.3	1	%
Dropout Voltage	$I_O \leq$ 10 mA I_O = 100 mA		0.05 0.3	0.2 0.6	V V
Quiescent Current	I_O = 10 mA I_O = 100 mA During Shutdown R_L = 500Ω		0.4 15 0.8	**1** **1**	mA mA mA
Output Noise Voltage	10Hz-100kHz		100		µV_{rms}/V
Output Impedance	100mA_{DC} and 10mA_{rms},100Hz=10kHz		40		mΩ
Long Term Stability	T =1000hr		0.4		%/1000hr
Ripple Rejection	f_O = 120Hz		0.02		%/V
Maximum Operating Input Voltage			21	22	V
Maximum Line Transient	I_O = 10mA, Reference Voltage ≤ 1.5V T = 1ms, τ ≤100ms	60	70		V
Reverse Polarity Input Voltage, D/C	R_L = 500Ω, $V_O \geq$ -0.3V	-15	-30		V
Reverse Polarity Input Voltage, Transient	R_L = 500Ω, T = 1ms, τ ≤100ms	-50	-80		V
On/Off Threshold Voltage On Off	V_O = 3V	 3.25	 2.0 2.2	 1.2 	 V V
On/Off Threshold Current			20	50	µA

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. For guaranteed performance limits and associated test conditions, see the Electrical Characteristics tables.

Note 2: See Circuit in Typical Applications. To ensure constant junction temperature, low duty cycle pulse testing is used.

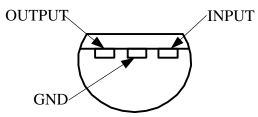
Note 3: Limits appearing in **boldface** type apply over the entire junction temperature range for operation. Limits appearing in normal type apply for $T_A = T_J$ = 25°C.

Note 4: The junction-to-ambient thermal resistance are as follows: 195°C/W for the TO-92 (N) package, 160°C/W for the molded plastic SO-8 (S), 50°C/W for the TO-220 package and 73°C/W for the TO-263 package. 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 the thermal interface. The thermal resistance of the TO-263 package can be reduced by increasing the PCB copper area thermally connected to the package: using 0.5 square inches of copper area, φ_{JA} is 50°C/W; with 1 square inch of copper area φ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area φ_{JA} is 32°C/W.

PIN CONNECTIONS

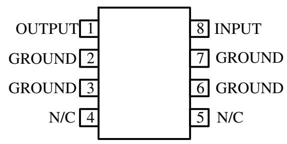
FIXED OUTPUT VOLTAGE

TO-92
Plastic Package (N)



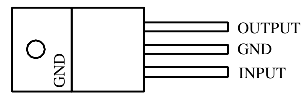
Bottom View

8L SOIC
SO-Package (S)



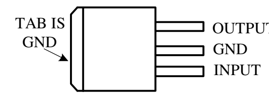
Top View

TO-220 (T)



Front View

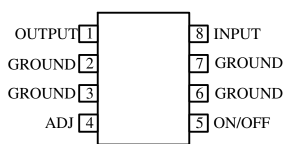
TO-263 (M)



Top View

ADJUSTABLE OUTPUT VOLTAGE

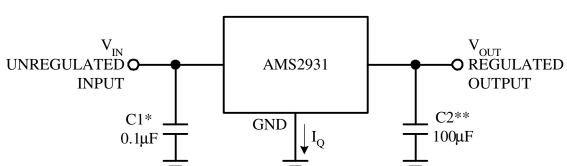
8L SOIC
SO-Package (S)



Top View

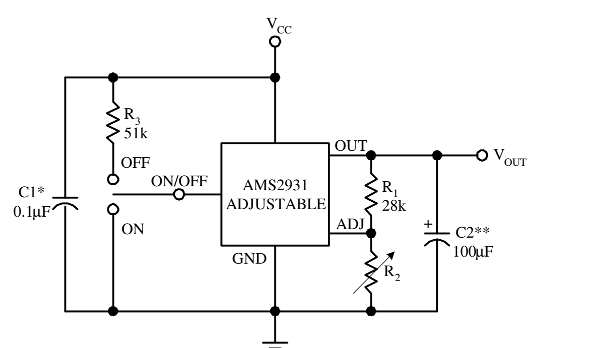
TYPICAL APPLICATIONS

AMS2931-X (Fixed Output)



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

AMS2931C (Adjustable Output)



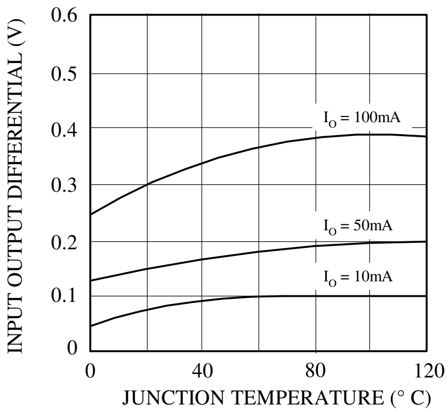
$V_{OUT} = V_{REF} \times (R_1+R_2)/R_1$

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

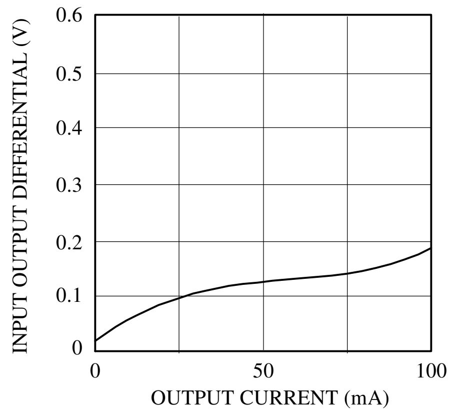
updated April 24, 2009

TYPICAL PERFORMANCE CHARACTERISTICS

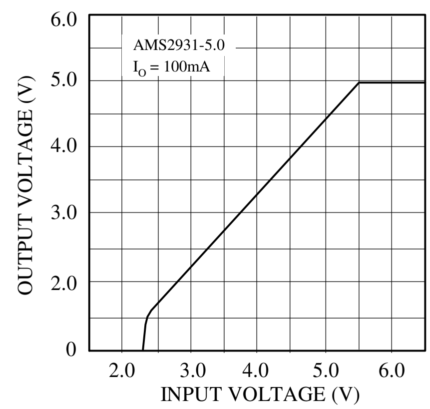
Dropout Voltage



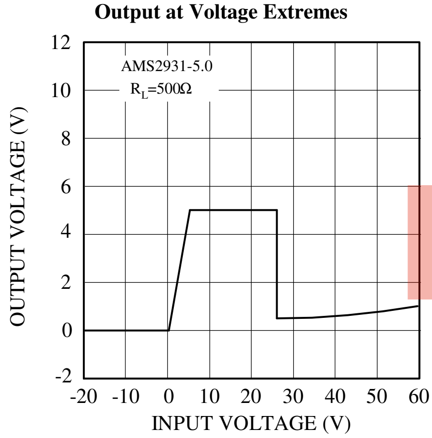
Dropout Voltage



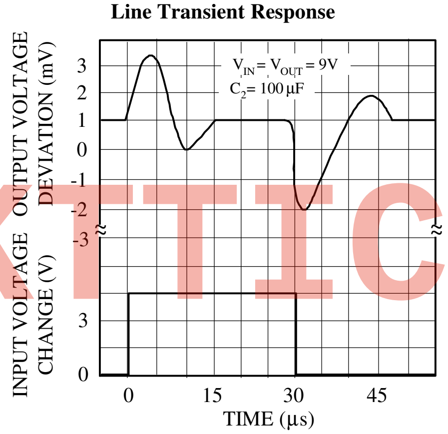
Low Voltage Behavior



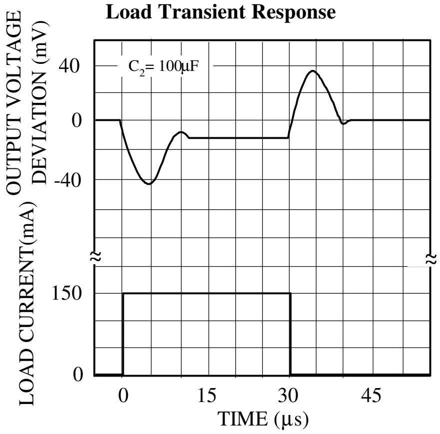
Output at Voltage Extremes



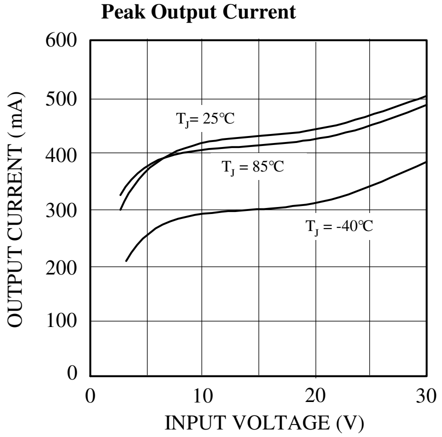
Line Transient Response



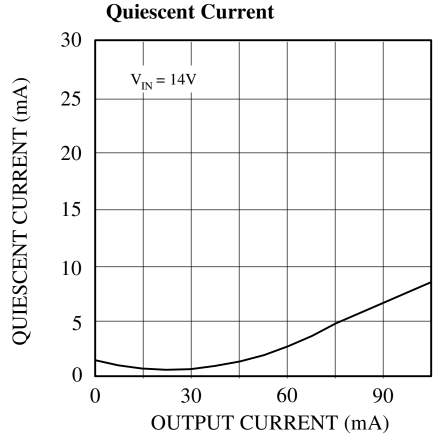
Load Transient Response



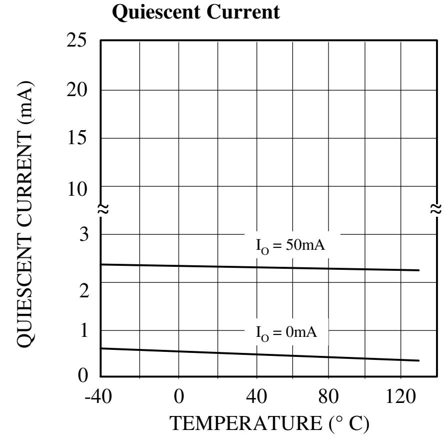
Peak Output Current



Quiescent Current

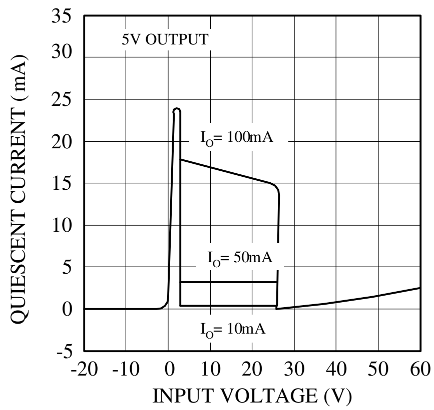


Quiescent Current

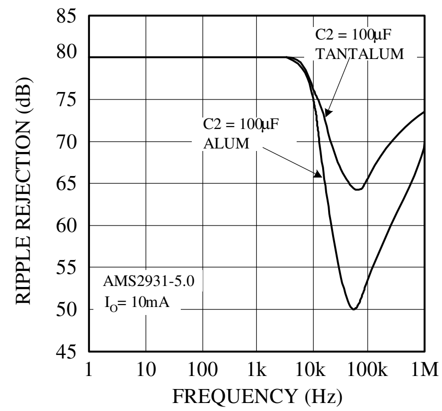


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

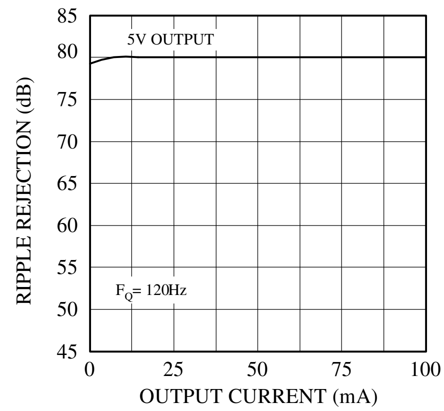
Quiescent Current



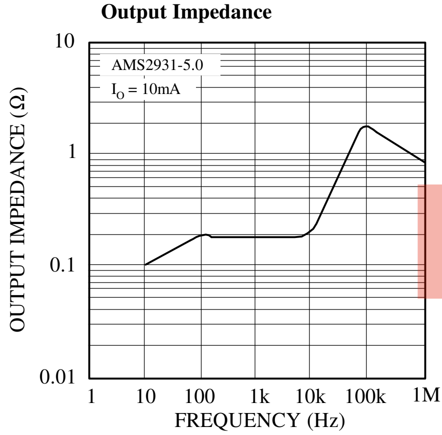
Ripple Rejection



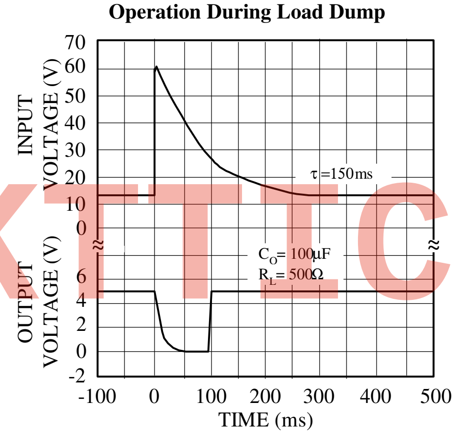
Ripple Rejection



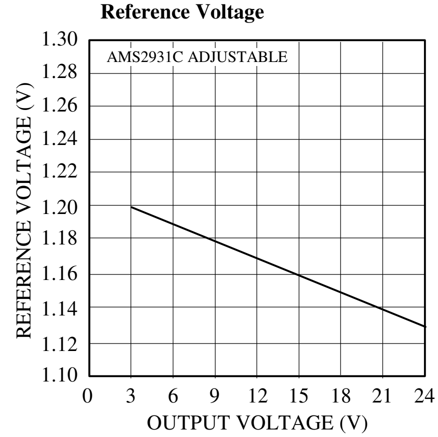
Output Impedance



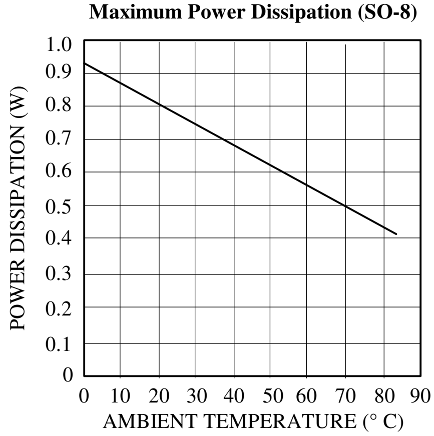
Operation During Load Dump



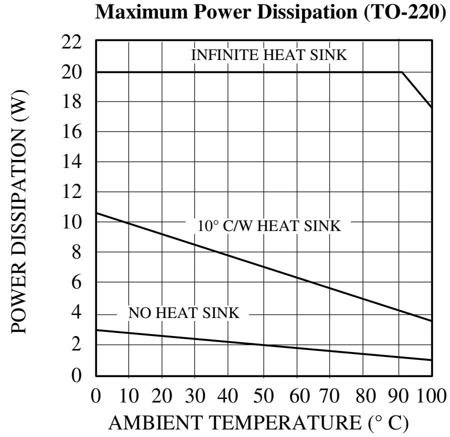
Reference Voltage



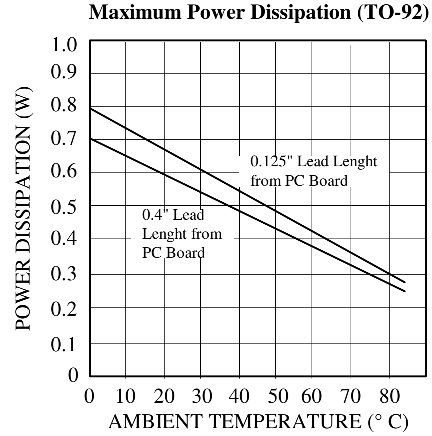
Maximum Power Dissipation (SO-8)



Maximum Power Dissipation (TO-220)

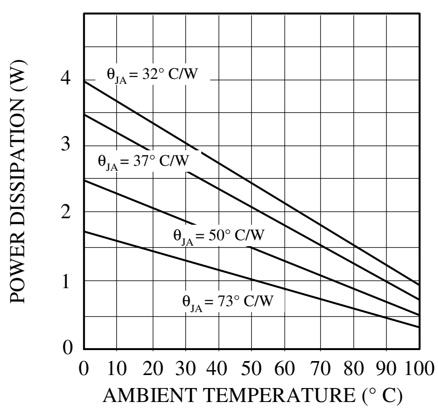


Maximum Power Dissipation (TO-92)

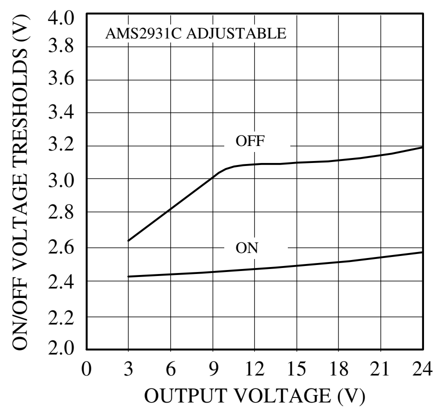


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

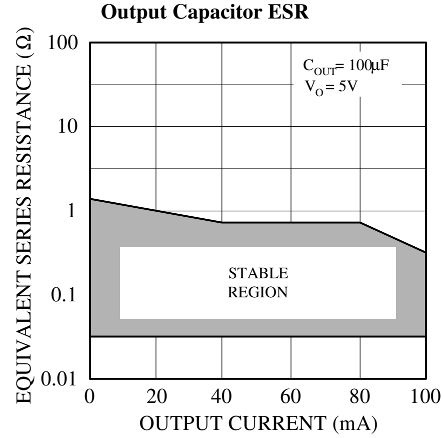
Maximum Power Dissipation (TO-263)



On/Off Treshold



Output Capacitor ESR



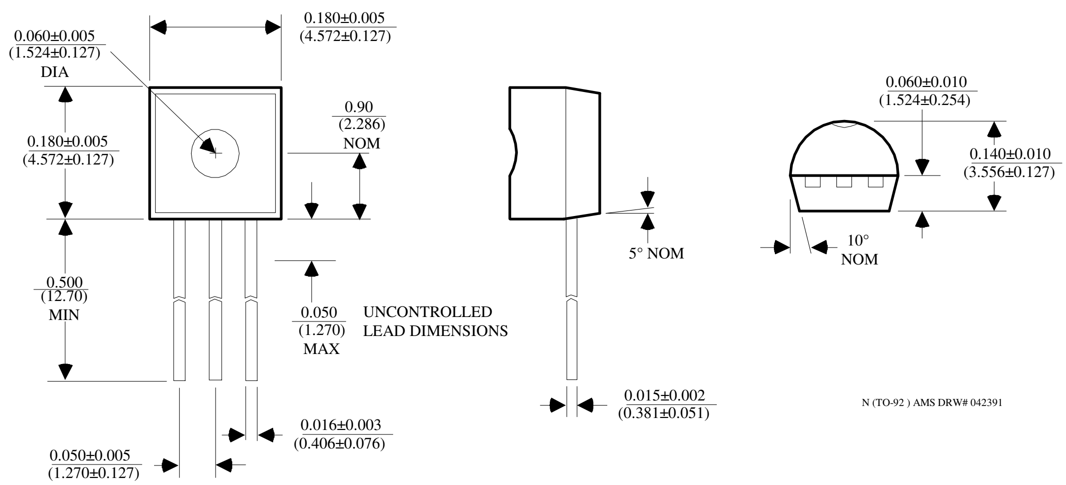
APPLICATION HINTS

The AMS2931 series require an output capacitor for device stability. The value required depends on the application circuit and other factors.
Because high frequency characteristics of electrolytic capacitors depend greatly on the type and even the manufacturer, the value of capacitance that works well with AMS2931 for one brand or type may not necessary be sufficient with an electrolytic of different origin. Sometimes actual bench testing will be the only means to determine the proper capacitor type and value. To obtain stability in all general applications a high quality 100µF aluminum electrolytic or a 47µF tantalum electrolytic can be used.
A critical characteristic of the electrolytic capacitors is their performance over temperature. The AMS2931 is designed to operate to -40°C, but some electrolytics will freeze around -30°C therefore becoming ineffective. In such case the result is oscillation 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. In applications where the regulator junction temperature will never be lower than 25°C the output capacitor value can be reduced by a factor of two over the value required for the entire temperature range (47µF for a high quality aluminum or 22µF for a tantalum electrolytic capacitor).

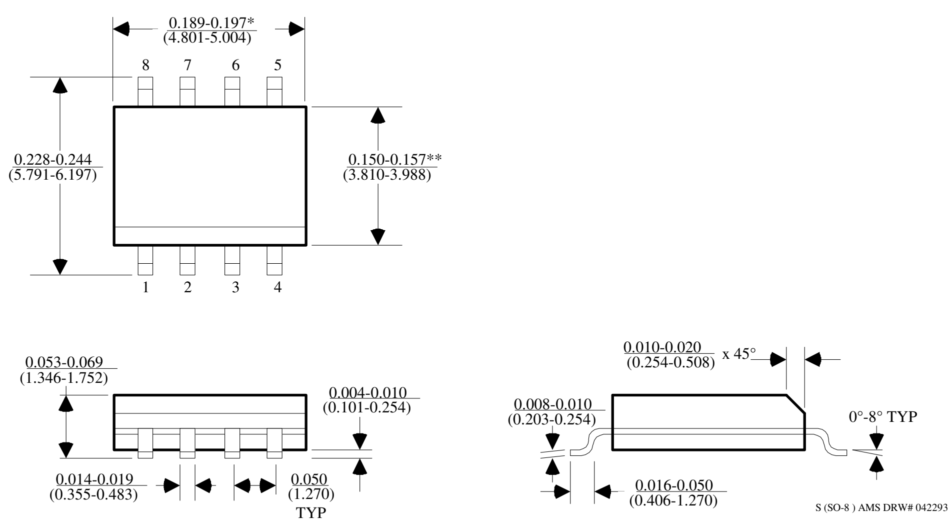
With higher output currents, the stability of AMS2931 decreases. Considering the fact that in many applications the AMS2931 is operated at only a few milliamps (or less) of output current, the output capacitor value can be reduced even further. For example, a circuit that is required to deliver a maximum of 10mA of output current from the regulator output will need an output capacitor of only half the value compared to the same regulator required to deliver the full output current of 100mA.
In the case of AMS2931C (adjustable), the minimum value of output capacitance is a function of the output voltage. As a general rule, with higher output voltages the value of the output capacitance decreases, since the internal loop gain is reduced.
In order to determine the minimum value of the output capacitor, for an application circuit, the entire circuit including the capacitor should be bench tested at minimum operating temperatures and maximum operating currents. To maintain internal power dissipation and die heating to a minimum, the input voltage should be maintain at 0.6V above the output. Worst-case occurs just after input power is applied and before the die had the chance to heat up. After the minimum capacitance value has been found for the specific brand and type of electrolytic capacitor, the value should be doubled for actual use to cover for production variations both in the regulator and the capacitor.

PACKAGE DIMENSIONS inches (millimeters) unless otherwise noted.

3 LEAD TO-92 PLASTIC PACKAGE (N)



8 LEAD SOIC PLASTIC PACKAGE (S)



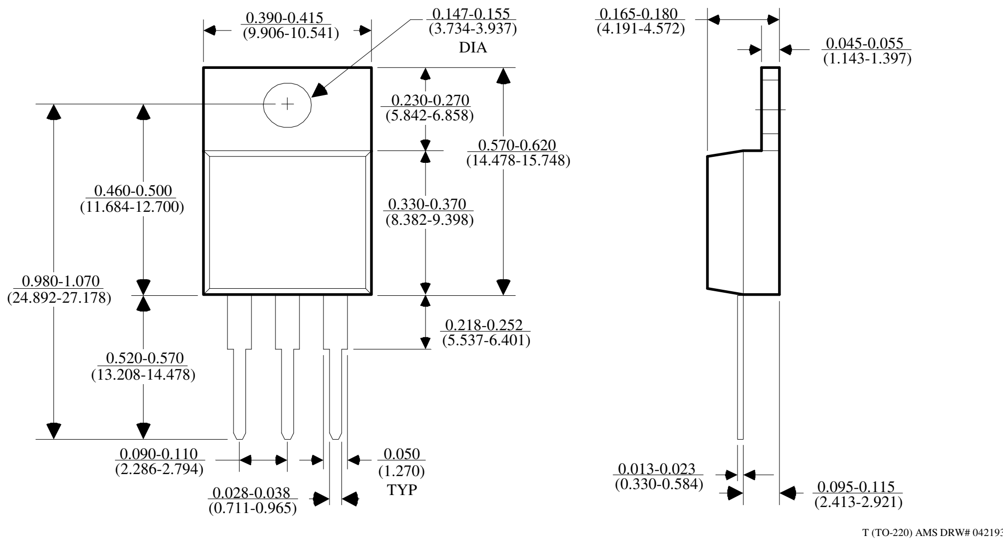
*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

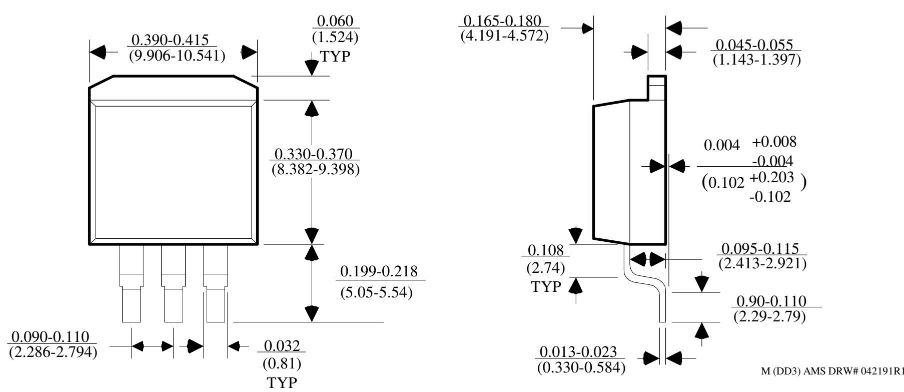
updated April 24, 2009

PACKAGE DIMENSIONS inches (millimeters) unless otherwise noted (Continued).

3 LEAD TO-220 PLASTIC PACKAGE (T)



3 LEAD TO-263 PLASTIC DD (M)



updated April 24, 2009