National Semiconductor

LM2937 500 mA Low Dropout Regulator

General Description

The LM2937 is a positive voltage regulator capable of supplying up to 500 mA of load current. The use of a PNP power transistor provides a low dropout voltage characteristic. With a load current of 500 mA the minimum input to output voltage differential required for the output to remain in regulation is typically 0.5V (1V guaranteed maximum over the full operating temperature range). Special circuitry has been incorporated to minimize the quiescent current to typically only 10 mA with a full 500 mA load current when the input to output voltage differential is greater than 3V.

The LM2937 requires an output bypass capacitor for stability. As with most low dropout regulators, the ESR of this capacitor remains a critical design parameter, but the LM2937 includes special compensation circuitry that relaxes ESR requirements. The LM2937 is stable for all ESR below 3Ω. This allows the use of low ESR chip capacitors.

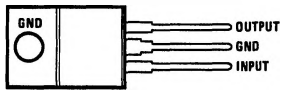
Ideally suited for automotive applications, the LM2937 will protect itself and any load circuitry from reverse battery connections, two-battery jumps and up to +60V/−50V load dump transients. Familiar regulator features such as short circuit and thermal shutdown protection are also built in.

Features

- Fully specified for operation over −40°C to +125°C
- Output current in excess of 500 mA
- Output trimmed for 5% tolerance under all operating conditions
- Typical dropout voltage of 0.5V at full rated load current
- Wide output capacitor ESR range, up to 3Ω
- Internal short circuit and thermal overload protection
- Reverse battery protection
- 60V input transient protection
- Mirror image insertion protection

Connection Diagram and Ordering Information

TO-220 Plastic Package



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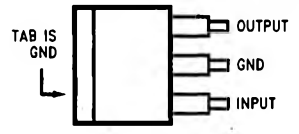
Front View

Order Number LM2937ET-5.0, LM2937ET-8.0, LM2937ET-10, LM2937ET-12 or LM2937ET-15
See NS Package Number T03B

TO-263 Surface-Mount Package



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Top View

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Side View

Order Number LM2937ES-5.0, LM2937ES-8.0, LM2937ES-10, LM2937ES-12 or LM2937ES-15
See NS Package Number TS3B

Temperature Range	Output Voltage					NSC Package Drawing	Package
	5.0	8.0	10	12	15		
−40°C ≤ T_A ≤ 125°C	LM2937ES-5.0	LM2937ES-8.0	LM2937ES-10	LM2937ES-12	LM2937ES-15	TS3B	TO-263
	LM2537ET-5.0	LM2537ET-8.0	LM2537ET-10	LM2537ET-12	LM2537ET-15	T03B	TO-220

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Input Voltage	
Continuous	26V
Transient (t ≤ 100 ms)	60V
Internal Power Dissipation (Note 2)	Internally Limited
Maximum Junction Temperature	150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	230°C
ESD Susceptibility (Note 3)	2 kV

Operating Conditions (Note 1)

Temperature Range (T_J) (Note 2)	−40°C to +125°C
Maximum Input Voltage	26V

Electrical Characteristics

$V_{IN} = V_{NOM} + 5V$ (Note 4), $I_{OUT} = 500$ mA, $C_{OUT} = 10\ \mu F$ unless otherwise indicated. **Boldface limits apply over the entire operating temperature range, −40°C ≤ T_J ≤ +125°C**, all other specifications are for $T_A = T_J = 25°C$.

Output Voltage (V_{OUT})		5V		8V		10V		Units
Parameter	**Conditions**	**Typ**	**Limit**	**Typ**	**Limit**	**Typ**	**Limit**	
Output Voltage	5 mA ≤ I_{OUT} ≤ 0.5A	5.00	4.85 **4.75** 5.15 **5.25**	8.00	7.76 **7.60** 8.24 **8.40**	10.00	9.70 **9.50** 10.30 **10.50**	V(Min) V(Min) V(Max) V(Max)
Line Regulation	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA	15	**50**	24	**80**	30	**100**	mV(Max)
Load Regulation	5 mA ≤ I_{OUT} ≤ 0.5A	5	**50**	8	**80**	10	**100**	mV(Max)
Quiescent Current	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA	2	**10**	2	**10**	2	**10**	mA(Max)
	V_{IN} = (V_{OUT} + 5V), I_{OUT} = 0.5A	10	**20**	10	**20**	10	**20**	mA(Max)
Output Noise Voltage	10 Hz–100 kHz I_{OUT} = 5 mA	150		240		300		μVrms
Long Term Stability	1000 Hrs.	20		32		40		mV
Dropout Voltage	I_{OUT} = 500 mA	0.5	**1.0**	0.5	**1.0**	0.5	**1.0**	V(Max)
	I_{OUT} = 50 mA	110	**250**	110	**250**	110	**250**	mV(Max)
Short-Circuit Current		1.0	**0.6**	1.0	**0.6**	1.0	**0.6**	A(Min)
Peak Line Transient Voltage	t_f < 100 ms, R_L = 100Ω	75	**60**	75	**60**	75	**60**	V(Min)
Maximum Operational Input Voltage			**26**		**26**		**26**	V(Min)
Reverse DC Input Voltage	V_{OUT} ≥ −0.6V, R_L = 100Ω	−30	**−15**	−30	**−15**	−30	**−15**	V(Min)
Reverse Transient Input Voltage	t_r < 1 ms, R_L = 100Ω	−75	**−50**	−75	**−50**	−75	**−50**	V(Min)

Electrical Characteristics

$V_{IN} = V_{NOM} + 5V$ (Note 4), $I_{OUT} = 500$ mA, $C_{OUT} = 10\ \mu F$ unless otherwise indicated. **Boldface limits apply over the entire operating temperature range, $-40°C \le T_J \le +125°C$,** all other specifications are for $T_A = T_J = 25°C$.

Output Voltage (V_{OUT})		12V		15V		Units
Parameter	**Conditions**	**Typ**	**Limit**	**Typ**	**Limit**	
Output Voltage	$5\ mA \le I_{OUT} \le 0.5A$	12.00	11.64 **11.40** 12.36 **12.60**	15.00	14.55 **14.25** 15.45 **15.75**	V (Min) V(Min) V(Max) V(Max)
Line Regulation	$(V_{OUT} + 2V) \le V_{IN} \le 26V$, $I_{OUT} = 5$ mA	36	**120**	45	**150**	mV(Max)
Load Regulation	$5\ mA \le I_{OUT} \le 0.5A$	12	**120**	15	**150**	mV(Max)
Quiescent Current	$(V_{OUT} + 2V) \le V_{IN} \le 26V$, $I_{OUT} = 5$ mA	2	**10**	2	**10**	mA(Max)
	$V_{IN} = (V_{OUT} + 5V)$, $I_{OUT} = 0.5A$	10	**20**	10	**20**	mA(Max)
Output Noise Voltage	10 Hz–100 kHz, $I_{OUT} = 5$ mA	360		450		μVrms
Long Term Stability	1000 Hrs.	44		56		mV
Dropout Voltage	$I_{OUT} = 500$ mA	0.5	**1.0**	0.5	**1.0**	V(Max)
	$I_{OUT} = 50$ mA	110	**250**	110	**250**	mV(Max)
Short-Circuit Current		1.0	**0.6**	1.0	**0.6**	A(Min)
Peak Line Transient Voltage	$t_f < 100$ ms, $R_L = 100\Omega$	75	**60**	75	**60**	V(Min)
Maximum Operational Input Voltage			**26**		**26**	V(Min)
Reverse DC Input Voltage	$V_{OUT} \ge -0.6V$, $R_L = 100\Omega$	−30	**−15**	−30	**−15**	V(Min)
Reverse Transient Input Voltage	$t_r < 1$ ms, $R_L = 100\Omega$	−75	**−50**	−75	**−50**	V(Min)

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device outside of its rated Operating Conditions.

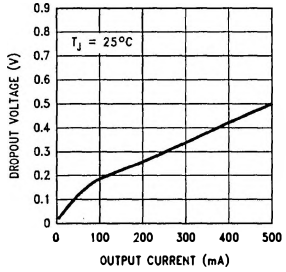
Note 2: The maximum allowable power dissipation at any ambient temperature is $P_{MAX} = (125 - T_A)/\theta_{JA}$, where 125 is the maximum junction temperature for operation, T_A is the ambient temperature, and θ_{JA} is the junction-to-ambient thermal resistance. If this dissipation is exceeded, the die temperature will rise above 125°C and the electrical specifications do not apply. If the die temperature rises above 150°C, the LM2937 will go into thermal shutdown. For the LM2937, the junction-to-ambient thermal resistance θ_{JA} is 65°C/W, for the TO-220, and 73°C/W for the TO-263. When used with a heatsink, θ_{JA} is the sum of the LM2937 junction-to-case thermal resistance θ_{JC} of 3°C/W and the heatsink case-to-ambient thermal resistance. 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 sqaure inches of copper area, θ_{JA} is 32°C/W.

Note 3: ESD rating is based on the human body model, 100 pF discharged through 1.5 kΩ.

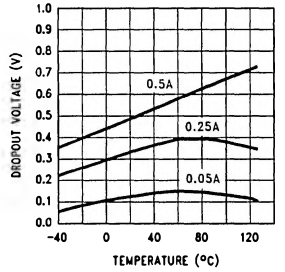
Note 4: Typicals are at $T_J = 25°C$ and represent the most likely parametric norm.

Typical Performance Characteristics

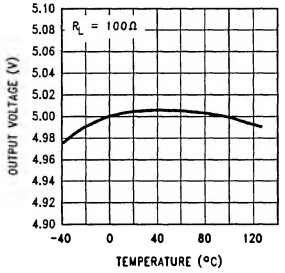
Dropout Voltage vs Output Current



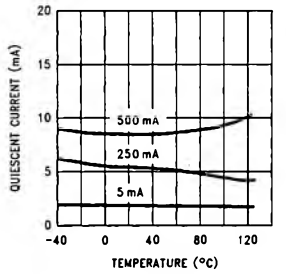
Dropout Voltage vs Temperature



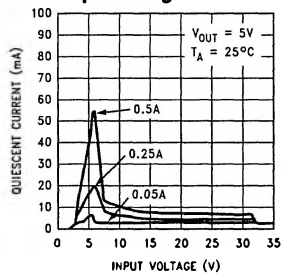
Output Voltage vs Temperature



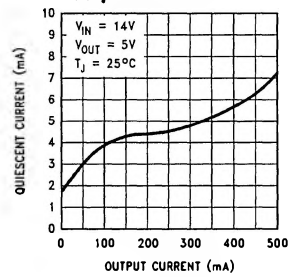
Quiescent Current vs Temperature



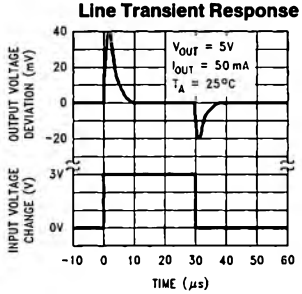
Quiescent Current vs Input Voltage



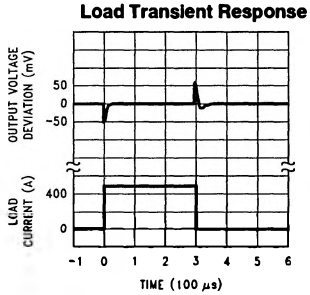
Quiescent Current vs Output Current



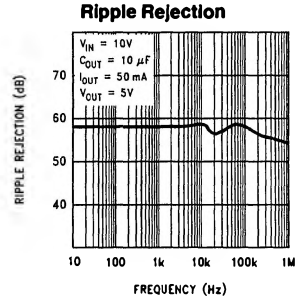
Line Transient Response



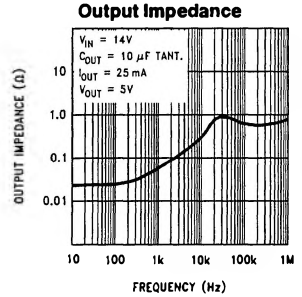
Load Transient Response



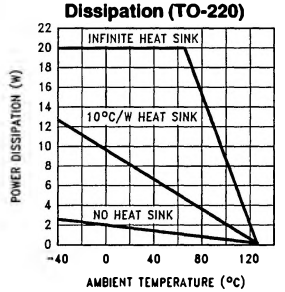
Ripple Rejection



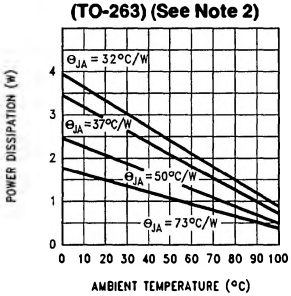
Output Impedance



Maximum Power Dissipation (TO-220)



Maximum Power Dissipation (TO-263) (See Note 2)



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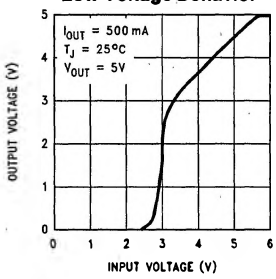
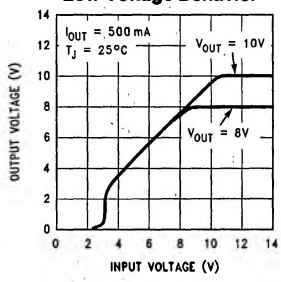
Typical Performance Characteristics (Continued)

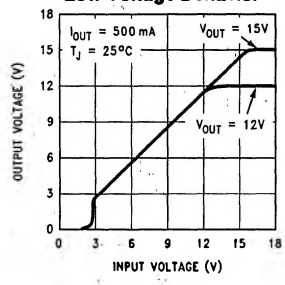
Low Voltage Behavior



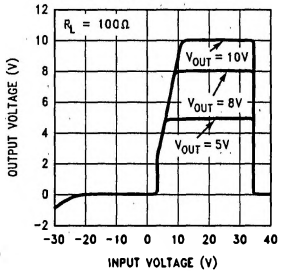
Low Voltage Behavior



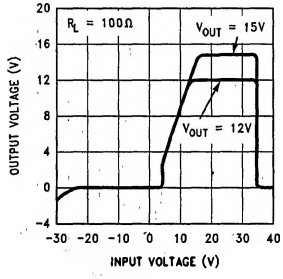
Low Voltage Behavior



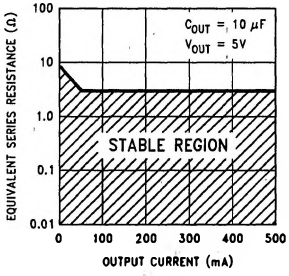
Output at Voltage Extremes



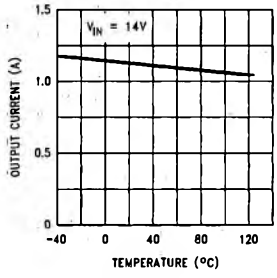
Output at Voltage Extremes



Output Capacitor ESR



Peak Output Current



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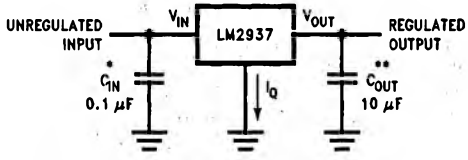
Typical Application



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*Required if the regulator is located more than 3 inches from the power supply filter capacitors.

**Required for stability. C_{out} must be at least 10 μF (over the full expected operating temperature range) and located as close as possible to the regulator. The equivalent series resistance, ESR, of this capacitor may be as high as 3Ω.