LM2937 500-mA Low Dropout Regulator

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 0.5 V at Full Rated Load Current
- Wide Output Capacitor ESR Range, up to 3 Ω
- Internal Short Circuit and Thermal Overload Protection
- Reverse Battery Protection
- 60-V Input Transient Protection
- Mirror Image Insertion Protection

Applications

- Automotive
- Industrial Control
- Point-of-Load regulation

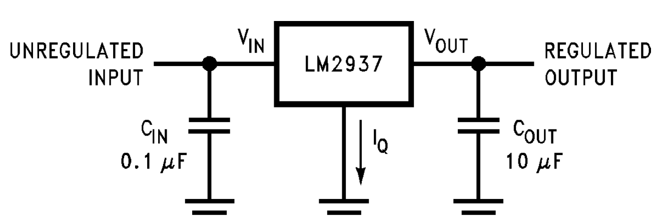
Description

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 0.5 V (1-V ensured 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 3 V.

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 device is stable for all ESR below 3 Ω. This allows the use of low ESR chip capacitors.

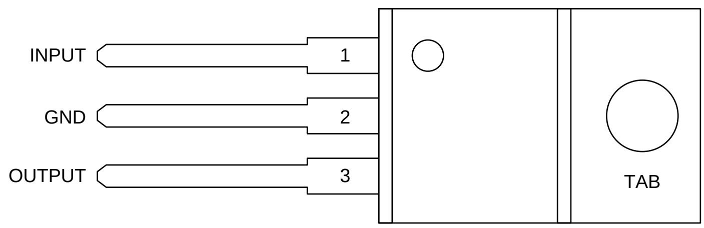
Ideally suited for automotive applications, the LM2937 will protect itself and any load circuitry from reverse battery connections, two-battery jumps, and up to 60-V/−50-V load dump transients. Familiar regulator features such as short circuit and thermal shutdown protection are also built in.

Simplified Schematic

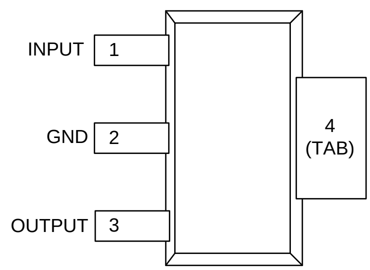


Pin Configuration and Functions

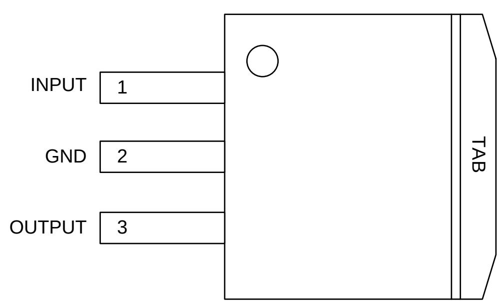
TO-220 Plastic Package (NDE)
3
Top View



SOT-223 Plastic Package (DCY)
4
Top View



DDPAK/TO-263 Surface-Mount Package (KTT)
3
Top View



Pin Functions

PIN				I/O	DESCRIPTION
NAME	NDE	KTT	DCY		
INPUT	1	1	1	I	Unregulated voltage input
GND	2	2	2	—	Ground
OUTPUT	3	3	3	O	Regulated voltage output. This pin requires an output capacitor to maintain stability. See the *Detailed Design Procedure* section for output capacitor details.
GND	TAB	TAB	4	—	Thermal and ground connection. Connect the TAB to a large copper area to remove heat from the device. The TAB is internally connected to device pin 2 (GND). Connect the TAB to GND or leave floating. Do not connect the TAB to any potential other than GND at device pin 2.

Absolute Maximum Ratings[(1)(2)]

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

		MIN	MAX	UNIT
Input voltage (V_{IN})	Continuous		26	V
	Transient (t ≤ 100 ms)		60	
Internal power dissipation[(3)]		Internally limited		
Maximum junction temperature			150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
(3) The maximum allowable power dissipation at any ambient temperature is $P_{MAX} = (125°C - T_A)/R_{\theta JA}$, where 125 is the maximum junction temperature for operation, T_A is the ambient temperature, and $R_{\theta JA}$ 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.

Handling Ratings

			MIN	MAX	UNIT
T_{stg}	Storage temperature range		−65	150	°C
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins[(1)]	–2000	2000	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions[(1)]

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

	MIN	NOM	MAX	UNIT
Junction temperature (T_J) [(2)]	−40		85	°C
Input voltage (V_{IN})	V_{OUT} + 1V		26	V

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The maximum allowable power dissipation at any ambient temperature is $P_{MAX} = (125°C - T_A)/R_{\theta JA}$, where 125°C is the maximum junction temperature for operation, T_A is the ambient temperature, and $R_{\theta JA}$ 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.

Electrical Characteristics: LM2937-5

Unless otherwise specified: $V_{IN} = V_{OUT(NOM)} + 5$ V; $I_{OUT(MAX)} = 500$ mA for the TO-220 and DDPAK/TO-263 packages; $I_{OUT(MAX)} = 400$ mA for the SOT-223 package; and $C_{OUT} = 10$ µF. Conditions and the associated minimum and maximum limits apply over the Recommended Operating temperature range for the specific package, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage	$T_A = T_J = 25°C$, 5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	4.85	5	5.15	V
	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	4.75	5	5.25	V
Line regulation	(V_{OUT} + 2 V) ≤ V_{IN} ≤ 26 V, I_{OUT} = 5 mA		15	50	mV
Load regulation	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$		5	50	mV
Quiescent Current	(V_{OUT} + 2 V) ≤ V_{IN} ≤ 26 V, I_{OUT} = 5 mA		2	10	mA
	V_{IN} = (V_{OUT} + 5 V), I_{OUT} = $I_{OUT(MAX)}$		10	20	mA
Output noise voltage	10 Hz to 100 kHz, I_{OUT} = 5 mA		150		µVrms
Long-term stability	1000 Hrs.		20		mV
Dropout voltage	I_{OUT} = $I_{OUT(MAX)}$		0.5	1	V
	I_{OUT} = 50 mA		110	250	mV
Short-circuit current		0.6	1		A
Peak line transient voltage	tf < 100 ms, R_L = 100 Ω	60	75		V
Maximum operational input voltage		26			V
Reverse DC input voltage	V_{OUT} ≥ −0.6 V, R_L = 100 Ω	–15	–30		V
Reverse transient input voltage	tr < 1 ms, R_L = 100 Ω	–50	–75		V

Electrical Characteristics: LM2937-8

Unless otherwise specified: $V_{IN} = V_{OUT(NOM)} + 5$ V; $I_{OUT(MAX)} = 500$ mA for the TO-220 and DDPAK/TO-263 packages; $I_{OUT(MAX)} = 400$ mA for the SOT-223 package; and $C_{OUT} = 10$ µF. Conditions and the associated Minimum and Maximum limits apply over the Recommended Operating temperature range for the specific package, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage	$T_A = T_J = 25°C$, 5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	7.76	8	8.24	V
	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	7.6	8	8.4	V
Line regulation	(V_{OUT} + 2 V) ≤ V_{IN} ≤ 26 V, I_{OUT} = 5 mA		24	80	mV
Load regulation	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$		8	80	mV
Quiescent Current	(V_{OUT} + 2 V) ≤ V_{IN} ≤ 26 V, I_{OUT} = 5 mA		2	10	mA
	V_{IN} = (V_{OUT} + 5 V), I_{OUT} = $I_{OUT(MAX)}$		10	20	mA
Output noise voltage	10 Hz to 100 kHz, I_{OUT} = 5 mA		240		µVrms
Long-term stability	1000 Hrs.		32		mV
Dropout voltage	I_{OUT} = $I_{OUT(MAX)}$		0.5	1	V
	I_{OUT} = 50 mA		110	250	mV
Short-circuit current		0.6	1		A
Peak line transient voltage	tf < 100 ms, R_L = 100 Ω	60	75		V
Maximum operational input voltage		26			V
Reverse DC input voltage	V_{OUT} ≥ −0.6 V, R_L = 100 Ω	–15	–30		V
Reverse transient input voltage	tr < 1 ms, R_L = 100 Ω	–50	–75		V

Electrical Characteristics: LM2937-10

Unless otherwise specified: $V_{IN} = V_{OUT(NOM)} + 5$ V; $I_{OUT(MAX)} = 500$ mA for the TO-220 and DDPAK/TO-263 packages; $I_{OUT(MAX)} = 400$ mA for the SOT-223 package; and $C_{OUT} = 10$ µF. Conditions and the associated Minimum and Maximum limits apply over the Recommended Operating temperature range for the specific package, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage	$T_A = T_J = 25°C$, 5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	9.7	10	10.3	V
	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	9.5	10	10.5	V
Line regulation	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA		30	100	mV
Load regulation	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$		10	100	mV
Quiescent Current	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA		2	10	mA
	V_{IN} = (V_{OUT} + 5V), I_{OUT} = $I_{OUT(MAX)}$		10	20	mA
Output noise voltage	10 Hz to 100 kHz, I_{OUT} = 5 mA		300		µVrms
Long-term stability	1000 Hrs.		40		mV
Dropout voltage	I_{OUT} = $I_{OUT(MAX)}$		0.5	1	V
	I_{OUT} = 50 mA		110	250	mV
Short-circuit current		0.6	1		A
Peak line transient voltage	tf < 100 ms, R_L = 100 Ω	60	75		V
Maximum operational input voltage		26			V
Reverse DC input voltage	V_{OUT} ≥ −0.6 V, R_L = 100 Ω	–15	–30		V
Reverse transient input voltage	tr < 1 ms, R_L = 100 Ω	–50	–75		V

Electrical Characteristics: LM2937-12

Unless otherwise specified: $V_{IN} = V_{OUT(NOM)} + 5$ V; $I_{OUT(MAX)} = 500$ mA for the TO-220 and DDPAK/TO-263 packages; $I_{OUT(MAX)} = 400$ mA for the SOT-223 package; and $C_{OUT} = 10$ µF. Conditions and the associated Minimum and Maximum limits apply over the Recommended Operating temperature range for the specific package, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage	$T_A = T_J = 25°C$, 5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	11.64	12	12.36	V
	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	11.4	12	12.6	V
Line regulation	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA		36	120	mV
Load regulation	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$		12	120	mV
Quiescent Current	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA		2	10	mA
	V_{IN} = (V_{OUT} + 5V), I_{OUT} = $I_{OUT(MAX)}$		10	20	mA
Output noise voltage	10 Hz to 100 kHz, I_{OUT} = 5 mA		360		µVrms
Long-term stability	1000 Hrs.		44		mV
Dropout voltage	I_{OUT} = $I_{OUT(MAX)}$		0.5	1	V
	I_{OUT} = 50 mA		110	250	mV
Short-circuit current		0.6	1		A
Peak line transient voltage	tf < 100 ms, R_L = 100 Ω	60	75		V
Maximum operational input voltage		26			V
Reverse DC input voltage	V_{OUT} ≥ −0.6 V, R_L = 100 Ω	–15	–30		V
Reverse transient input voltage	tr < 1 ms, R_L = 100 Ω	–50	–75		V

Electrical Characteristics: LM2937-15

Unless otherwise specified: $V_{IN} = V_{OUT(NOM)} + 5$ V; $I_{OUT(MAX)} = 500$ mA for the TO-220 and DDPAK/TO-263 packages; $I_{OUT(MAX)} = 400$ mA for the SOT-223 package; and $C_{OUT} = 10$ μF. Conditions and the associated Minimum and Maximum limits apply over the Recommended Operating temperature range for the specific package, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Output voltage	$T_A = T_J = 25°C$, 5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	14.55	15	15.45	V
	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$	14.25	15	15.75	V
Line regulation	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA		45	150	mV
Load regulation	5 mA ≤ I_{OUT} ≤ $I_{OUT(MAX)}$		15	150	mV
Quiescent Current	(V_{OUT} + 2V) ≤ V_{IN} ≤ 26V, I_{OUT} = 5 mA		2	10	mA
	V_{IN} = (V_{OUT} + 5V), I_{OUT} = $I_{OUT(MAX)}$		10	20	mA
Output noise voltage	10 Hz to 100 kHz, I_{OUT} = 5 mA		450		μVrms
Long-term stability	1000 Hrs.		56		mV
Dropout voltage	I_{OUT} = $I_{OUT(MAX)}$		0.5	1	V
	I_{OUT} = 50 mA		110	250	mV
Short-circuit current		0.6	1		A
Peak line transient voltage	tf < 100 ms, R_L = 100 Ω	60	75		V
Maximum operational input voltage		26			V
Reverse DC input voltage	V_{OUT} ≥ −0.6 V, R_L = 100 Ω	–15	–30		V
Reverse transient input voltage	tr < 1 ms, R_L = 100 Ω	–50	–75		V

Typical Characteristics

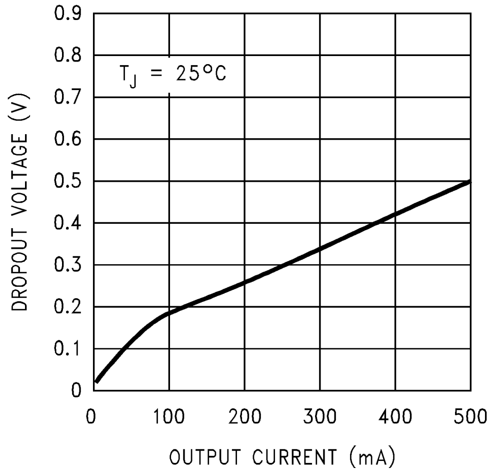


Figure 1. Dropout Voltage vs. Output Current

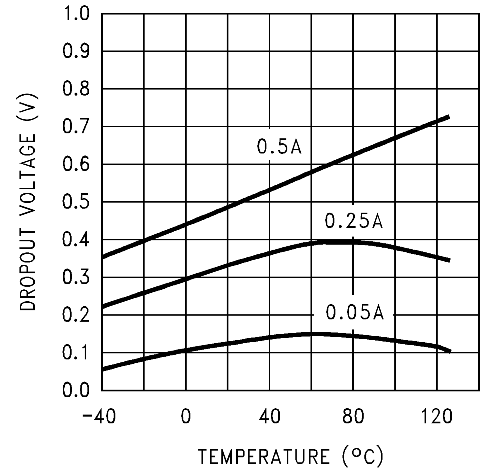


Figure 2. Dropout Voltage vs. Temperature

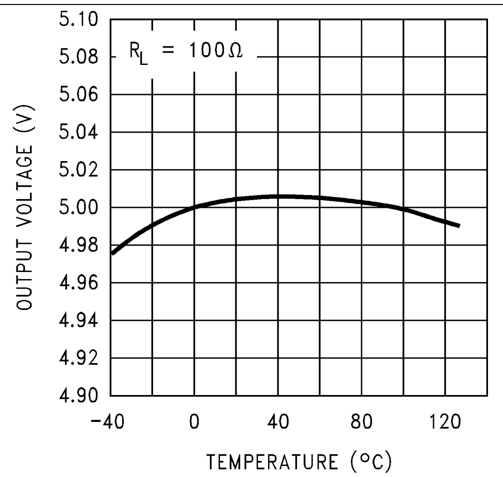


Figure 3. Output Voltage vs. Temperature

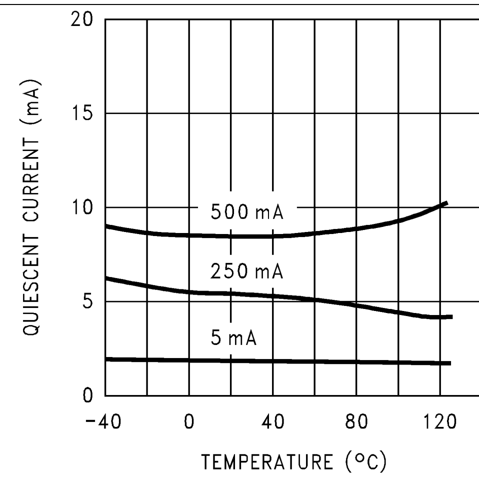


Figure 4. Quiescent Current vs. Temperature

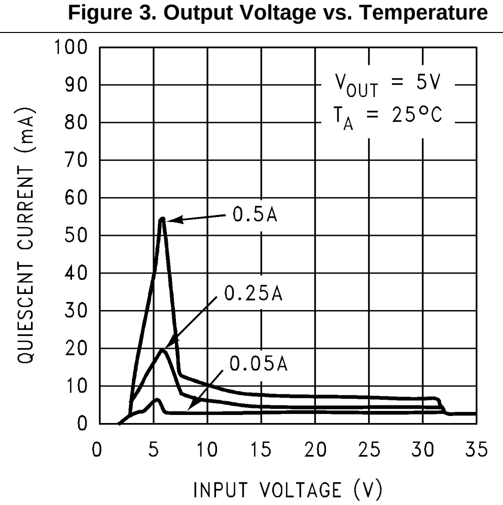


Figure 5. Quiescent Current vs. Input Voltage

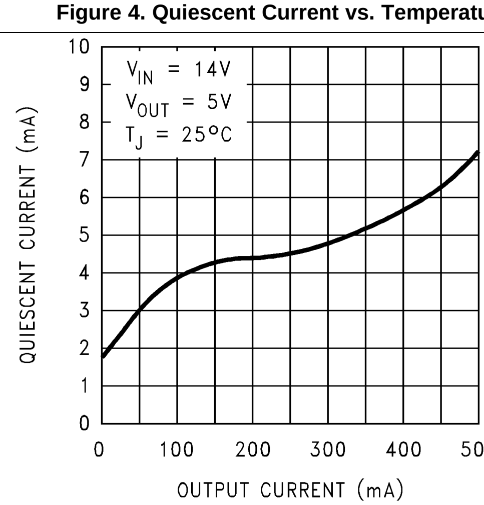


Figure 6. Quiescent Current vs. Output Current

Typical Characteristics (continued)

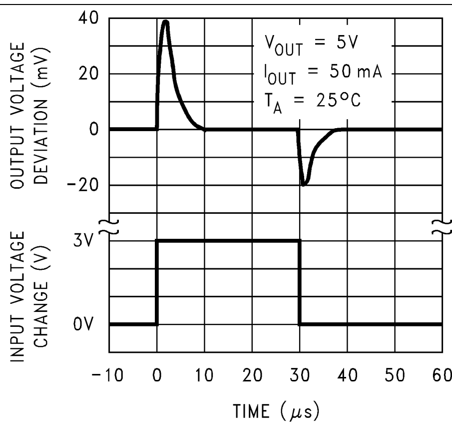


Figure 7. Line Transient Response

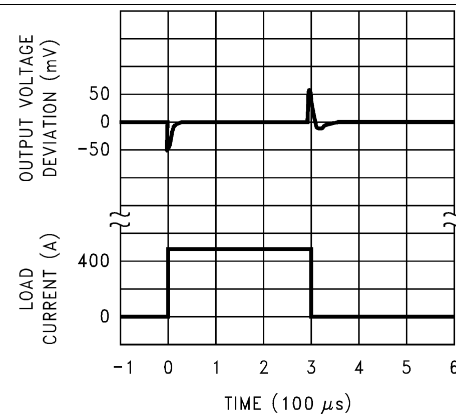


Figure 8. Load Transient Response

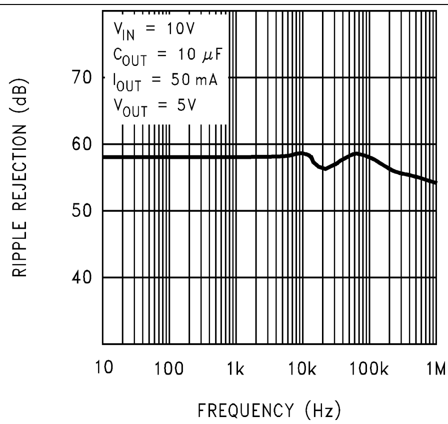


Figure 9. Ripple Rejection

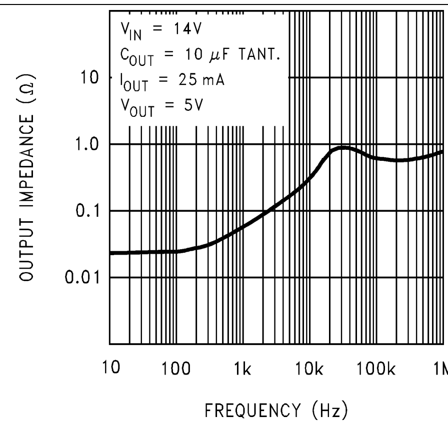


Figure 10. Output Impedence

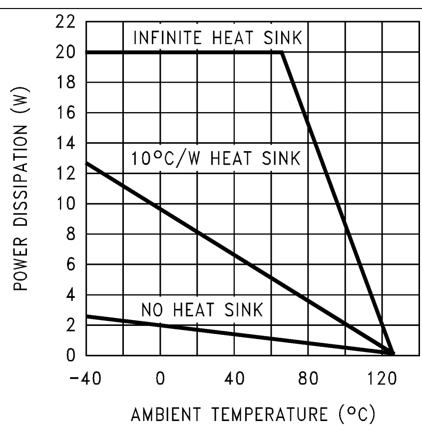


Figure 11. Maximum Power Dissipation (TO-220)[1]

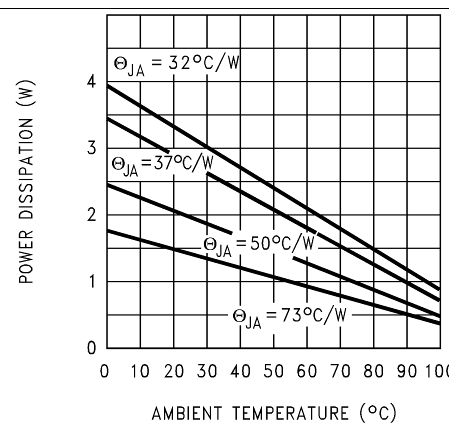


Figure 12. Maximum Power Dissipation (DDPAK/TO-263)

1. The maximum allowable power dissipation at any ambient temperature is $P_{MAX} = (125°C - T_A)/R_{\theta JA}$, where 125 is the maximum junction temperature for operation, T_A is the ambient temperature, and $R_{\theta JA}$ 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.

Typical Characteristics (continued)

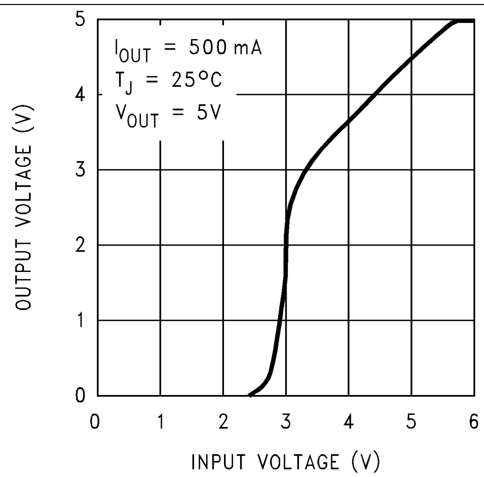


Figure 13. Low-Voltage Behavior

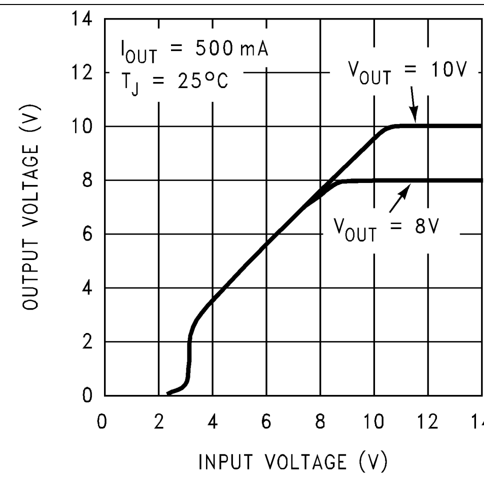


Figure 14. Low-Voltage Behavior

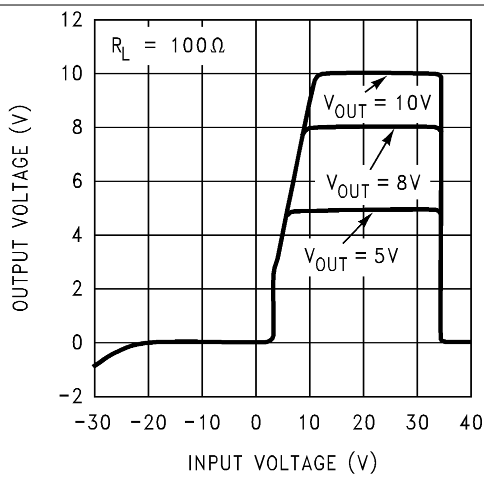


Figure 15. Output at Voltage Extremes

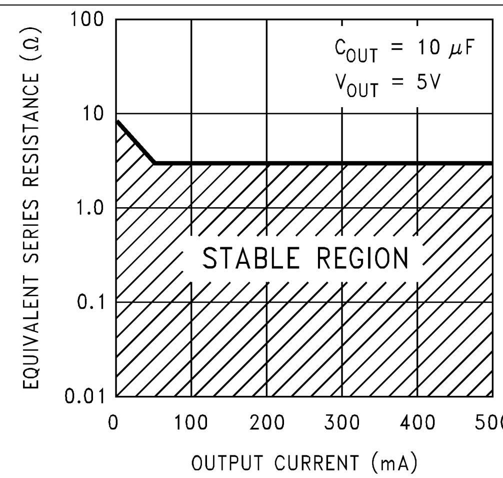


Figure 16. Output Capacitor ESR

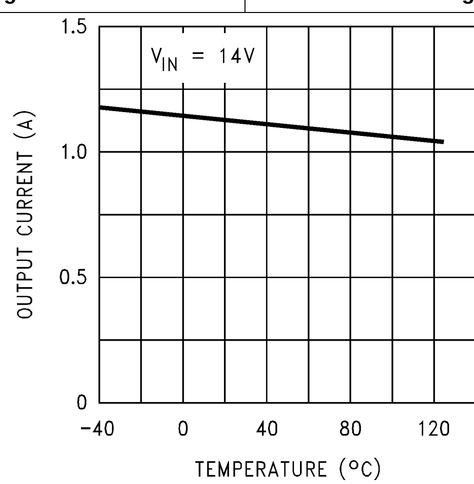
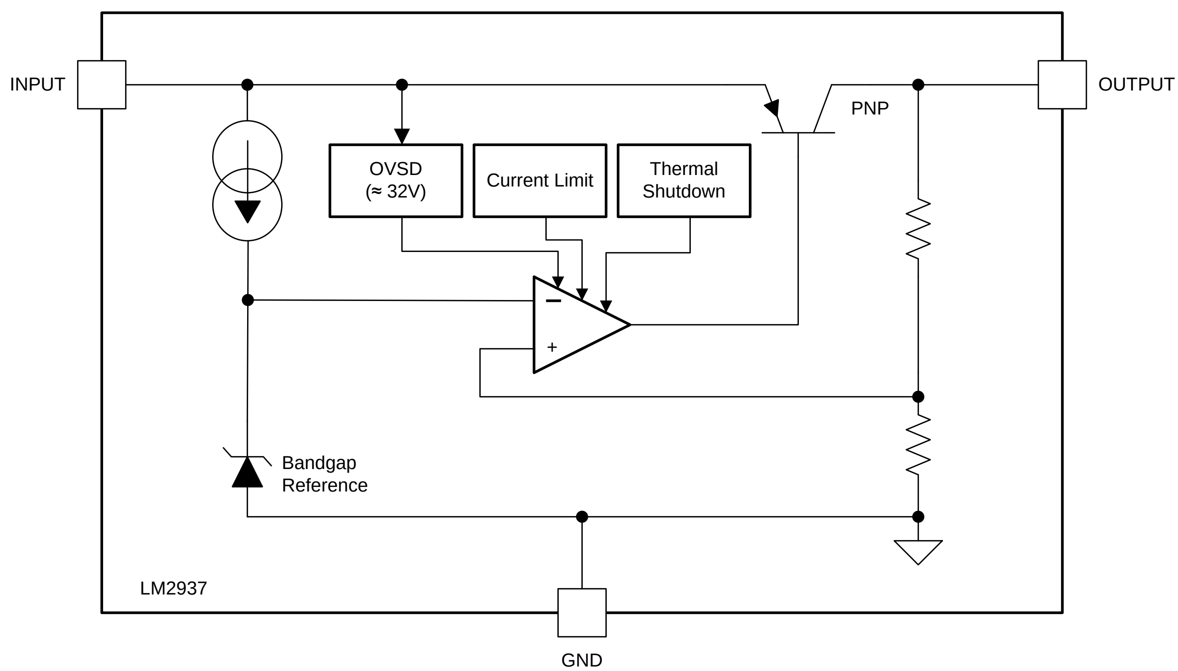


Figure 17. Peak Output Current

Overview

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 0.5 V (1 V ensured 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 3 V.

Functional Block Diagram



Thermal Shutdown (TSD)

The Thermal Shutdown circuitry of the LM2937 has been designed to protect the device against temporary thermal overload conditions. The TSD circuitry is not intended to replace proper heat-sinking. Continuously running the LM2937 device at thermal shutdown may degrade device reliability as the junction temperature will be exceeding the absolute maximum junction temperature rating.

Short Circuit Current Limit

The output current limiting circuitry of the LM2937 has been designed to limit the output current in cases where the load impedance is unusually low. This includes situations where the output may be shorted directly to ground. Continuous operation of the LM2937 at the current limit will typically result in the LM2937 transitioning into Thermal Shutdown mode.

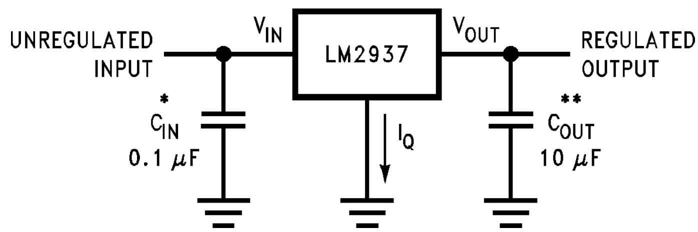
Overvoltage Shutdown (OVSD)

Input voltages greater than typically 32 V will cause the LM2937 output to be disabled. When operating with the input voltage greater than the maximum recommended input voltage of 26 V the device performance is not ensured. Continuous operation with the input voltage greater than the maximum recommended input voltage is discouraged.

Device Functional Modes

The LM2937 design does not include any undervoltage lock-out (UVLO), or enable functions. Generally, the output voltage will track the input voltage until the input voltage is greater than V_{OUT} + 1V. When the input voltage is greater than V_{OUT} + 1V the LM2937 will be in linear operation, and the output voltage will be regulated; however, the device will be sensitive to any small perturbation of the input voltage. Device dynamic performance is improved when the input voltage is at least 2 V greater than the output voltage.

Typical Application



LM2937 Typical Application

*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 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 3 Ω.

Important statement:

Huaguan Semiconductor Co,Ltd. reserves the right to change the products and services provided without notice. Customers should obtain the latest relevant information before ordering, and verify the timeliness and accuracy of this information.

Customers are responsible for complying with safety standards and taking safety measures when using our products for system design and machine manufacturing to avoid potential risks that may result in personal injury or property damage.

Our products are not licensed for applications in life support, military, aerospace, etc., so we do not bear the consequences of the application of these products in these fields.

Our documentation is only permitted to be copied without any tampering with the content, so we do not accept any responsibility or liability for the altered documents.