National Semiconductor Corporation

PRELIMINARY

LM2940 1A Low Dropout Regulator

General Description

The LM2940 positive voltage regulator features the ability to source 1A of output current with a dropout voltage of typically 0.5V and a maximum of 1V over the entire temperature range. Futhermore, a quiescent current reduction circuit has been included which reduces the ground current when the differential between the input voltage and the output voltage exceeds approximately 3V. The quiescent current with 1A of output current and an input-output differential of 5V is therefore only 30 mA. Higher quiescent currents only exist when the regulator is in the dropout mode ($V_{in} - V_{out} \leq 3V$).

Designed also for vehicular applications, the LM2940 and all regulated circuitry are protected from reverse battery installations or 2 battery jumps. During line transients, such as load dump (60V) when the input voltage can momentarily exceed the specified maximum operating voltage, the regulator will automatically shut down to protect both the internal circuits and the load. The LM2940 cannot be harmed by temporary mirror-image insertion. Familiar regulator features such as short circuit and thermal overload protection are also provided.

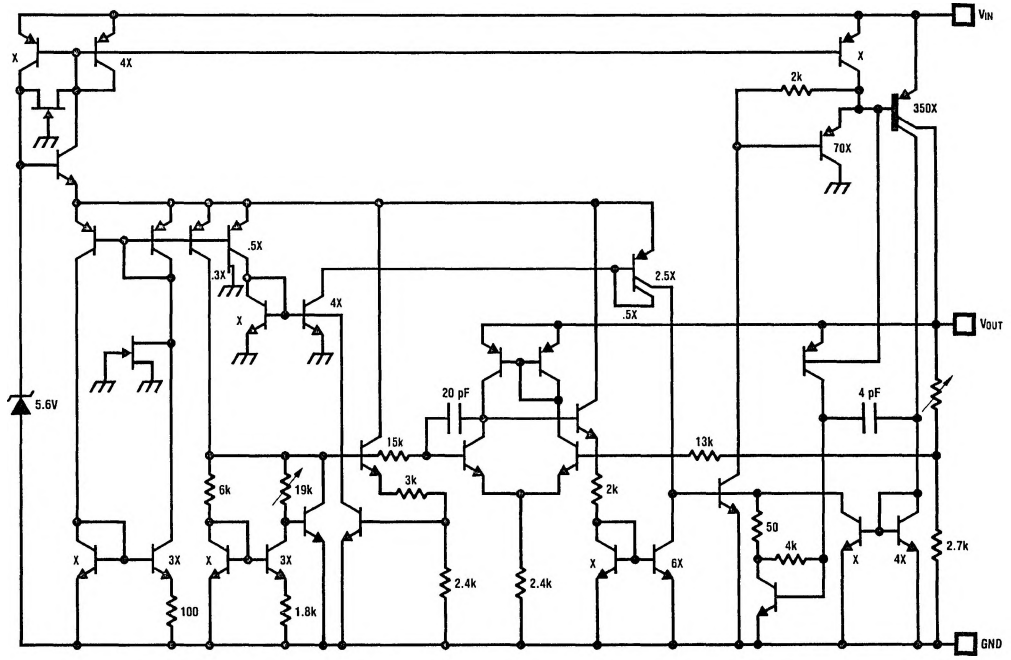
Features

- Dropout voltage typically 0.5V @I_o = 1A
- Output current in excess of 1A
- Output trimmed before assembly
- Reverse battery protection
- Internal short circuit current limit
- Mirror image insertion protection
- 100% electrical burn-in in thermal limit

Output Voltages

LM2940T-5.0	5V
LM2940T-8.0	8V
LM2940T-10	10V

Equivalent Schematic Diagram



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Order Number LM2940T-5.0, LM2940T-8.0, LM2940T-10
See NS Package Number TO3B

Absolute Maximum Ratings

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

Input Voltage
- Survival Voltage (≤ 100 ms) 60V
- Operational Voltage 26V

Internal Power Dissipation (Note 1) Internally Limited

Operating Temperature Range (T_A) −40°C to +125°C

Maximum Junction Temperature 150°C

Storage Temperature Range −65°C to +150°C

Lead Temperature (Soldering, 10 seconds) 230°C

ESD susceptibility rating is to be determined

Electrical Characteristics $V_{in} = V_o + 5V$, $I_o = 1A$, $C_{out} = 22\ \mu F$, $T_j = 25°C$ unless otherwise specified.

Output Voltage (V_o)		5V			8V			10V			Units
Parameter	**Conditions**	**Typ**	**Tested Limit (Note 2)**	**Design Limit (Note 3)**	**Typ**	**Tested Limit (Note 2)**	**Design Limit (Note 3)**	**Typ**	**Tested Limit (Note 2)**	**Design Limit (Note 3)**	
		6.25V ≤ V_{IN} ≤ 26V			**9.4V ≤ V_{IN} ≤ 26V**			**11.5V ≤ V_{IN} ≤ 26V**			
Output Voltage	5 mA ≤ I_o ≤ 1A	5.00	4.85 5.15	4.75 5.25	8.00	7.76 8.24	7.60 8.40	10.00	9.70 10.30	9.50 10.50	V_{MIN} V_{MAX}
Line Regulation	$V_o + 2V \le V_{in} \le 26V$, $I_o = 5$ mA	20	50		20	80		20	100		mV_{MAX}
Load Regulation	50 mA ≤ I_o ≤ 1A	35	50	80	55	80	130	65	100	165	mV_{MAX}
Output Impedance	100 mADC and 20 mArms $f_o = 120$ Hz	35			55			65			mΩ
Quiescent Current	$V_o + 2V \le V_{in} < 26V$, $I_o = 5$ mA	10	15	20	10	15	20	10	15	20	mA_{MAX}
	$V_{in} = V_o + 5V$, $I_o = 1A$	30	45	60	30	45	60	30	45	60	mA_{MAX}
Output Noise Voltage	10 Hz − 100 kHz $I_o = 5$ mA	150			240			300			μV_{RMS}
Ripple Rejection	$f_o = 120$ Hz, 1 Vrms; $I_l = 100$ mA	72	60	54	66	54	48	63	51	45	dB_{MIN}
Long Term Stability		20			32			36			mV/ 1000 Hr
Dropout Voltage	$I_o = 1A$	0.5	0.8	1.0	0.5	0.8	1.0	0.5	0.8	1.0	V_{MAX}
	$I_o = 100$ mA	110	150	200	110	150	200	110	150	200	mV_{MAX}
Short Circuit Current		1.9	1.6		1.9	1.6		1.9	1.6		A_{MIN}
Maximum Line Transient	$R_o = 100\ \Omega$ T ≤ 100 ms	$V_o \le 6V$			$V_o < 9V$			$V_o < 11V$			
		75	60	60	75	60	60	75	60	60	V_{MIN}
Maximum Operational Input Voltage		31	26	26	31	26	26	31	26	26	V_{dc}
Reverse Polarity Input Voltage DC	$R_O = 100\ \Omega$	−30	−15	−15	−30	−15	−15	−30	−15	−15	V_{MIN}
Reverse Polarity Input Voltage Transient	T ≤ 100 ms, $R_o = 100\ \Omega$	−75	−50	−50	−75	−50	−50	−75	−50	−50	V_{MIN}

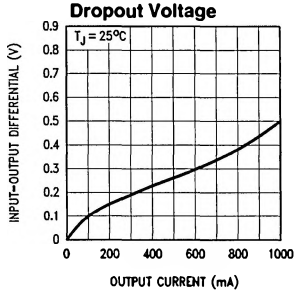
Note 1: Thermal resistance without a heatsink for junction-to-case temperature is 3°C/W. Thermal resistance case-to-ambient is 50°C/W.

Note 2: Tested Limits are guaranteed and 100% production tested.

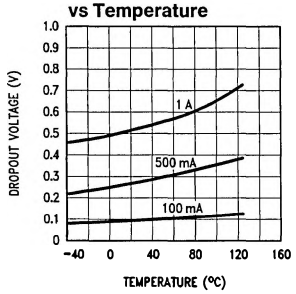
Note 3: Design Limits are guaranteed (but not 100% production tested) over the operating temperature and supply voltage range. These limits are not used to calculate outgoing quality levels.

Typical Performance Characteristics

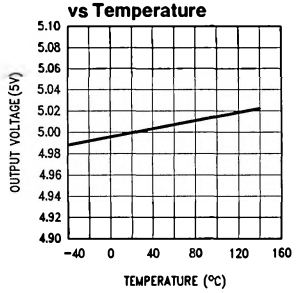
Dropout Voltage



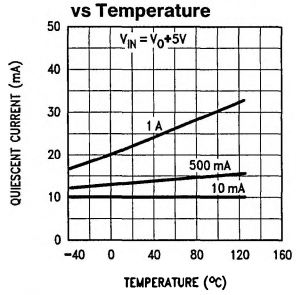
Dropout Voltage vs Temperature



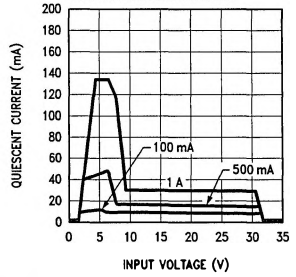
Output Voltage vs Temperature



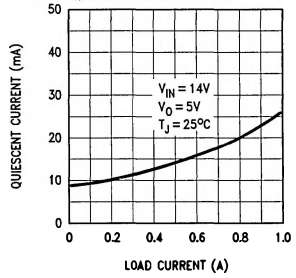
Quiescent Current vs Temperature



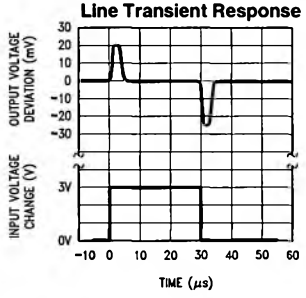
Quiescent Current



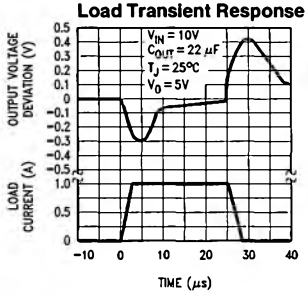
Quiescent Current



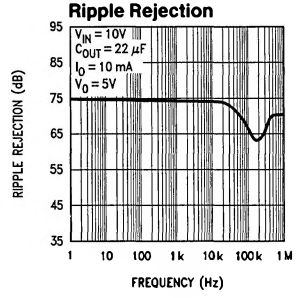
Line Transient Response



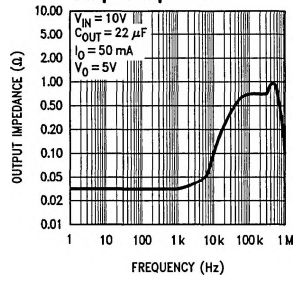
Load Transient Response



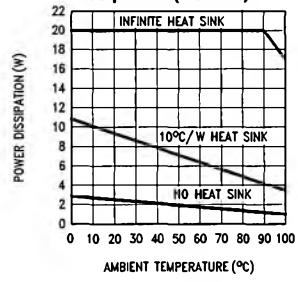
Ripple Rejection



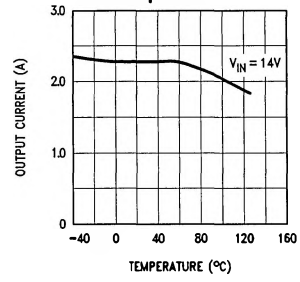
Output Impedance



Maximum Power Dissipation (TO-220)



Peak Output Current



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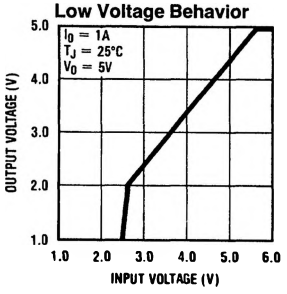
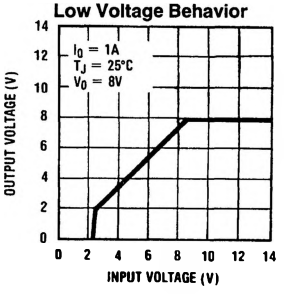
Typical Performance Characteristics (Continued)

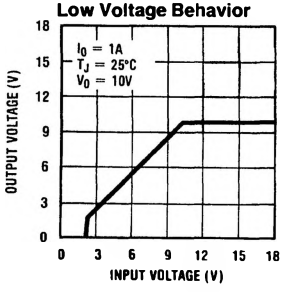
Low Voltage Behavior



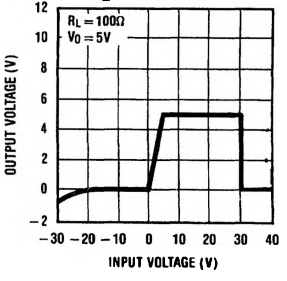
Low Voltage Behavior



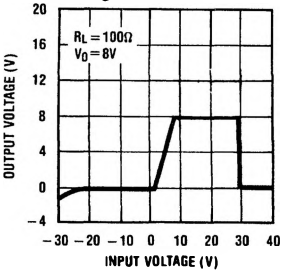
Low Voltage Behavior



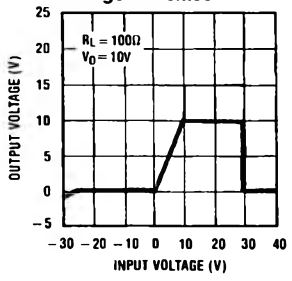
Output at Voltage Extremes



Output at Voltage Extremes



Output at Voltage Extremes



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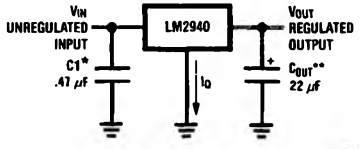
Typical Application



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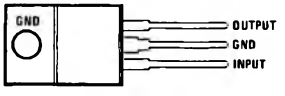
*Required if regulator is located far from power supply filter.

**C_{OUT} must be at least 22 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 and should have an ESR less than 1Ω to maintain stability.

Connection Diagram

(TO-220) Plastic Package



TL/H/8822–2

Front View
Order Number LM2940T-5.0, LM2940T-8.0, LM2940T-10
See NS Package Number T03B

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 (V_O + 5V) 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.

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