National Semiconductor

LM2941C 1A Low Dropout Adjustable Regulator

General Description

The LM2941C positive voltage regulator features the ability to source 1A of output current with a typical dropout voltage of 0.5V and a maximum of 1V over the entire temperature range. Furthermore, a quiescent current reduction circuit has been included which reduces the ground pin 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 ($V_{IN} - V_{OUT} \leq 3V$).

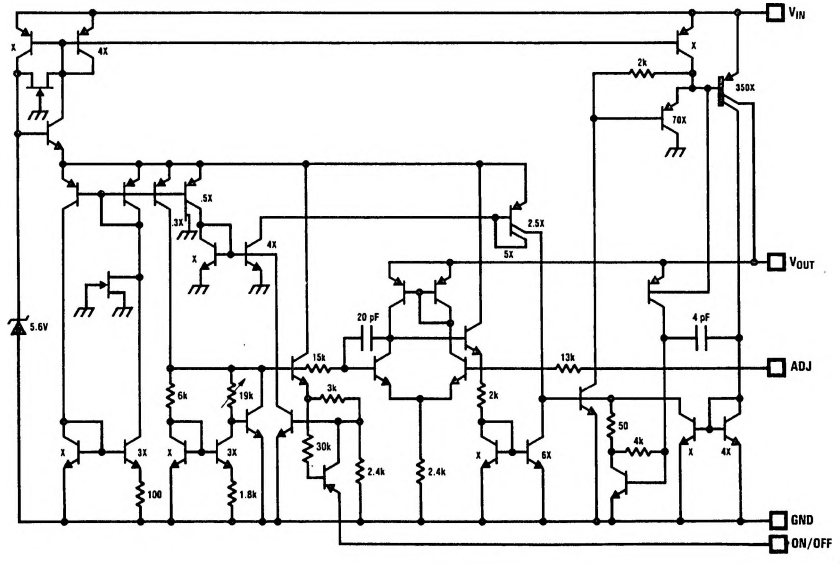
Low dropout voltage, coupled with 1A current capability, makes the LM2941C useful in applications where the input voltage is maintained at a level within one or two volts of the output voltage. Operation at these low input-output voltage differentials reduces regulator power dissipation and increases overall system efficiency.

The LM2941C can be used to provide on-board regulation and post-switcher regulation. Other applications include fault protected 1A switches.

Features

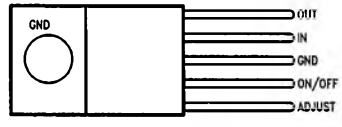
- Output voltage adjustable from 5V to 20V
- Dropout voltage typically 0.5V @ I_O = 1A
- Output current in excess of 1A
- Trimmed reference voltage
- Reverse battery protection
- Internal short circuit current limit
- Mirror image insertion protection
- 100% electrical burn-in in thermal limit
- TTL, CMOS compatible ON/OFF switch

Equivalent Schematic and Connection Diagram



TL/H/10367–1

(TO-220)
Plastic Package



TL/H/10367–2

Front View
Order Number LM2941CT
See NS Package Number TO5A

Absolute Maximum Ratings

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

Input Voltage
- Survival Voltage (≤ 100 ms) 45V
- Operational Voltage 26V

Internal Power Dissipation (Note 1) Internally limited

Operating Temperature Range (T_A) 0°C to +125°C

Maximum Junction Temperature 150°C

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

Lead Temperature (Soldering, 10 seconds) 260°C

ESD susceptibility rating is to be determined.

Electrical Characteristics

$5V \le V_O \le 20V$, $V_{IN} = V_O + 5V$, $C_O = 22\ \mu F$, $T_J = 25°C$ (unless otherwise specified)

Parameter	Conditions	Typ	Tested Limit (Note 2)	Design Limit (Note 3)	Units (Limits)
Reference Voltage	5 mA ≤ I_O ≤ 1A, (Note 4)	1.275	1.237 1.313	1.211 1.339	V(min) V(max)
Line Regulation	$V_O + 2V \le V_{IN} \le 26V$, I_O = 5 mA	4	10		mV/V(max)
Load Regulation	50 mA ≤ I_O ≤ 1A	7	10		mV/V(max)
Output Impedance	100 mADC and 20 mArms f_O = 120 Hz	7			mΩ/V
Quiescent Current	$V_O + 2V \le V_{IN} < 26V$, I_O = 5 mA	10	15		mA(max)
	$V_{IN} = V_O + 5V$, I_O = 1A	30	45	60	mA(max)
RMS Output Noise, % of V_{OUT}	10 Hz–100 kHz I_O = 5 mA	0.003			%
Ripple Rejection	f_O = 120 Hz, 1 Vrms, I_L = 100 mA	0.005	0.02		%/V(max)
Long Term Stability		0.4			%/1000 Hr
Dropout Voltage	I_O = 1A	0.5	0.8	1.0	V(max)
	I_O = 100 mA	110	200	200	mV(max)
Short Circuit Current	V_{IN} max = 26V (Note 5)	1.9	1.6		A(min)
Maximum Line Transient	V_O max 1V above nominal V_O R_O = 100Ω, T ≤ 100 ms	55	45		V(min)
Maximum Operational Input Voltage		31	26		V_{DC}
Reverse Polarity DC Input Voltage	R_O = 100Ω, $V_O \ge -0.6V$	−30	−15		V(min)
Reverse Polarity Transient Input Voltage	T ≤ 100 ms, R_O = 100Ω	−55	−45		V(min)
ON/OFF Threshold Voltage ON	I_O ≤ 1A	1.30	0.80		V(max)
ON/OFF Threshold Voltage OFF	I_O ≤ 1A	1.30	2.00		V(min)
ON/OFF Threshold Current	$V_{ON/OFF}$ = 2.0V I_O ≤ 1A	50	100		μA(max)

Note 1: The maximum power dissipation is a function of $T_{J(max)}$, θ_{JA} and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(max)} - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2941C will go into thermal shutdown. For the LM2941C, the junction-to-ambient thermal resistance is 53°C/W, and the junction-to-case thermal resistance is 3°C/W.

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

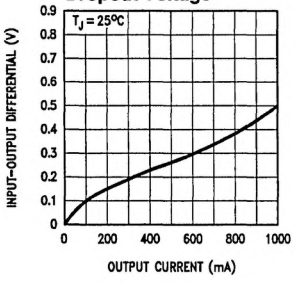
Note 3: Design Limits are guaranteed (but not 100% production tested) over the operating temperature and supply voltage range. These limits are not used to calculate outgoing quality levels.

Note 4: The output voltage range is 5V to 20V and is determined by the two external resistors, R1 and R2. See Typical Application Circuit.

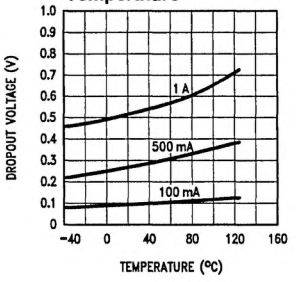
Note 5: Output current will decrease with increasing temperature, but will not go below 1A at the maximum specified temperatures.

Typical Performance Characteristics

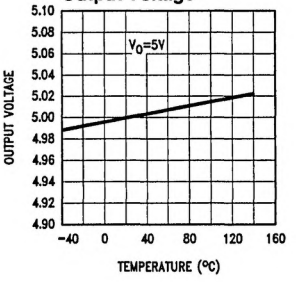
Dropout Voltage



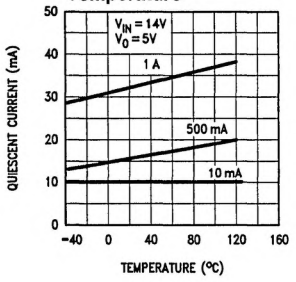
Dropout Voltage vs Temperature



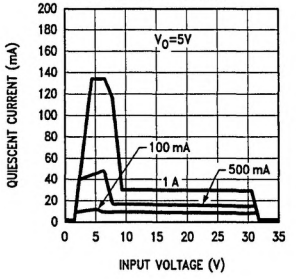
Output Voltage



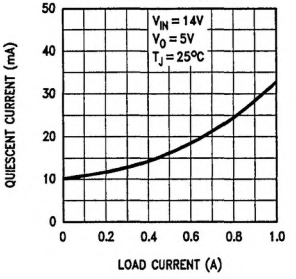
Quiescent Current vs Temperature



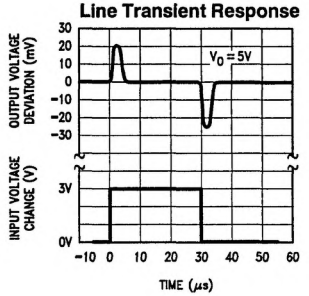
Quiescent Current



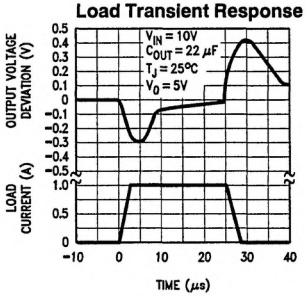
Quiescent Current



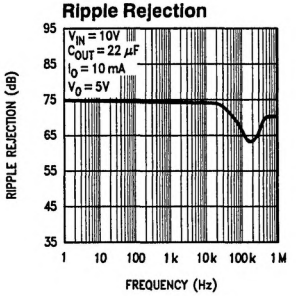
Line Transient Response



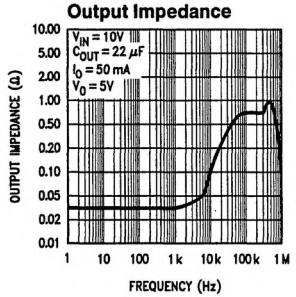
Load Transient Response



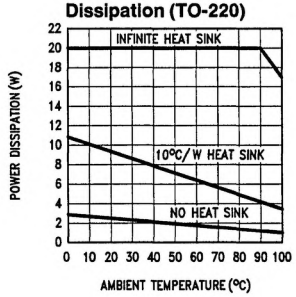
Ripple Rejection



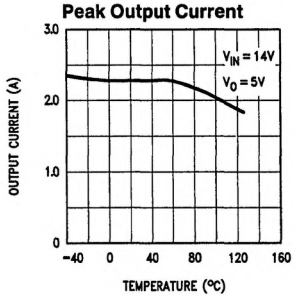
Output Impedance



Maximum Power Dissipation (TO-220)

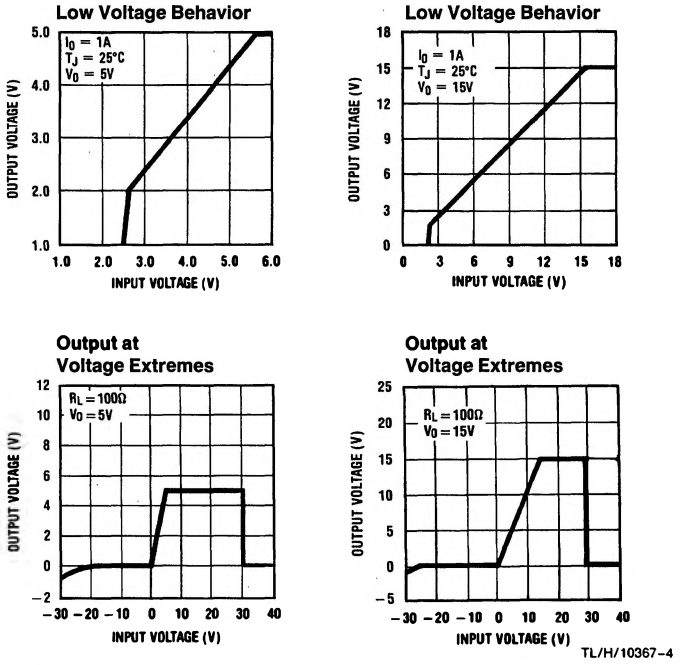


Peak Output Current



TL/H/10367–3

Typical Performance Characteristics (Continued)



TL/H/10367–4

Definition of Terms

Dropout Voltage: The input-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_{OUT} + 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.

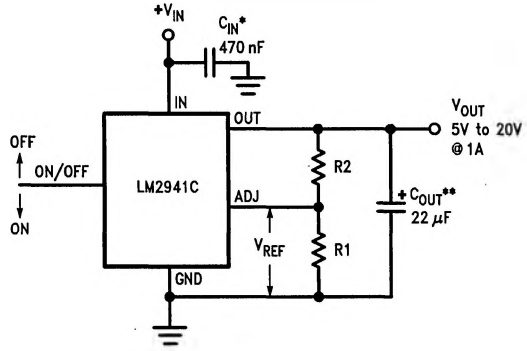
Quiescent Current: That part of the positive input current that does not contribute to the positive load current. The regulator ground lead current.

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 percentage change in output voltage for a thermal variation from room temperature to either temperature extreme.

Typical Applications

5V to 20V Adjustable Regulator



TL/H/10367–5

V_{OUT} = Reference voltage $\times \frac{R1 + R2}{R1}$ where V_{REF} = 1.275 typical

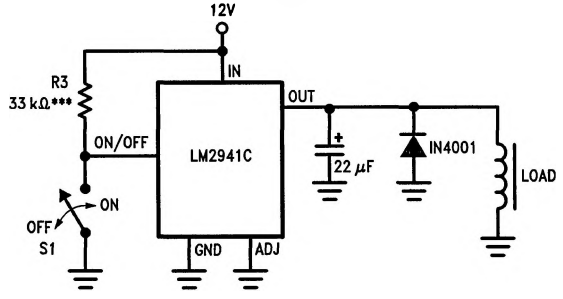
Solving for R2: $R2 = R1\left(\frac{V_O}{V_{REF}} - 1\right)$

Note: Using 1k for R1 will ensure that the input bias current error of the adjust pin will be negligible. Do not bypass R1 or R2. This will lead to instabilities.

*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.

1A Switch



TL/H/10367–6

***To assure shutdown, select resistor R3 to guarantee at least 300 μA of pull-up current when S1 is open. (Assume 2V at the ON/OFF pin.)