National Semiconductor

August 25, 2009

LM2941QML

1A Low Dropout Adjustable Regulator

General Description

The LM2941 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 30mA. Higher quiescent currents only exist when the regulator is in the dropout mode ($V_I - V_O \leq 3V$).

Originally designed for vehicular applications, the LM2941 and all regulated circuitry are protected from reverse battery installations or two-battery jumps. During line transients, such as load dump 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. Familiar regulator features such as short circuit and thermal overload protection are also provided.

Features

- Available with radiation guarantee
  — ELDRS Free 100 krad(Si)
- 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
- TTL, CMOS compatible ON/OFF switch

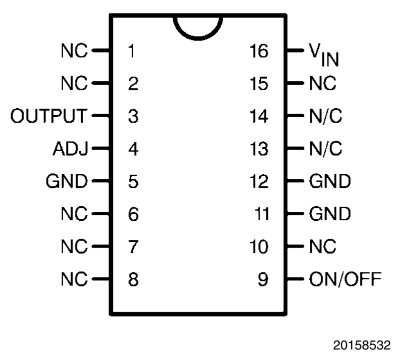
Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM2941WG/883	5962-9166701QYA	WG16A	16LD Ceramic SOIC
LM2941WG-QMLV	5962-9166701VYA	WG16A	16LD Ceramic SOIC
LM2941WGRLQMLV **ELDRS FREE** *(Note 10)*	5962R9166702VYA 100 krad(Si)	WG16A	16LD Ceramic SOIC
LM2941 MDE **ELDRS FREE** *(Note 10)*	5962R9166702V9A 100 krad(Si)	*(Note 1)*	Bare Die

Note 1: FOR ADDITIONAL DIE INFORMATION, PLEASE VISIT THE HI REL WEB SITE AT: www.national.com/analog/space/level_die

Connection Diagrams

16-Lead Ceramic Surface Mount Package



Top View
See NS Package Number WG16A

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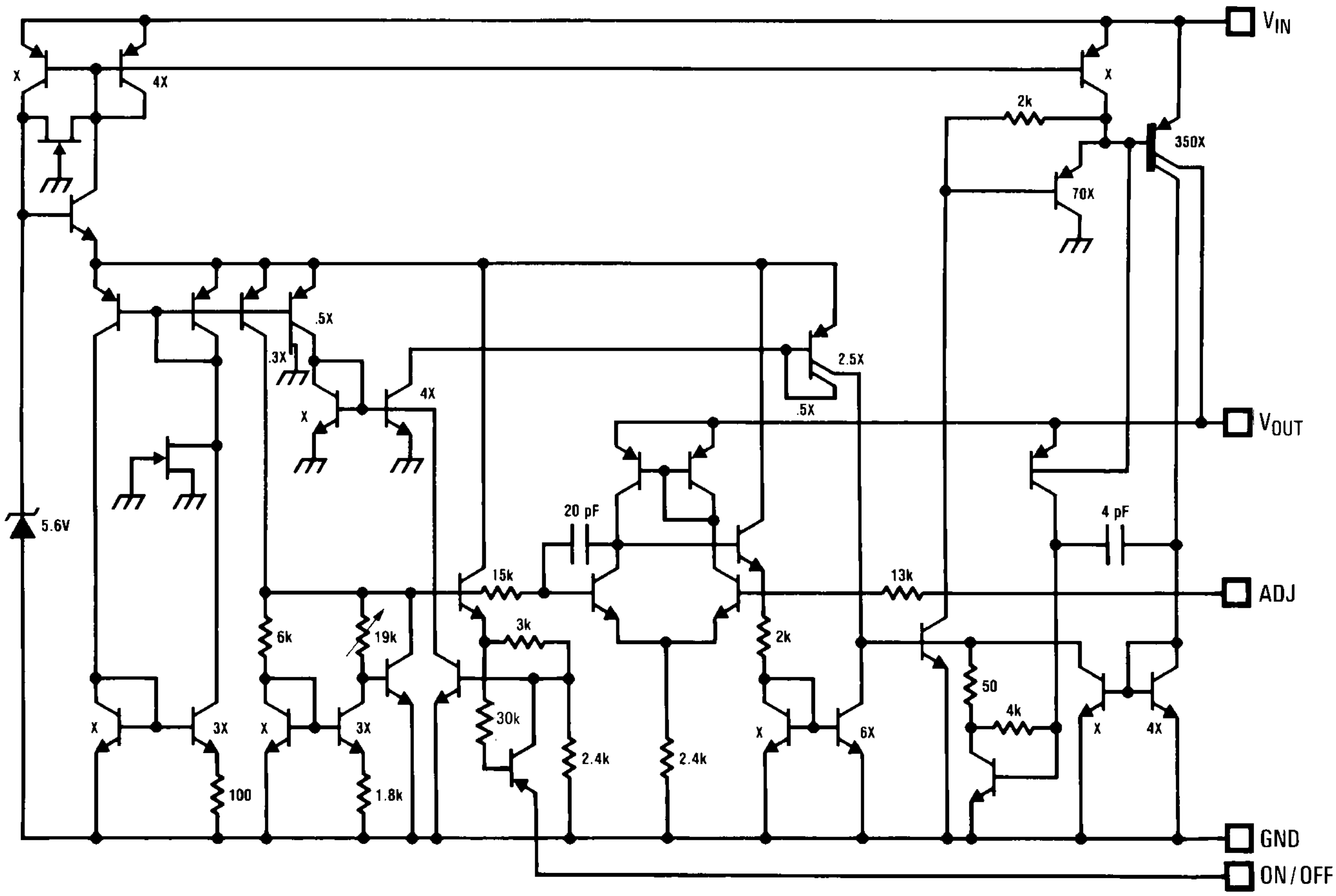
Equivalent Schematic Diagram



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Absolute Maximum Ratings *(Note 2)*

Input Voltage (Survival Voltage, ≤ 100ms)	60V
Internal Power Dissipation *(Note 3)*	Internally Limited
Maximum Junction Temperature	150°C
Storage Temperature Range	$-65°C \le T_J \le +150°C$
Lead Temperature (Soldering, 10 seconds)	300°C
Thermal Resistance	
θ_{JA}	
Ceramic SOIC (Still Air)	122°C/W
Ceramic SOIC (500LF/Min Air Flow)	77°C/W
θ_{JC}	
Ceramic SOIC *(Note 4)*	5°C/W
Package Weight (Typ)	
Ceramic SOIC	360mg
ESD susceptibility to be determined. *(Note 5)*	500V

Recommended Operating Conditions

Maximum Input Voltage	26V
Temperature Range	$-55°C \le T_A \le 125°C$

Quality Conformance Inspection

Mil-Std-883, Method 5005 - Group A

Subgroup	Description	Temp °C
1	Static tests at	25
2	Static tests at	125
3	Static tests at	-55
4	Dynamic tests at	25
5	Dynamic tests at	125
6	Dynamic tests at	-55
7	Functional tests at	25
8A	Functional tests at	125
8B	Functional tests at	-55
9	Switching tests at	25
10	Switching tests at	125
11	Switching tests at	-55
12	Settling time at	25
13	Settling time at	125
14	Settling time at	-55

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LM2941 Electrical Characteristics

DC Parameters

The following conditions apply, unless otherwise specified.

DC: $5V \leq V_O \leq 20V$, $V_{IN} = V_O+5V$, $C_O = 22\mu F$

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	$5mA \leq I_O \leq 1A$		1.237	1.313	V	1
				1.211	1.339	V	2, 3
V_{RLine}	Line Regulation	$V_O + 2V \leq V_{IN} \leq 26V$, $I_O = 5mA$	(Note 8)		10	mV/V	1, 2, 3
V_{RLoad}	Load Regulation	$50mA \leq I_O \leq 1A$, $V_{IN} = 10V$, $V_{OUT} = 5V$	(Note 8)		10	mV/V	1, 2, 3
		$50mA \leq I_O \leq 1A$, $V_{IN} = 25V$, $V_{OUT} = 20V$			10	mV/V	1, 2, 3
I_Q	Quiescent Current	$V_O + 2V \leq V_{IN} \leq 26V$, $I_O = 5mA$			15	mA	1
					20	mA	2, 3
		$V_{IN} = V_O + 5V$, $I_O = 1A$			45	mA	1
					60	mA	2, 3
V_{DO}	Dropout Voltage	$I_O = 1A$			0.8	V	1
					1.0	V	2, 3
		$I_O = 100mA$			200	mV	1
					300	mV	2, 3
I_{SC}	Short Circuit Current	$V_{IN\ Max} = 26V$		1.6	3.5	A	1
				1.3	3.7	A	2, 3
	Maximum Operational Input Voltage		(Note 7)		26	V_{DC}	1, 2, 3
	Reverse Polarity DC Input Voltage	$R_O = 100\Omega$, $V_O \geq -0.6V$	(Note 6)	-15		V	1, 2, 3
$V_{TH\ On}$	ON/OFF Threshold Voltage ON	$I_O \leq 1A$	(Note 6)		0.8	V	1, 2, 3
$V_{Th\ Off}$	ON/OFF Threshold Voltage OFF	$I_O \leq 1A$	(Note 6)	2.00		V	1, 2, 3
	ON/OFF Threshold Current	$V_{ON/OFF} = 2.0V$, $I_O \leq 1A$			100	μA	1
					300	μA	2, 3

AC Parameters

The following conditions apply, unless otherwise specified.

AC: $5V \leq V_O \leq 20V$, $V_{IN} = V_O+5V$, $C_O = 22\mu F$

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
	Maximum Line Transient	$V_{O\ Max}$ 1V above nominal V_O, $R_O = 100\Omega$, $t \leq 100mS$		60		V	4, 5, 6
	Reverse Polarity Transient Input Voltage	$t \leq 100mS$, $R_O = 100\Omega$		-50		V	4, 5, 6
RR	Ripple Rejection	$f_O = 1KHz$, 1 V_{RMS}, $I_L = 100mA$	(Note 9)		0.02	%/V	4
		$f_O = 1KHz$, 1 V_{RMS}, $I_L = 100mA$	(Note 9)		0.04	%/V	5, 6

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DC Drift Parameters

The following conditions apply, unless otherwise specified.

DC: $5V \leq V_O \leq 20V$, $V_{IN} = V_O+5V$, $C_O = 22\mu F$

Delta calculations performed on QMLV devices at group B , subgroup 5.

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
V_{Ref}	Reference Voltage	$5mA \leq I_O \leq 1A$		-25	+25	mV	1

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 3: The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (package junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $P_{Dmax} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower.

Note 4: The package material for these devices allows much improved heat transfer over our standard ceramic packages. In order to take full advantage of this improved heat transfer, heat sinking must be provided between the package base (directly beneath the die), and either metal traces on, or thermal vias through, the printed circuit board. Without this additional heat sinking, device power dissipation must be calculated using θ_{JA}, rather than θ_{JC}, thermal resistance. It must not be assumed that the device leads will provide substantial heat transfer out of the package, since the thermal resistance of the lead frame material is very poor, relative to the material of the package base. The stated θ_{JC} thermal resistance is for the package material only, and does not account for the additional thermal resistance between the package base and the printed circuit board. The user must determine the value of the additional thermal resistance and must combine this with the stated value for the package, to calculate the total allowed power dissipation for the device.

Note 5: Human body model, 1.5 kΩ in series with 100 pF.

Note 6: Functional test go-no-go only.

Note 7: Condition for V_{IN}

Note 8: Limit = mV per volt of V_O.

Note 9: %/V = % of V_{IN} per Volt of V_O.

Note 10: These parts are tested on a wafer by wafer basis at high and low dose rates according to MIL-STD-883 Test Method 1019 Conditions A and D with no enhanced low dose rate sensitivity (ELDRS). Pre and post irradiation limits are identical to those listed under AC and DC electrical characteristics.

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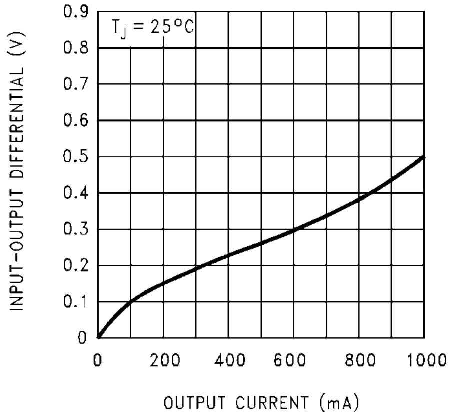
Typical Performance Characteristics

Dropout Voltage



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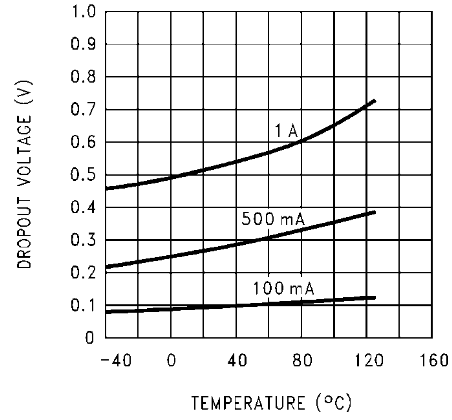
Dropout Voltage vs. Temperature



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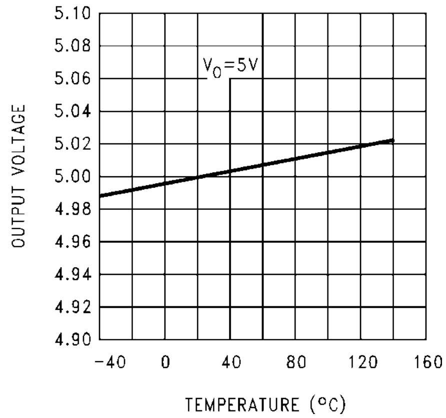
Output Voltage



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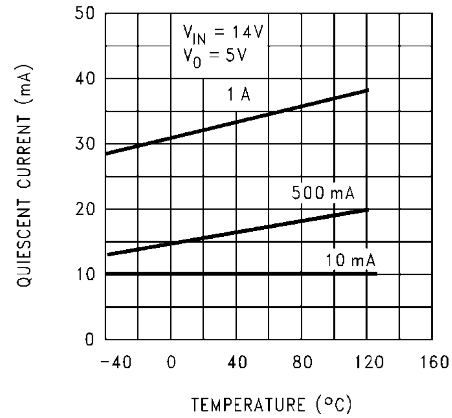
Quiescent Current vs. Temperature



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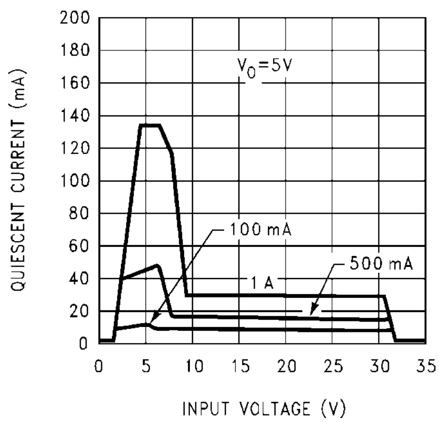
Quiescent Current



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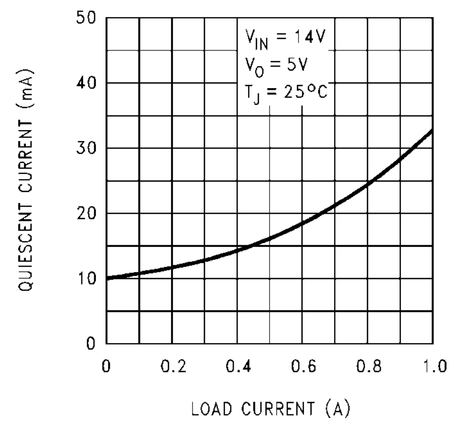
Quiescent Current



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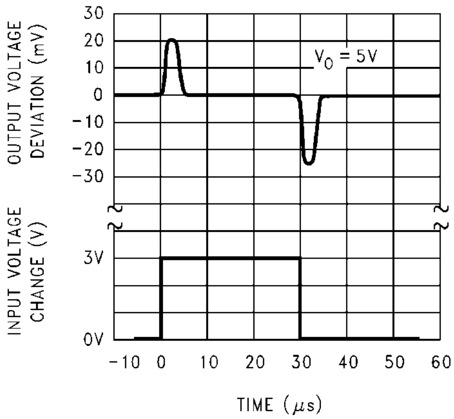
Line Transient Response



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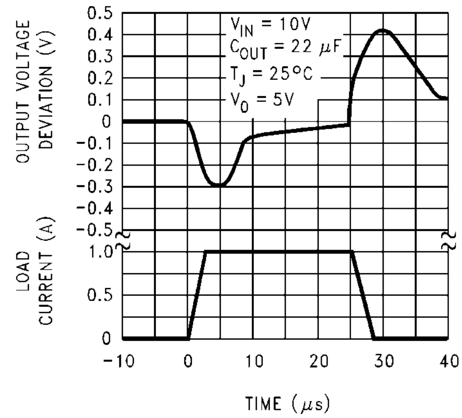
Load Transient Response



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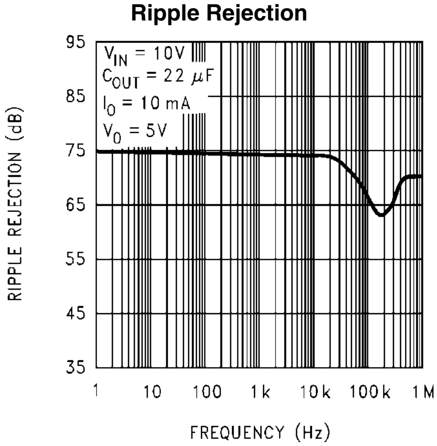
Ripple Rejection



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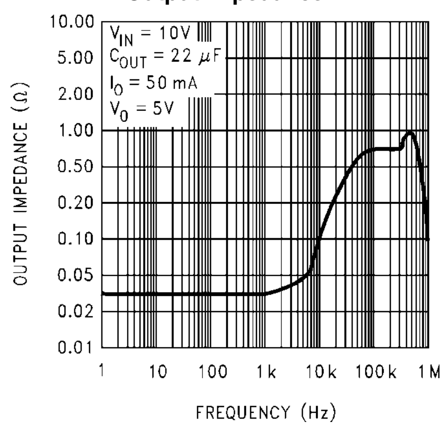
Output Impedance



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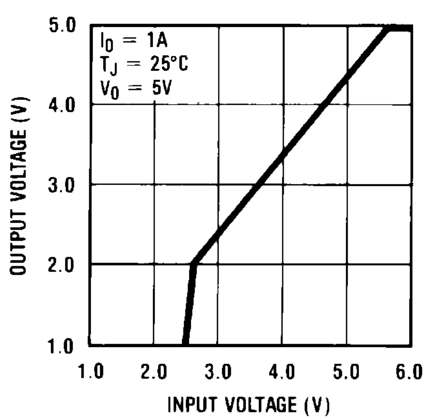
Low Voltage Behavior



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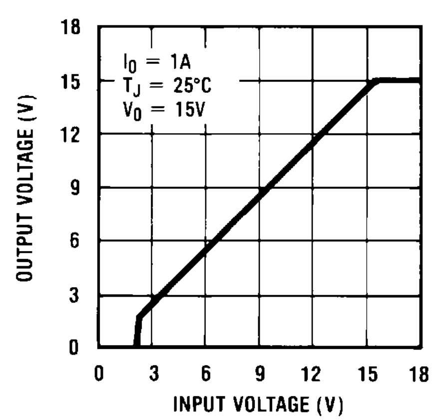
Low Voltage Behavior



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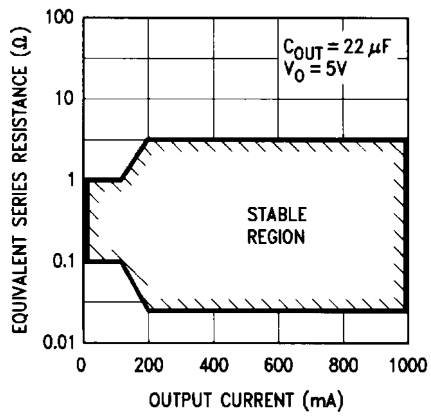
Output Capacitor ESR



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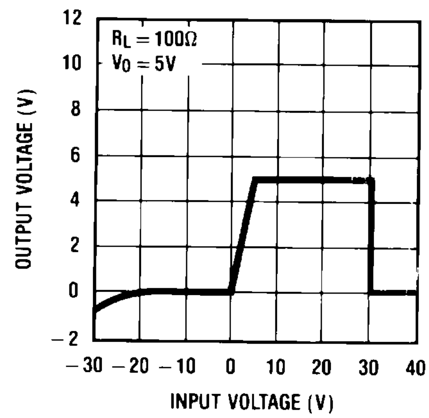
Output at Voltage Extremes



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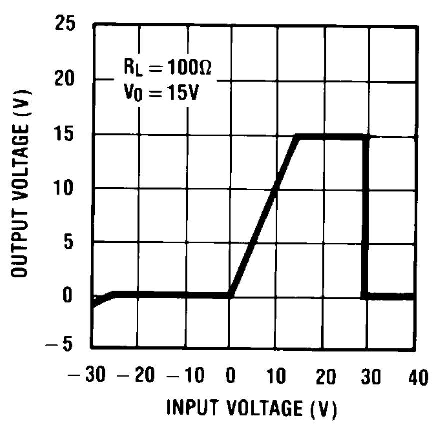
Output at Voltage Extremes



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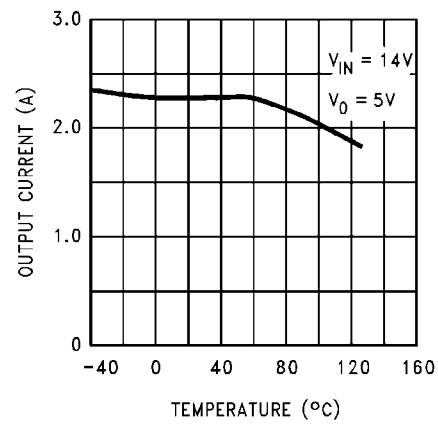
Peak Output Current



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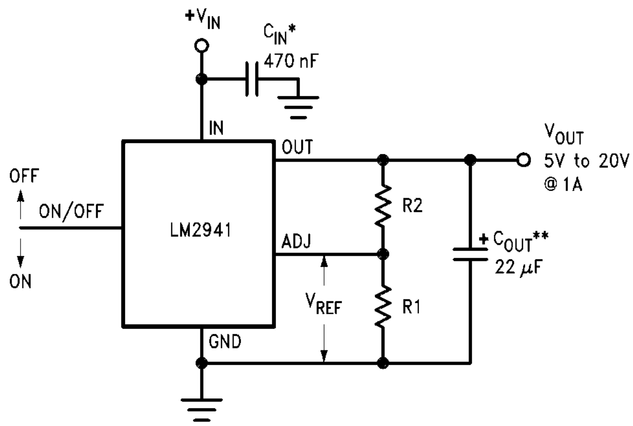
Typical Applications

5V to 20V Adjustable Regulator



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

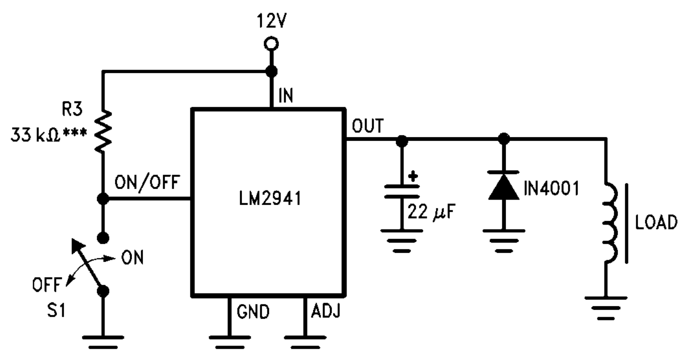
$$\text{Solving for R2: } R2 = R1 \left(\frac{V_O}{V_{REF}} - 1 \right)$$

Note: Using 1KΩ 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_O must be at least 22µF 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 the ESR is critical; see curve.

1A Switch



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

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Revision History Section

Released	Revision	Section	Changes
08/25/09	A	New Release, Corporate format	1 MDS data sheet converted into one Corp. data sheet format. Added Radiation products to ordering table. MNLM2941-X Rev 4A1 will be archived.

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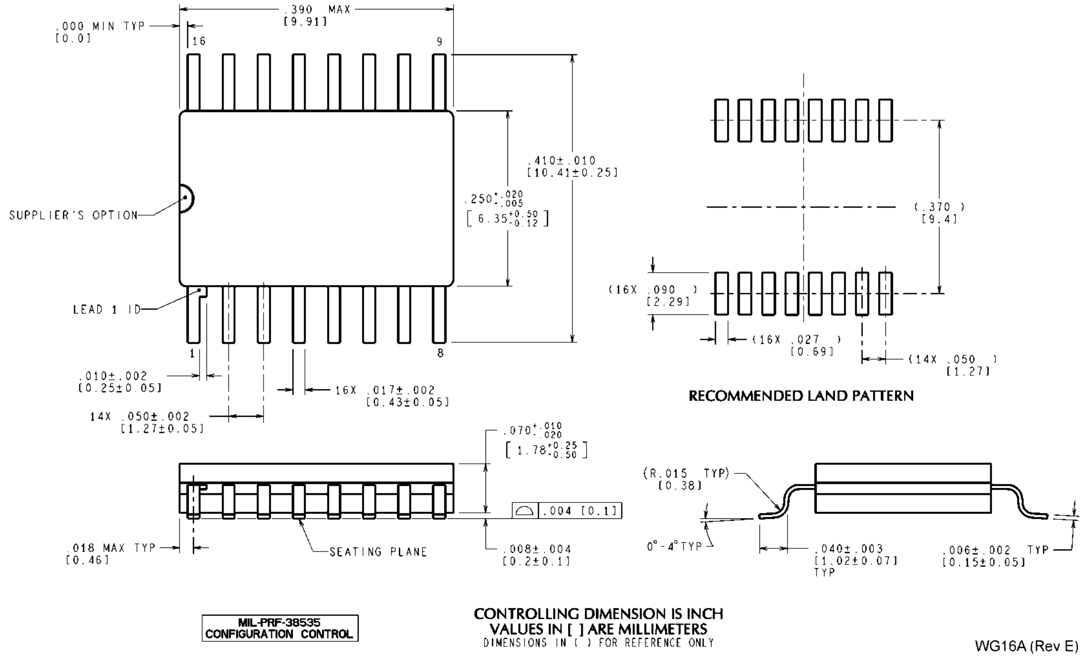
Physical Dimensions inches (millimeters) unless otherwise noted



16LD Ceramic SOIC
NS Package Number WG16A

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LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback
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