



LM2941x 1-A Low Dropout Adjustable Regulator

1 Features

- Operating V_{IN} Range: 6 V to 26 V
- Output Voltage Adjustable From 5 V to 20 V
- Dropout Voltage Typically 0.5 V at $I_{OUT} = 1$ A
- Output Current in Excess of 1 A
- Trimmed Reference Voltage
- Reverse Battery Protection
- Internal Short-Circuit Current Limit
- Mirror Image Insertion Protection
- P⁺ Product Enhancement Tested
- TTL, CMOS Compatible ON/OFF Switch
- WSON Space-Saving Package

2 Applications

- Industrial
- Automotive

3 Description

The LM2941 positive voltage regulator features the ability to source 1 A of output current with a typical dropout voltage of 0.5 V and a maximum of 1 V 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 3 V. The quiescent current with 1 A of output current and an input-output differential of 5 V is therefore only 30 mA. Higher quiescent currents only exist when the regulator is in the dropout mode ($V_{IN} - V_{OUT} \leq 3$ V).

Designed also 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.

Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM2941	WSON (8)	4.00 mm x 4.00 mm
	TO-263 (5)	10.16 mm x 8.42 mm
	TO-220 (5)	14.986 mm x 10.16 mm
	TO-220 (5)	10.16 mm x 8.51 mm
LM2941C	TO-263 (5)	10.16 mm x 8.42 mm
	TO-220 (5)	14.986 mm x 10.16 mm
	TO-220 (5)	10.16 mm x 8.51 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

Simplified Schematic

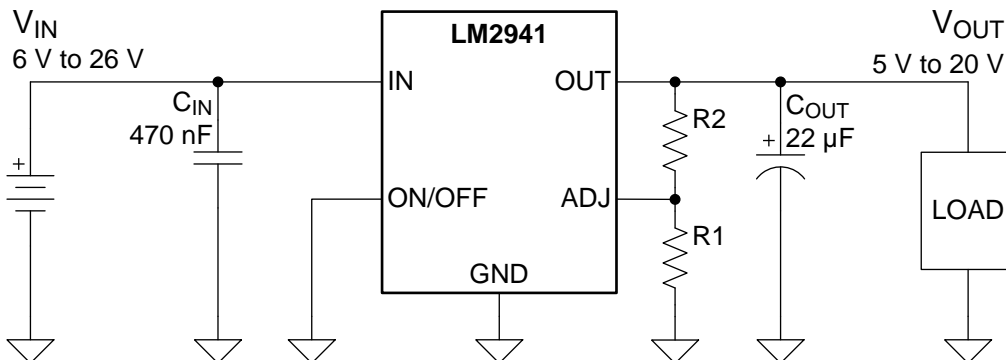


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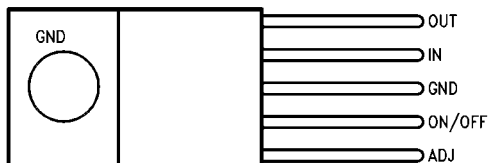
4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

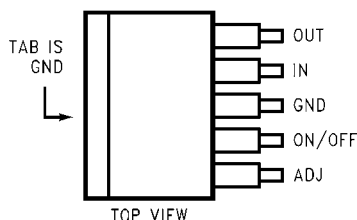
Changes from Revision H (December 2014) to Revision I	Page
• Changed update pin names to TI nomenclature	1
Changes from Revision G (April 2013) to Revision H	Page
• Added <i>Device Information</i> and <i>ESD Ratings</i> tables, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section; updated <i>Thermal Info..</i>	1
Changes from Revision F (April 2013) to Revision G	Page
• Changed layout of National Data Sheet to TI format	1

5 Pin Configuration and Functions

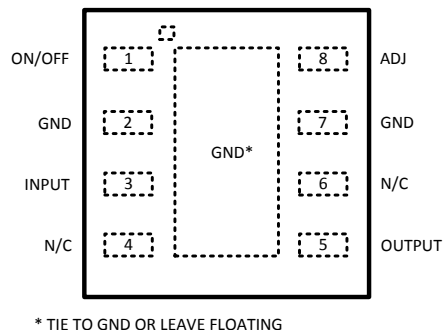
TO-220 (KC) Plastic Package
4 Pins
Top View



TO-263 (KTT) Surface-Mount Package
4 Pins
Top View



WSO (NGN) Surface Mount Package
8 Leads
Top View



* TIE TO GND OR LEAVE FLOATING

Pin Functions

NAME	PIN			TYPE	DESCRIPTION
	KC	KTT	NGN		
ADJ	1	1	8	I	Sets output voltage
ON/OFF	2	2	1	I	Enable/Disable control
GND	3	3	2, 7	—	Ground
IN	4	4	3	I	Input supply
OUT	5	5	5	O	Regulated output voltage. This pin requires an output capacitor to maintain stability. See the Detailed Design Procedure section for output capacitor details.
NC	—	—	4, 6	—	No internal connection. Connect to GND or leave open.

6 Specifications

6.1 Absolute Maximum Ratings⁽¹⁾⁽²⁾

		MIN	MAX	UNIT
Input voltage (Survival Voltage, ≤ 100 ms)	LM2941T, LM2941S, LM2941LD		60	V
	LM2941CT, LM2941CS		45	V
Internal power dissipation ⁽³⁾		Internally Limited		
Maximum junction temperature			150	°C
Soldering temperature ⁽⁴⁾	TO-220 (T), Wave, 10 s		260	°C
	TO-263 (S), 30 s		235	°C
	WSO-8 (LD), 30 s		235	°C
Storage temperature, T _{stg}		–65	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 power dissipation is a function of T_{J(max)}, R_{θJA}, and T_A. The maximum allowable power dissipation at any ambient temperature is P_D = (T_{J(max)} – T_A)/R_{θJA}. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2941 will go into thermal shutdown. If the TO-263 package is used, the thermal resistance can be reduced by increasing the PC board copper area thermally connected to the package. The value R_{θJA} for the WSO package is specifically dependent on PCB trace area, trace material, and the number of layers and thermal vias. For improved thermal resistance and power dissipation for the WSO package, refer to Application Note AN-1187 ([SNOA401](#)). It is recommended that 6 vias be placed under the center pad to improve thermal performance.
- (4) Refer to JEDEC J-STD-020C for surface mount device (SMD) package reflow profiles and conditions. Unless otherwise stated, the temperature and time are for Sn-Pb (STD) only.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000	V

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

6.3 Recommended Operating Conditions

		MIN	MAX	UNIT
Temperatures	LM2941T	–40	125	°C
	LM2941CT	0	125	
	LM2941S	–40	125	
	LM2941CS	0	125	
	LM2941LD	–40	125	

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾⁽²⁾		LM2941LD	LM2941S, LM2941T		UNIT
		WSN (NGN)	TO-263 (KTT)	TO-220 (KC)	
		8 PINS	5 PINS	5 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	40.5	41	32.1	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	26.2	43.2	25.6	
R _{θJB}	Junction-to-board thermal resistance	17	22.9	18.3	
Ψ _{JT}	Junction-to-top characterization parameter	0.2	11.4	8.5	
Ψ _{JB}	Junction-to-board characterization parameter	17.2	21.9	17.7	
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	3.2	0.9	0.7	

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).
- (2) The maximum power dissipation is a function of T_{J(max)}, R_{θJA}, and T_A. The maximum allowable power dissipation at any ambient temperature is P_D = (T_{J(max)} – T_A)/R_{θJA}. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2941 will go into thermal shutdown. If the TO-263 package is used, the thermal resistance can be reduced by increasing the PC board copper area thermally connected to the package. The value R_{θJA} for the WSON package is specifically dependent on PCB trace area, trace material, and the number of layers and thermal vias. For improved thermal resistance and power dissipation for the WSON package, refer to Application Note AN-1187 ([SNOA401](#)). It is recommended that 6 vias be placed under the center pad to improve thermal performance.

6.5 Electrical Characteristics: LM2941T, LM2941S, LM2941LD

5 V ≤ V_{OUT} ≤ 20 V, V_{IN} = V_{OUT} + 5 V, C_{OUT} = 22 μF, unless otherwise specified. MIN (minimum) and MAX (maximum) specifications in apply over the full Operating Temperature Range (unless otherwise specified) and typical values apply at T_J = 25°C.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Reference voltage	5 mA ≤ I _{OUT} ≤ 1 A ⁽¹⁾	1.211	1.275	1.339	V
	5 mA ≤ I _{OUT} ≤ 1 A ⁽¹⁾ , T _J = 25°C	1.237	1.275	1.313	
Line regulation	V _{OUT} + 2 V ≤ V _{IN} ≤ 26 V, I _{OUT} = 5 mA		4	10	mV/V
Load regulation	50 mA ≤ I _{OUT} ≤ 1 A		7	10	mV/V
Output impedance	100 mADC and 20 mArms, f _{OUT} = 120 Hz		7		mΩ/V
Quiescent current	V _{OUT} + 2 V ≤ V _{IN} < 26 V, I _{OUT} = 5 mA		10	20	mA
	V _{OUT} + 2 V ≤ V _{IN} < 26 V, I _{OUT} = 5 mA, T _J = 25°C		10	15	
	V _{IN} = V _{OUT} + 5 V, I _{OUT} = 1 A		30	60	mA
	V _{IN} = V _{OUT} + 5 V, I _{OUT} = 1 A, T _J = 25°C		30	45	
RMS output noise, % of V _{OUT}	10 Hz to 100 kHz, I _{OUT} = 5 mA		0.003%		
Ripple rejection	f _{OUT} = 120 Hz, 1 Vrms, I _L = 100 mA		0.005	0.04	%V
	f _{OUT} = 120 Hz, 1 Vrms, I _L = 100 mA, T _J = 25°C		0.005	0.02	
Long-term stability			0.4		%/1000 Hr
Dropout voltage	I _{OUT} = 1 A		0.5	1	V
	I _{OUT} = 1 A, T _J = 25°C		0.5	0.8	
	I _{OUT} = 100 mA		110	200	mV
Short-circuit current	V _{IN} max = 26 V ⁽²⁾	1.6	1.9		A
Maximum line transient	V _{OUT} max 1 V above nominal V _{OUT} R _{OUT} = 100 Ω, t ≤ 100 ms	60	75		V
Maximum operational input voltage		26	31		V _{DC}
Reverse polarity DC input voltage	R _{OUT} = 100 Ω, V _{OUT} ≥ –0.6 V	–15	–30		V
Reverse polarity transient input voltage	t ≤ 100 ms, R _{OUT} = 100 Ω	–50	–75		

(1) The output voltage range is 5 V to 20 V and is determined by the two external resistors, R1 and R2. See [Figure 18](#).

(2) Output current capability will decrease with increasing temperature, but will not go below 1 A at the maximum specified temperatures.