

Micropower 50mA Ultra Low-Dropout Adjustable Voltage Regulator

FEATURES

- Ultra Low Dropout Voltage
- Output Adjusts from 1.23V to 15V
- Specified 50mA Output Current
- Uses Tiny SOT-23 Package
- Requires Few External Components
- <1 μ A Quiescent Current when Shutdown
- Low Ground Pin Current at All Loads
- High Peak Current Capability (150mA Typical)
- Wide Supply Voltage Range (2.5V–16V)
- Over temperature/over current Protection
- –40°C to +125°C Junction Temperature Range



ORDERING INFORMATION

DEVICE	Package Type	MARKING	Packing	Packing Qty
LP2980AIM5-ADJ/TR	SOT-23-5	L06B	REEL	3000pcs/reel

DESCRIPTION

The LP2980A-ADJ is a 50mA adjustable voltage regulator designed to provide ultra low dropout in battery powered applications. Using an optimized VIP (vertically Integrated PNP) process, the LP2980A-ADJ delivers unequalled performance in all specifications critical to battery-powered designs:

Adjustable Output: output voltage can be set from 1.23V to 15V

Precision Reference: 1.0% tolerance.

Dropout Voltage: typically 120mV @ 50mA load, and 7mV @ 1mA load.

Ground Pin Current: typically 320 μ A @ 50mA load, and 80 μ A @ 1mA load.

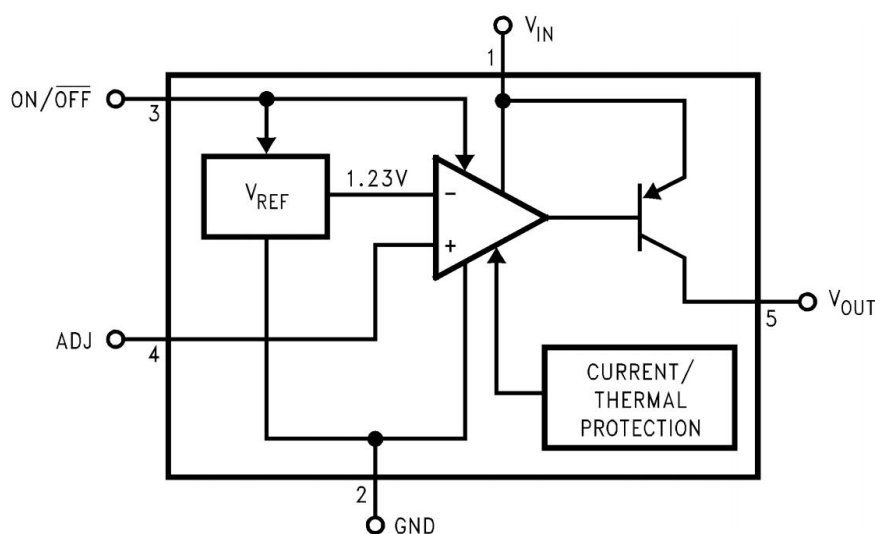
Sleep Mode: less than 1 μ A quiescent current when on/off pin is pulled low.

Smallest Possible Size: Package uses minimum board space.

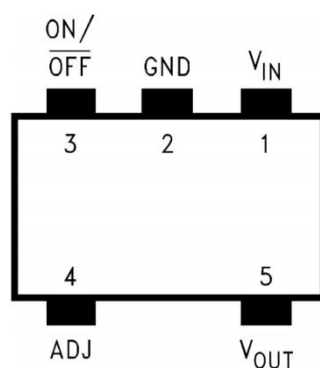
APPLICATIONS

- Cellular Phone
- Palmtop/Laptop Computer
- Camcorder, Personal Stereo, Camera

BLOCK DIAGRAM



CONNECTION DIAGRAM



SOT-23-5(Top View)

PIN DESCRIPTIONS

Name	Pin Number	Function
V _{IN}	1	Input Voltage
GND	2	Common Ground (device substrate)
ON/OFF	3	Logic high enable pin
ADJ	4	Output voltage feedback pin
V _{OUT}	5	Regulated output voltage

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

Parameter	LIMITS
Storage Temperature Range	-65 to +150°C
Operating Junction Temperature Range ⁽⁶⁾	-40 to +125°C
Lead Temp. (Soldering, 10seconds)	260°C
ESD Rating ⁽²⁾	2kV
Power Dissipation ⁽³⁾	Internally Limited
Input Supply Voltage (Survival)	-0.3V to +16V
Input Supply Voltage (Operating)	2.5V to +16V
Shutdown Input Voltage (Survival)	-0.3V to +16V
Output Voltage (Survival) ⁽⁴⁾	-0.3V to 16V
IOUT (Survival)	Short Circuit Protected
Input-Output Voltage (Survival) ⁽⁵⁾	-0.3V to 16V

- (1) Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.
- (2) The ESD rating of pins 3 and 4 is 1kV.
- (3) The maximum allowable power dissipation is a function of the maximum junction temperature, $T_J(\text{MAX})$, the junction-to-ambient thermal resistance, θ_{JA} , and the ambient temperature, T_A . The maximum allowable power dissipation at any ambient temperature is calculated using:

$$P(\text{MAX}) = \frac{T_J(\text{MAX}) - T_A}{\theta_{JA}}$$

The value of θ_{JA} for the SOT-23 package is 300°C/W. Exceeding the maximum allowable power Dissipation will cause excessive die temperature, and the regulator will into, thermal shutdown.

- (4) If used in a dual-supply system where the regulator load is returned to a negative supply, the LP2980A-ADJ output must be diodeclamped to ground.
- (5) The output PNP structure contains a diode between the V_{IN} and V_{OUT} terminals that is normally reverse-biased. Reversing the polarity from V_{IN} to V_{OUT} will turn on this diode
- (6) Operating temperature range: -40°C to +125°C. This product is designed for industrial grade applications. For automotive grade versions compliant with AEC-Q100, please conduct internal screening per the standard or contact our sales team for availability.

ELECTRICAL CHARACTERISTICS

Limits in standard typeface are for $T_J = 25^\circ\text{C}$, and limits in **boldface type** apply over the full operating temperature range.

Unless otherwise specified: $V_{IN} = 4.3\text{V}$, $V_{OUT} = 3.3\text{V}$, $I_L = 1\text{mA}$, $C_{IN} = 1\mu\text{F}$, $C_{OUT} = 2.2\mu\text{F}$, $V_{ON/OFF} = 2\text{V}$.

Symbol	Parameter	Conditions	Typ	LP2980AI-ADJ ⁽¹⁾		Units
				Min	Max	
V_{REF}	Reference Voltage		1.225	1.213	1.237	V
		$1\text{mA} < I_L < 50\text{mA}$ $V_{OUT} + 1 \leq V_{IN} \leq 16\text{V}$	1.225	1.206 1.182	1.243 1.268	
$\Delta V_{REF}/\Delta V_{IN}$	Reference Voltage Line Regulation	$2.5\text{V} \leq V_{IN} \leq 16\text{V}$	3		6.0 15.0	mV
$V_{IN}-V_O$	Dropout Voltage (2)	$I_L = 0$	1		3 5	mV
		$I_L = 1\text{mA}$	7		10 15	
		$I_L = 10\text{mA}$	40		60 90	
		$I_L = 50\text{mA}$	120		150 225	
I_{GND}	Ground Pin Current	$I_L = 0$	60		95 125	μA
		$I_L = 1\text{mA}$	80		110 170	
		$I_L = 10\text{mA}$	120		220 460	
		$I_L = 50\text{mA}$	320		600 1200	
		$V_{ON/OFF} < 0.18\text{V}$	0.01		1	
I_{ADJ}	ADJ Pin Bias Current	$1\text{mA} \leq I_L \leq 50\text{mA}$	150		350	nA
$V_{ON/OFF}$	ON/OFF Input Voltage ⁽³⁾	High = O/P ON	1.4	1.6		V
		Low = O/P OFF	0.55		0.18	
$I_{ON/OFF}$	ON/OFF Input Current	$V_{ON/OFF} = 0$	0.01		-1	μA
		$V_{ON/OFF} = 5\text{V}$	5		15	
$I_O(\text{PK})$	Peak Output Current	$V_{OUT} \geq V_O(\text{NOM}) - 5\%$	150	100		mA
e_n	Output Noise Voltage (RMS)	$\text{BW} = 300\text{ Hz to } 50\text{ kHz}$, $C_{OUT} = 10\mu\text{F}$	160			μV
$\Delta V_{OUT}/\Delta V_{IN}$	Ripple Rejection	$f = 1\text{ kHz}$ $C_{OUT} = 10\mu\text{F}$	68			dB
$I_O(\text{MAX})$	Short Circuit Current	$R_L = 0$ (Steady State) ⁽⁴⁾	150			mA

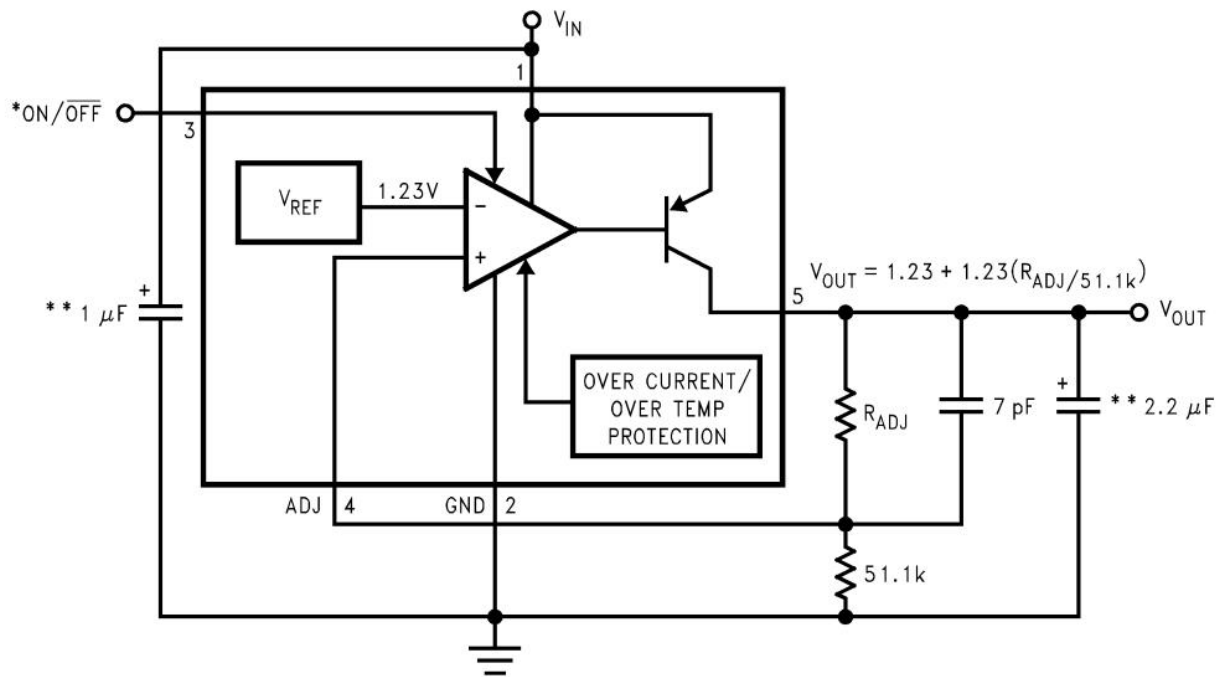
(1) Limits are 100% production tested at 25°C . Limits over the operating temperature range are specified through correlation using Statistical Quality Control (SQC) methods. The limits are used to calculate TI's Average Outgoing Quality Level (AOQL).

(2) Dropout voltage is defined as the input to output differential at which the output voltage drops 100mV below the value measured with a 1V differential.

(3) The ON/OFF input must be properly driven to prevent possible misoperation. For details, refer to APPLICATION HINTS.

(4) See TYPICAL PERFORMANCE CHARACTERISTICS curves.

TYPICAL APPLICATION CIRCUIT



* $\overline{ON/OFF}$ Input Must Be Actively Terminated. Tie To V_{IN} If This Function Is Not To Be Used.

**Minimum Capacitance Is Shown To Ensure Stability Over Full Load Current Range (See Application Hints).

TYPICAL PERFORMANCE CHARACTERISTICS

Unless otherwise specified: $T_A = 25^\circ\text{C}$, $V_{IN} = V_O(\text{NOM}) + 1\text{V}$, $I_L = 1\text{mA}$, ON/OFF pin tied to V_{IN} , $R_{ADJ} = 86.6\text{k}$, and test circuit is as shown in Basic Application Circuit.

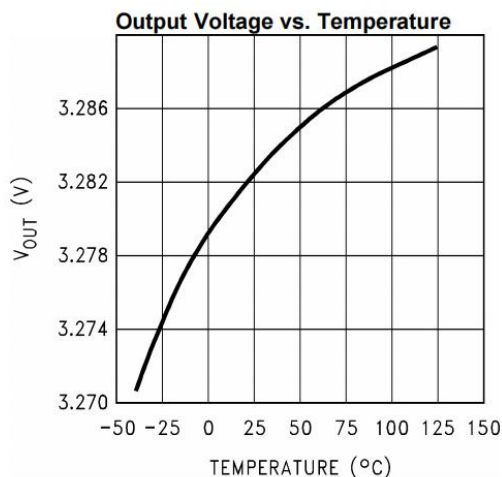


Figure 2.

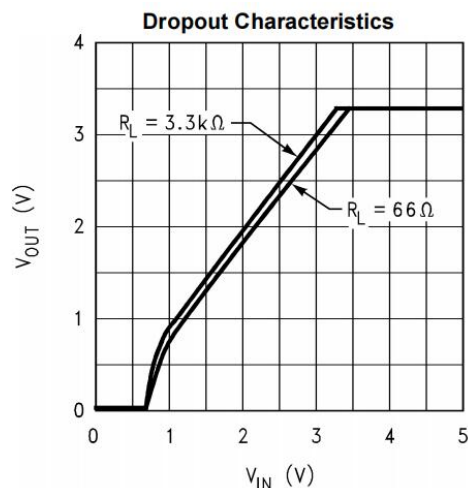


Figure 3.

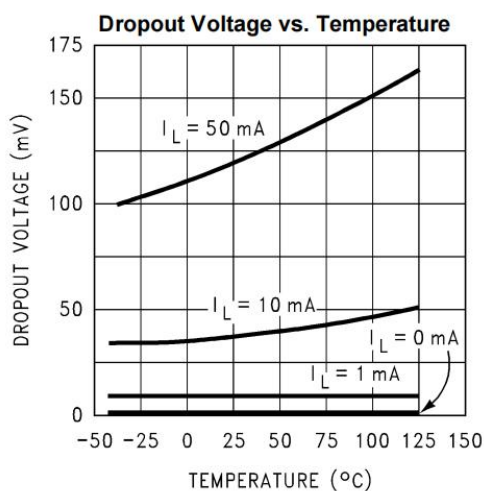


Figure 4.

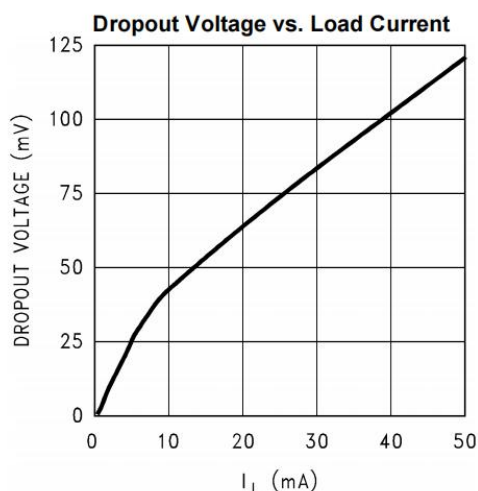


Figure 5.

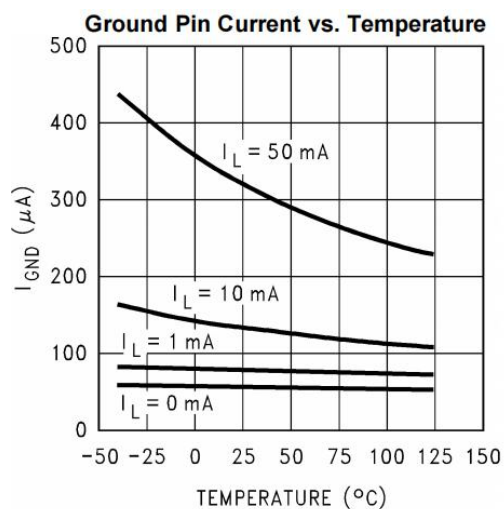


Figure 6.

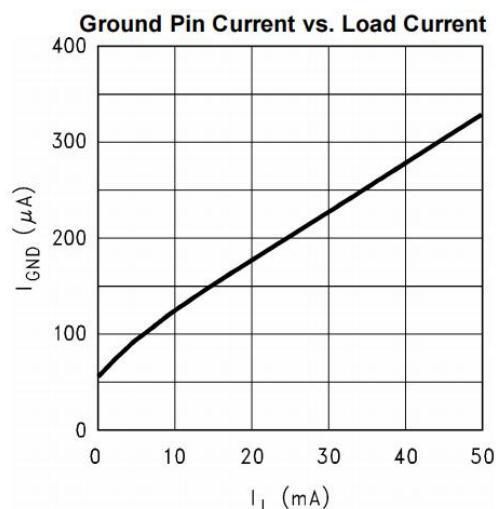


Figure 7.

TYPICAL PERFORMANCE CHARACTERISTICS(continued)

Unless otherwise specified: $T_A = 25^\circ\text{C}$, $V_{IN} = V_{O(NOM)} + 1\text{V}$, $I_L = 1\text{mA}$, ON/OFF pin tied to V_{IN} , $R_{ADJ} = 86.6\text{k}$, and test circuit is as shown in Basic Application Circuit.

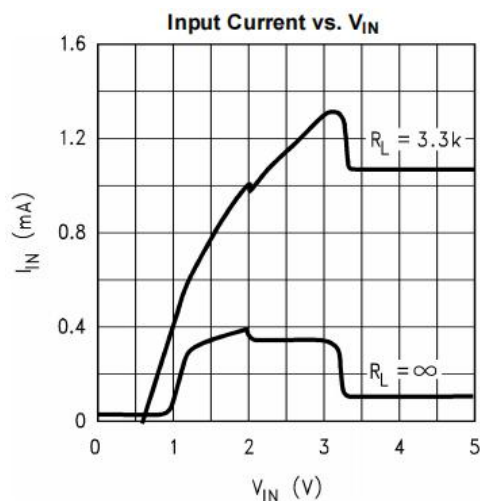


Figure 8.

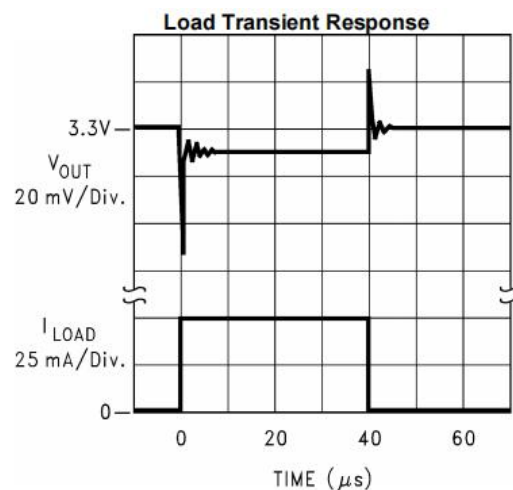


Figure 9.

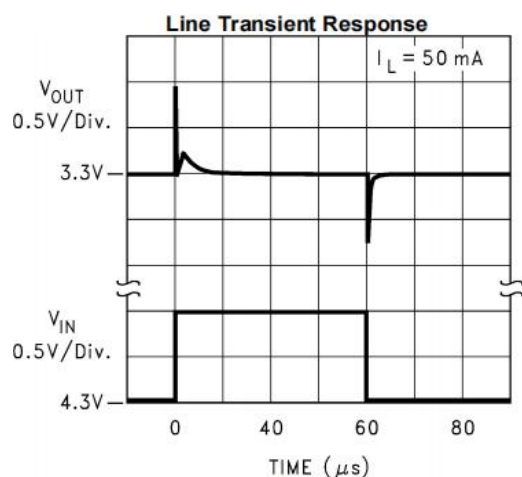


Figure 10.

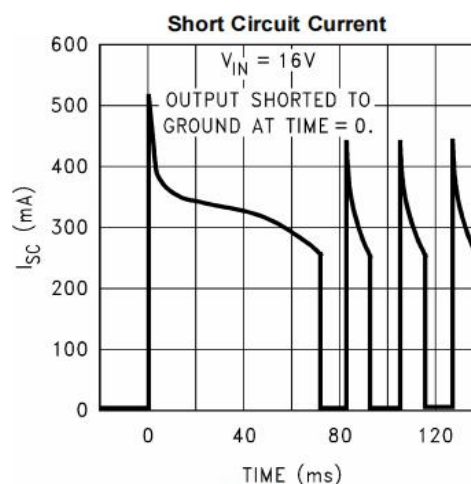


Figure 11.

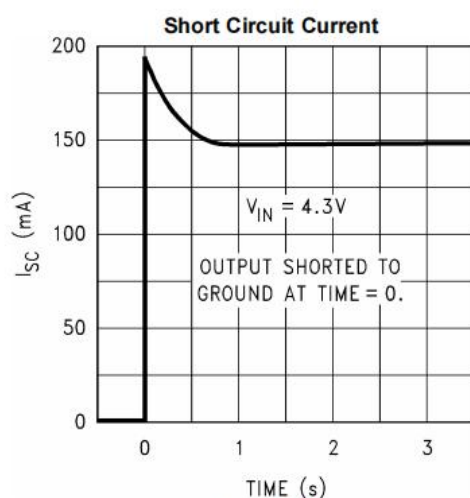


Figure 12.

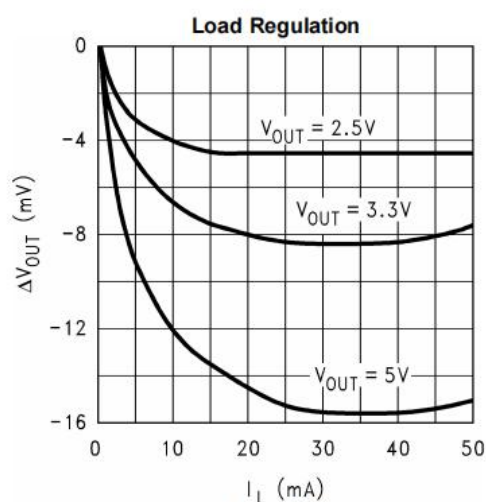


Figure 13.

TYPICAL PERFORMANCE CHARACTERISTICS(continued)

Unless otherwise specified: $T_A = 25^\circ\text{C}$, $V_{IN} = V_O(\text{NOM}) + 1\text{V}$, $I_L = 1\text{mA}$, ON/OFF pin tied to V_{IN} , $R_{ADJ} = 86.6\text{k}$, and test circuit is as shown in Basic Application Circuit.

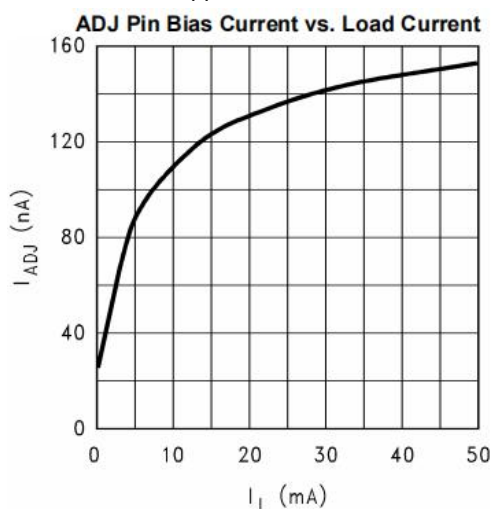


Figure 14.

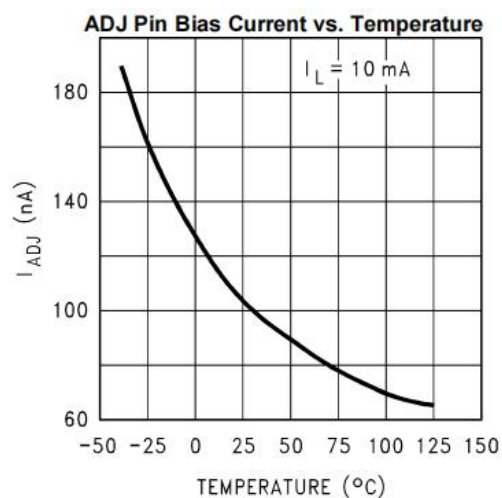


Figure 15.

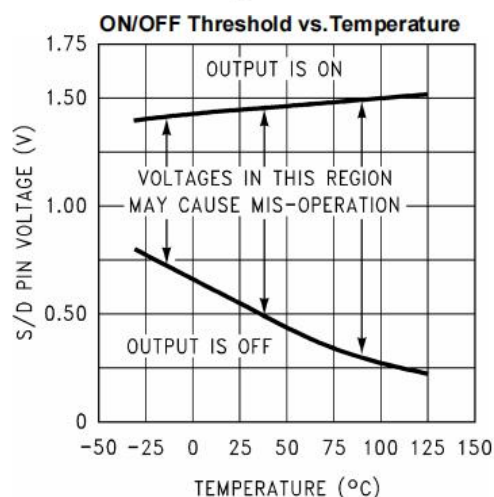


Figure 16.

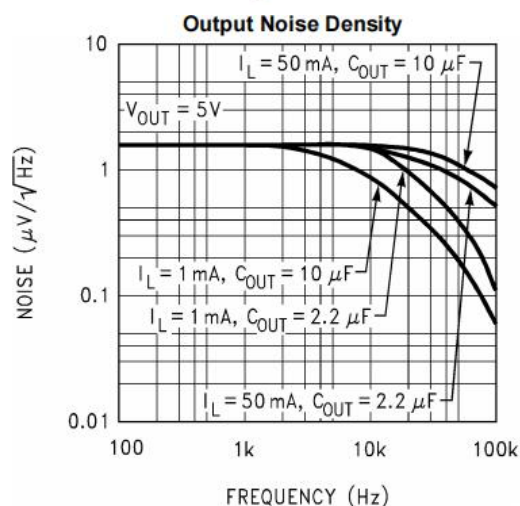


Figure 17.

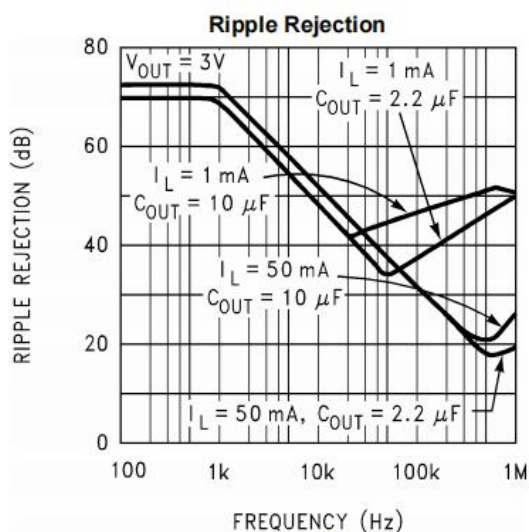


Figure 18.

APPLICATION HINTS

EXTERNAL CAPACITORS

Like any low-dropout regulator, the external capacitors must be selected carefully to assure regulator loop stability.

INPUT CAPACITOR: An input capacitor whose value is $\geq 1\mu\text{F}$ is required (the amount of capacitance may be increased without limit).

Any good quality Tantalum or Ceramic capacitor may be used here. The capacitor must be located not more than 0.5" from the input pin and returned to a clean analog ground.

OUTPUT CAPACITOR: The output capacitor must meet both the requirement for minimum amount of capacitance and E.S.R. (Equivalent Series Resistance) for stable operation.

Curves are provided below which show the allowable ESR of the output capacitor as a function of load current for both $2.2\mu\text{F}$ and $4.7\mu\text{F}$. A solid Tantalum capacitor is the best choice for the output.

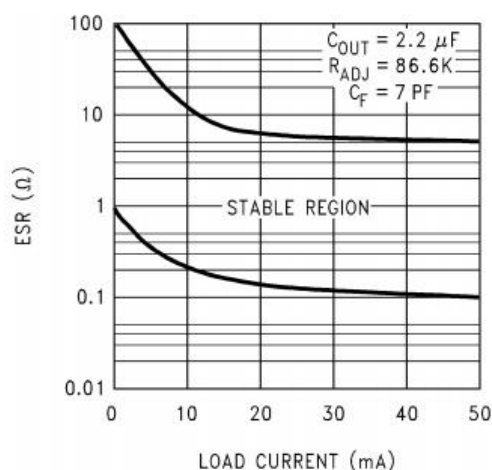


Figure 19. 2.2 μF ESR Curves

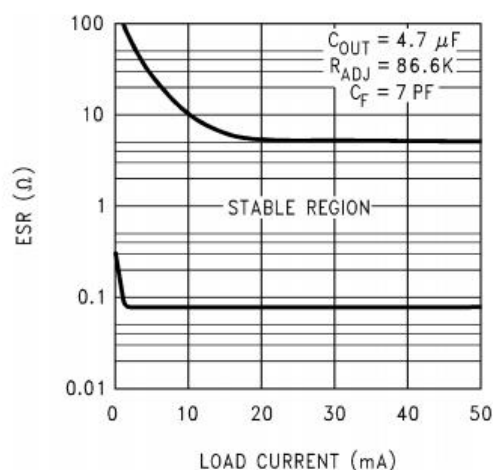


Figure 20. 4.7 μF ESR Curves

IMPORTANT: The output capacitor must maintain its ESR in the stable region over the full operating temperature range to assure stability. Also, capacitor tolerance and variation with temperature must be considered to assure the minimum amount of capacitance is provided at all times.

Note that this capacitor must be located not more than 0.5" from the output pin and returned to a clean analog ground.

FEED-FORWARD CAPACITOR: A 7pF feed-forward capacitor is required (see Basic Application Circuit). The function of this capacitor is to provide the lead compensation necessary for loop stability.

A temperature-stable ceramic capacitor (type NPO or COG) should be used here.

CAPACITOR CHARACTERISTICS

TANTALUM: The best capacitor choice for the LP2980A-ADJ output is solid Tantalum. The ESR of a good quality Tantalum is almost perfectly centered in the middle of the "stable" range of the ESR curve (about 0.5Ω – 1Ω).

The temperature stability of Tantalums is typically very good, with a total variation of only about 2:1 over the temperature range of -40°C to $+125^\circ\text{C}$ (ESR increases at colder temperatures).

Off-brand capacitors should be avoided, as some poor quality Tantalums are seen with ESR's $> 10\Omega$, and this usually causes oscillation problems.

One caution about Tantalums if they are used on the input: the ESR of a Tantalum is low enough that it can be destroyed by surge current if powered up from a low impedance source (like a battery) that has no limit on inrush current. In these cases, use a ceramic input capacitor which does not have this problem.

CERAMIC: Ceramics are generally larger and more costly than Tantalums for a given amount of capacitance. Also, they have a very low ESR which is quite stable with temperature.

Be warned that the ESR of a ceramic capacitor is typically low enough to make an LDO oscillate: a 2.2μF ceramic demonstrated an ESR of about 15 mΩ when tested. If used as an output capacitor, this will cause instability (see ESR Curves).

If a ceramic is used on the output of an LDO, a small resistance (about 1Ω) should be placed in series with the capacitor. If it is used as an input capacitor, no resistor is needed as there is no requirement for ESR on capacitors used on the input.

EXTERNAL RESISTORS

The output voltage is set using two external resistors (see Basic Application Circuit). It is recommended that the resistor from the ADJ pin to ground be 51.1 kΩ.

The other resistor (R_{ADJ}) which connects between V_{OUT} and the ADJ pin is selected to set V_{OUT} as given by the formula:

$$V_{OUT} = V_{REF} + (V_{REF} \times (R_{ADJ} / 51.1K\Omega))$$

REVERSE CURRENT PATH

The PNP power transistor used as the pass element in the LP2980A-ADJ has an inherent diode connected between the regulator output and input. During normal operation (where the input voltage is higher than the output) this diode is reverse biased (See Figure 21).

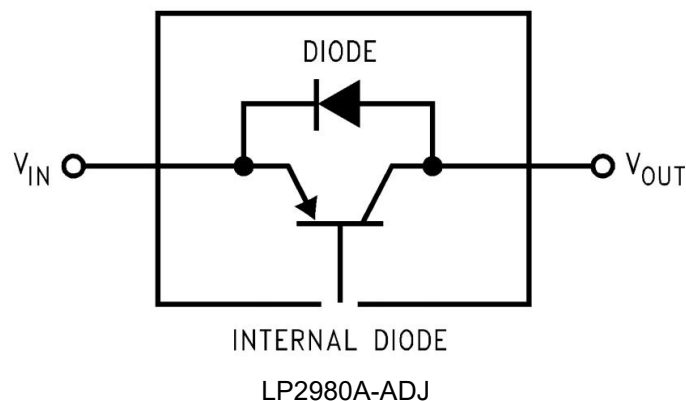


Figure 21. LP2980A-ADJ Reverse Current Path

However, if the input voltage is more than a V_{BE} below the output voltage, this diode will turn ON and current will flow into the regulator output. In such cases, a parasitic SCR can latch which will allow a high current to flow into the V_{IN} pin and out the ground pin, which can damage the part.

The internal diode can also be turned on if the input voltage is abruptly stepped down to a voltage which is a V_{BE} below the output voltage.

In any application where the output may be pulled above the input, an external Schottky diode must be connected from V_{IN} to V_{OUT} (cathode on V_{IN} , anode on V_{OUT} . See Figure 22), to limit the reverse voltage across the LP2980A-ADJ to 0.3V (see Absolute Maximum Ratings).

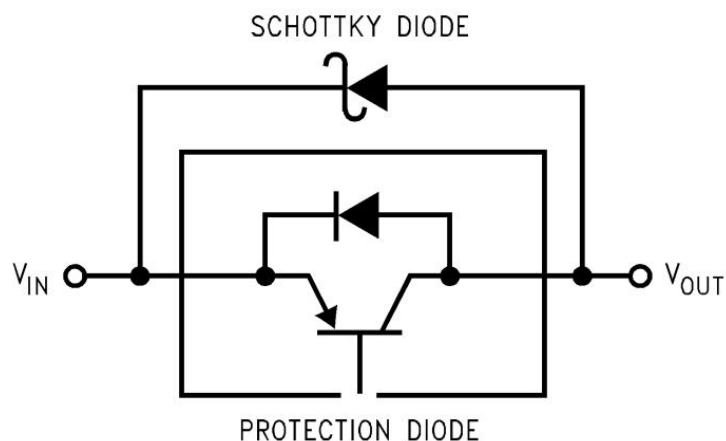


Figure 22. Adding External Schottky Diode Protection

ON/OFF INPUT OPERATION

The LP2980A-ADJ is shut off by driving the ON/OFF input low, and turned on by pulling the ON/OFF input high. If this feature is not to be used, the ON/OFF input must be tied to V_{IN} to keep the regulator output on at all times (the ON/OFF input must not be left floating).

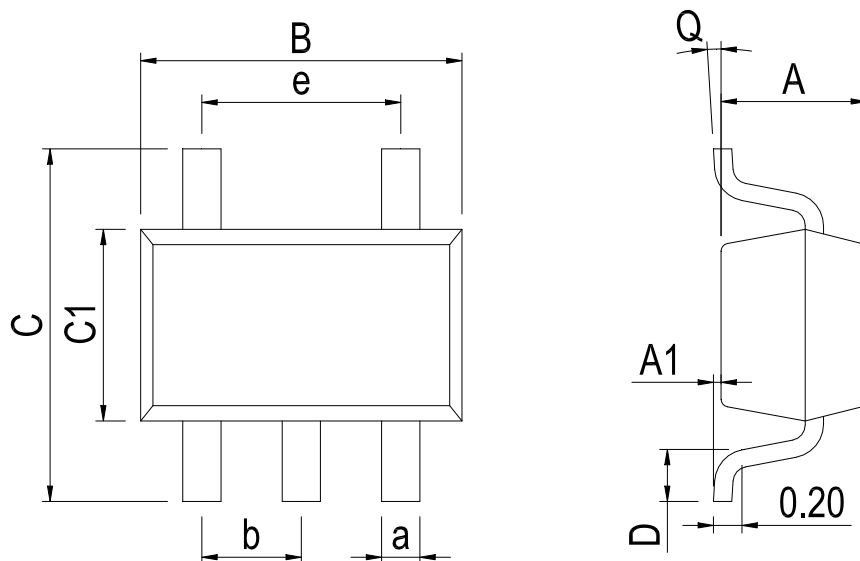
To ensure proper operation, the signal source used to drive the ON/OFF input must be able to swing above and below the specified turn-on/turn-off voltage thresholds which specify an ON or OFF state (see Electrical Characteristics).

It is also important that the turn-on (and turn-off) voltage signals applied to the ON/OFF input have a slew rate which is greater than 40mV/ μ s.

IMPORTANT: The ON/OFF function will not operate correctly if a slow-moving signal is used to drive the ON/OFF input.

PHYSICAL DIMENSIONS

SOT-23-5



Dimensions In Millimeters(SOT-23-5)										
Symbol:	A	A1	B	C	C1	D	Q	a	b	e
Min:	1.00	0.00	2.82	2.65	1.50	0.30	0°	0.30	0.95 BSC	1.90 BSC
Max:	1.15	0.15	3.02	2.95	1.70	0.60	8°	0.50		

REVISION HISTORY

REVISION NUMBER	DATE	REVISION	PAGE
V1.0	2013-6	New	1-15
V1.1	2018-7	Update encapsulation type	1
V1.2	2024-10	Update SOT-23-5 Physical dimension、Update Lead Temperature	13、 4
V1.3	2025-12	Update important statements	15

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