钍地半导体
Tudi Semiconductor

Product Specification

TUDI-LM1086

1.5-A Low Dropout Positive Voltage Regulators

网址 www.sztdbdt.com

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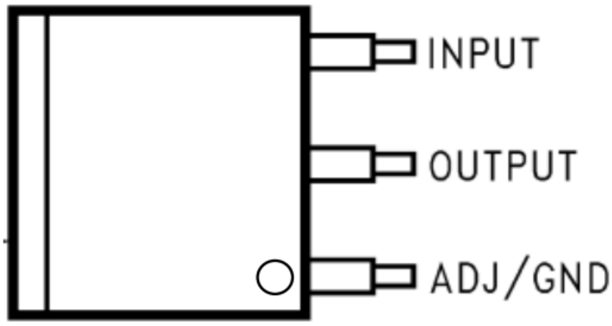
semiconductor device manufacturer

- Design
- research and development
- production
- and sales

Features

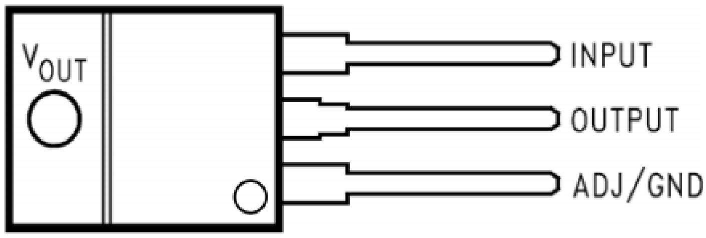
- Available in Fixed 3.3-V, 5-V
- Available in Adjustable Version
- Current Limiting and Thermal Protection
- 2% Output Accuracy
- Output Current 1.5 A
- Line Regulation 0.015% (Typical)
- Load Regulation 0.1% (Typical)
- Maximum Input Voltage up to 29V
- Minimum Adjustable Output Voltage Down to 1.25V
- Stable with Ceramic Output Capacitor with ESR
- Temperature Range : -40 ° C to 125 ° C



TO263 Pin Diagram

Applications

- High-Efficiency Linear Regulators
- Battery Chargers
- Post Regulation for Switching Supplies
- Constant Current Regulators
- Microprocessor Supplies
- Audio Amplifiers Supplies
- Fire Alarm Control



TO220 Pin Diagram

Description

The LM1086 is a regulator with a maximum dropout of 1.5 V at 1.5 A of load current. The device has the same pin-out as TI's industry standard LM317.
Two resistors are required to set the output voltage of the adjustable output voltage version of the LM1086. Fixed output voltage versions integrate the adjust resistors. Typically, no input capacitor is needed unless the device is situated more than 6 inches from the input filter capacitors. Output capacitor can be replaced with ceramic and appropriate ESR.
The LM1086 circuit includes a zener trimmed bandgap reference, current limiting, and thermal shutdown. Because the LM1086 regulator is floating and detects only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input-to-output differential is not exceeded. Exceeding the maximum input-to-output deferential will result in short-circuiting the output. By connecting a fixed resistor between the adjustment pin and output, the LM1086 can be also used as a precision current regulator.
For applications requiring greater output current, refer to LM1084 (clickable link) for the 5-A version, and the LM1085 (clickable link) for the 3-A version.

Pin Functions

PIN			I/O	DESCRIPTION
NAME	NUMBER			
	KTT/ NDE	NGN		
ADJ/GND	1	1	—	Adjust pin for the adjustable output voltage version. Ground pin for the fixedoutput voltage versions.
V_{OUT}	2,TAB	6,7,8,PAD	O	Output voltage pin for the regulator.
V_{In}	3	2	I	Input voltage pin for the regulator.
N/C		3,4,5	—	No Connection

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	**Human-body model (HBM),per ANSI/ESDAJEDEC JS -001(1)**	± 2000	V

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

Recommended Operating Conditions

		MIN	MAX	UNIT
"C"Grade	Control Section	0	125	℃
	Output Section	0	150	℃
"I"Grade	Control Section	-40	125	℃
	Output Section	-40	150	℃

(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 $P_D = (T_{J(MAX)} - T_A) / \theta_{JA}$. All numbers apply for packages soldered directly into a PC board. Refer to Thermal Considerations

Specifications

Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) [(1)(2)]

		MIN	MAX	UNIT
Maximum Input to Output Voltage Differential	LM1086-ADJ		29	V
	LM1086-1.8		27	V
	LM1086-2.5		27	V
	LM1086-3.3		27	V
	LM1086-5.0		25	V
Power Dissipation[(3)]		Internally Limited		
Junction Temperature [(T)(4)]			150	℃
Lead Temperature			260, to 10 sec	℃
Storage temperature,Tstg		-65	150	℃

(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) Power dissipation is kept in a safe range by current limiting circuitry. Refer to Overload Recovery in Application and Implementation. The value θJA for the WSON package is specifically dependent on PCB trace area, trace material, and the number of thermal vias. For improved thermal resistance and power dissipation for the WSON package, refer to Application Note AN-1187 (literature number SNOA401).
(4) 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 $P_D = (T_{J(MAX)} – T_A)/\theta_{JA}$. All numbers apply for packages soldered directly into a PC board. Refer to Thermal Considerations

Electrical Characteristics

Typicals and limits appearing in normal type apply for T_J = 25 ° C unless specified otherwise.

PARAMETER	TEST CONDITIONS	TJ = 25°C			TJ over the entire range foroperation (seeRecommended Operating Conditions)			UNIT
		MIN	TYP	MAX	MIN[1]	TYP[2]	MAX [1]	
V_{REF} Reference Voltage	LM1086-ADJ,I_{ouT}=10 mA,V_{In}-V_{ouT}=3V,10 mA≤I_{ouT}≤$I_{FULL\ LOAp}$,1.5V≤V_{IN}-V_{ouT}≤15V[3]	1.238	1.25	1.262	1.225	1.25	1.27	V
V_{ouT} Output Voltage[3]	LM1086-1.8,I_{ouT}=0 mA,V_{IN}=5V, O≤I_{ouT}≤$I_{FUL\ LOAD}$,3.3V≤V_{In}≤18V	1.782	1.8	1.818	1.764	1.8	1.836	V
	LM1086-2.5,I_{ouT}=0mA,V_{IN}=5V, O≤Io_{uT}≤$I_{FUL\ LOAD}$,4.0V≤V_{In}≤18V	2.475	2.5	2.525	2.45	2.5	2.55	V
	LM1086-3.3,I_{ouT}=0 mA,V_{IN}=5V, O≤I_{ouT}≤$I_{FUL\ LOAD}$,4.75V≤V_{In}≤18V	3.267	3.3	3.333	3.235	3.3	3.365	V
	LM1086-5.0,I_{ouT}=0 mA,V_{IN}=8V, O≤I_{ouT}≤$I_{FUL\ LOAD}$,6.5V≤V_{In}≤20V	4.95	5	5.050	4.9	5	5.1	V
$\triangle V_{ouT}$ Line Regulation[4]	LM1086-ADJ,I_{ouT}=10 mA,1.5V≤(V_{In}-V_{ouT})≤15V	0.015%		0.2%	0.035%		0.2%	
	LM1086-1.8,I_{ouT}=0 mA,3.3V≤V_{In}≤18V		0.3	6		0.6	6	mV
	LM1086-2.5,I_{ouT}=0 mA,4.0V≤V_{In}≤18V		0.3	6		0.6	6	mV
	LM1086-3.3,I_{ouT}=0mA,4.5V≤V_{IN}≤18V		0.5	10		1	10	mV
	LM1086-5.0,I_{ouT}=0mA,6.5V≤V_{In}≤20V		0.5	10		1	10	mV

(1) All limits are specified by testing or statistical analysis.
(2) Typical Values represent the most likely parametric norm.
(3) IFULL LOAD is defined in the current limit curves. The IFULL LOAD Curve defines current limit as a function of input-to-output voltage. Note that 15W power dissipation for the LM1086 is only achievable over a limited range of input-to-output voltage.
(4) Load and line regulation are measured at constant junction temperature, and are specified up to the maximum power dissipation of 15W. Power dissipation is determined by the input/output differential and the output current. Ensured maximum power dissipation will not be available over the full input/output range.

Electrical Characteristics (continued)

Typicals and limits appearing in normal type apply for T_J = 25 ° C unless specified otherwise.

PARAMETER	TEST CONDITIONS	T_J=25℃			Tjover the entire range foroperation (seeRecommended OperatingConditions)			UNIT
		MIN	TYP	MAX	MIN(1)	TYP(2)	MAX(1)	
Δ_{VOUT} Load Regulation(4)	LM1086-ADJ,(V_{In}-V_{oUT})= 3V,10 mA≤I_{ouT}≤$I_{FULL\ LOAD}$		0.10%	0.30%		0.20%	0.40%	
	LM1086-1.8,2.5,V_{In}=5V,0≤I_{ouT}≤$I_{FULL\ LOAD}$		3	12		6	20	mV
	LM1086-3.3,V_{In}=5V,0≤I_{ouT}≤$I_{FULL\ LOAD}$		3	15		7	25	mV
	LM1086-5.0,V_{In}=8V,O≤I_{ouT}≤$I_{FULL\ LOAD}$		5	20		10	35	mV
Dropout Voltage(5)	LM1086-ADJ,1.8,2.5,3.3,5,△V_{REF},△V_{oUT}=1%,I_{ouT}=1.5A					1.3	1.5	V
L_{IMIT} Current Limit	LM1086-ADJ,V_{IN}-V_{ouT}=5V, V_{In}-V_{oUT}=25V				1.5	2.7		A
					0.05	0.15		
	LM1086-1.8,2.5,3.3,V_{IN}=8V				1.5	2.7		A
	LM1086-5.0,V_{In}=10V				1.5	2.7		A
Minimum Load Current(6)	LM1086-ADJ,V_{In}-V_{ouT}=25 v					5	10	mA

Quiescent Current	LM1086-1.8,2.5,V_{In}≤18V					5	10	mA
	LM1086-3.3,V_{In}≤18V					5	10	mA
	LM1086-5.0,V_{In}≤20V					5	10	mA
Thermal Regulation	T_A=25℃,30ms Pulse		0.008	0.04				%/W
Ripple Rejection	f_{RIPPLE}=120 Hz,C_{ouT}=25μF Tantalum,I_{ouT}=1.5 A							dB
	LM1086-ADJ,C_{ADJ}=25μF,(V_{In}-V_o)=3V				60	75		
	LM1086-1.8,2.5,V_{In}=6V				60	72		dB
	LM1086-3.3,V_{In}=6.3V				60	72		dB
	LM1086-5.0 V_{In}=8V				60	68		dB
Adjust Pin Current	LM1086	55					120	μA
Adjust Pin Current Change	10 mA≤I_{ouT}≤$I_{FULL\ LOAD}$,1.5V≤(V_{In}-V_{ouT})≤15V					0.2	5	μA
Temperature Stability					0.5%			
Long Term Stability	T_A=125℃,1000 Hrs	0.3% 1.0%						
RMS Noise (% of V_{ouT})	10 Hz≤f≤10 kHz	0.003%						

(5) Dropout voltage is specified over the full output current range of the device.
(6) The minimum output current required to maintain regulation.

Thermal Information

	THERMAL METRIC[1]	LM1086			UNIT
		KTT	NDE	NGN	
		3 PINS	3 PINS	8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	40.8	23.0	35.9	CN
$R_{\theta JC(top)}$	Junction-to-case (top)thermal resistance	42.3	16.1	24.2	
$R_{\theta JB}$	Junction-to-board thermal resistance	23.3	4.5	13.2	
ψ_{JT}	Junction-to-top characterization parameter	10.2	2.4	0.2	
ψ_{JB}	Junction-to-board characterization parameter	22.3	2.5	13.3	
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance: ControlSection/Output Section	1.5/4.0	1.5/4.0	2.9	

(1) For more information about traditional and new thermal metrics, see the IC Package Thermal Metrics application report, SPRA953.

Order information

Order Number	Package	Package Quantity	Marking On The park	Temperature
LM1086S-3.3/TR-TUDI	TO263-3	Tape,Reel,500	LM1086S-3.3	- 40°C to 125°C
LM1086T-3.3-TUDI	TO220-3	Tube,50,A box of 2000	LM1086T-3.3	
LM1086S-5.0/TR-TUDI	TO263-3	Tape,Reel,500	LM1086S-5.0	
LM1086T-5.0-TUDI	TO220-3	Tube,50,A box of 2000	LM1086T-5.0	
LM1086S-ADJ/TR-TUDI	TO263-3	Tape,Reel,500	LM1086S-ADJ	
LM1086T-ADJ-TUDI	TO220-3	Tube,50,A box of 2000	LM1086T-ADJ	

Detailed Description

Overview

A basic functional diagram for the LM1086-ADJ (excluding protection circuitry) is shown in Figure 1. The topology is basically that of the LM317 except for the pass transistor. Instead of a Darlington NPN with its two diode voltage drop, the LM1086 uses a single NPN. This results in a lower dropout voltage. The structure of the pass transistor is also known as a quasi LDO. The advantage of a quasi LDO over a PNP LDO is its inherently lower quiescent current. The LM1086 is specified to provide a minimum dropout voltage of 1.5V over temperature, at full load.

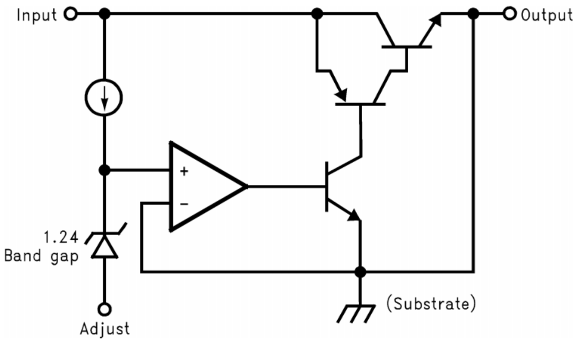
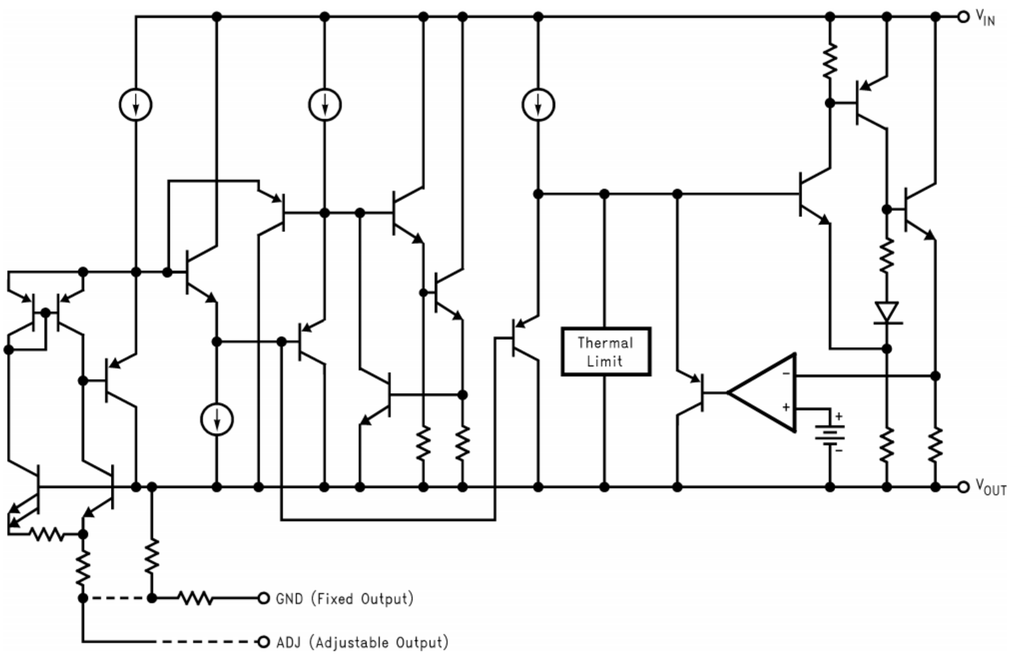


Figure 1. Basic Functional Block Diagram

Functional Block Diagram



Feature Description

Ripple Rejection

Ripple rejection is a function of the open loop gain within the feed-back loop (refer to Figure 1 and Figure 4). The LM1086 exhibits 75dB of ripple rejection (typ.). When adjusted for voltages higher than V_{REF}, the ripple rejection decreases as function of adjustment gain: (1+R1/R2) or V_O/V_{REF}. Therefore a 5-V adjustment decreases ripple rejection by a factor of four (12dB); Output ripple increases as adjustment voltage increases.

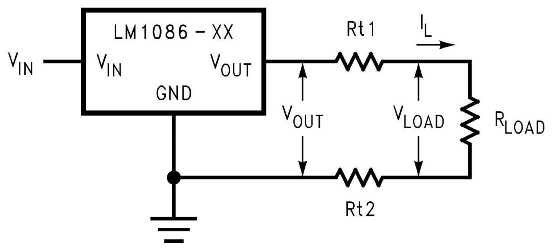
However, the adjustable version allows this degradation of ripple rejection to be compensated. The adjust terminal can be bypassed to ground with a capacitor (C_{ADJ}). The impedance of the C_{ADJ} should be equal to or less than R1 at the desired ripple frequency. This bypass capacitor prevents ripple from being amplified as the output voltage is increased.

$$1/(2\pi * f_{RIPPLE} * C_{ADJ}) \leq R_1 \qquad (1)$$

Load Regulation

The LM1086 regulates the voltage that appears between its output and ground pins, or between its output and adjust pins. In some cases, line resistances can introduce errors to the voltage across the load. To obtain the best load regulation, a few precautions are needed.

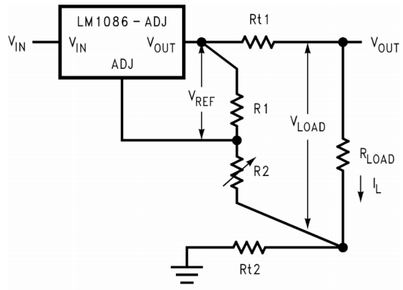
Figure 14 shows a typical application using a fixed output regulator. Rt1 and Rt2 are the line resistances. V_{LOAD} is less than the V_{OUT} by the sum of the voltage drops along the line resistances. In this case, the load regulation seen at the R_{LOAD} would be degraded from the data sheet specification. To improve this, the load should be tied directly to the output terminal on the positive side and directly tied to the ground terminal on the negative side.



$$V_{LOAD} = V_{OUT} - I_L(Rt1+Rt2)$$

Figure 2. Typical Application Using Fixed Output Regulator

When the adjustable regulator is used (Figure 3), the best performance is obtained with the positive side of the resistor R1 tied directly to the output terminal of the regulator rather than near the load. This eliminates line drops from appearing effectively in series with the reference and degrading regulation. For example, a 5V regulator with 0.05-Ωresistance between the regulator and load will have a load regulation due to line resistance of 0.05Ω × I_L. If R1 (=125 Ω) is connected near the load the effective line resistance will be 0.05 Ω (1 + R2/R1) or in this case, it is 4 times worse. In addition, the ground side of the resistor R2 can be returned near the ground of the load to provide remote ground sensing and improve load regulation.



$V_{LOAD}=V_{REF}(R1+R2)/R_1$-L Rt1

Figure 3. Best Load Regulation Using Adjustable Output Regulator

Feature Description (continued)

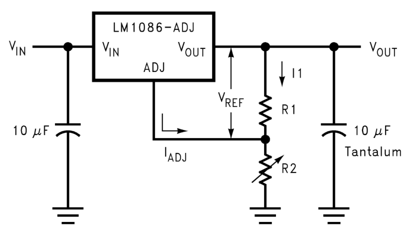
7.3.3 Overload Recovery

Overload recovery refers to regulator's ability to recover from a short circuited output. A key factor in the recovery process is the current limiting used to protect the output from drawing too much power. The current limiting circuit reduces the output current as the input to output differential increases. Refer to short circuit curve in the Typical Characteristics section.
During normal start-up, the input to output differential is small since the output follows the input . But, if the output is shorted, then the recovery involves a large input to output differential. Sometimes during this condition the current limiting circuit is slow in recovering. If the limited current is too low to develop a voltage at the output, the voltage will stabilize at a lower level. Under these conditions it may be necessary to recycle the power of the regulator in order to get the smaller differential voltage and thus adequate start up conditions. Refer to Typical Characteristics section for the short circuit current vs. input differential voltage.

7.4 Device Functional Modes

7.4.1 Output Voltage

The LM1086 adjustable version develops a 1.25-V reference voltage, (V_{REF}), between the output and the adjust terminal. As shown in Figure 4, this voltage is applied across resistor R1 to generate a constant current I1. This constant current then flows through R2. The resulting voltage drop across R2 adds to the reference voltage to sets the desired output voltage.
The current I_{ADJ} from the adjustment terminal introduces an output error . But since it is small (120uA max), it becomes negligible when R1 is in the 100 Ω range.
For fixed voltage devices, R1 and R2 are integrated inside the devices.



$$V_{OUT} = V_{REF}\left(1+\frac{R2}{R1}\right) + I_{ADJ}\,R2$$

Figure 4. Basic Adjustable Regulator

Stability Consideration

Stability consideration primarily concerns the phase response of the feedback loop. In order for stable operation, the loop must maintain negative feedback. The LM1086 requires a certain amount series resistance with capacitive loads. This series resistance introduces a zero within the loop to increase phase margin and thus increase stability. The equivalent series resistance (ESR) of solid tantalum or aluminum electrolytic capacitors is used to provide the appropriate zero (approximately 500 kHz).
Aluminum electrolytics are less expensive than tantalums, but their ESR varies exponentially at cold temperatures; therefore requiring close examination when choosing the desired transient response over temperature. Tantalums are a convenient choice because their ESR varies less than 2:1 over temperature.
The recommended load/decoupling capacitance is a 10 uF tantalum or a 50 uF aluminum. These values will assure stability for the majority of applications.
The adjustable versions allows an additional capacitor to be used at the ADJ pin to increase ripple rejection. If this is done the output capacitor should be increased to 22uF for tantalum or to 150 uF for aluminum.
Capacitors other than tantalum or aluminum can be used at the adjust pin and the input pin. A 10 uF capacitor is a reasonable value at the input. See Ripple Rejection section regarding the value for the adjust pin capacitor.

Device Functional Modes (continued)

It is desirable to have large output capacitance for applications that entail large changes in load current (microprocessors for example). The higher the capacitance, the larger the available charge per demand. It is also desirable to provide low ESR to reduce the change in output voltage:

$$\Delta V = \Delta I \times ESR \tag{2}$$

It is common practice to use several tantalum and ceramic capacitors in parallel to reduce this change in the output voltage by reducing the overall ESR.
Output capacitance can be increased indefinitely to improve transient response and stability.

Protection Diodes

Under normal operation, the LM1086 regulator does not need any protection diode. With the adjustable device, the internal resistance between the adjustment and output terminals limits the current. No diode is needed to divert the current around the regulator even with a capacitor on the adjustment terminal. The adjust pin can take a transient signal of ±25 V with respect to the output voltage without damaging the device.

When an output capacitor is connected to a regulator and the input is shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage of the regulator, and rate of decrease of V_{IN}. In the LM1086 regulator, the internal diode between the output and input pins can withstand microsecond surge currents of 10 A to 20 A. With an extremely large output capacitor (≥1000 µf), and with input instantaneously shorted to ground, the regulator could be damaged. In this case, an external diode is recommended between the output and input pins to protect the regulator, shown in Figure 5

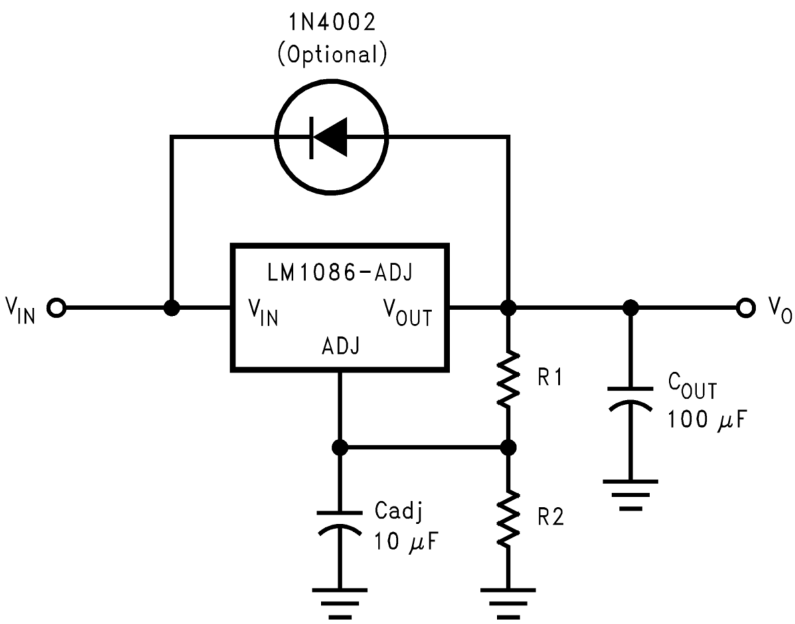


Figure 5. Regulator with Protection Diode

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