

FEATURES

- Wide input voltage range: 3.6 V to 30 V
- Adjustable and fixed (3.3 V, 5 V) output options
- Integrated 1 A power switch
- Uses small surface-mount components
- Cycle-by-cycle current limiting
- Peak input voltage (100 ms): 60 V
- Configurable as a buck, buck-boost, and SEPIC regulator
- Available in 8-lead SOIC package

APPLICATIONS

- Industrial power systems
- PC peripheral power systems
- Preregulator for linear regulators
- Distributed power systems
- Automotive systems
- Battery chargers

FUNCTIONAL BLOCK DIAGRAM

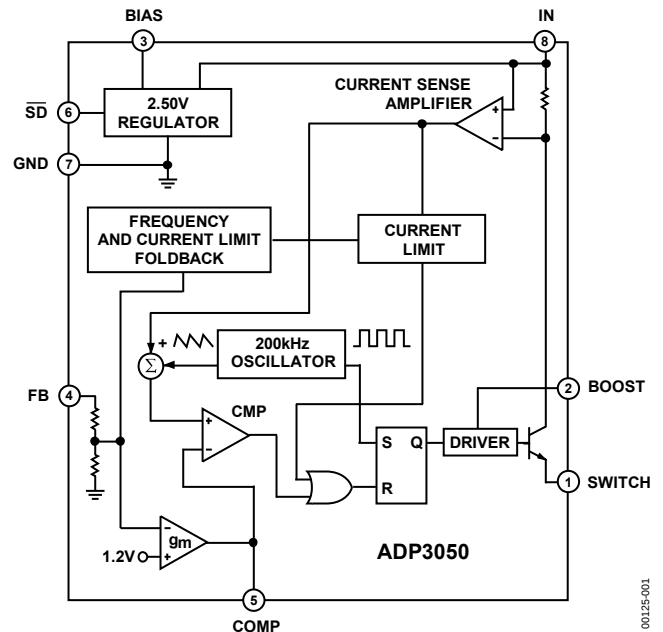


Figure 1.

GENERAL DESCRIPTION

The ADP3050 is a current mode monolithic buck (step down) PWM switching regulator that contains a high current 1 A power switch and all control, logic, and protection functions. It uses a unique compensation scheme allowing the use of any type of output capacitor (tantalum, ceramic, electrolytic, OS-CON). Unlike some buck regulators, the design is not restricted to using a specific type of output capacitor or ESR value.

A special boosted drive stage is used to saturate the NPN power switch, providing a system efficiency higher than conventional bipolar buck switchers. Further efficiency improvements are obtained by using the low voltage regulated output to provide the internal operating current of the device. A high switching frequency allows the use of small external surface-mount components. A wide variety of standard off-the-shelf devices can be used, providing a great deal of design flexibility. A complete regulator design requires only a few external components.

The ADP3050 includes a shutdown input that places the device in a low power mode, reducing the total supply current to under 20 μ A. Internal protection features include thermal shutdown circuitry and a cycle-by-cycle current limit for the power switch to provide complete device protection under fault conditions.

The ADP3050 provides excellent line and load regulation, maintaining typically less than $\pm 3\%$ output voltage accuracy over temperature and under all input voltage and output current conditions.

The ADP3050 is specified over the industrial temperature range of -40°C to $+85^{\circ}\text{C}$ and is available in a thermally enhanced 8-lead (not Pb-free only) SOIC package and a standard 8-lead (Pb-free only) RoHS-compliant SOIC package.

SPECIFICATIONS

$V_{IN} = 10\text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, unless otherwise noted.

Table 1.

Parameter ¹	Symbol	Conditions	Min	Typ	Max	Unit
FEEDBACK						
Feedback Voltage	V _{FB}	Over line and temperature	1.16	1.20	1.24	V
ADP3050			3.20	3.30	3.40	V
ADP3050-3.3			4.85	5.00	5.15	V
ADP3050-5				0.005		%/V
Line Regulation			V _{IN} = 10 V to 30 V, no load			
Load Regulation		I _{LOAD} = 100 mA to 1 A, ADP3050AR only	−1.0	+0.1	+1.0	%/A
		ADP3050AR-3.3, ADP3050AR-5	−0.5	+0.1	+0.5	%/A
Input Bias Current	I _{FB}	ADP3050AR only		0.65	2	μA
ERROR AMPLIFIER						
Transconductance ²	g _m A _{VOL}	COMP = 1.0 V, FB = 1.1 V to 1.3 V COMP = 1.0 V, FB = 3.0 V to 3.6 V COMP = 1.0 V, FB = 4.5 V to 5.5 V		1250		μMho
Voltage Gain ²				300		V/V
Output Current						
ADP3050				±115		μA
ADP3050-3.3				±120		μA
ADP3050-5		±135		μA		
OSCILLATOR						
Oscillator Frequency ³	f _{OSC}		170	200	240	kHz
Minimum Duty Cycle	D _{MIN}			10		%
Maximum Duty Cycle	D _{MAX}			90		%
SWITCH						
Average Output Current Limit ⁴	I _{CL(AVG)}	BOOST = 15 V, FB = 1.1 V BOOST = 15 V, FB = 3.0 V BOOST = 15 V, FB = 4.5 V	1.0	1.25	1.5	A
ADP3050			1.0	1.25	1.5	A
ADP3050-3.3			1.0	1.25	1.5	A
ADP3050-5	I _{CL(PEAK)}	BOOST = 15 V, I _{LOAD} = 1 A	1.5	1.7	2.1	A
Peak Switch Current Limit ⁵				0.65	0.95	V
Saturation Voltage				50		nA
Leakage Current						
SHUTDOWN						
Input Voltage Low					0.4	V
Input Voltage High			2.0			V
SUPPLY						
Input Voltage Range ⁶	V _{IN}		3.6		30	V
Minimum BIAS Voltage	V _{BIAS}				3.0	V
Minimum BOOST Voltage	V _{BOOST}				3.0	V
IN Supply Current	I _Q	BIAS = 5.0 V $\overline{SD}$ = 0 V, V _{IN} ≤ 30 V				
Normal Mode			0.7	1.5	mA	
Shutdown Mode			15	40	μA	
BIAS Supply Current	I _{BIAS}	BIAS = 5.0 V	4.0	6.0		mA
BOOST Supply Current	I _{BOOST}	BOOST = 15 V, I _{SW} = 0.5 A	18			mA
		BOOST = 15 V, I _{SW} = 1.0 A	20	40		mA

¹ All limits at temperature extremes are guaranteed via correlation using standard statistical quality control (SQC).

² Transconductance and voltage gain measurements refer to the internal amplifier without the voltage divider. To calculate the transconductance and gain of the fixed voltage parts, divide the values shown by $FB/1.20$.

³ The switching frequency is reduced when the feedback pin is lower than $0.8 \times FB$.

⁴ See Figure 24 for typical application circuit.

⁵ Switch current limit is measured with no diode, no inductor, and no output capacitor.

⁶ Minimum input voltage is not measured directly, but is guaranteed by other tests. The actual minimum input voltage needed to keep the output in regulation depends on output voltage and load current.

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
IN Voltage	
Continuous	–0.3 V to +40 V
Peak (<100 ms)	–0.3 V to +60 V
BOOST Voltage	
Continuous	–0.3 V to +45 V
Peak (<100 ms)	–0.3 V to +65 V
$\overline{\text{SD}}$, BIAS Voltage	–0.3 V to IN + 0.3 V
FB Voltage	–0.3 V to +8 V
COMP Voltage	–0.3 V to IN + 0.3 V
SWITCH Voltage	–0.3 V to IN + 0.3 V
Operating Ambient Temperature Range	–40°C to +85°C
Operating Junction Temperature Range	–40°C to +125°C
Storage Temperature Range	–65°C to +150°C
θ_{JA} (4-Layer PCB) ¹	60.6°C/W
θ_{JA} (4-Layer PCB) ²	87.5°C/W
Lead Temperature (Soldering, 60 sec)	300°C

¹ Applied to all models that are not Pb-free.² Applied to all Pb-free models.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Table 4. Manufacturers

Inductor Manufacturers	Capacitor Manufacturers	Schottky Diode Manufacturers
Sumida Coilcraft Cooper Bussmann Coiltronics NEC Tokin Würth Elektronik Toko	AVX Kemet Murata Nemco Vishay Sprague NEC Tokin Taiyo Yuden	Motorola Diodes, Inc. International Rectifier Nihon Inter Electronics

CATCH DIODE SELECTION

The recommended catch diode is a Type 1N5818 Schottky or equivalent. The low forward voltage drop (450 mV typical at 1 A) and fast switching speed of a Schottky rectifier provide the best performance and efficiency. The 1N5818 is rated at 30 V reverse voltage and 1 A average forward current. For lower input voltages, use a lower voltage Schottky to reduce the diode forward voltage drop and increase overall system efficiency; for example, a 12 V to 5 V system does not need a 30 V diode. For automotive applications, a 60 V Schottky may be necessary. The average forward current for the catch diode is calculated by

$$I_{DIODE(AVG)} = I_{OUT} \times \frac{V_{IN} - V_{OUT}}{V_{IN}} \quad (5)$$

For the earlier continuous mode example (12 V to 5 V at 800 mA), the average diode current is

$$I_{DIODE(AVG)} = 0.8 \times \frac{12 - 5}{12} = 0.47 \text{ A} \quad (6)$$

For this system, a 1N5817 is a good choice (rated at 20 V and 1 A). Do not use catch diodes rated less than 1 A. Even though the average current can be less than 1 A under normal operating conditions, as the diode current is much higher under fault conditions. The worst-case fault condition for the diode occurs when the regulator becomes slightly overloaded (sometimes called a soft short). This is usually only a problem when the input voltage to output voltage ratio is greater than 2.5. Under this condition, the load current needed is slightly more than the regulator can provide. The output voltage droops slightly, and the switch stays on every cycle until the internal current limit is reached. Under this condition, the load current can reach around 1.2 A. For example, when using a system with an input voltage of 24 V and an output voltage of 5 V, if a gradual overload causes the output voltage to droop to 4 V, the average diode current is

$$I_{DIODE(AVG)} = 1.2 \times \frac{24 - 4}{24} = 1.0 \text{ A} \quad (7)$$

If the system must survive such gradual overloads for a prolonged period of time, ensure the diode chosen can survive these conditions. A larger 2 A or 3 A diode can be used if necessary.

Choosing a Catch Diode

Use the following steps to pick an appropriate catch diode. Table 5 shows several Schottky rectifiers with different reverse voltage and forward current ratings.

The average diode current rating must be sufficient to provide the required load current (see the calculations in the previous section). Diodes rated below 1 A should not be used, even if the average diode current is much lower.

The reverse voltage rating of the catch diode should be at least the maximum input voltage. Often a higher rating is chosen (1.2× the maximum input voltage) to provide a safety margin.

Table 5. Schottky Diode Selection Guide

V _R	1 A	2 A	3 A
15 V	10BQ15	30BQ15	
20 V	1N5817	B220	SK32
30 V	V1N5818	B230	SK33
40 V	1N5819	B240	SK34

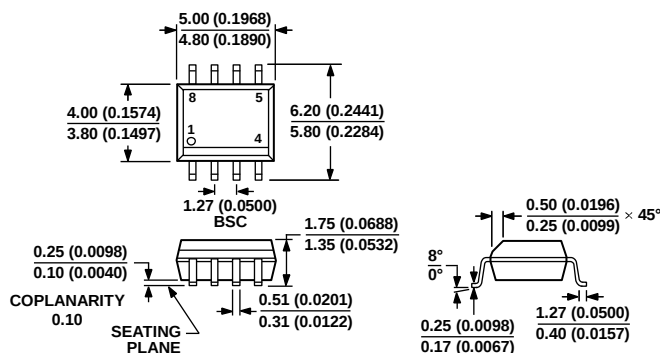
INPUT CAPACITOR SELECTION

The input bypass capacitor plays an important role in proper regulator operation, minimizing voltage transients at the input and providing a short local loop for the switching current. Place this capacitor close to the ADP3050 between the IN and GND pins using short, wide traces. This input capacitor should have an rms ripple current rating of at least

$$I_{CIN(RMS)} \geq I_{OUT} \times \sqrt{\frac{V_{OUT}}{V_{IN}} - \left(\frac{V_{OUT}}{V_{IN}}\right)^2} \quad (8)$$

This rating is crucial because the input capacitor must be able to withstand the large current pulses present at the input of a step-down regulator. Values of 20 μF to 50 μF are typical, but the main criteria for capacitor selection is the ripple current and voltage ratings.

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-012-A A
CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS
(IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR
REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

0.12 407-A

Figure 31. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-8)

Dimensions shown in millimeters and (inches)

ORDERING GUIDE

Model	Output Voltage	Temperature Range ¹	Package Description	Package Option	Ordering Quantity
ADP3050AR	ADJ	−40°C to +85°C	8-Lead SOIC_N	R-8	98
ADP3050AR-REEL	ADJ	−40°C to +85°C	8-Lead SOIC_N	R-8	2,500
ADP3050AR-REEL7	ADJ	−40°C to +85°C	8-Lead SOIC_N	R-8	1,000
ADP3050AR-3.3	3.3 V	−40°C to +85°C	8-Lead SOIC_N	R-8	98
ADP3050AR-3.3-REEL	3.3 V	−40°C to +85°C	8-Lead SOIC_N	R-8	2,500
ADP3050AR-3.3-RL7	3.3 V	−40°C to +85°C	8-Lead SOIC_N	R-8	1,000
ADP3050AR-5	5 V	−40°C to +85°C	8-Lead SOIC_N	R-8	98
ADP3050AR-5-REEL	5 V	−40°C to +85°C	8-Lead SOIC_N	R-8	2,500
ADP3050AR-5-REEL7	5 V	−40°C to +85°C	8-Lead SOIC_N	R-8	1,000
ADP3050ARZ ²	ADJ	−40°C to +85°C	8-Lead SOIC_N	R-8	98
ADP3050ARZ-RL ²	ADJ	−40°C to +85°C	8-Lead SOIC_N	R-8	2,500
ADP3050ARZ-R7 ²	ADJ	−40°C to +85°C	8-Lead SOIC_N	R-8	1,000
ADP3050ARZ-3.3 ²	3.3 V	−40°C to +85°C	8-Lead SOIC_N	R-8	98
ADP3050ARZ-3.3-RL ²	3.3 V	−40°C to +85°C	8-Lead SOIC_N	R-8	2,500
ADP3050ARZ-3.3-RL7 ²	3.3 V	−40°C to +85°C	8-Lead SOIC_N	R-8	1,000
ADP3050ARZ-5 ²	5 V	−40°C to +85°C	8-Lead SOIC_N	R-8	98
ADP3050ARZ-5-REEL ²	5 V	−40°C to +85°C	8-Lead SOIC_N	R-8	2,500
ADP3050ARZ-5-REEL7 ²	5 V	−40°C to +85°C	8-Lead SOIC_N	R-8	1,000

¹ Operating junction temperature is −40 to +125°C.

² Z = RoHS Compliant Part.