19-3894; Rev 3; 10/94

MAXIM

+5V/Programmable Low-Dropout Voltage Regulator

General Description

The MAX667 low-dropout, positive, linear voltage regulator supplies up to 250mA of output current. With no load, it has a typical quiescent current of 20µA. At 200mA of output current, the input/output voltage differential is typically 150mV. Other features include a low-voltage detector to indicate power failure, as well as early-warning and low-dropout detectors to indicate an imminent loss of output voltage regulation. A shutdown control disables the output and puts the circuit into a low quiescent-current mode.

The MAX667 employs Dual Mode™ operation. One mode uses internally trimmed feedback resistors to produce +5V. In the other mode, the output may be varied from +1.3V to +16V by connecting two external resistors.

The MAX667 is a pin-compatible upgrade to the MAX666 in most applications where the input voltages are above +3.5V. Choose the MAX667 when high output currents and/or low dropout voltages are desired, as well as for improved performance at higher temperatures.

Applications

Battery-Powered Devices

Pagers and Radio Control Receivers

Portable Instruments

Solar-Powered Instruments

Features

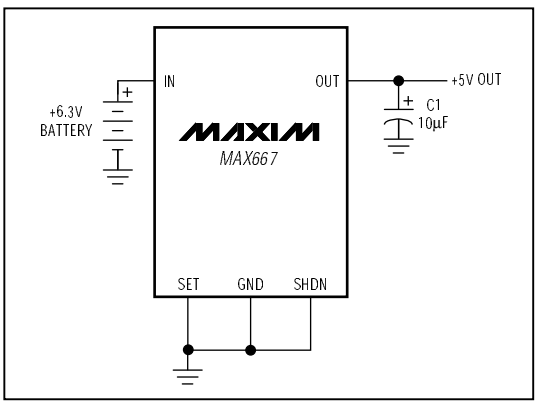
- **350mV Max Dropout at 200mA**
- **250mA Output Current**
- **Normal Mode: 20µA Typ Quiescent Current**
  Shutdown Mode: 0.2µA Typ Quiescent Current
- **Low-Battery Detector**
- **Fixed +5V (Min Component Count) or Adjustable Output**
- **+3.5V to +16.5V Input**
- **Dropout Detector Output**
- **10µF Output Capacitor**

Ordering Information

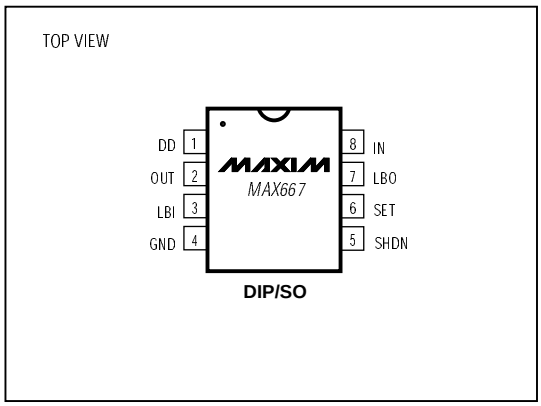
PART	TEMP. RANGE	PIN-PACKAGE
MAX667CPA	0°C to +70°C	8 Plastic DIP
MAX667CSA	0°C to +70°C	8 SO
MAX667C/D	0°C to +70°C	Dice*
MAX667EPA	-40°C to +85°C	8 Plastic DIP
MAX667ESA	-40°C to +85°C	8 SO
MAX667MJA	-55°C to +125°C	8 CERDIP

** Contact factory for dice specifications.*

Typical Operating Circuit



Pin Configuration



™ *Dual Mode is a trademark of Maxim Integrated Products.*

+5V/Programmable Low-Dropout Voltage Regulator

ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage ..... +18V
Output Short Circuited to Ground 1sec
LBO Output Sink Current 50mA
LBO Output Voltage ..... GND to V_{OUT}
SHDN Input Voltage ..... -0.3V to (V_{IN} + 0.3V)
Input Voltages LBI, SET ..... -0.3V to (V_{IN} - 1.0V)
Continuous Power Dissipation
  Plastic DIP (derate 9.09mW/°C above +70°C) 727mW
  SO (derate 5.88mW/°C above +70°C) 471mW
  CERDIP (derate 8.00mW/°C above +70°C) 640mW
Operating Temperature Ranges
  MAX667C_A ..... 0°C to +70°C
  MAX667E_A ..... -40°C to +85°C
  MAX667MJA ..... -55°C to +125°C
Storage Temperature Range ..... -65°C to +160°C
Lead Temperature (soldering, 10sec) ..... +300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(GND = 0V, V_{IN} = +9V, V_{OUT} = +5V, C1 = 10µF, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		T_A = +25°C MIN	T_A = +25°C TYP	T_A = +25°C MAX	T_A = T_{MIN} to T_{MAX} MIN	T_A = T_{MIN} to T_{MAX} TYP	T_A = T_{MIN} to T_{MAX} MAX	UNITS
Input Voltage	V_{IN}						3.5		16.5	V
Output Voltage	V_{OUT}	V_{SET} = 0V, V_{IN} = 6V, I_{OUT} = 10mA, T_A = -40°C to +85°C			5		4.8		5.2	V
		V_{SET} = 0V, V_{IN} = 6V, I_{OUT} = 10mA, T_A = -55°C to +125°C			5		4.75		5.25	
Maximum Output Current	I_{OUT}	V_{IN} = 6V, 4.5V < V_{OUT} < 5.5V		250			250			mA
Quiescent Current	I_Q	V_{SHDN} = 2V			0.2	1			2	µA
		V_{SHDN} = 0V, V_{SET} = 0V	I_{OUT} = 0µA		20	25			35	
			I_{OUT} = 100µA		20	30			50	
			I_{OUT} = 200mA		5	15			20	mA
Dropout Voltage (Note1)		I_{OUT} = 100µA			5	60			75	mV
		I_{OUT} = 200mA			150	250			350	
Load Regulation		I_{OUT} = 10mA to 200mA			50	100			250	mV
Line Regulation		V_{IN} = 6V to 10V, I_{OUT} = 10mA			5	10			15	mV
SET Reference Voltage	V_{SET}				1.225		1.20		1.25	V
SET Input Leakage Current	I_{SET}	V_{SET} = 1.5V			0.01	±10			±1000	nA
Output Leakage Current	I_{OUT}	V_{SHDN} = 2V			0.1				1	µA
Short-Circuit Current	I_{OUT}	(Note 2)				400			450	mA
Low-Battery Detector Reference Voltage	V_{LBI}				1.225		1.195		1.255	V
Low-Battery Detector Input Leakage Current	I_{LBI}	V_{LBI} = 1.5V			0.01	±10			±1000	nA
Low-Battery Detector Output Voltage	V_{LBO}	V_{IN} = 9V, V_{LBI} = 2V, I_{LBO} = 10mA				0.25			0.4	V
SHDN Threshold	V_{SHDN}	V_{IH}		1.5			1.5			V
		V_{IL}				0.3			0.3	
SHDN Leakage Current	I_{SHDN}	V_{SHDN} = 0V to V_{IN}			0.01	±10			±1000	nA
Dropout Detector Output Voltage	V_{DD}	V_{SET} = 0V, V_{SHDN} = 0V, R_{DD} = 100kΩ, I_{OUT} = 10mA	V_{IN} = 7V						0.25	V
			V_{IN} = 4.5V				3.5			

Note 1: Dropout Voltage is V_{IN}-V_{OUT} when V_{OUT} falls to 0.1V below its value at V_{IN} = V_{OUT} + 2V.
Note 2: Short-Circuit Current is pulse tested to maintain junction temperature. Short-circuit duration is limited by package dissipation.

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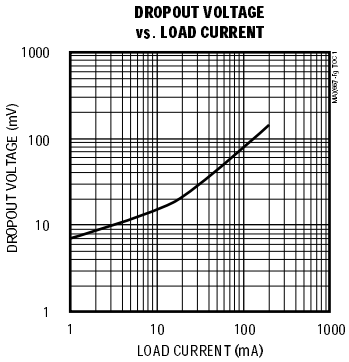
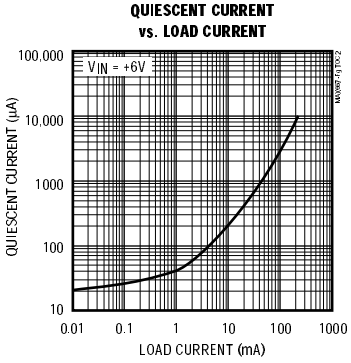
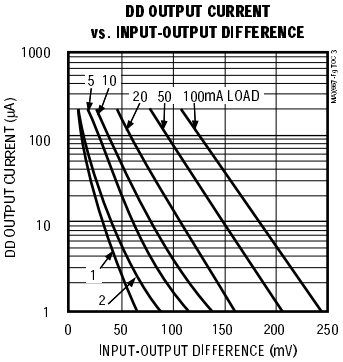
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)







Pin Description

PIN	NAME	FUNCTION
1	DD	Dropout Detector Output—the collector of a PNP pass transistor. Normally an open circuit, it sources current as dropout is reached.
2	OUT	Regulated Output Voltage. OUT falls to 0V when SHDN is above 1.5V. SET determines output voltage when SET is above 50mV; otherwise, it is 5V. OUT must be connected to an output filter capacitor.
3	LBI	Low-Battery Detector. A CMOS input to an internal 1.255V comparator whose output is the LBO pin.
4	GND	Ground
5	SHDN	Shutdown Input. Connect to GND for normal operation (output active). Pull above 1.5V to disable OUT, LBO, and DD and to reduce quiescent current to less than 1µA.
6	SET	(Output) Voltage Set, CMOS Input. Connect to GND for 5V output. For other voltages, connect external resistive divider from OUT.
7	LBO	Low-Battery Output. An open-drain N-channel transistor that sinks current to GND when LBI is less than 1.22V.
8	IN	Positive Input Voltage (unregulated)

Detailed Description

Figure 1 shows a micropower bandgap reference, an error amplifier, a PNP pass transistor, and two comparators as the main elements of the MAX667. One comparator, C1, selects the fixed 5V or adjustable operation with an external voltage divider. The other comparator, C2, is a low-battery detector.

The bandgap reference, which is trimmed to 1.22V, connects internally to one input of the error amplifier, A1. The feedback signal from the regulator output supplies the other input of A1 from either an on-chip voltage divider or two external resistors. When SET is grounded, the internal divider provides the error amplifier feedback signal for a fixed 5V output. When SET is more than 50mV above ground, the error amplifier's input switches directly to SET while an external resistor divider from OUT determines the output voltage.

A second comparator, C2, compares the LBI input to the internal reference voltage. LBO is an open-drain FET connected to GND. The low-battery threshold can also be set with a voltage divider at LBI. In addition, the MAX667 has a shutdown input (SHDN) that disables the load and the device while reducing quiescent current when it is pulled high.

+5V Output

Figure 2 shows the connection for a fixed 5V output. The SET input is grounded, and no external resistors are required. Figure 3 shows adjustable output operation. R1 and R2 set the output voltage. SHDN should be grounded if not used.