

EVALUATION KIT AVAILABLE

MAX8516/MAX8517/ MAX8518

1.425V to 3.6V Input, 1A, 0.2V Dropout LDO Regulators

General Description

The MAX8516/MAX8517/MAX8518 low-dropout linear regulators operate from input voltages as low as 1.425V and are able to deliver up to 1A of continuous output current with a maximum dropout voltage of only 200mV. The output voltage can be set from 0.5V to (V_{IN} - 0.2V) and is 1.4% accurate over load and line variations, from 0°C to +85°C.

These regulators use small, 1µF ceramic input capacitors and 4.7µF ceramic output capacitors to deliver 1A output current. High bandwidth provides excellent transient response and limits the output voltage deviation to 45mV for a 20mA to 1A load step, with only a 4.7µF ceramic output capacitor, and the voltage deviations can be reduced further by increasing the output capacitor.

Designed with an internal p-channel MOSFET pass transistor, the MAX8516/MAX8517/MAX8518 feature low 340µA (typ) supply current during dropout conditions. Soft-start reduces inrush current. Other features include a logic-controlled shutdown mode, short-circuit protection, and thermal-overload protection.

The MAX8517 features a power-OK (POK) output that transitions high when the regulator output is within ±10% of its nominal output voltage. The MAX8518 features a 150ms power-on reset output.

The parts are packaged in a 10-pin µMAX® package that includes an exposed pad for optimal power dispation.

Applications

- Servers
- Storage
- Networking
- Base Stations
- Optical Modules
- Post Regulators
- Notebooks
- PDAs
- ATE

µMAX is a registered trademark of Maxim Integrated Products, Inc.

Features

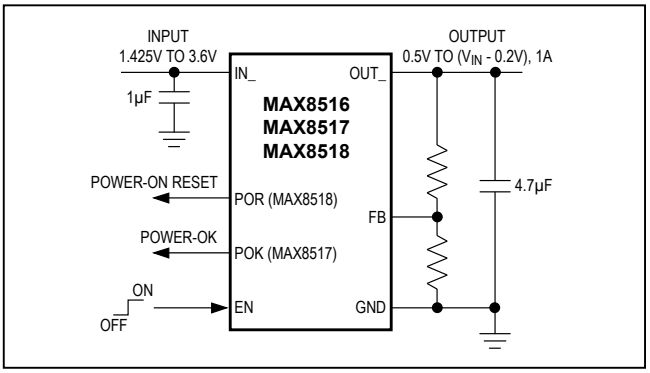
- 1.425V to 3.6V Input Voltage Range
- Guaranteed 200mV Dropout at 1A Output Current
- ±1.4% Output Accuracy Over Load, Line, and Temperature (0°C to +85°C), ±0.6% Initial Accuracy
- Compatible with Ceramic Capacitors
- Fast Transient Response
- 320µA Operating Supply Current
- <25µA Shutdown Supply Current
- Short-Circuit Protection
- Thermal-Overload Protection
- Soft-Start Limits Inrush Current

Ordering Information

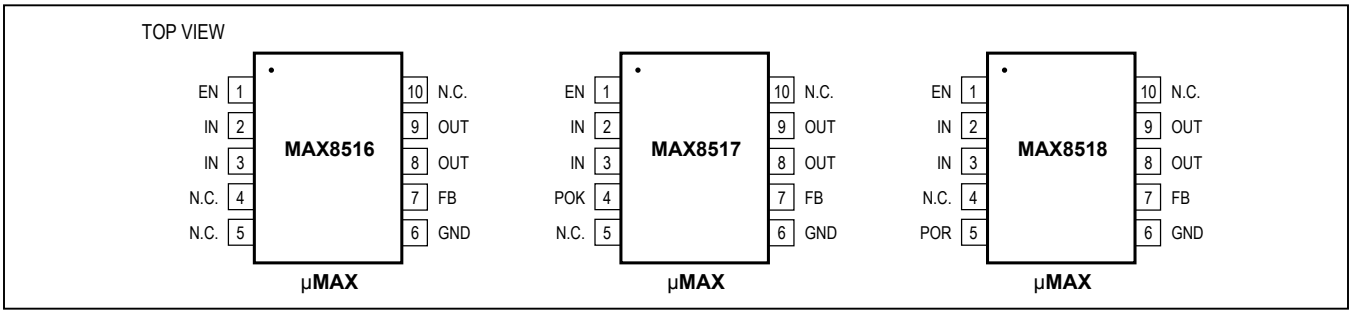
PART	TEMP RANGE	PIN-PACKAGE
MAX8516EUB	-40°C to +85°C	10 µMAX
MAX8517EUB	-40°C to +85°C	10 µMAX
MAX8517EUB/V+	-40°C to +85°C	10 µMAX
MAX8518EUB	-40°C to +85°C	10 µMAX

/V Denotes an automotive qualified part.
+Denotes lead(Pb)-free/RoHS-compliant package.

Typical Operating Circuit



Pin Configurations



maxim integrated™

Absolute Maximum Ratings

IN, EN, POK (MAX8517), POR (MAX8518),
FB to GND ..... -0.3V to +4.0V
OUT to GND ..... -0.3V to (IN + 0.3V)
Output Short-Circuit Duration ..... Continuous
Continuous Power Dissipation
(T_A = +70°C, EP soldered to PC board ground)
10-Pin µMAX (derate 10.3mW/°C above +70°C) 824mW

Operating Temperature Range ..... -40°C to +85°C
Junction Temperature ..... +150°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10s) ..... +300°C
Soldering Temperature (soldering, 10s) ..... +240°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

(Circuit of Figure 1. V_{IN} = +1.8V, V_{OUT} = +1.5V, EN = IN, I_{OUT} = 1mA, T_A = -40°C to +85°C, unless otherwise noted.) (Note 1)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
IN						
Input Voltage Range			1.425		3.600	V
Input Undervoltage Lockout	V_{IN} rising, 70mV hysteresis		1.32	1.35	1.38	V
OUT						
Output Voltage Range			0.5		3.4	V
Load Regulation	I_{OUT} = 1mA to 1A			0.1		%/A
Line Regulation	V_{IN} = 1.425V to 3.6V, V_{OUT} = 1.225V, I_{OUT} = 1mA		-0.15	0	+0.15	%/V
Dropout Voltage (V_{IN} - V_{OUT})	V_{IN} = 1.425V, I_{OUT} = 1A, V_{FB} = 480mV			100	200	mV
Current Limit	V_{IN} = 3.6V, V_{OUT} = 3V, V_{FB} = 480mV		1.6	2	2.4	A
Output Shutdown Leakage	V_{IN} = 3.6V, V_{OUT} = 0, V_{EN} = 0			0.25	25	µA
FB						
FB Threshold Accuracy	I_{OUT} = 10mA, T_A = +85°C		497	500	503	mV
	V_{OUT} = 1.225V to 3V, V_{IN} = V_{OUT} + 0.2V to 3.6V, I_{OUT} = 1mA to 1A		493		507	
FB Input Bias Current	V_{FB} = 0.5V, V_{IN} = 3.6V			0.001	1	µA
GND						
GND Supply Current	V_{IN} = 3.6V, V_{OUT} = 3V, I_{OUT} = 100mA			320		µA
	Dropout, V_{IN} = 3.6V, V_{FB} = 480mV			340	600	
GND Shutdown Current	V_{IN} = 3.6V, EN = GND			0.25	25	µA
POK (MAX8517 ONLY)						
POK Threshold	V_{FB} moving out of regulation, V_{HYS} = 10mV, IN = 1.425V to 3.6V	FB high	540	550	560	mV
		FB low	440	450	460	
POK Output Voltage Low	V_{FB} = 0.4V or 0.6V, I_{POK} = 1mA			25	200	mV
POK Output Current High	V_{POK} = 3.6V			0.001	1	µA
POK Fault Delay Time	From FB to POK		25	50	100	µs

Electrical Characteristics (continued)

(Circuit of Figure 1. V_{IN} = +1.8V, V_{OUT} = +1.5V, EN = IN, I_{OUT} = 1mA, T_A = -40°C to +85°C, unless otherwise noted.) (Note 1)

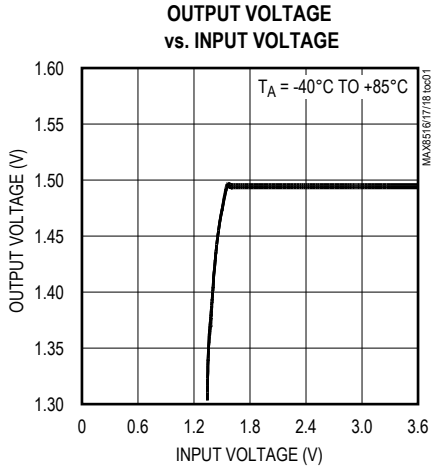
PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
POR (MAX8518 ONLY)						
POR Reset Threshold	V_{FB} falling, V_{HYS} = 10mV, V_{IN} = 1.425V to 3.6V		440	450	460	mV
POR Output Voltage Low	V_{FB} = 0.4V or 0.6V, I_{POR} = 1mA			25	200	mV
POR Output Current High	V_{POR} = 3.6V			0.001	1	µA
POR Rising Delay Time	From FB to POR		105	150	210	ms
EN						
Enable Input Threshold	V_{IN} = 1.425V to 3.6V	EN rising			1.2	V
		EN falling	0.4			
Enable Input Bias Current	V_{EN} = 0 or 3.6V		-1		+1	µA
THERMAL SHUTDOWN						
Thermal-Shutdown Threshold	Output on or off	T_J rising		+165		°C
		T_J falling		+150		
OUTPUT TRANSIENT						
Load Transient	I_{OUT} = 20mA to 1A to 20mA, t_{RISE} = t_{FALL} = 1µs			3		%
Line Transient	δV_{IN} = 0.5V, t_{RISE} = t_{FALL} = 5µs			3		%

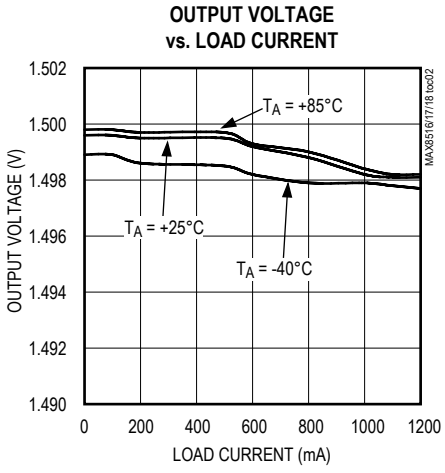
Note 1: Specifications to T_A = -40°C are guaranteed by design, not production tested.

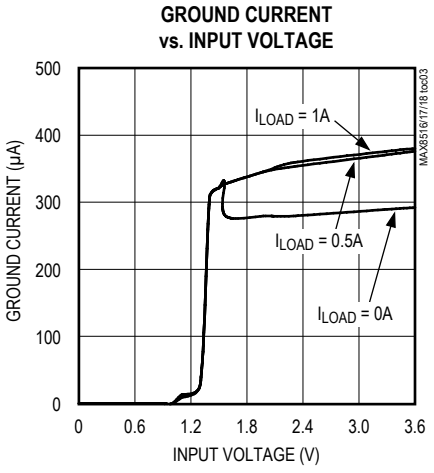
Note 2: Measurements at high current are pulse tested, such that the junction temperature is ambient temperature. Minimum supply voltage for output accuracy must be at least 1.425V.

Typical Operating Characteristics

(Circuit of Figure 1, V_{IN} = +1.8V, V_{OUT} = +1.5V, I_{OUT} = 1A, C_{OUT} = 4.7µF, C_{IN} = 1µF, T_A = +25°C.)



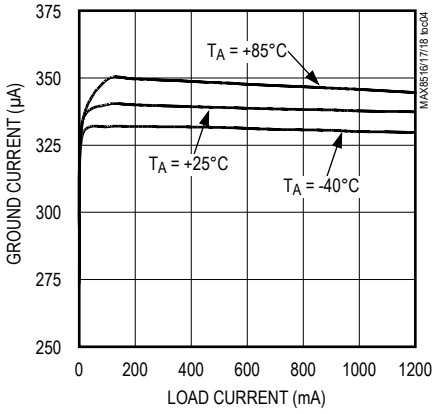




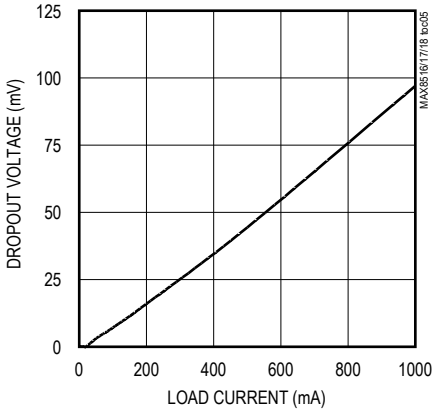
Typical Operating Characteristics (continued)

(Circuit of Figure 1, V_{IN} = +1.8V, V_{OUT} = +1.5V, I_{OUT} = 1A, C_{OUT} = 4.7µF, C_{IN} = 1µF, T_A = +25°C.)

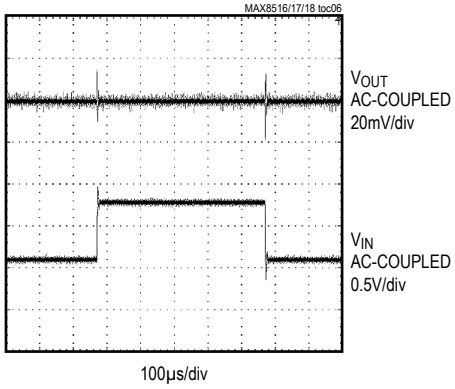
GROUND CURRENT vs. LOAD CURRENT



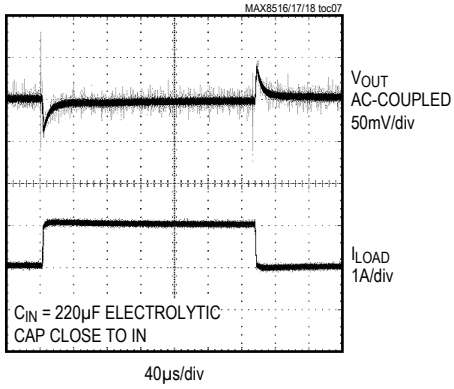
DROPOUT VOLTAGE vs. LOAD CURRENT



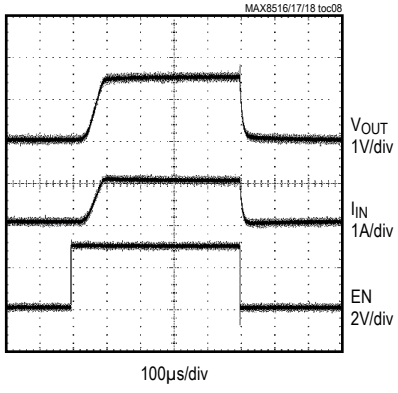
LINE INPUT TRANSIENT (V_{IN} = +1.8V TO +2.5V, I_{LOAD} = 1A)



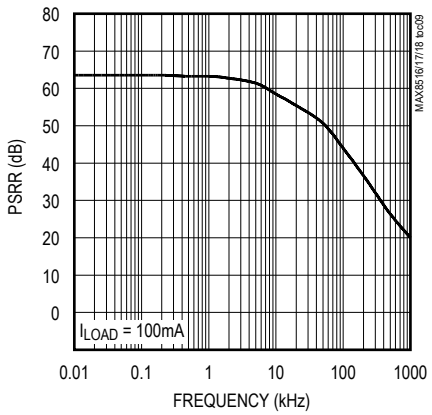
LOAD-TRANSIENT RESPONSE (I_{LOAD} = 0.1A TO 1A)



SHUTDOWN RESPONSE



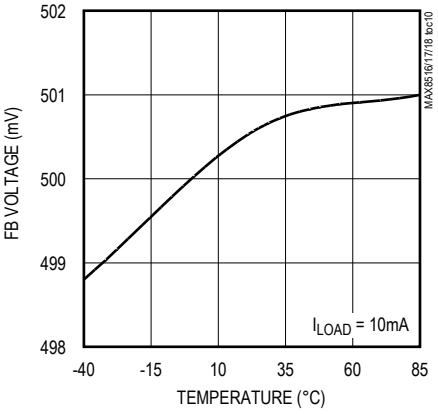
PSRR vs. FREQUENCY (MAX8516)



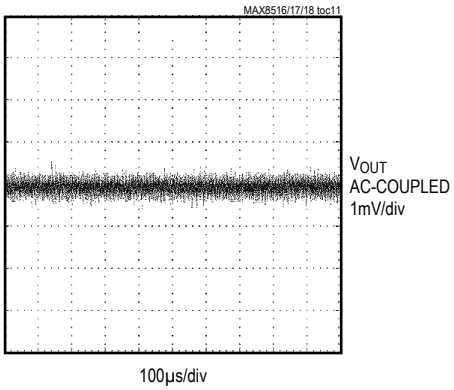
Typical Operating Characteristics (continued)

(Circuit of Figure 1, V_{IN} = +1.8V, V_{OUT} = +1.5V, I_{OUT} = 1A, C_{OUT} = 4.7µF, C_{IN} = 1µF, T_A = +25°C.)

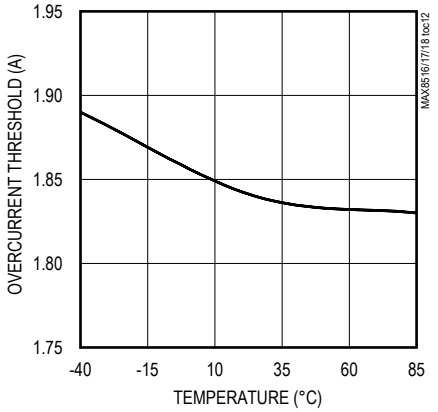
FB VOLTAGE vs. TEMPERATURE



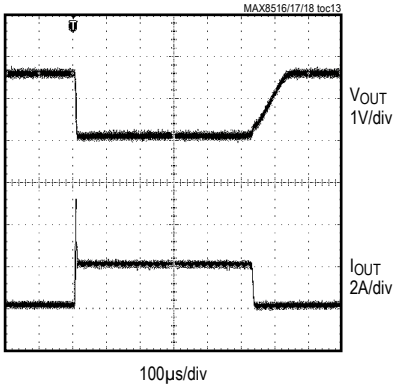
OUTPUT RIPPLE VOLTAGE



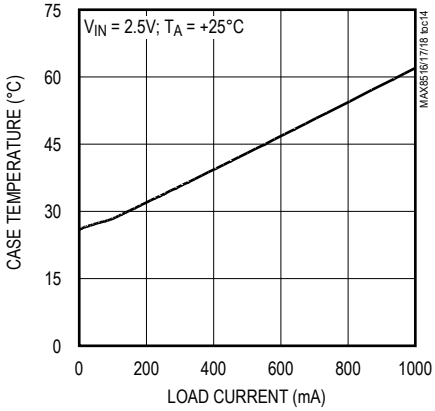
OVERCURRENT THRESHOLD vs. TEMPERATURE



SHORT-CIRCUIT CURRENT



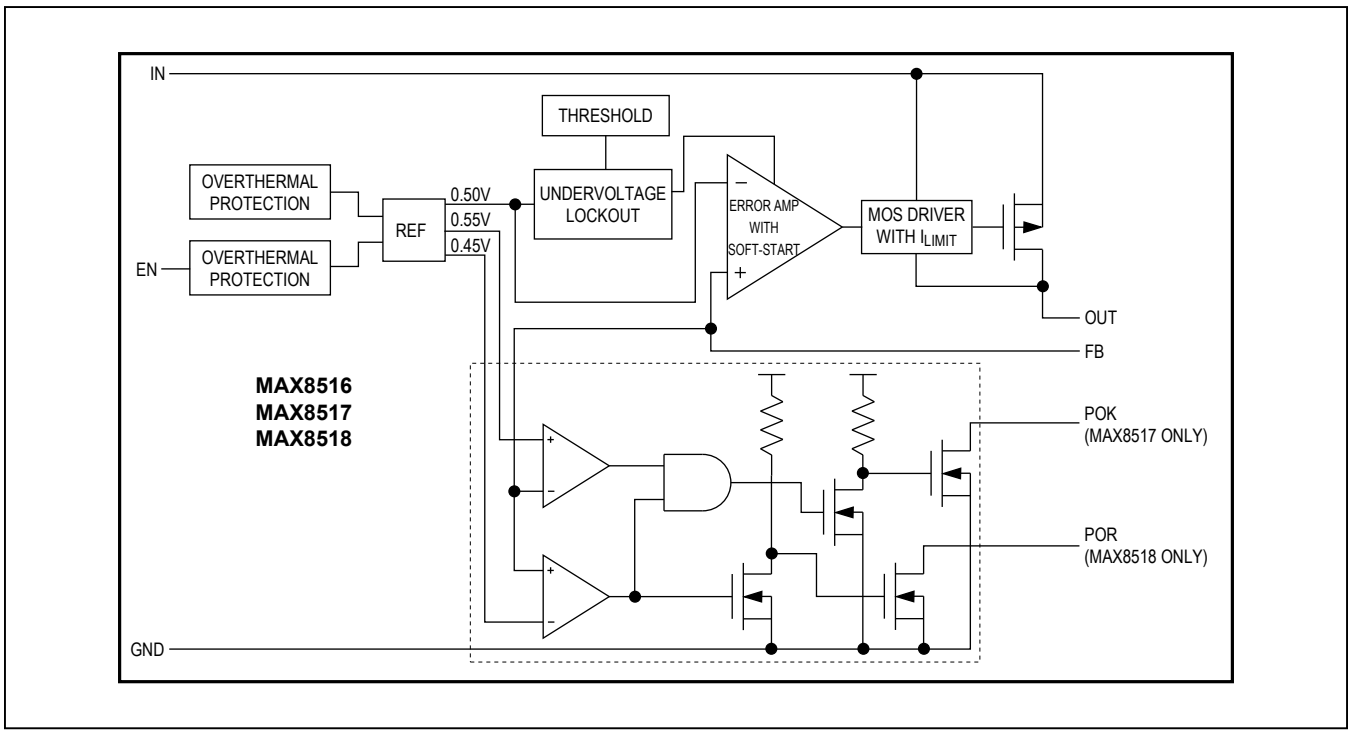
CASE TEMPERATURE vs. LOAD CURRENT



Pin Description

PIN			NAME	DESCRIPTION
MAX8516	MAX8517	MAX8518		
1	1	1	EN	Enable Input. Set low to place the device in low-current shutdown mode. Set high for normal operation.
2, 3	2, 3	2, 3	IN	Regulator Input. V_{IN} can range from +1.425V to +3.6V. Bypass with a 1µF or higher ceramic capacitor to GND.
4, 5, 10	5, 10	4, 10	N.C.	No Connection. Pin 10 is internally pulled down to GND with a 10kΩ resistor. Leave floating.
6	6	6	GND	Ground
7	7	7	FB	Feedback Pin. Connect to output through a voltage-divider to set the output.
8, 9	8, 9	8, 9	OUT	Regulator Output. Bypass with a 4.7µF ceramic capacitor to GND (a smaller capacitor can be used if maximum load is less than 1A, i.e., $C_{OUT} = I_{OUT}$ (max) x (1µF/200mA).
—	4	—	POK	Power-OK Output (MAX8517 Only). Open-drain output. Connect to a positive supply with a pullup resistor. If not used, leave pin unconnected. See the *Detailed Description*.
—	—	5	POR	Power-On Reset Output. Open-drain output. Connect to a positive supply with a pullup resistor. If not used, leave pin unconnected (see the *Detailed Description* for more details).
EP			GND	Exposed Pad on the Underside of the Package. Solder to the ground plane for proper heat dissipation.

Functional Diagram



Detailed Description

The MAX8516/MAX8517/MAX8518 are low-input, low-dropout, PMOS regulators capable of delivering up to 1A of output current with as little as 200mV of headroom from input to output. The PMOS output stage can be driven from input voltages down to +1.425V without sacrificing stability or transient performance. Since these regulators have a PMOS output device, supply current is not a significant function of load or input headroom.

Internal P-Channel Pass Transistor

The MAX8516/MAX8517/MAX8518 feature a 100mΩ (typ) p-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, p-channel MOSFETs require no base drive, which reduces quiescent current. PNP-based regulators also waste considerable current in dropout when the pass transistor saturates and use high base-drive currents under large loads. The MAX8516/MAX8517/MAX8518 do not suffer from these problems and consume only 340µA (typ) of quiescent current under heavy loads, as well as in dropout.

Short-Circuit/Thermal Fault Protection

The MAX8516/MAX8517/MAX8518 are fully protected from a short circuit at the output through current-limiting and thermal-overload circuitry. In the fault condition when the output is shorted to ground, the output current is limited to 2A. Under these conditions, the part quickly heats up. When the junction temperature reaches +165°C, the thermal-overload circuitry turns off the output, allowing the part to cool down. When the junction temperature cools to +150°C, the output turns back on and tries to reestablish regulation. Current limiting and thermal protection continue until the fault is removed. For continuous operation, do not exceed the absolute maximum junction-temperature rating of T_J = +150°C.

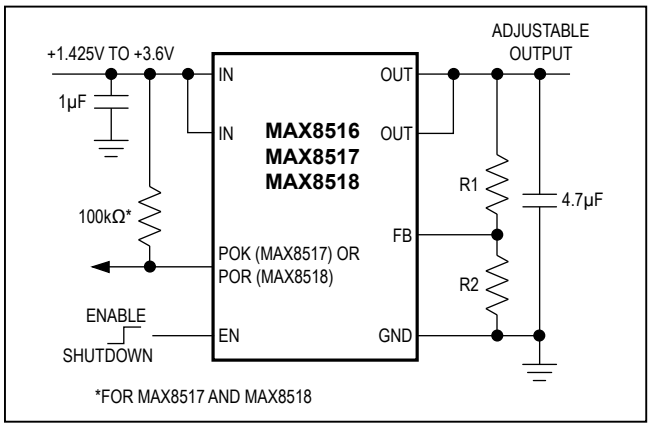


Figure 1. Typical Application Circuit

Output Voltage Selection

The MAX8516/MAX8517/MAX8518 feature an adjustable output voltage from 0.5V to 3.4V, using two external resistors connected as a voltage-divider to FB as shown in Figure 1. The output voltage is set by the following equation:

$$V_{OUT} = V_{FB}\left(1+\frac{R1}{R2}\right)$$

where typically V_{FB} = 0.5V. Choose R2 ≤ 5kΩ to optimize quiescent current, accuracy, and high-frequency power-supply rejection. To simplify resistor selection:

$$R1 = R2\left(\frac{V_{OUT}}{V_{FB}} - 1\right)$$

Soft-Start

Inherent soft-start limits inrush current. Peak inrush current is dependent on the value of C_{OUT} and can be calculated as follows:

$$I_{INRUSH} = I_{LOAD} + \left(\frac{C_{OUT}(\mu F)}{66}\right)$$

Shutdown Mode

The MAX8516/MAX8517/MAX8518 include an enable input. To shut down the device, pull EN to GND. For normal operation, connect the EN to IN. During shutdown, an internal 10kΩ resistor pulls down the output.

Power-OK (MAX8517 Only)

The MAX8517 features a power-OK (POK) output to indicate the status of the output. POK remains high when the regulator output is within ±10% of its nominal output voltage. If the output voltage falls or rises outside this range, POK transitions low. This open-drain output requires an external pullup resistor to IN. An internal delay circuit prevents POK from switching for 50µs (typ) after the trip threshold is initially reached. If the part is in shutdown mode, POK is low.

Power-On Reset (MAX8518 Only)

The MAX8518 features a power-on reset (POR) output that transitions high 140ms (typ) after the output has risen above 90% of its final value. This open-drain output requires an external pullup resistor to IN. If the part is in shutdown mode, falls below 90% of the nominal output voltage, or experiences a short-circuit or thermal fault, POR immediately transitions low.

Operating Region and Power Dissipation

The maximum power dissipation depends on the thermal resistance of the IC package and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power dissipated in the device is $P = I_{OUT} \times (V_{IN} - V_{OUT})$.

The package features an exposed thermal pad on its underside. This pad lowers the thermal resistance of the package by providing a direct heat conduction path from the die to the PCB.

Additionally, the ground pins (GND) perform the dual function of providing an electrical connection to system ground and channeling heat away. Connect the exposed backside pad and GND to the system ground using a large pad or ground plane, or multiple vias to the ground plane layer.

Applications Information

Capacitor Selection and Regulator Stability

Capacitors are required at the MAX8516/MAX8517/MAX8518 inputs and outputs for stable operation over the full temperature range and with load currents up to 1A. Connect a 1µF capacitor between IN and ground and a 4.7µF capacitor with low equivalent series resistance (ESR) between OUT and ground for 1A output current. The input capacitor (C_{IN}) lowers the source impedance of the input supply. If input-supply source impedance is high, place a larger input capacitor close to IN to prevent V_{IN} sagging due to load transients. Smaller output capacitors can be used for output currents less than 1A. Calculate C_{OUT} as follows:

$$C_{OUT} = I_{OUT(MAX)} \times (1\mu F / 200mA)$$

Noise, PSRR, and Transient Response

The MAX8516/MAX8517/MAX8518 are designed to operate with low dropout voltages and low quiescent currents while still maintaining good noise, transient response, and AC rejection (see the *Typical Operating Characteristics* for a plot of Power-Supply Rejection Ratio (PSRR) vs. Frequency). When operating from noisy sources, improved supply-noise rejection and transient response can be achieved by increasing the values of the input and output bypass capacitors and through passive filtering techniques. The MAX8516/MAX8517/MAX8518 load-transient response graphs (see the *Typical Operating Characteristics*) show two components of the output response: a DC shift from the output impedance due to the load current change, and the transient response. A typical transient overshoot for a step change in the load current from 20mA to 1A is 45mV. Use larger output ceramic capacitors greater than 4.7µF up to 50µF to attenuate the overshoot.

Chip Information

TRANSISTOR COUNT: 2849

PROCESS: BiCMOS

Chip Information

TRANSISTOR COUNT: 2849

PROCESS: BiCMOS

Package Information

For the latest package outline information and land patterns (footprints), go to **www.maximintegrated.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	DOCUMENT NO.
10 µMAX	U10E+3	**21-0109**

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/04	Initial release	—
1	4/04	Removed future product asterisks for MAX8517/MAX8518. Updated *Electrical Characteristics* and *Pin Description*.	1–3, 6
2	9/09	Added MAX8517 automotive package to *Ordering Information*.	1
3	4/16	Added lead-free designation	1, 9

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at www.maximintegrated.com.

Maxim Integrated cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim Integrated product. No circuit patent licenses are implied. Maxim Integrated reserves the right to change the circuitry and specifications without notice at any time. The parametric values (min and max limits) shown in the Electrical Characteristics table are guaranteed. Other parametric values quoted in this data sheet are provided for guidance.