Features



Regulated 5V USB Charge Pump with **Programmable Current Limit**

General Description

The MAX5008 charge-pump regulator generates a regulated 5V output up to 125mA with a 2.95V to 5.5V input voltage range. The device includes resistor-programmable overcurrent limit. The MAX5008 requires a minimum number of external components for normal operation. The high 1MHz switching frequency allows the use of small surface-mount ceramic capacitors.

The fault-protection circuitry limits the output current when it exceeds the limit set by an external resistor. The output current can range from 1mA to 150mA to accommodate circuit requirements. A FAULT output indicates when the device is in current limit or the output is out of regulation.

A low-power shutdown mode reduces supply current to less than 1µA and places the output in a high-impedance state. The MAX5008 is offered in a space-saving 10-pin µMAX® package that is only 1.1mm high.

Applications

Flash Memory Supplies **USB Host Devices** Battery-Powered Systems 3.3V to 5V Local Conversion

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♦ Regulated 5V Output Up to 125mA

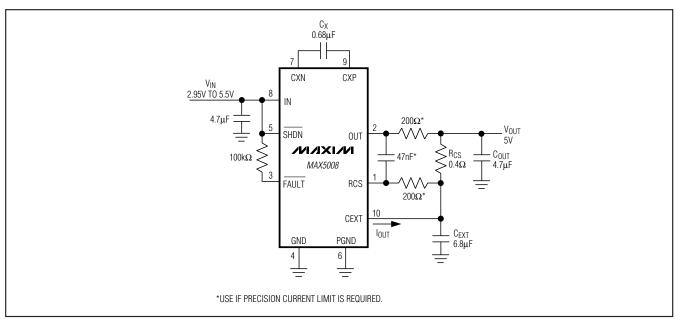
- ♦ Indefinite Short-Circuit Protection
- ◆ Adjustable Output Current Limit
- ♦ No Inductors Required
- ♦ 0.1µA Shutdown Current
- ♦ Thermal Shutdown
- ♦ Fault Output Indicates Overcurrent or Output Voltage Out of Regulation
- ♦ 2.95V to 5.5V Input Voltage Range
- ♦ 10-Pin µMAX Package

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE		
MAX5008CUB	0°C to +70°C	10 μMAX		

Pin Configuration appears at end of data sheet.

Typical Operating Circuit



Maxim Integrated Products 1

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

ABSOLUTE MAXIMUM RATINGS

IN, SHDN, RCS, FAULT, OUT to GND0.3V to +6V	Continuous Power Dissipation (T _A = +70°C)
PGND to GND±0.3V	10-Pin μMAX444mW
CXN to GND0.3V to (V _{IN} + 0.3V)	Operating Temperature Range0°C to +70°C
CXP to GND0.3V to (V _{CEXT} + 0.3V)	Junction Temperature+150°C
CEXT to GND0.3V to (V _{CEXT} + 0.3V)	Storage Temperature Range65°C to +150°C
Short-Circuit Duration to GNDIndefinite	Lead Temperature (soldering, 10s)+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

 $(V_{IN} = \overline{SHDN} = 3V, C_{IN} = 4.7\mu F, C_X = 0.68\mu F, C_{EXT} = 6.8\mu F, C_{OUT} = 4.7\mu F, R_{CS} = 0.4\Omega, T_A = 0^{\circ}C$ to $+70^{\circ}C$, unless otherwise noted. Typical values are at $T_A = +25^{\circ}C$.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range	VIN	I _{OUT} = 125mA, 4.75V ≤ V _{OUT} ≤ 5.25V			4.25	V
(Note 1)		I _{OUT} = 70mA	2.95		5.50	
Input Undervoltage Lockout Threshold	I RISING EGGE		2.0	2.35	2.6	V
Input Undervoltage Lockout Hysteresis	T Falling 6006			100		mV
Output Voltage	Vout	$0 \le I_{OUT} < 30$ mA, 2.95 V $< V_{IN} < 5.5$ V	4.75	5.0	5.30 V	
(Note 2)	VOU1	$0mA \le I_{OUT} \le 125mA, 2.95V \le V_{IN} \le 4.25V$	4.75	5.0	5.25]
Output Voltage Ripple	V _{RIP}	0mA ≤ I _{OUT} ≤ 125mA		100		mV
VOUT Fault Threshold	V _{TH}	V _{OUT} = 5V (nominal), no load	82.5		92.5	%Vout
Maximum Output Current	rrent I _{OUT} V _{OUT} = 5V ±4%		100	140		mA
No Lood look Current	IQ	I _{OUT} = 0, V _{IN} = 4.25V		0.6	6	то Л
No-Load Input Current		I _{OUT} = 0, V _{IN} = 3.3V	1		6	mA
SHDN Logic High VINH,SHDN		2.4			V	
SHDN Logic Low	VINL, SHDN				0.4	V
Shutdown Supply Current	IQSHDN	SHDN = low		0.1	10	μΑ
Current-Sense Trip Level	Vcs	V _{CS} = I _{OUT} x R _{CS} (Note 3)	55	60	73	mV
FAULT Leakage Current		VFAULT = 5V, OUT in regulation			1	μΑ
FAULT Logic Low		IOUT > ILIMIT, OR VOUT < VTH, IFAULT = 1mA			0.4	V
FAULT Assertion Delay	t _{FD}	IOUT > ILIMIT		2		ms
(Note 4)		Vout < Vth		30		μs
FAULT Deassertion Delay (Note 5)	t _{FDD}	I _{OUT} < I _{LIMIT} and V _{OUT} > 4.5V		16		ms
Switching Frequency			0.5	1	1.5	MHz
Startup Time	tstart	$V_{OUT} > V_{TH}$, $R_{LOAD} = 46\Omega$, from rising edge of \overline{SHDN}		200		μs

ELECTRICAL CHARACTERISTICS (continued)

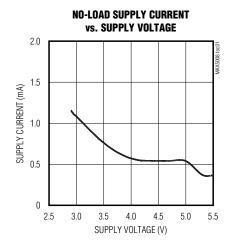
 $(V_{IN} = \overline{SHDN} = 3V, C_{IN} = 4.7\mu\text{F}, C_X = 0.68\mu\text{F}, C_{EXT} = 6.8\mu\text{F}, C_{OUT} = 4.7\mu\text{F}, R_{CS} = 0.4\Omega, T_A = 0^{\circ}\text{C}$ to +70°C, unless otherwise noted. Typical values are at $T_A = +25^{\circ}\text{C}$.)

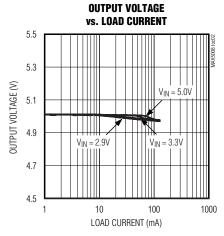
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Thermal Shutdown Junction Temperature				150		°C
Thermal Shutdown Hysteresis				30		°C

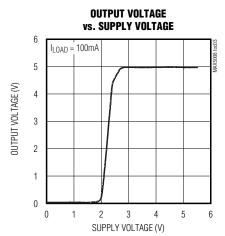
- Note 1: When the input exceeds 4.25V, the power dissipation on the chip exceeds the maximum rating if the output current is 125mA.
- Note 2: The MIN/MAX limits are 100% production tested at +25°C and +70°C, and guaranteed by design at 0°C.
- Note 3: IOUT is output current flowing from CEXT.
- **Note 4:** The delay from the fault event to the assertion of FAULT. Fault delays are specified with either a current fault or a voltage fault, but not both simultaneously.
- Note 5: The delay from the removal of the fault event to the deassertion of FAULT.

Typical Operating Characteristics

 $(V_{IN}=3V, C_{IN}=4.7\mu F, C_X=0.47\mu F, C_{OUT}=4.7\mu F, C_{EXT}=4.7\mu F, R_{CS}=0.4\Omega, T_A=+25^{\circ}C, unless otherwise noted.)$

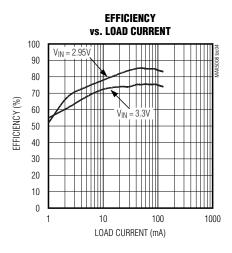


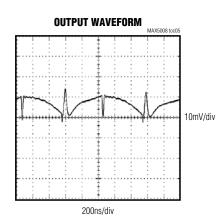


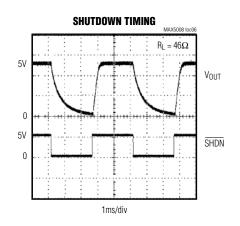


Typical Operating Characteristics (continued)

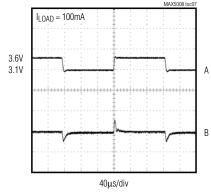
 $(V_{IN}=3V, C_{IN}=4.7\mu\text{F}, C_{X}=0.47\mu\text{F}, C_{OUT}=4.7\mu\text{F}, C_{EXT}=4.7\mu\text{F}, R_{CS}=0.4\Omega, T_{A}=+25^{\circ}\text{C}, unless otherwise noted.)$





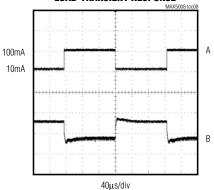


LINE-TRANSIENT RESPONSE



A: INPUT VOLTAGE: 500mV/div B: OUTPUT VOLTAGE: AC-COUPLED, 100mV/div

LOAD-TRANSIENT RESPONSE



A: LOAD CURRENT B: OUTPUT VOLTAGE: AC-COUPLED, 100mV/div

Pin Description

PIN	NAME	FUNCTION	
1 RCS		External Current-Sense Resistor. Connect a resistor from RCS to OUT to set the overcurrent threshold. I _{LIMIT} = 60mV / R _{CS} .	
2	OUT	Fixed 5V Output. Bypass OUT to GND with a 4.7µF capacitor.	
Output Fault Indicator. FAULT is asserted when either I _{OUT} > I _{LIMIT} or V _{OUT} < V _{TH} . FAULT is an open-drain output that is high during normal operation or during shutdown.		Output Fault Indicator. \overline{FAULT} is asserted when either $I_{OUT} > I_{LIMIT}$ or $V_{OUT} < V_{TH}$. \overline{FAULT} is an open-drain output that is high during normal operation or during shutdown.	
4	GND	Ground Pin. Connect GND to PGND.	
5	Shutdown Input. When SHDN = low, the device turns off. Drive SHDN high or connect to IN formal operation.		
6	PGND	PGND Power Ground Pin. Connect PGND to GND.	
7	CXN	Negative Terminal of the Charge-Pump Capacitor. Connect a 0.68µF capacitor from CXN to CXP.	
8	8 IN Input Supply, 2.95V to 5.5V. Bypass IN to GND with a 4.7μF ceramic capacitor.		
9	CXP Positive Terminal of the Charge-Pump Capacitor. Connect a 0.68µF capacitor from CXP to CXN.		
10	CEXT	Charge-Pump Output. Bypass CEXT to PGND with a 6.8µF capacitor.	

Detailed Description

The MAX5008 charge pump provides a regulated 5V output from a 2.95V to 5.5V input. The device delivers a maximum of 125mA load current. Designed specifically for compact applications, a complete regulator circuit requires a minimum number of external components.

Adjustable Current Limit

The MAX5008 has an adjustable overcurrent protection. An external current-sense resistor is connected from RCS to OUT to set the current limit. The current limit is defined by:

where V_{CS} is the current-sense trip level, typically 60mV. For example, $I_{LIMIT} = 150$ mA when RCS = 0.40Ω .

When the output current limit is exceeded, the output voltage falls and the device maintains the average output current at ILIMIT. Upon removal of the overcurrent condition, the part resumes normal operation.

FAULT Indication

When $I_{OUT} > I_{LIMIT}$ or $V_{OUT} < V_{TH}$, FAULT asserts. FAULT is an open-drain output that needs to be connected through a $100k\Omega$ (typ) pullup resistor to a logic supply voltage.

Thermal Shutdown

The MAX5008 has internal thermal shutdown circuitry, which shuts down the device when the die temperature exceeds +150°C. The thermal shutdown circuitry has 30°C hysteresis.

Shutdown Mode

Driving SHDN low places the device in shutdown mode, which disables the oscillator, the control logic, and the reference. The output goes into high-impedance state and drops to ground if loaded. Placing the device in shutdown mode reduces the supply current to less than 0.1µA. In normal operation, SHDN is driven high or connected to IN.

Applications Information

Capacitor Selection

The MAX5008 requires four external capacitors. Their values depend on the required output current. Table 1 shows the capacitor values recommended for different load currents.

Input Voltage Range

The MAX5008 maintains a regulated 5V output with input voltages from 2.95V to 5.5V. If the input voltage exceeds 4.25V, limit the output current to 75mA or less. This keeps the MAX5008 within its maximum power dissipation limits.

Table 1. Recommended Capacitor Values

lout	C _{IN} (µF)	Cχ (μF)	C _{EXT} (µF)	C _{OUT} (µF)
50mA	3.3	0.33	3.3	3.3
125mA	4.7	0.68	6.8	4.7

Layout Considerations

All capacitors should be located as close to the IC as practical. Connect GND and PGND through a short,



_Functional Diagram

CXN SWITCHES CXP PGND FAULT SHDN GND

Pin Configuration

TOP VIEW

RCS 1

OUT 2

FAULT 3

GND 4

SHDN 5

FAULT 3

GND 4

SHDN 5

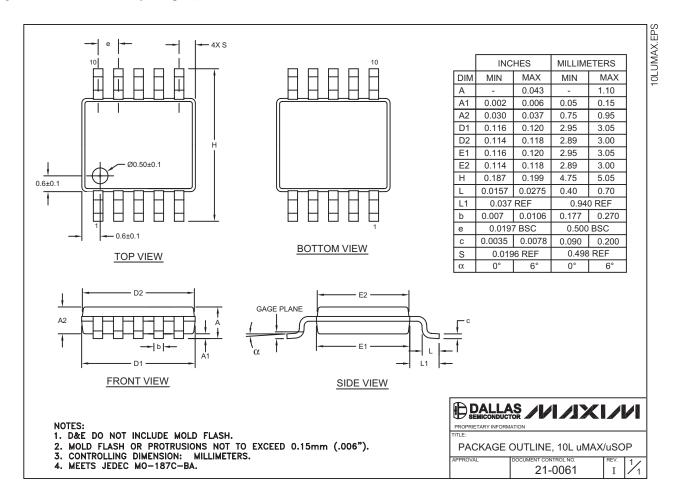
low-impedance trace, and connect the ground for C_{IN} , C_{EXT} , and C_{OUT} directly to PGND in a star configuration. Connect R_{CS} to C_{EXT} through a short and low impedance trace.

Chip Information

TRANSISTOR COUNT: 2632 PROCESS: BICMOS

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)



_Revision History

Pages changed at Rev 1: 1, 2, 7

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