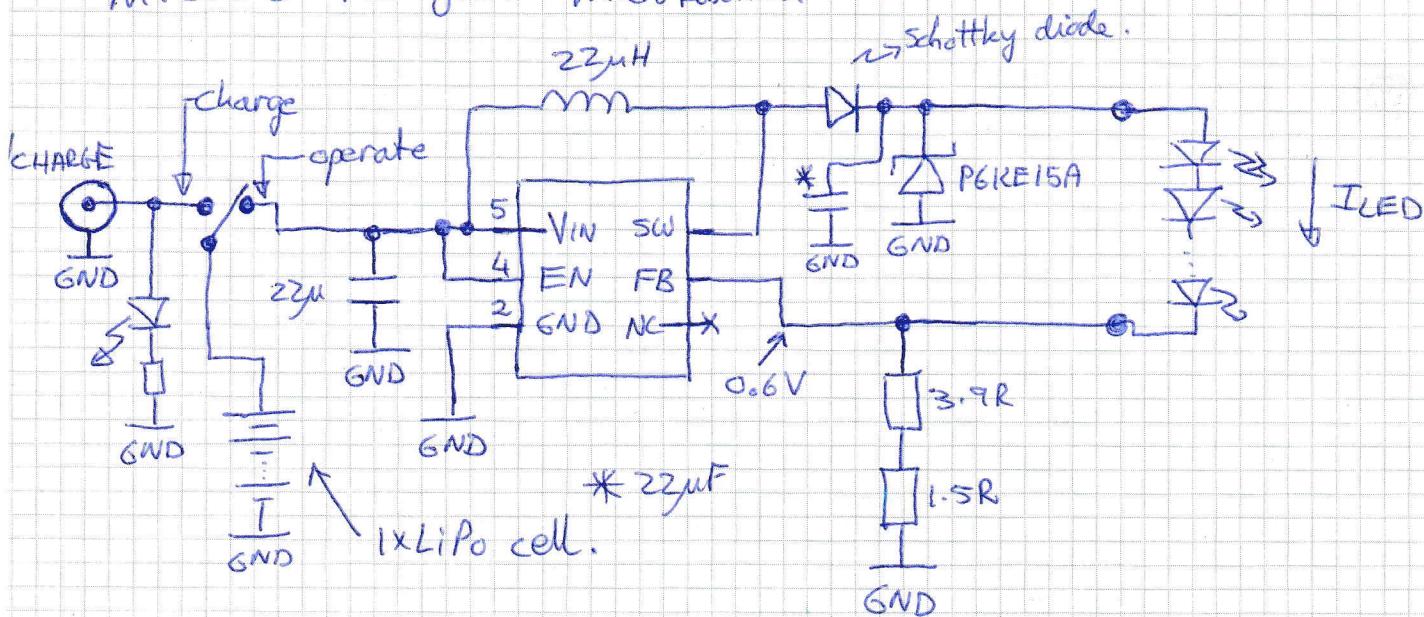


Kamp LAMPIES (EN. LAAGER)

MT3608 PCB from microRobotics.



$$I_{LED} = V_{FB} / (3.9R + 1.5R) \sim 100 \mu A.$$

↳ 0.6V reference.

~~AB~~



AEROSEMI

MT3608

High Efficiency 1.2MHz
2A Step Up Converter

FEATURES

- Integrated 80mΩ Power MOSFET
- 2V to 24V Input Voltage
- 1.2MHz Fixed Switching Frequency
- Internal 4A Switch Current Limit
- Adjustable Output Voltage
- Internal Compensation
- Up to 28V Output Voltage
- Automatic Pulse Frequency Modulation Mode at Light Loads
- up to 97% Efficiency
- Available in a 6-Pin SOT23-6 Package

APPLICATIONS

- Battery-Powered Equipment
- Set-Top Boxed
- LCD Bias Supply
- DSL and Cable Modems and Routers
- Networking cards powered from PCI or PCI express slots

GENERAL DESCRIPTION

The MT3608 is a constant frequency, 6-pin SOT23 current mode step-up converter intended for small, low power applications. The MT3608 switches at 1.2MHz and allows the use of tiny, low cost capacitors and inductors 2mm or less in height. Internal soft-start results in small inrush current and extends battery life.

The MT3608 features automatic shifting to pulse frequency modulation mode at light loads. The MT3608 includes under-voltage lockout, current limiting, and thermal overload protection to prevent damage in the event of an output overload. The MT3608 is available in a small 6-pin SOT-23 package.

TYPICAL APPLICATION

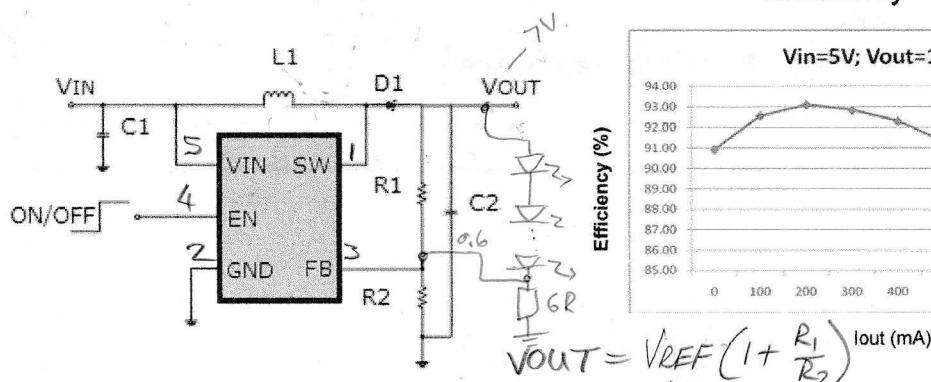


Figure 1. Basic Application Circuit

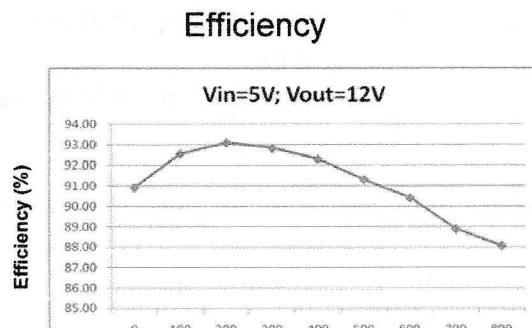
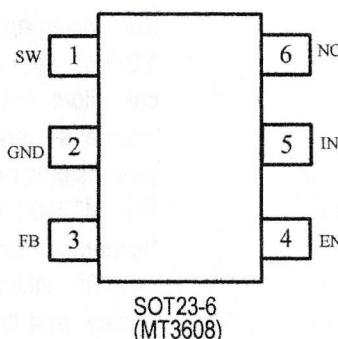


Figure 2. Efficiency Curve

ABSOLUTE MAXIMUM RATINGS

IN, EN voltages	-0.3V to 26V	SW Voltage	-0.3V to 30V
Operating Temperature.....	-40°C to +85°C	Storage Temperature Range	-65°C to 150°C
FB Voltages	-0.3V to 6V	Peak SW Sink and Source Current	4A
Junction Temperature	160°C	Lead Temperature (Soldering, 10s) ...	+300°C

PACKAGE/ORDER INFORMATION**PIN DESCRIPTION**

PIN	NAME	FUNCTION
1	SW	Power Switch Output. SW is the drain of the internal MOSFET switch. Connect the power inductor and output rectifier to SW. SW can swing between GND and 28V.
2	GND	Ground Pin
3	FB	Feedback Input. The FB voltage is 0.6V. Connect a resistor divider to FB.
4	EN	Regulator On/Off Control Input. A high input at EN turns on the converter, and a low input turns it off. When not used, connect EN to the input supply for automatic startup.
5	IN	Input Supply Pin. Must be locally bypassed.
6	NC	NC

ELECTRICAL CHARACTERISTICS

($V_{IN}=V_{EN}=5V$, $T_A = 25^\circ C$, unless otherwise noted.)

Parameter	Conditions	MIN	TYP	MAX	unit
Operating Input Voltage		2		24	V
Under Voltage Lockout				1.98	V
Under Voltage Lockout Hysteresis			100		mV
Current (Shutdown)	$V_{EN}=0V$		0.1	1	μA
Quiescent Current (PFM)	$V_{FB}=0.7V$, No switch		100	200	μA
Quiescent Current (PWM)	$V_{FB}=0.5V$, switch		1.6	2.2	mA
Switching Frequency			1.2		MHz
Maximum Duty Cycle	$V_{FB} = 0V$	90			%
EN Input High Voltage		1.5			V
EN Input Low Voltage				0.4	V
FB Voltage		0.588	0.6	0.612	V
FB Input Bias Current	$V_{FB} = 0.6V$	-50	-10		nA
SW On Resistance (1)			80	150	$m\Omega$
SW Current Limit (1)	$V_{IN}= 5V$, Duty cycle=50%		4		A
SW Leakage	$V_{SW} = 20V$			1	μA
Thermal Shutdown			155		$^\circ C$

Note:

- Guaranteed by design, not tested.

OPERATION

The MT3608 uses a fixed frequency, peak current mode boost regulator architecture to regulate voltage at the feedback pin. The operation of the MT3608 can be understood by referring to the block diagram of Figure 3. At the start of each oscillator cycle the MOSFET is turned on through the control circuitry. To prevent sub-harmonic oscillations at duty cycles greater than 50 percent, a stabilizing ramp is added to the output of the current sense amplifier and the result is fed into the negative input of the PWM comparator. When this voltage equals

The output voltage of the error amplifier the power MOSFET is turned off. The voltage at the output of the error amplifier is an amplified version of the difference between the 0.6V bandgap reference voltage and the feedback voltage. In this way the peak current level keeps the output in regulation. If the feedback voltage starts to drop, the output of the error amplifier increases. These results in more current to flow through the power MOSFET, thus increasing the power delivered to the output. The MT3608 has internal soft start to limit the amount of input current at startup and to also limit the amount of overshoot on the output.

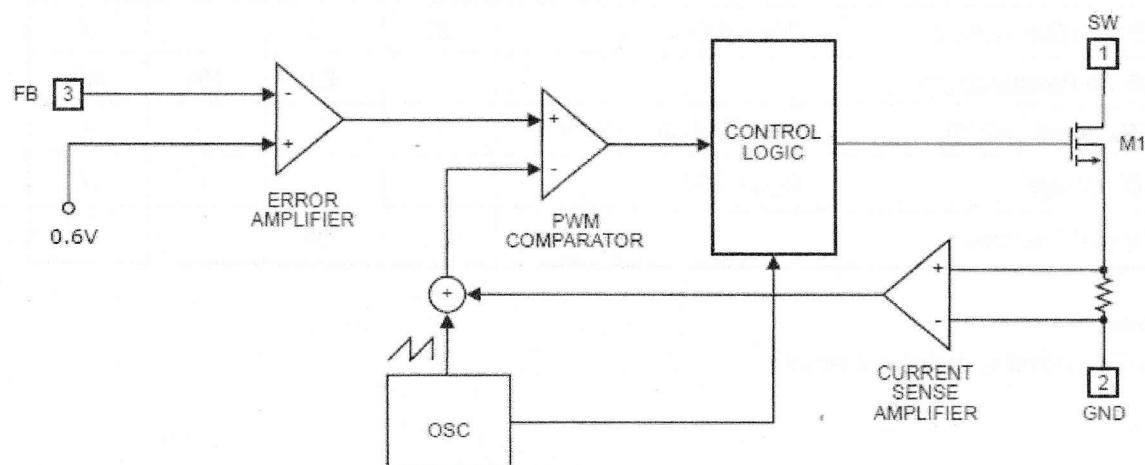
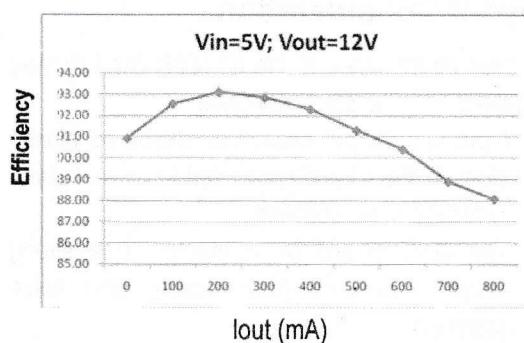


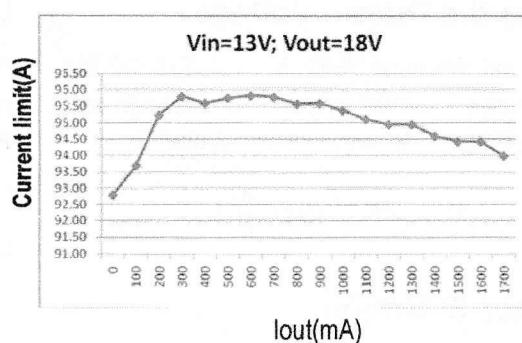
Figure 3. Functional Block Diagram

TYPICAL OPERATING CHARACTERISTICS

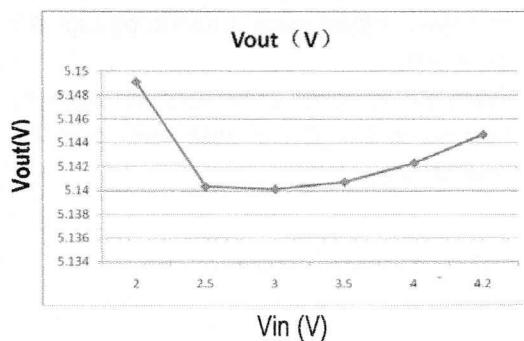
Efficiency Curve



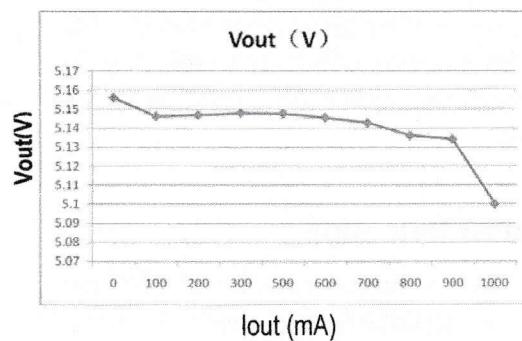
Efficiency Curve



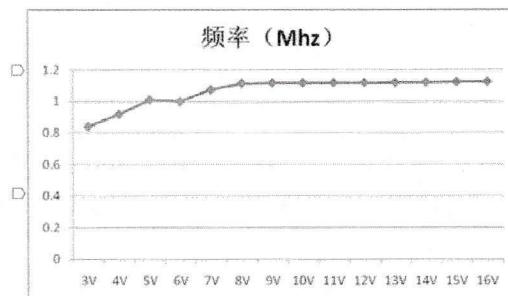
line Regulation



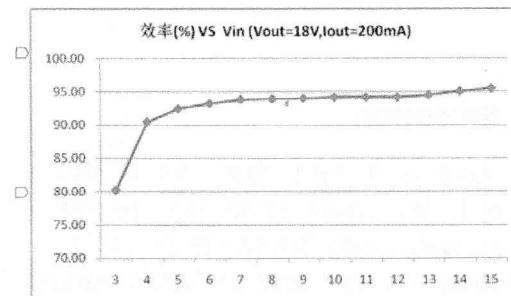
Load regulation



Freq VS Vin



Efficiency VS Vin



APPLICATION INFORMATION

Setting the Output Voltage

The internal reference VREF is 0.6V (Typical). The output voltage is divided by a resistor divider, R1 and R2 to the FB pin. The output voltage is given by

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

Inductor Selection

The recommended values of inductor are 4.7 to 22 μ H. Small size and better efficiency are the major concerns for portable device, such as MT3608 used for mobile phone. The inductor should have low core loss at 1.2MHz and low DCR for better efficiency. To avoid inductor saturation current rating should be considered.

Capacitor Selection

Input and output ceramic capacitors of 22 μ F are recommended for MT3608 applications. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wider voltage and temperature ranges.

Diode Selection

Schottky diode is a good choice for MT3608 because of its low forward voltage drop and fast reverse recovery. Using Schottky diode can get better efficiency. The high speed rectification is also a good characteristic of Schottky diode for high switching frequency. Current rating of the diode must meet the root mean square of the peak current and output average current multiplication as following :

$$I_D(RMS) \approx \sqrt{I_{OUT} \times I_{PEAK}}$$

The diode's reverse breakdown voltage should be larger than the output voltage.

Layout Consideration

For best performance of the MT3608, the following guidelines must be strictly followed.

- Input and Output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
- The GND should be connected to a strong ground plane for heat sinking and noise protection.
- Keep the main current traces as possible as short and wide.
- SW node of DC-DC converter is with high frequency voltage swing. It should be kept at a small area.
- Place the feedback components as close as possible to the IC and keep away from the noisy devices.

APPLICATION INFORMATION

Setting the Output Voltage

The internal reference VREF is 0.6V (Typical). The output voltage is divided by a resistor divider, R1 and R2 to the FB pin. The output voltage is given by

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

Inductor Selection

The recommended values of inductor are 4.7 to 22 μ H. Small size and better efficiency are the major concerns for portable device, such as MT3608 used for mobile phone. The inductor should have low core loss at 1.2MHz and low DCR for better efficiency. To avoid inductor saturation current rating should be considered.

Capacitor Selection

Input and output ceramic capacitors of 22 μ F are recommended for MT3608 applications. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wider voltage and temperature ranges.

Diode Selection

Schottky diode is a good choice for MT3608 because of its low forward voltage drop and fast reverse recovery. Using Schottky diode can get better efficiency. The high speed rectification is also a good characteristic of Schottky diode for high switching frequency. Current rating of the diode must meet the root mean square of the peak current and output average current multiplication as following :

$$I_D(RMS) \approx \sqrt{I_{OUT} \times I_{PEAK}}$$

The diode's reverse breakdown voltage should be larger than the output voltage.

Layout Consideration

For best performance of the MT3608, the following guidelines must be strictly followed.

- Input and Output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
- The GND should be connected to a strong ground plane for heat sinking and noise protection.
- Keep the main current traces as possible as short and wide.
- SW node of DC-DC converter is with high frequency voltage swing. It should be kept at a small area.
- Place the feedback components as close as possible to the IC and keep away from the noisy devices.

TP4056 1A Standalone Linear Li-Ion Battery Charger with Thermal Regulation in SOP-8

DESCRIPTION

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion batteries. Its SOP package and low external component count make the TP4056 ideally suited for portable applications. Furthermore, the TP4056 can work within USB and wall adapter.

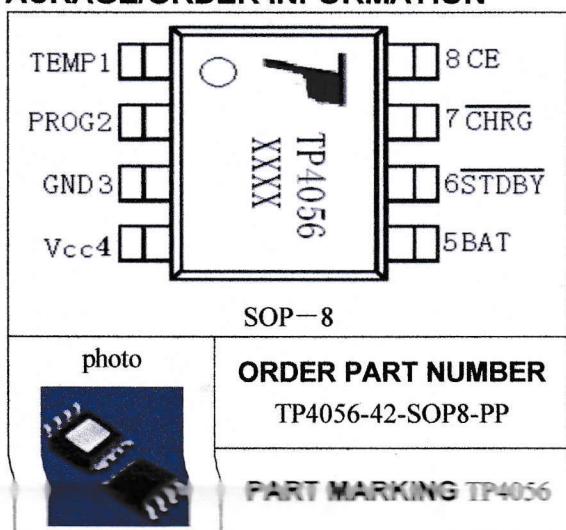
No blocking diode is required due to the internal PMOSFET architecture and have prevent to negative Charge Current Circuit. Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The TP4056 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached.

TP4056 Other features include current monitor, under voltage lockout, automatic recharge and two status pin to indicate charge termination and the presence of an input voltage.

FEATURES

- Programmable Charge Current Up to 1000mA
- No MOSFET, Sense Resistor or Blocking Diode Required
- Complete Linear Charger in SOP-8 Package for Single Cell Lithium-Ion Batteries
- Constant-Current/Constant-Voltage
- Charges Single Cell Li-Ion Batteries Directly from USB Port
- Preset 4.2V Charge Voltage with 1.5% Accuracy
- Automatic Recharge
- two Charge Status Output Pins
- C/10 Charge Termination
- 2.9V Trickle Charge Threshold (TP4056)
- Soft-Start Limits Inrush Current
- Available Radiator in 8-Lead SOP Package, the Radiator need connect GND or Impending

PACKAGE/ORDER INFORMATION



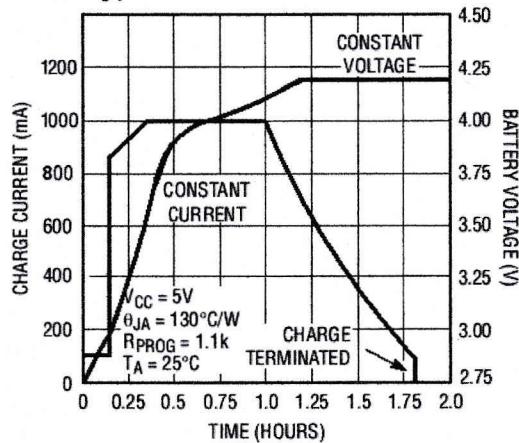
ABSOLUTE MAXIMUM RATINGS

- Input Supply Voltage(V_{CC}): -0.3V~8V
- TEMP: **-0.3V~10V**
- CE: **-0.3V~10V**
- BAT Short-Circuit Duration: Continuous
- BAT Pin Current: 1200mA
- PROG Pin Current: 1200uA
- Maximum Junction Temperature: 145°C
- Operating Ambient Temperature Range: -40°C~85°C
- Lead Temp.(Soldering, 10sec): 260°C

APPLICATIONS

- Cellular Telephones, PDAs, GPS
- Charging Docks and Cradles
- Digital Still Cameras, Portable Devices
- USB Bus-Powered Chargers, Chargers

Complete Charge Cycle (1000mAh Battery)



TEMP(Pin 1) :Temperature Sense Input Connecting TEMP pin to NTC thermistor's output in Lithium ion battery pack. If TEMP pin's voltage is below 45% or above 80% of supply voltage VIN for more than 0.15S, this means that battery's temperature is too high or too low, charging is suspended. The temperature sense function can be disabled by grounding the TEMP pin.

PROG(Pin 2): Constant Charge Current Setting and Charge Current Monitor Pin charge current is set by connecting a resistor R_{SET} from this pin to GND. When in precharge mode, the I_{SET} pin's voltage is regulated to 0.2V. When in constant charge current mode, the I_{SET} pin's voltage is regulated to 2V. In all modes during charging, the voltage on I_{SET} pin can be used to measure the charge current as follows:

$$I_{BAT} = \frac{V_{PROG}}{R_{PROG}} \times 1200 \quad (V_{PROG}=1V)$$

GND(Pin3): Ground Terminal

Vcc(Pin 4): Positive Input Supply Voltage VIN is the power supply to the internal circuit. When VIN drops to within 30mV of the BAT pin voltage, TP4056 enters low power sleep mode, dropping BAT pin's current to less than 2uA.

BAT(Pin5): Battery Connection Pin. Connect the positive terminal of the battery to BAT pin. BAT pin draws less than 2uA current in chip disable mode or in sleep mode. BAT pin provides charge current to the battery and provides regulation voltage of 4.2V.

STDBY(Pin6): Open Drain Charge Status Output When the battery Charge Termination, the STDBY pin is pulled low by an internal switch, otherwise STDBY pin is in high impedance state.

CHRG (Pin7): Open Drain Charge Status Output When the battery is being charged, the CHRG pin is pulled low by an internal switch, otherwise CHRG pin is in high impedance state.

CE(Pin8): Chip Enable Input. A high input will put the device in the normal operating mode.

Pulling the CE pin to low level will put the TP4056 into disable mode. The CE pin can be driven by TTL or CMOS logic level.

ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range, otherwise specifications are at T_A=25°C, V_{CC}=5V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V _{CC}	Input Supply Voltage		●	4.0	5	8.0
I _{CC}	Input Supply Current	Charge Mode, R _{PROG} = 1.2k StandbyMode(Charge Terminated) Shutdown Mode (R _{PROG} Not Connected, V _{CC} < V _{BAT} , or V _{CC} < V _{UV})	● ● ●	150 55 55	500 100 100	μA μA μA
V _{FLOAT}	Regulated Output (Float) Voltage	0°C ≤ T _A ≤ 85°C, I _{BAT} =40mA		4.137	4.2	4.263
I _{BAT}	BAT Pin Current	R _{PROG} = 2.4k, Current Mode R _{PROG} = 1.2k, Current Mode Standby Mode, V _{BAT} = 4.2V	● ● ●	450 950 0	500 1000 -2.5	mA mA μA
I _{TRIKL}	Trickle Charge Current	V _{BAT} <V _{TRIKL} , R _{PROG} =1.2K	●	120	130	140
V _{TRIKL}	Trickle Charge Threshold Voltage	R _{PROG} =1.2K, V _{BAT} Rising		2.8	2.9	3.0
V _{TRHYS}	Trickle Charge Hysteresis Voltage	R _{PROG} =1.2K		60	80	100
T _{LIM}	Junction Temperature in Constant Temperature Mode				145	°C

Indicator light state

Charge state	Red LED CHRG	Greed LED STDBY
charging	bright	extinguish
Charge Termination	extinguish	bright
Vin too low; Temperature of battery too low or too high; no battery	extinguish	extinguish
BAT PIN Connect 10u Capacitance; No battery	Greed LED bright, Red LED Coruscate T=1-4 S	

Rprog Current Setting

RPROG (k)	I _{BAT} (mA)
10	130
5	250
4	300
3	400
2	580
1.66	690
1.5	780
1.33	900
1.2	1000

TYPICAL APPLICATIONS

