Single Cell Li-Ion Battery Linear Charger

Features

- **No External Power MOSFET, Sense Resistor or Blocking Diode Required**
- **Programmable Constant Charge Current Limit up to 800mA**
- **Automatic Recharge**
- **Complete Trickle-Charge, Constant Current, Constant Voltage and Charge Termination Charge Procedure with Thermal Regulation to Maximize Charge Rate without Risk of Overheating**
- **Charges Single Cell Li-Ion Batteries Directly from USB Port**
- **Preset 4.2V Charge Voltage with ±1% Accuracy**
- **Soft-Start Limits Inrush Current**
- **Internal Thermal Protection Circuit**
- **TSOT-23-5 Package**

General Description

The G2267 is a standalone linear Li-Ion battery charger with a complete trickle-charge, constant-current and constant-voltage charge loop.

No external power MOSFET, sense resistor and blocking diode is required due to internal power MOSFET architecture. The charge voltage is regulated at 4.2V, and the charge current is programmable by an external resistor. After the final regulation voltage is reached and the charge current drops to $1/10^{th}$ the programmed charge current, the open drain NMOS /CHRG pin would be automatic weakly pull low and terminating the charge loop.

Other features include under voltage lockout, automatic recharge, over temperature protection and a charge status indication pin.

Applications

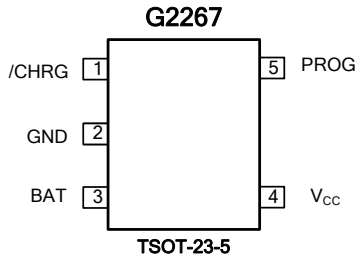
- **MP3 Players**
- **Cellular Phones**
- **PDAs**
- **Hand-Held Devices**

Ordering Information

ORDER NUMBER	MARKING	TEMP. RANGE	PACKAGE (Green)
G2267TO1U	2267x	-40°C ~ +85°C	TSOT-23-5

Note: TO: TSOT-23-5
1: Bonding Code
U: Tape & Reel Green :
Lead Free / Halogen Free

Pin Configuration



Absolute Maximum Ratings

V_{CC} to GND . . . . . -0.3V to +10V
BAT to GND . . . . . -0.3V to 7V
PROG to GND . . . . . -0.3V to V_{CC}+0.3V
/CHRG to GND . . . . . -0.3V to 10V
Thermal Resistance Junction to Ambient, (θ_{JA})*
TSOT-23-5 . . . . . .125°C/W
Continuous Power Dissipation (T_A = +25°C)*
TSOT-23-5 . . . . . 1W

Operating Temperature Range . . . . . .-40°C to +85°C
Junction Temperature . . . . . .+150°C
Storage Temperature Range . . . . . .-65°C to +160°C
Reflow Temperature (soldering, 10sec) . . . . . 260°C
ESD (HBM) 2KV
ESD (MM) 200V

* Please refer to "PCB Layout Guidelines"

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_{cc}=5V; T_A=25°C, C_{IN}=1µF

The device is not guaranteed to function outside its operating conditions. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified.

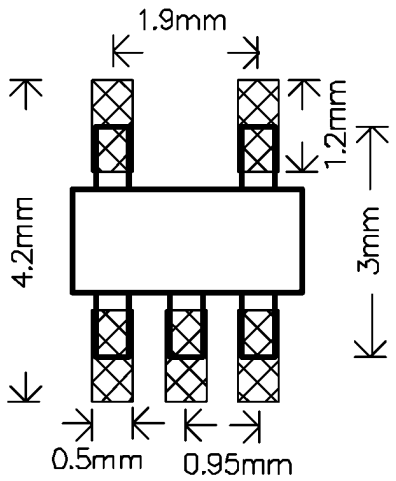
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
General						
Input Supply Voltage	V_{CC}		4.25	---	6.5	V
Input Supply Current	I_{CC}	Charge Mode , R_{PROG}=10k	---	300	2000	µA
	I_{CC_STBY}	Standby Mode (Charge Terminated)	---	200	500	µA
	I_{CC_SDN}	Shutdown Mode (R_{PROG} Not Connected, V_{CC}<V_{BAT}, or V_{CC}<V_{UV})	---	25	50	µA
V_{CC} Under voltage Lockout Threshold	V_{UV}	From V_{CC} Low to High	3.7	3.8	3.92	V
V_{CC} Under voltage Lockout Hysteresis	V_{UVHYS}		150	200	300	mV
V_{CC} – V_{BAT} Lockout Threshold Voltage	V_{ASD_R}	V_{CC} from Low to High	70	100	140	mV
	V_{ASD_F}	V_{CC} from High to Low	5	30	50	mV
V_{CC} Over Voltage Protection	V_{OV}	V_{CC} Rising	5.75	6.0	6.25	V
V_{CC} Over Voltage Protection Hysteresis	V_{OV_HYS}		---	300	---	mV
BAT Pin Current	I_{BAT_STBY}	Standby Mode, V_{BAT}=4.2V	0	–2.5	–6	µA
	I_{BAT_SDN}	Shutdown Mode (R_{PROG} Not Connected)	---	±1	±2	µA
	I_{BAT_SLP}	Sleep Mode, V_{CC}=0V	---	±0.5	±1	µA
Manual Shutdown Threshold Voltage	V_{MSD_R}	PROG Pin Rising	1.15	1.21	1.3	V
	V_{MSD_F}	PROG Pin Falling	1.05	1.1	1.15	V
/CHRG Pin Weak Pull-Down Current	$I_{/CHRG}$	$V_{/CHRG}$=5V	8	20	35	µA
/CHRG Pin Output Low Voltage	$V_{/CHRG}$	$I_{/CHRG}$=5mA	---	0.35	0.6	V
Voltage Regulation						
Regulated Output (Float) Voltage	V_{FLOAT}	0°C<TA<85°C, I_{BAT}=40mA	4.158	4.2	4.242	V
V_{CC} to BAT ON Resistance	R_{ON_BAT}		---	600	---	mΩ
Recharge Battery Threshold Voltage	ΔV_{RECHRG}	V_{FLOAT}-V_{RECHRG}	100	150	200	mV
Recharge Comparator Filter Time	$T_{RECHARGE}$	V_{BAT} High to Low	---	120	---	mS
Trickle Charge Threshold Voltage	V_{TRIKL}	R_{PROG}=10kΩ, V_{BAT} Rising	2.8	2.9	3	V
Trickle Charge Hysteresis Voltage	V_{TRHYS}	R_{PROG}=10kΩ	60	80	110	mV

Electrical Characteristics (Continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Current Regulation						
Fast Charge Current	I_{CHG}	R_{PROG}=10kΩ, Current Mode	93	100	107	mA
		R_{PROG}=2kΩ, Current Mode	465	500	535	mA
PROG Pin Voltage	V_{PROG}	R_{PROG}=10kΩ, Current Mode	0.93	1	1.07	V
PROG Pin Pull-Up Current	I_{PROG}		---	3	---	μA
Trickle Charge Current	I_{TRIKL}	V_{BAT}<V_{TRIKL}, R_{PROG}=2kΩ	20	45	70	mA
C/10 Termination Current Threshold	I_{TERM}		0.085	0.1	0.115	A/A
Termination Comparator Filter Time	T_{TERM}	I_{BAT} Falling Below I_{CHG}/10	---	30	---	mS
Protection						
Junction Temperature in Constant Temperature Mode	T_{LIM}		---	120	---	°C
Thermal Shutdown Temperature	T_{SD}		---	155	---	°C

Minimum Footprint PCB Layout Section

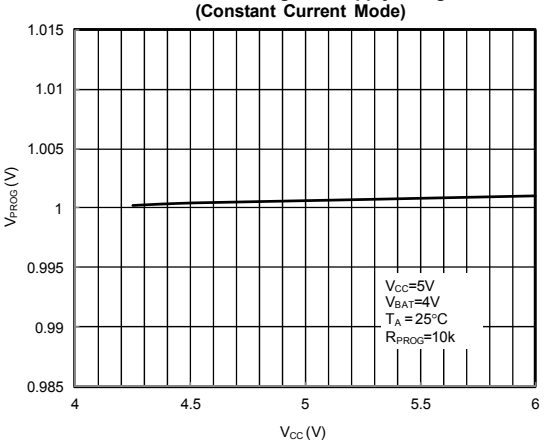
TSOT-23-5



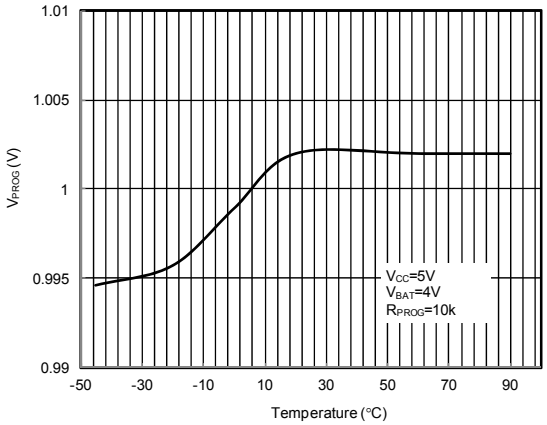
Typical Performance Characteristics

V_{IN}=5.0V, C_{VIN}=1μF, C_{VBAT}=1μF, T_A=25°C, unless otherwise noted.

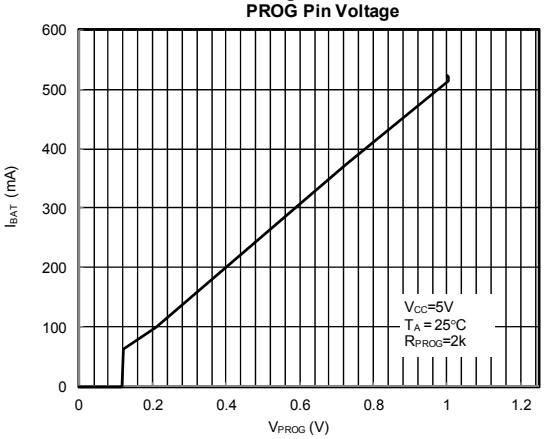
PROG Pin Voltage vs SupplyVoltage (Constant Current Mode)



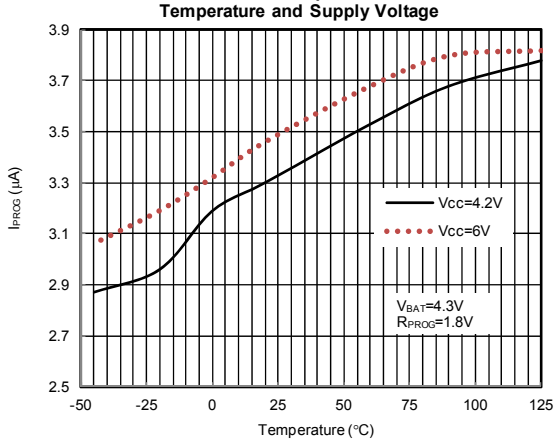
PROG Pin Voltage vs Temperature



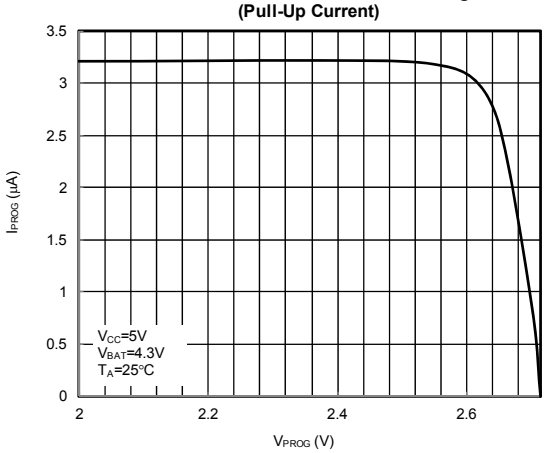
Charge Current vs PROG Pin Voltage



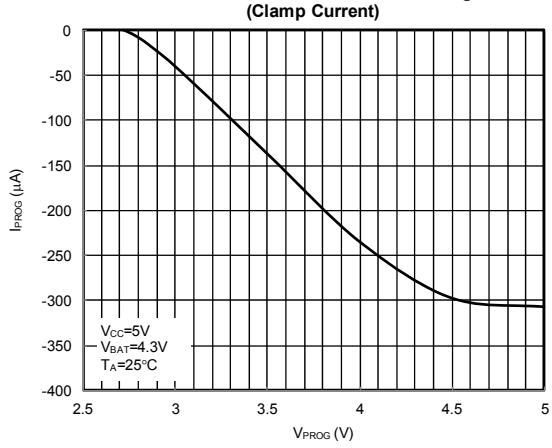
PROG Pin Pull-Up Current vs Temperature and Supply Voltage



PROG Pin Current vs PROG Pin Voltage (Pull-Up Current)

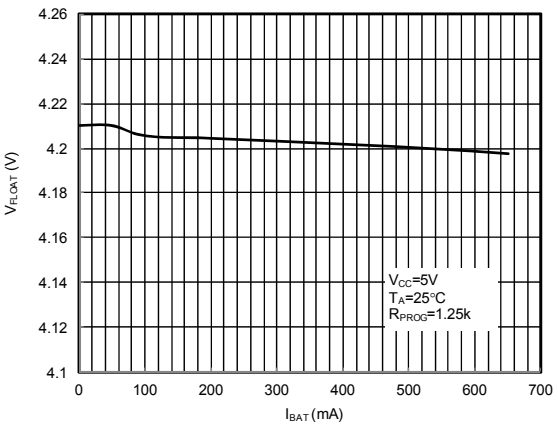


PROG Pin Current vs PROG Pin Voltage (Clamp Current)

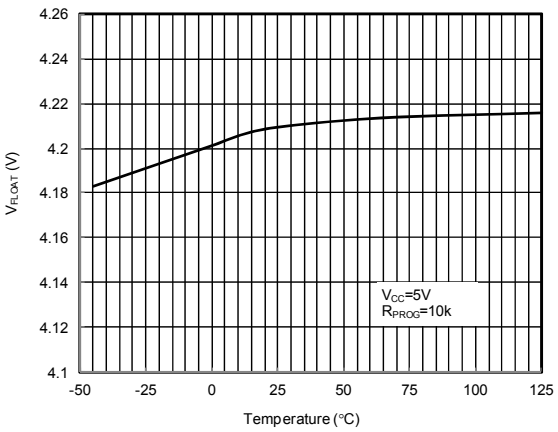


Typical Performance Characteristics (Continued)

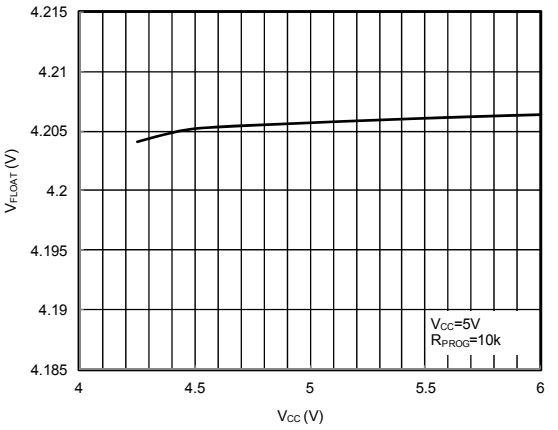
Regulated Output (Float) Voltage vs Charge Current



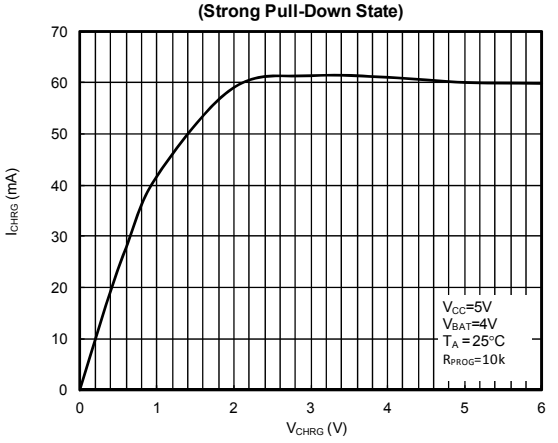
Regulated Output (Float) Voltage vs Temperature



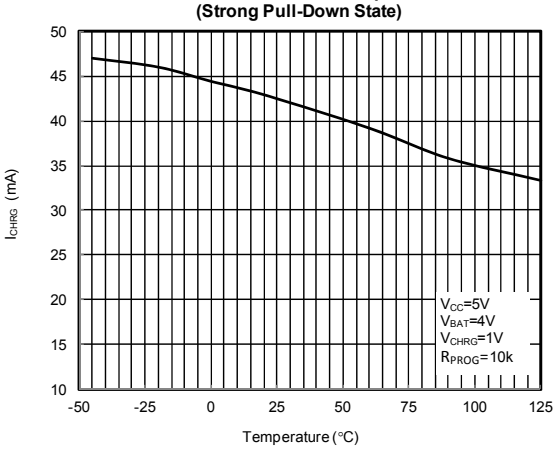
Regulated Output (Float) Voltage vs Supply Voltage



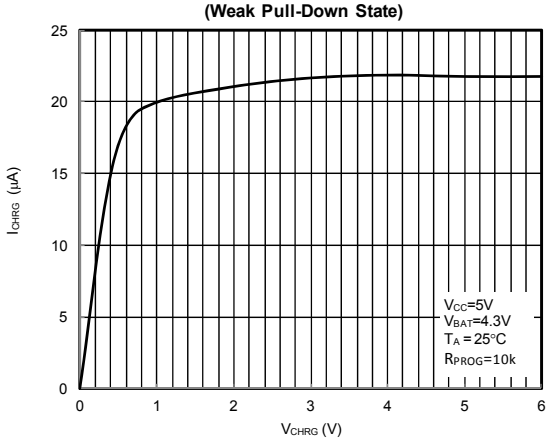
/CHRG Pin I-V Curve (Strong Pull-Down State)



/CHRG Pin Current vs Temperature (Strong Pull-Down State)

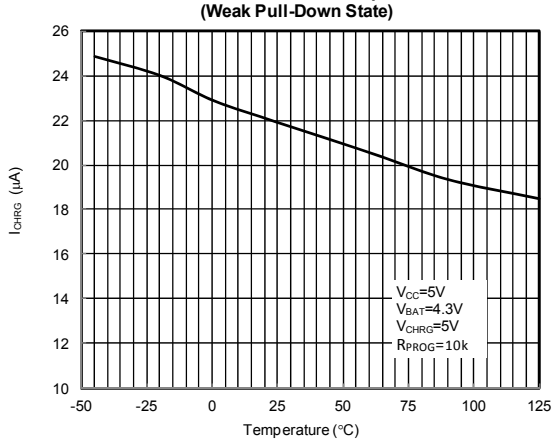


/CHRG Pin I-V Curve (Weak Pull-Down State)

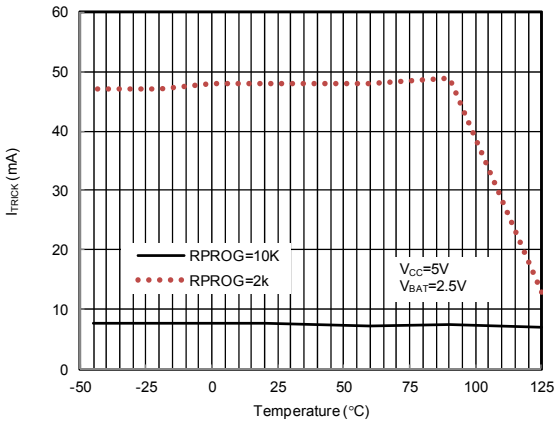


Typical Performance Characteristics (Continued)

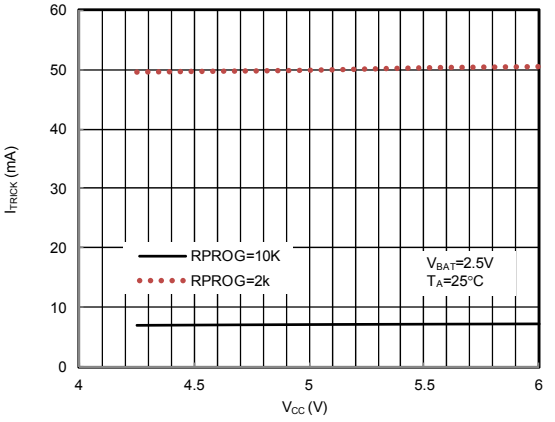
/CHRG Pin Current vs Temperature
(Weak Pull-Down State)



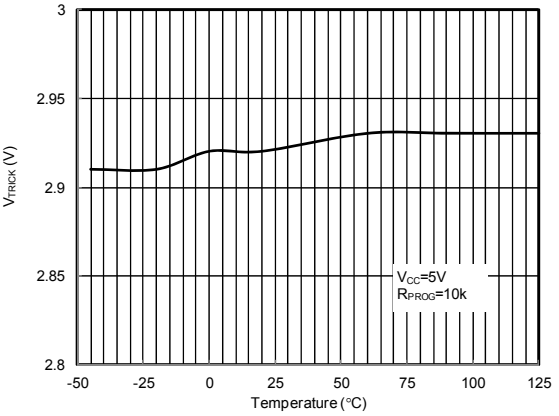
Trickle Charge Current vs Temperature



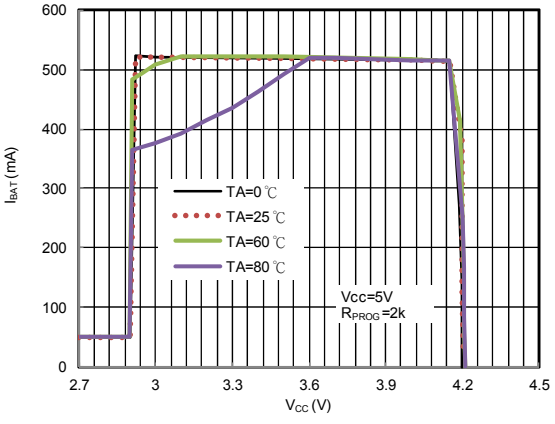
Trickle Charge Current vs Supply Voltage



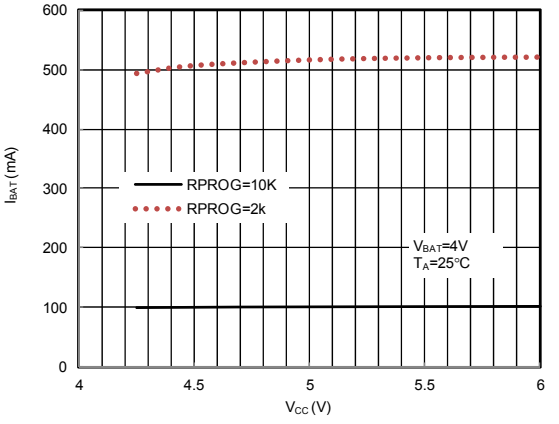
Trickle Charge Threshold vs Temperature



Charge Current vs Battery Voltage

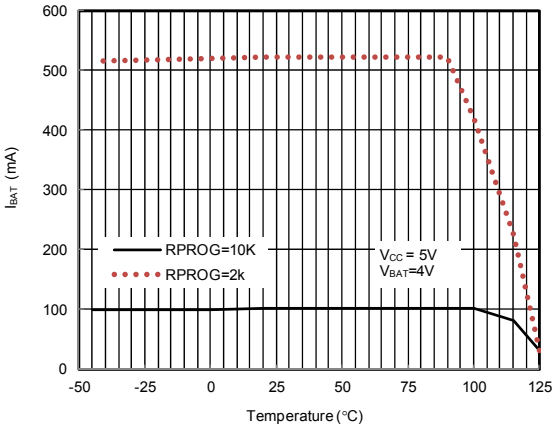


Charge Current vs Supply Voltage

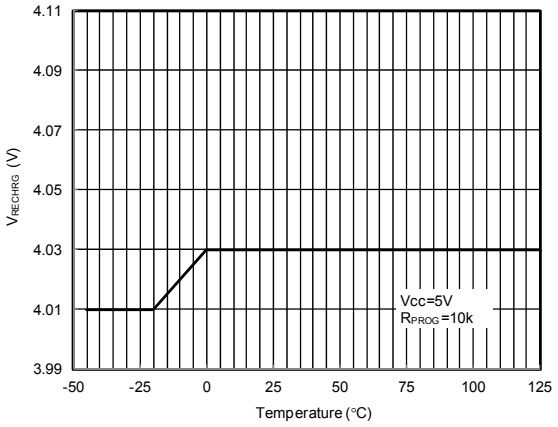


Typical Performance Characteristics (Continued)

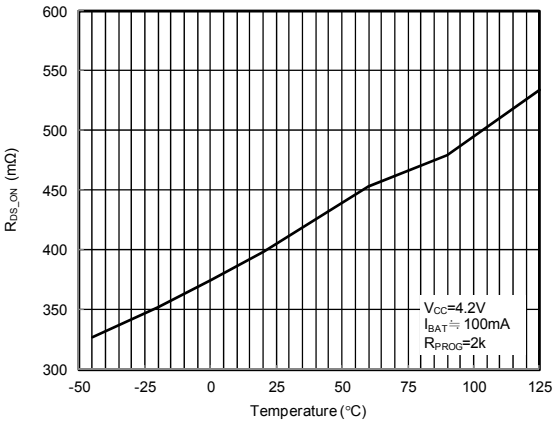
Charge Current vs Temperature



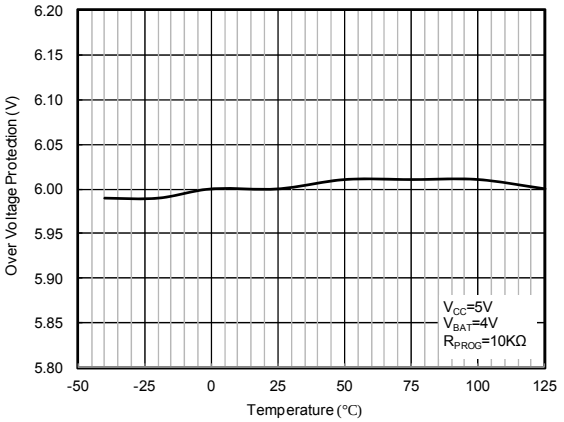
Recharge Voltage Threshold vs Temperature



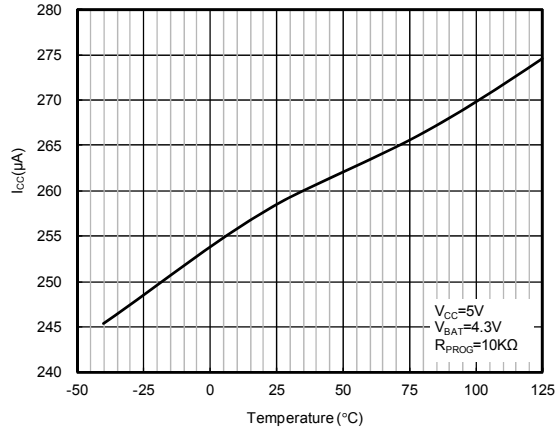
Power FET "ON" Resistance vs Temperature



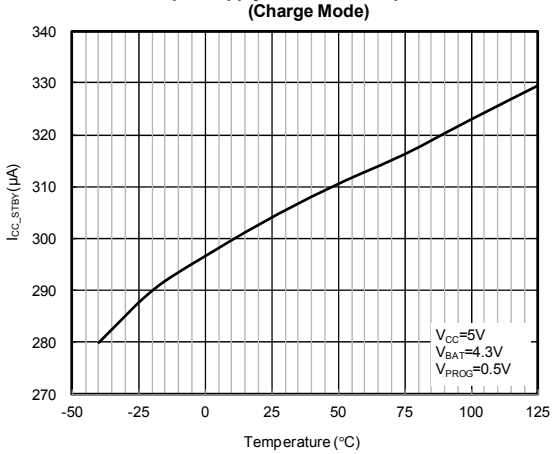
Over Voltage Protection vs Temperature



Input Supply Current vs Temperature (Standby Mode)



Input Supply Current vs Temperature (Charge Mode)

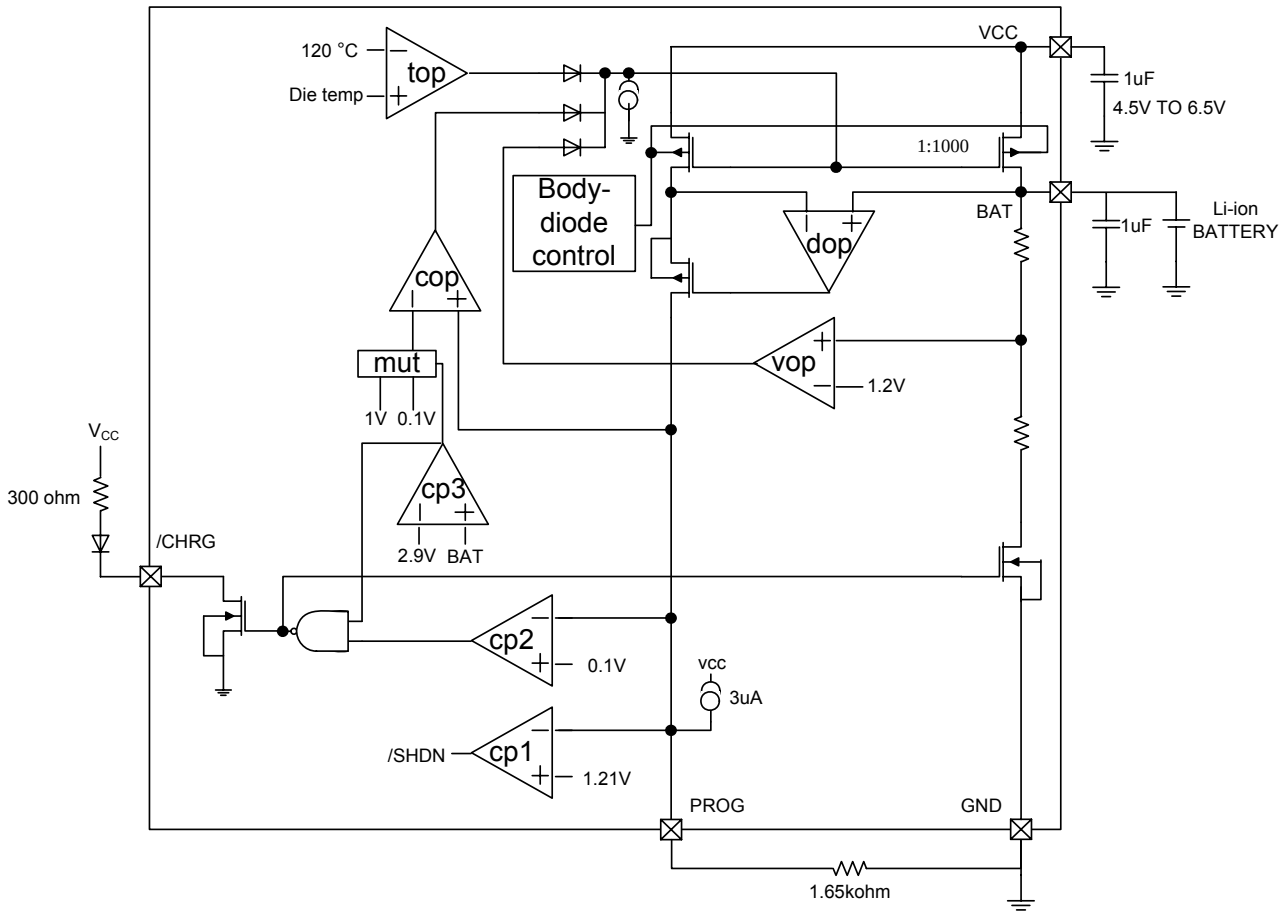


Pin Description

PIN	PIN NAME	FUNCTION
1	/CHRG	Open drain out, charge status output pin
2	GND	IC ground
3	BAT	Charge current output pin
4	V_{CC}	Power supply input
5	PROG	Constant charge current program pin, I_{BAT}= (V_{PROG}/R_{PROG})*1000

Block Diagram & Application Circuit

600mA Single Cell Li-Ion Charger



Detailed Description

Under voltage Lockout (UVLO)

An internal under voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until V_{CC} rise above 3.8V. The UVLO circuit has a built-in hysteresis of 0.2V.

Programmable Charge Current

The charge current is programmed by an external resistor from the PROG pin to ground. The charge current is 1000 times the current out of the PROG pin. In the trickle-charge mode, the program resistor and the charge current can be calculated by the following equations:

R_{PROG} = 1000 * 0.1V / I_{CHG}, I_{CHG}=1000 * 0.1V / R_{PROG};

In the constant-current mode, the program resistor and the charge current can be calculated by the following equations:

R_{PROG} = 1000 * 1V / I_{CHG}, I_{CHG} = 1000 * 1V / R_{PROG}.

The charge current out of the BAT pin can be determined by probing the PROG pin voltage by the following equation: I_{BAT} = 1000 * V_{PROG} / R_{PROG}

Normal Charge Cycle

When the voltage at the V_{CC} pin is over the UVLO threshold, the program resistor is connected from the PROG pin to ground and the voltage at V_{CC} pin is over the voltage at BAT pin plus 0.1V, the charge cycle would start to charge. If the BAT pin voltage is less than 2.9V, the charge cycle starts from trickle-charge mode. If the BAT pin voltage is greater than 2.9V, the charge cycle would start from constant-current mode.

In the trickle-charge mode, the charge current is about 1/10th programmed charging current. In the constant-current mode, the G2267 would supply fully programmed charge current. When the BAT pin approaches the final regulation voltage (4.2V), the G2267 enters to the constant-voltage mode and the charge current starts to decrease from programmed current. When the charge current drops below to 1/10th programmed current, the open drain NMO /CHRG pin would be pull low weakly and turning off the charge loop.

The G2267 constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the 4.05V re-charge threshold (V_{RECHRG}), another charge cycle begins and current is once again supplied to the battery. To manually restart a charge cycle when in standby mode, the input voltage must be removed and reapplied, or the charger must be shut down and restarted using the PROG pin. Fig. 1 shows the state diagram of a typical charge cycle.

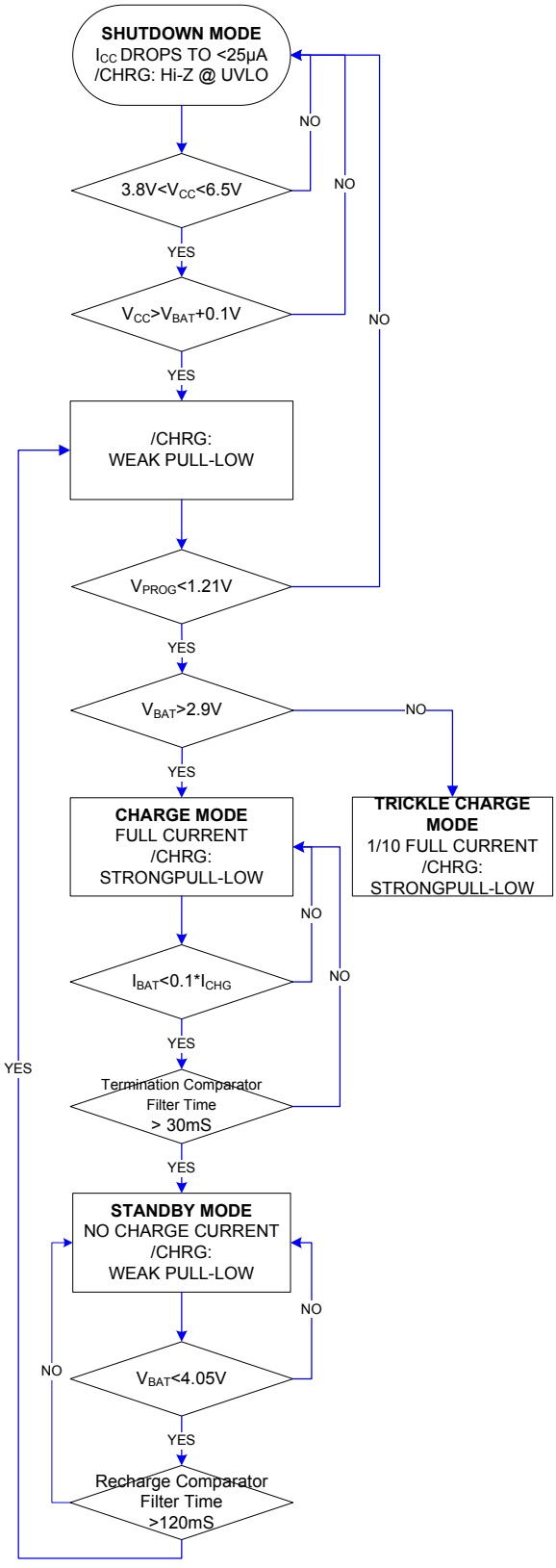


Fig. 1 State Diagram

Charge Status Indicator (/CHRG)

The charge status output has three different states: strong pull-down (~10mA), weak pull-down (~20μA) and high impedance. The strong pull-down indicates that G2267 is charging. Once the charge cycle has terminated, the pin state is determined by under voltage lockout conditions. A weak pull-down indicates that V_{CC} meets the UVLO conditions and the G2267 is ready to charge. High impedance indicates charge termination, manual shutdown, UVLO or over temperature conditions.

Over Temperature Protection

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 120°C. This feature protects the G2267 from excessive temperature and allows the user to push the limits of the power handling capability of a given circuit board without risk of damaging the G2267. The charge current can be set according to typical (not worst-case) ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

Manual Shutdown

The G2267 can be put into shutdown mode by removing R_{PROG} thus floating the PROG pin. This reduces the battery drain current to less than 1μA and the quiescent current to less than 25μA. The G2267 would be restarted by reconnecting the program resistor.

Application Information

Power Dissipation

The die attachment area of the G2267's lead frame is connected to pin 2, which is the GND pin. Therefore, the GND pin of G2267 can carry away the heat of the G2267 die very effectively. To improve the power dissipation, connect the GND pin to ground using a large ground plane near the GND pin.

V_{CC} Bypass Capacitor

Several types of capacitors can be used for input bypassing. Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, it could generate high voltage transients under some start-up conditions, such as connecting the charger input to a live power source. Adding a 1.5Ω resistor in series with a ceramic capacitor will minimize the start-up voltage overshoot transients.

USB and Wall Adapter Power

The power source of G2267 can be both a wall adapter and a USB port. Fig 2 shows an example of how to combine wall adapter and USB power inputs.

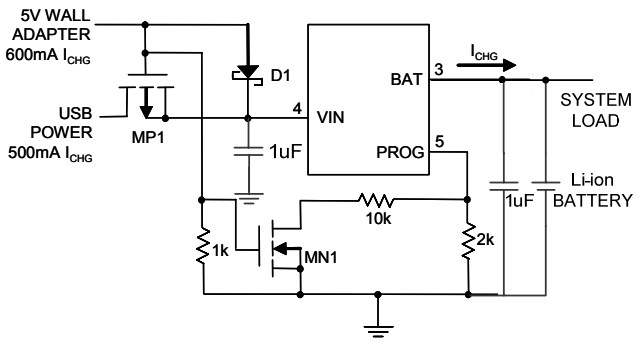
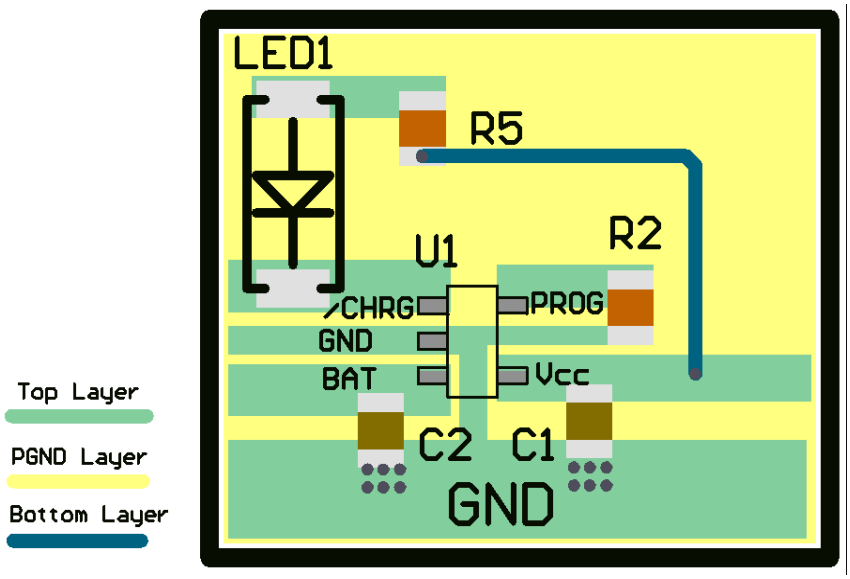


Fig. 2 Combining Wall Adapter and USB Power

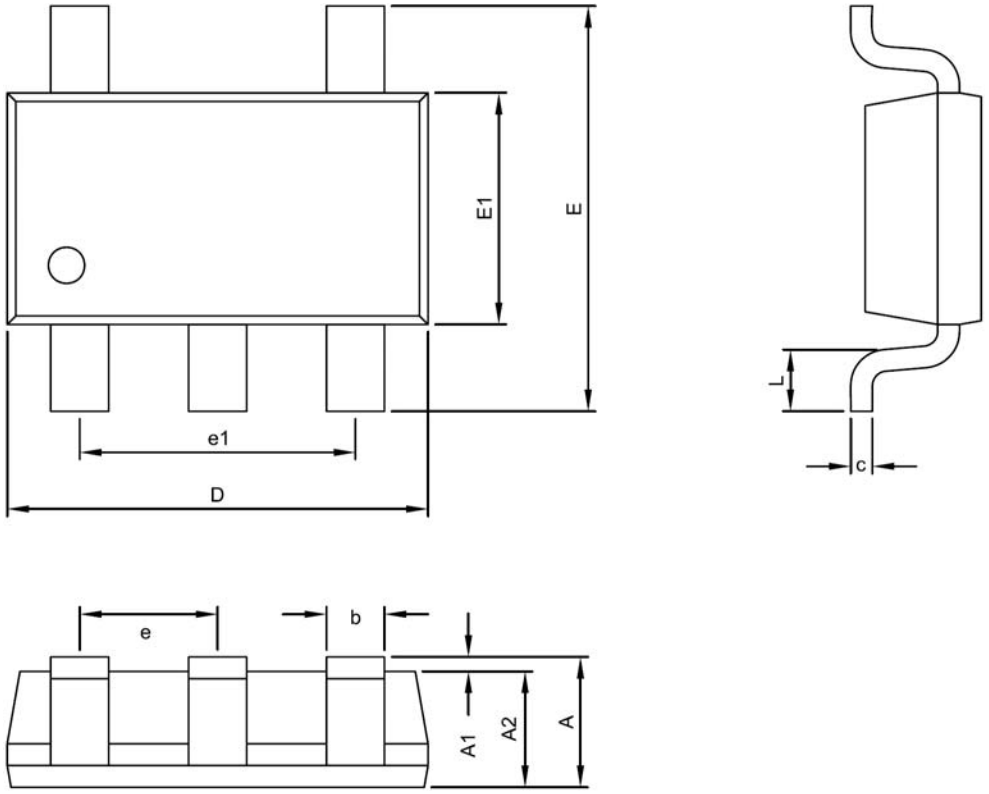
PCB Layout Guidelines

Power loops of the Linear Charger were considered to minimize the area. If possible, it is suggested to arrange the power loops at the top side copper plane. And the bottom side copper plane was considered to be the analog ground.



(1) Connect the bypass capacitor on VIN or VOUT as close to the device as possible. compo-nents away from the switch node to prevent stray capacitive noise pick-up.
(2) In case, the power loop crosses different layers, put vias as many as possible.

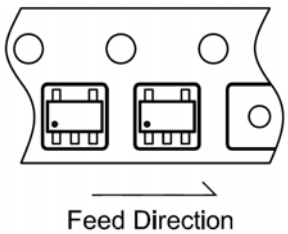
Package Information



TSOT-23-5 Package

Symbol	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	- - -	- - -	0.90	- - -	- - -	0.035
A1	0.00	0.05	0.10	0.000	0.002	0.004
A2	0.70	0.75	0.80	0.028	0.030	0.031
D	2.70	2.90	3.10	0.106	0.114	0.122
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
c	0.15 REF			0.006 REF		
b	0.30	0.40	0.50	0.012	0.016	0.020
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
L	0.30	0.45	0.60	0.012	0.018	0.024

Taping Specification



PACKAGE	Q'TY/REEL
TSOT-23-5	3,000 ea