GLF3006

Single Cell Li-Ion/Polymer Battery Protection IC

Preliminary Specification

DESCRIPTION

The GLF3006 is a highly integrated solution for single cell rechargeable battery protection. It incorporates a low on-resistance power NFET along with high precision over voltage, over current, over discharge, and short circuit protection.

When the battery voltage exceeds the over-voltage detection threshold, the GLF3006 turns off the charging switch after a preset delay. Similarly, if the load current surpasses the over discharge current threshold, the discharge switch is turned off after a preset delay. If the discharge current reaches the short circuit protection level (I_{SC}), the GLF3006 immediately shuts down and remains off to prevent serious system damage. A short circuit delay is included to avoid false triggering.

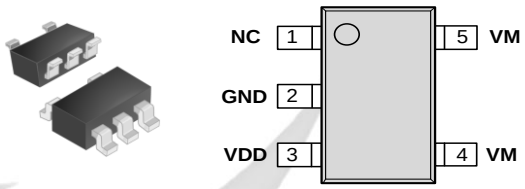
FEATURES

- Over Charge Voltage Detection, V_{OC} : 4.22 V
  - 4.22 V Typ. GLF3006A/B
  - 4.27 V Typ. GLF3006C
  - Accuracy : ± 1%
- Over Discharge Detection, V_{OD}
  - GLF3006A/C: Not Available for Applications with High Pulsating Currents
  - GLF3006B: 1.85 V_{DD}
- Over Charge Current Detection, I_{OC} : 4.4 A Typ.
  - I_{OC} with 10 ms Delay Time to avoid false trigger
- Over Discharge Current Detection, I_{OD} : 3.8 A Typ.
  - I_{OD} with 340 ms Delay Time to avoid false trigger
- Load Short Circuit Protection, I_{SC} : 8.4 A Typ.
- Thermal Shutdown Protection: GLF3006B Only
- Battery and Charger Reverse Polarity Connection Protection
- Low R_{ON} : 25 mΩ Typ. at 3.6 V_{DD}
- Low Quiescent Current, I_Q
  - GLF3006A/C: 2.1 µA Typ. @ 3.6 V_{DD}
  - GLF3006B: 2.6 µA Typ. @ 3.6 V_{DD}

APPLICATIONS

- Portable BLDC Motor Applications
- Electric Toothbrush
- Smart IoT Device

PACKAGE



SOT23 - 5L

DEVICE INFORMATION

Part Number	Top Mark	R_{ON} (Typ.) V_{DD} = 3.6 V	Over Charge Detection, V_{OC} (Typ.)	Over Discharge Voltage (Typ.)	Over Charge Current, I_{OC} (Typ.)	Over Discharge Current, I_{OD} (Typ.)	Short Circuit Current, I_{SC} (Typ.)
GLF3006A-T17	HN	25 mΩ	4.220 V	NA	4.4 A	3.8 A	8.4 A
GLF3006B-T17	HR			1.85 V			
GLF3006C-T17	HS		4.27 V	NA			

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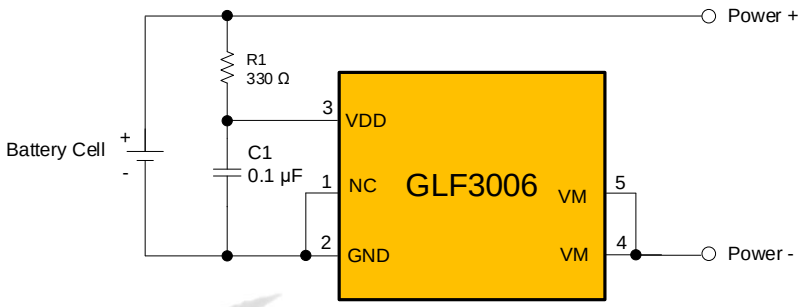
APPLICATION DIAGRAM



Note: 1) Recommend using 330 Ω for R1, it can ensure the safety of the IC when the battery is reversed.

Figure 1. Typical Application

FUNCTIONAL BLOCK DIAGRAM

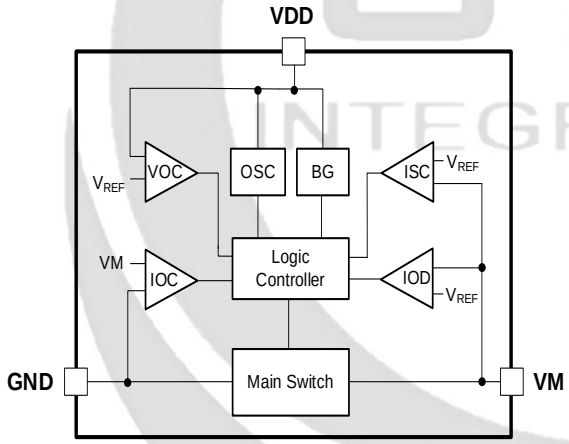


Figure 2. Functional Block Diagram, GLF3006A/C

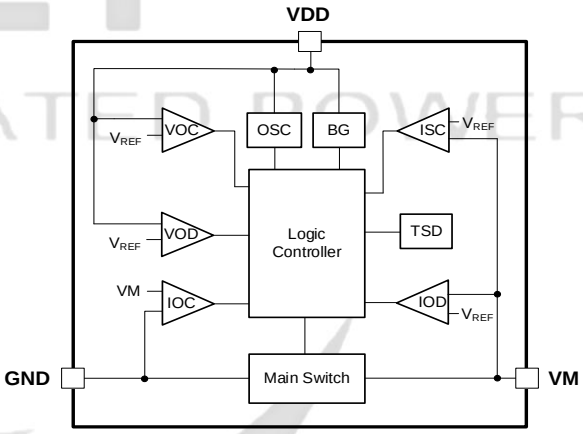


Figure 3. Functional Block Diagram, GLF3006B

PIN CONFIGURATION

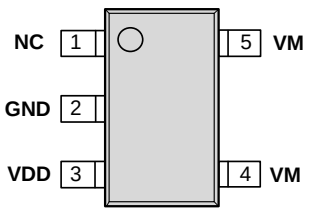


Figure 4. SOT23 - 5L

PIN DEFINITION

Pin #	Name	Description
1	NC	Connect to GND.
2	GND	Ground, Battery Cell Negative Terminal.
3	VDD	Power Supply, Battery Cell Positive Terminal.
4, 5	VM	Power Ground Pin.

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ABSOLUTE MAXIMUM RATINGS

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions; extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

Symbol	Parameter		Min.	Max.	Unit
V_{DD}, V_M	Each Pin Voltage Range to GND		- 0.3	6	V
T_{STG}	Storage Temperature		- 65	150	°C
T_J	Maximum Junction Temperature			150	°C
T_A	Operating Ambient Temperature		- 40	85	°C
θ_{JA}	Thermal Resistance, Junction to Ambient			180	°C/W
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	± 4		kV
		Charged Device Model, JESD22-C101	± 2		

ELECTRICAL CHARACTERISTICS

Values are at V_{DD} = 3.6 V, T_A = 25 °C unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{OC}	Over Charge Voltage Detection GLF3006A and GLF3006B	V_{DD} increases until switch turns off	4.180	4.220	4.260	V
		V_{DD} increases until switch turns off, T_A = 55 °C (1)		4.24		
	Over Charge Voltage Detection GLF3006C	V_{DD} increases until switch turns off	4.24	4.27	4.3	
		V_{DD} increases until switch turns off, T_A = 55 °C (1)	4.25	4.28	4.33	
V_{OC_HYS}	Over Charge Voltage Protection Release Hysteresis	V_{DD} decreases and switch turns on		140		mV
V_F	Forward Voltage	From VM to GND pin, V_{DD} > V_{OC}		0.6		V
t_{VOC}	Over Charge Voltage Protection Delay	V_{DD} > V_{OC}, Blanking time until switch turns off (1)		150		ms
V_{OD}	Over Discharge Voltage Detection	V_{DD} decreases until switch turns off GLF3006B Only	1.80	1.85	1.9	V
		V_{DD} decreases until switch turns off. T_A=55 °C (1)		1.86		
V_{OD_HYS}	Over Discharge Voltage Protection Release Hysteresis	V_{BAT} increases and switch turns on GLF3006B Only		160		mV
t_{VOD}	Over Discharge Voltage Protection Delay Time	V_{BAT} < V_{OD}, Blanking time until switch turns off(1) GLF3006B Only		270		ms
I_{OC}	Over Charge Current Detection (1)		3.0	4.4	6.0	A
t_{IOC}	Over Charge Current Protection Delay (1)	Charge Current > I_{OC}		10		ms
I_{OD}	Over Discharge Current Detection (1)		2.4	3.8	5.2	A
t_{IOD}	Over Discharge Current Detection Delay Time (1)	Discharge Current > I_{OD}	165	340	500	ms
I_{SC}	Short Circuit Shutdown (1)		5.5	8.4		A
t_{SC}	Short Circuit Protection Delay Time (1)	V_{DD} = 3.6 V, Short Circuit Current ≥ 8.4 A		80		µs
TSD	Thermal Shutdown Protection Threshold (1)	GLF3006B Only		148		°C
	Thermal Shutdown Release Hysteresis (1)			40		°C

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ELECTRICAL CHARACTERISTICS (CONTINUED)

Values are at V_{DD} = 3.6 V, T_A = 25 °C unless otherwise noted.

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Units
I_Q	Quiescent Current with Switch On GLF3006A and GLF3006C	V_{DD} = 2.0 V, I_{OUT} = 0 mA			1.8		µA
		V_{DD} = 3.6 V, I_{OUT} = 0 mA			2.1	2.9	
		V_{DD} = 4.0 V, I_{OUT} = 0 mA	T_A = 25 °C		2.2	3.0	
			T_A = 55 °C (1)		2.5		
	Quiescent Current with Switch On GLF3006B	V_{DD} = 3.6 V, I_{OUT} = 0 mA			2.6	3.2	
		V_{DD} = 4.0 V, I_{OUT} = 0 mA,	T_A = 25 °C		2.8	3.4	
			T_A = 55 °C (1)		2.9		
I_{SD}	Shutdown current after V_{OD} triggered	V_{DD} =1.75 V, I_{OUT} = 0 mA	T_A = 25 °C		0.8	1.5	µA
			T_A = 55 °C (1)		1		
R_{ON}	On-Resistance	V_{DD} = 2.0 V, I_{OUT} = 200 mA	T_A =25 °C		30		mΩ
		V_{DD} = 3.6 V, I_{OUT} = 200 mA	T_A = 25 °C		25	36	
			T_A = 55 °C (1)		27		
		V_{DD} = 4.0 V, I_{OUT} = 200 mA	T_A = 25 °C		24	35	
			T_A = 55 °C (1)		26		
R_{VMD}	Internal Resistance between VM and VDD	When battery discharge Voltage triggers V_{OD} and V_{DD} ≥ 1.5 V, GLF3006B Only		330	370	410	kΩ
R_{VMS}	Internal Resistance between VM and GND	V_{DD} = 3.6 V, When battery discharge current triggers I_{OD} or I_{SC}		20	30	40	kΩ

Note: 1. By design; characterized, not production tested.

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TYPICAL PERFORMANCE CHARACTERISTICS

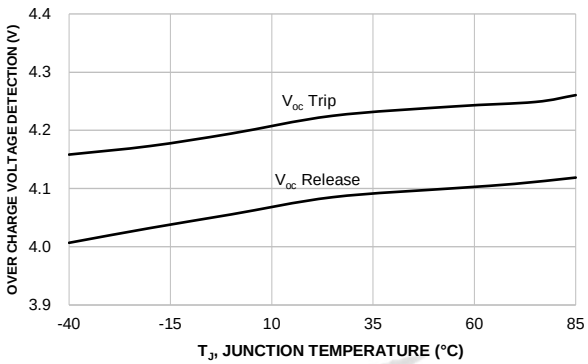

Figure 5. Over Charge Voltage Detection vs. Temperature, GLF3006A and GLF3006B

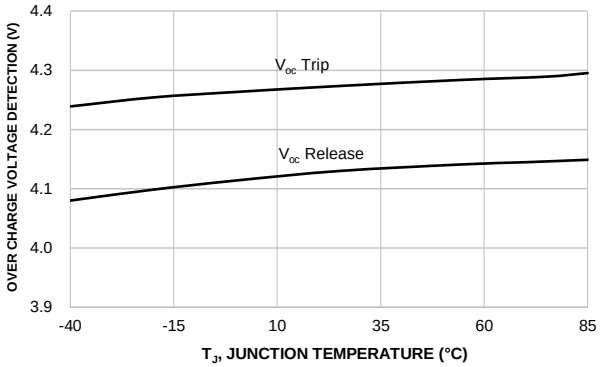

Figure 6. Over Charge Voltage Detection vs. Temperature, GLF3006C

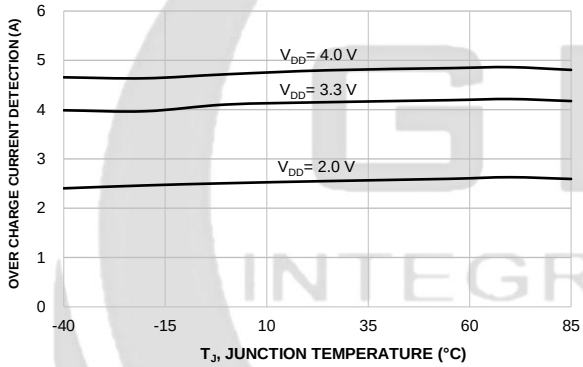

Figure 7. Over Charge Current Detection vs. Temperature

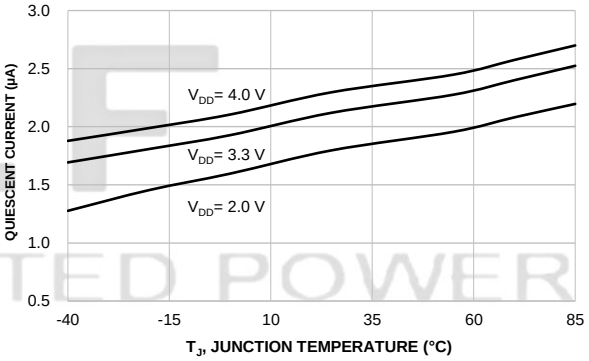

Figure 8. Quiescent Current vs. Temperature, GLF3006A and GLF3006C

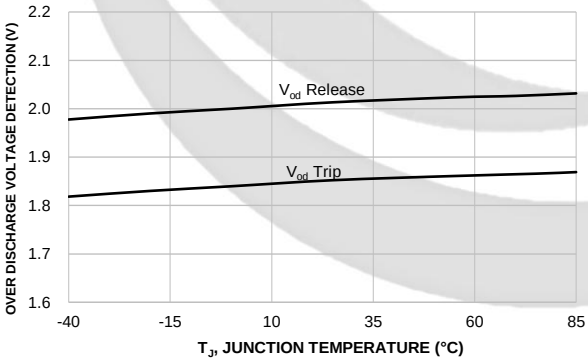

Figure 9. Over Discharge Voltage Detection vs. Temperature, GLF3006B Only

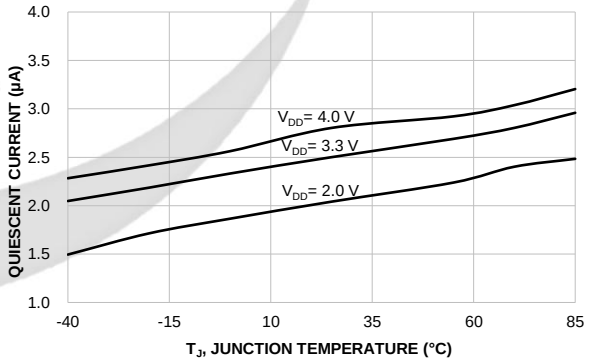

Figure 10. Quiescent Current vs. Temperature, GLF3006B

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TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

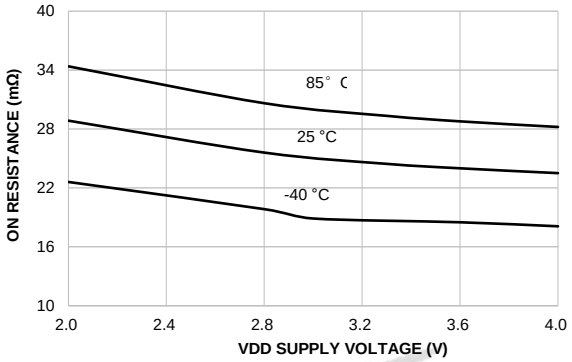

Figure 11. On-Resistance vs. VDD

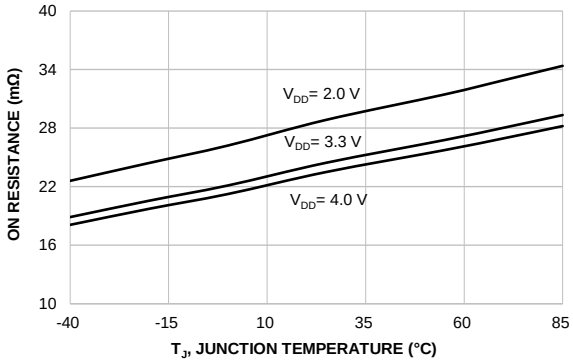

Figure 12. On-Resistance vs. Temperature

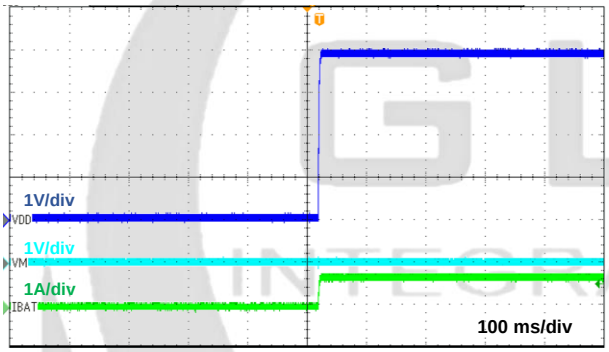

Figure 13. Power On

V_{DD} = 4.0 V, C1 = 0.1 µF, R_{Load} = 5.0 Ω

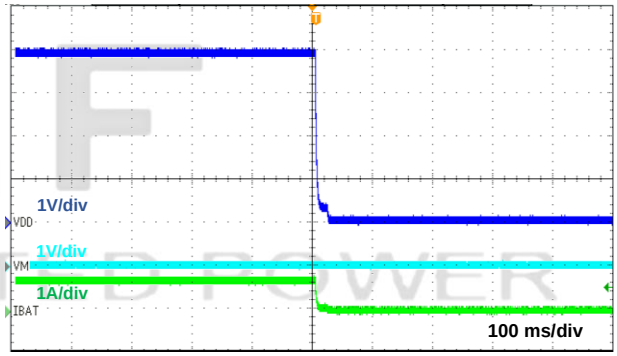

Figure 14. Power Off

V_{DD} = 4.0 V, C1 = 0.1 µF, R_{Load} = 5.0 Ω

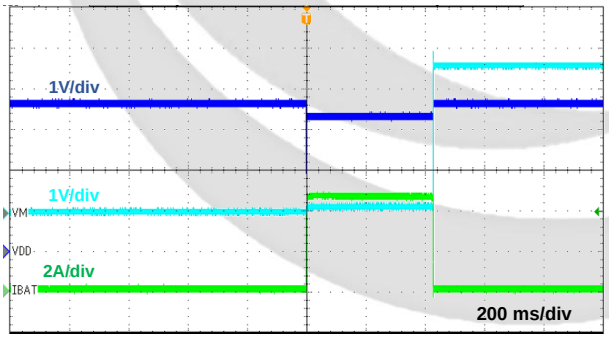

Figure 15. Over Discharge Current Response

V_{DD} = 3.6 V, C1 = 0.1 µF, I_{BAT} = From 0 A to 4.5 A

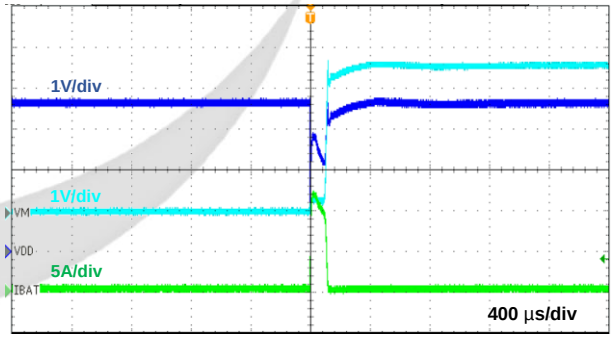

Figure 16. Short Circuit Response

V_{DD} = 3.6 V, C1 = 0.1 µF, R_{Load} = From 150 Ω to 0 Ω

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APPLICATION INFORMATION

The GLF3006 controls charging and discharging by monitoring the battery voltage between VDD and GND, as well as the voltage difference between VM and GND. At the same time, the VM pin is one terminal of the internal main switch. When no protection event is detected, the internal main switch will turn on, connecting the VM pin to GND. When a protection event is detected, the main switch will turn off, disconnecting the VM pin from GND. Depending on the type of protection event, the IC's internal control circuit will connect the VM pin to different states.

Activate Device

When a battery voltage of ≥1.5 V is applied (GLF3006A and GLF3006C), and no protection conditions are triggered, the GLF3006 can automatically activate its internal charge and discharge switches. Note: Upon initial battery connection with a load, the IC may fail to enter normal operating mode if a protection function is inadvertently triggered. In such cases, momentarily shorting VM to GND or enabling the charger connected between VDD and VM (negative terminal) will properly activate the GLF3006.

Over Charging Voltage Protection

When the voltage of a battery increases to the over charge voltage detection level (V_{OC}), the main switch between VM and GND will be turned off to stop charging the battery after a preset over charge detection delay time (t_{OC}) in order to avoid a false trigger. At this time, when the charger is unplugged and the system load is connected, the battery discharge current will through the internal parasitic diode (V_F). The charging path turns on again as the battery voltage decreases below the over charge release voltage level (V_{OC} - V_{OC_HYS}). The charging path is not turned off if the battery voltage returns to a voltage less than the detection level within the delay time. Note: When the over charging voltage protection is triggered, the voltage between VM and GND equals the battery voltage minus the voltage between V_{DD} and VM.

Over Discharging Voltage Protection

The GLF3006B has over discharging voltage protection. When the battery voltage drops to the over discharge detection level (V_{OD}) and the duration exceeds the over-discharge voltage protection delay time (t_{VOD}), the GLF3006B discharge path remains turn off until the battery voltage is charged higher than V_{OD} release Voltage (V_{OD}+V_{OD_HYS}). If the battery voltage drops to the over discharge detection level (V_{OD}) and the duration does not exceed the over discharge voltage protection delay time (t_{VOD}), the discharge path is not turned off. Note: When over discharging voltage protection is triggered, the internal 370 kΩ (R_{VMD}) resistor between VM and VDD is conducting. This will help the GLF3006B device quickly return to normal after protection events are cleared.

Over Charging Current Protection

If an over charging current is detected at the constant current charging mode, the GLF3006 will turn off the main switch between the internal VM and GND after a preset detection delay time (t_{IOC}). When the charger is unplugged and then a charger with a charging current lower than the I_{OC} is connected between VDD and VM, the charging path is activated again. Note: When the over charging current protection is triggered, the voltage between VM and GND equals the battery voltage minus the voltage between V_{DD} and VM.

Over Discharging Current and Short Circuit Protection

When the over discharging current happens for the detection delay time (t_{IOD}), the main switch between VM and GND will be turned off. If GLF3006 detects the discharge current over a short circuit current detection threshold (I_{SC}), the main switch between VM and GND will be turned off in a preset short circuit delay time (t_{SC}). The higher a short circuit current is occurred, the shorter the short circuit delay time is in order to protect the device. After an over discharging current or short circuit protection has been triggered, the discharge switch can be reactivated using one of the following two methods: (1) Connect VM to GND for a short time or (2) Enable the charger between VDD and VM. Note: When over discharging current protection or short circuit protection is triggered, the internal 30 kΩ (R_{VMS}) resistor between VM and GND is conducting. This will help the GLF3006 device quickly return to normal after protection events are cleared.

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OPERATION DIAGRAM

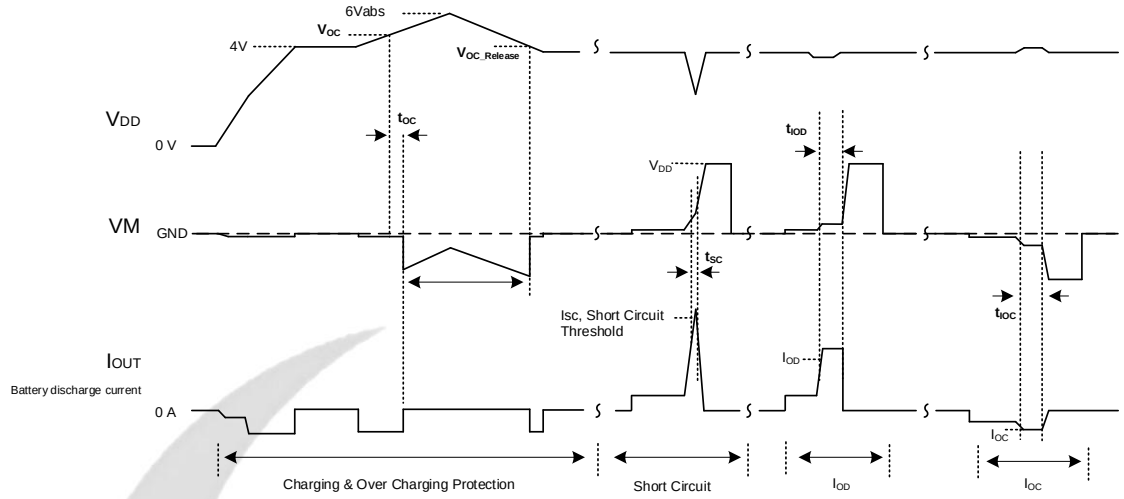

Figure 17. Operation Diagram, GLF3006A and GLF3006C

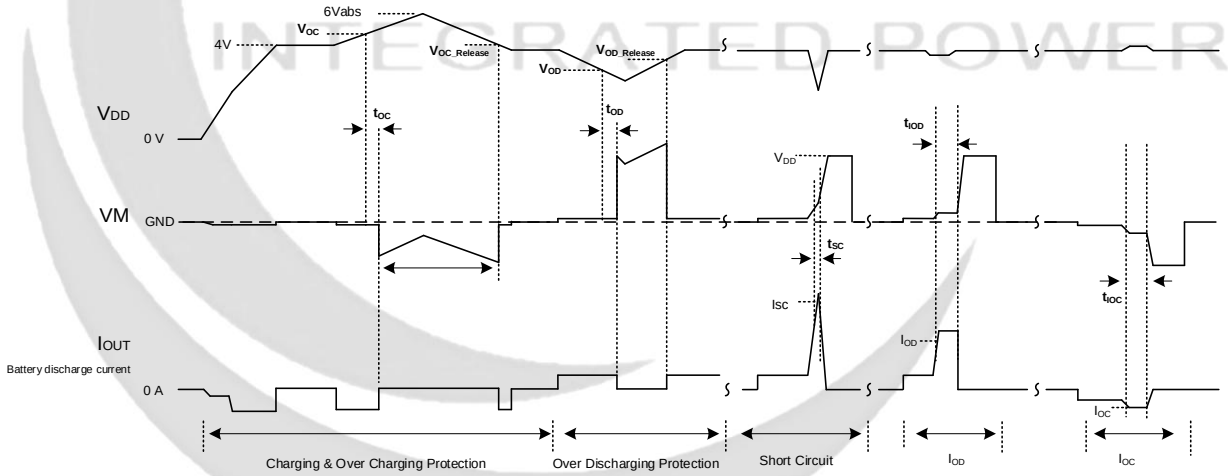

Figure 18. Operation Diagram, GLF3006B

Thermal Shutdown Protection

The GLF3006B has a thermal shutdown protection. When the junction temperature exceeds TSD threshold, the device will turn off the internal main switch to protect itself from damage due to overheating. When the junction temperature drops below the TSD hysteresis, the device will return to normal operation.

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Reverse Connection Protection

The GLF3006 has a reverse connection prevention feature for the charger, the GLF3006 will prevent charging. For battery reverse connection, the GLF3006 will limit the current flowing into GLF3006 through R1 to ensure safety. R1 is used to limit the current during reverse connection protection, Suggest range: 220~330 Ohm. Resistance higher than 350 Ohm is not recommend.

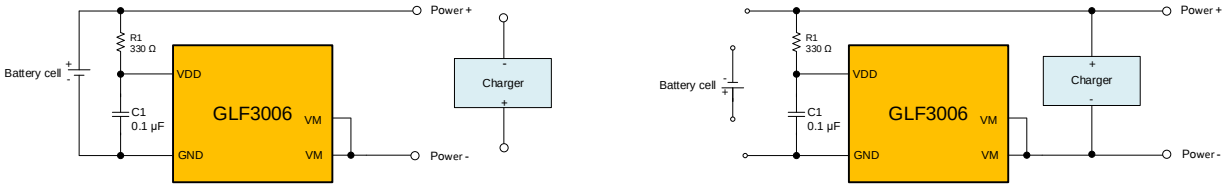

Figure 19. Charger & Battery Reverse Connection

Board Layout

All traces should be as short as possible to minimize parasitic inductance effects. Wide traces for VM and GND will help reduce voltage drops, and parasitic effects during dynamic operation as well as improve the thermal performance at high load currents.

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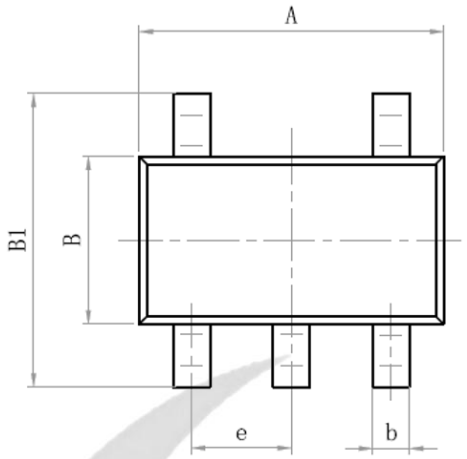
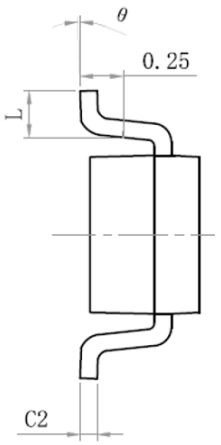
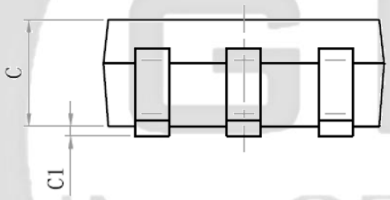
PACKAGE OUTLINE



TOP VIEW

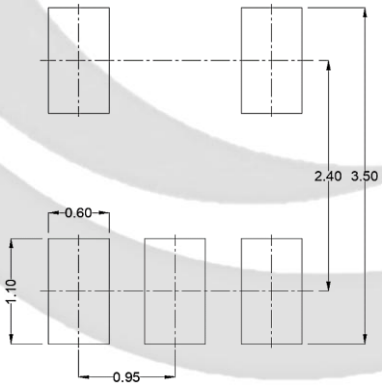


SIDE VIEW



FRONT VIEW

Recommended Footprint



REF.	Dimensions Ref.		
	Min.	Nom.	Max.
C1	0.03	0.08	0.15
C	1.05	1.10	1.15
b	0.27	-	0.35
C2	0.135	-	0.23
A	2.82	2.92	3.02
B1	2.60	2.90	3.00
B	1.50	1.62	1.70
e	0.95 BSC		
L	0.35	0.45	0.55
θ	0°	-	8°

PACKAGING INFORMATION

Part Number	Package	Pins	Top Mark	Moisture Sensitivity Level	Environmental Information
GLF3006A	SOT23-5	5	HN	MSL3	ROHS+HF
GLF3006B			HR		
GLF3006C			HS		

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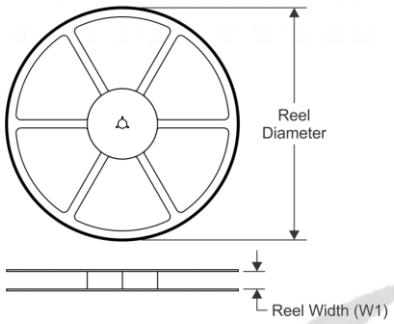
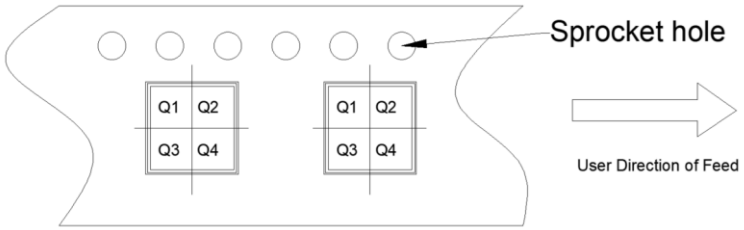
TAPE AND REEL DIMENSIONS

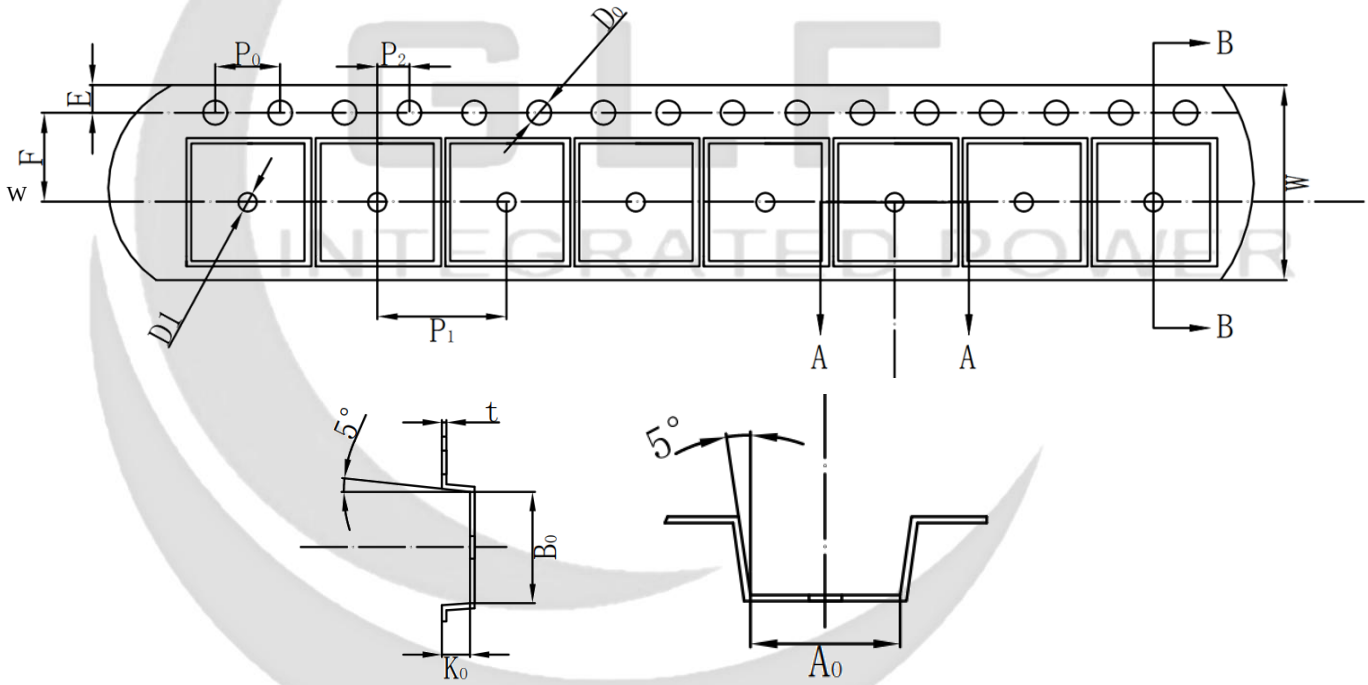
REEL DIMENSIONS



QUADRANT ASSIGNMENTS PIN 1 ORIENTATION TAPE



TAPE DIMENSIONS



Device	Package	Pins	SPQ	Reel Diameter (mm)	Reel Width W1	A0	B0	K0	P1	W	Pin1
GLF3006A	SOT23-5	5	3000	178	9	3.25	3.30	1.38	4	8	Q3
GLF3006B											
GLF3006C											

Remark:

A0: Dimension designed to accommodate the component width

B0: Dimension designed to accommodate the component length

K0: Dimension designed to accommodate the component thickness

W: Overall width of the carrier tape

P1: Pitch between successive cavity centers

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SPECIFICATION DEFINITIONS

Document Type	Meaning	Product Status
Target Specification	This is a target specification intended to support exploration and discussion of critical needs for a proposed or target device. Parameters including the typical, minimum, and maximum values are desired, or target. GLF reserves the right to change contents at any time without warning or notification. A target specification will not guarantee the future production of the device.	Design / Development
Preliminary Specification	This is a draft version of a product specification which is under internal review and subject to change. GLF reserves the right to change the specification at any time without warning or notification. A preliminary specification will not guarantee the future production of the device.	Qualification
Product Specification	This document represents the characteristics of the device.	Production

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