GLF73927

Ultra-Efficient, Optimized I_QSmart™ Battery Protection IC

Preliminary Specification

DESCRIPTION

The GLF73927 family is an I_QSmart™ ultra-efficient IC, with accurate over charge/discharge voltage protection, over charge current protection and short circuit protection.

The over charge and discharge voltage protections are capable of keeping a rechargeable battery working within the desired safe operating condition. When the battery is charged above the overcharge voltage detection level (V_{OC}), the GLF73927 charging switches off after a preset delay time. As the battery voltage decreases lower than the over discharge detection voltage (V_{OD}), the GLF73927 discharging switch is turned off immediately. In the off state, GLF73927 consumes an ultra-low leakage current (I_{SD}) to save the battery power. In addition, when the load current is higher than the short circuit protection current level (I_{SC}), the GLF73927 is turned off and will maintain the off state to avoid any serious damage to system. The short circuit delay time can avoid any false trigger which might turn off the switch.

The GLF73927 provides a shipping mode to prevent smart devices which has a non-removable battery from discharging during the shipping period. When a charged battery cell is connected to the GLF73927, and GLF73927 remains in the off state, the smart devices consume an ultra-low leakage current (I_{SD}). Note that the only way to active the GLF73927 is applying a charger output V_{ON} voltage to VOUT pin.

The GLF73927 has 0 V battery minimum voltage charging function, when discharged to around 0 V, the battery can still be charged up.

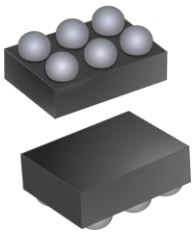
FEATURES

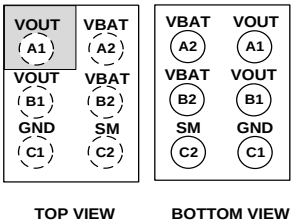
- Over Charge Detection Voltage, V_{OC}
  - GLF73927A/C, V_{OC}: 4.30 V
  - GLF73927B, V_{OC}: 4.45 V
  - V_{OC} accuracy: ±1.2 %
  - Detects VBAT to release V_{OC}
- Over Discharge Detection Voltage, V_{OD}
  - GLF73927A/B, V_{OD}: 2.80 V
  - GLF73927C, V_{OD}: 2.50 V
  - Detects VBAT to release V_{OD}
- Over Charge Current Detection, I_{OC}
  GLF73927A, I_{OC}: 1.90 A
  GLF73927B, I_{OC}: 2.15 A
  GLF73927C, I_{OC}: 1.20 A
- Short Circuit Protection, I_{SC}: 3.0 A
- Activated by Applying V_{ON} to the VOUT Pin from Charger
- Shipping Mode Implementation
- Low R_{ON} : 32 mΩ Typ. at 3.6 V_{BAT}
- Low Quiescent Current, I_Q : 1.6 µA Typ. at 3.6 V_{BAT}
- Shutdown Current:
  - I_{SD} = 6 nA Typ. at V_{BAT} < V_{OD}
  - I_{SD} = 8 nA Typ. at V_{BAT} = 3.6 V, Shipping Mode
  - I_{SD} = 10 nA Typ. at V_{BAT} = 4.2 V, Shipping Mode
- Latch-off at Over Charge Current, Over Discharge Voltage and Short Circuit Protection.
- 0 V Battery Charging

APPLICATIONS

- BLE Wireless Headset
- Wearables and Smart IoT Devices
- Digital Cameras

PACKAGE





0.97 mm x 1.47 mm x 0.55 mm WLCSP

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DEVICE INFORMATION

Part Number	Top Mark	R_{ON} (Typ.) V_{BAT}=3.6 V	Over Charge Detection V_{OC} (Typ.)	Over Discharge Detection V_{OD} (Typ.)	Over Charge Current I_{OC} (Typ.)	Short Circuit Current I_{SC} (Typ.)
GLF73927A-S37	EU	32 mΩ	4.30 V	2.80 V	1.90 A	3.0 A
GLF73927B-S37	FU		4.45 V	2.80 V	2.15 A	
GLF73927C-S37	GU		4.30 V	2.50 V	1.20 A	

APPLICATION DIAGRAM

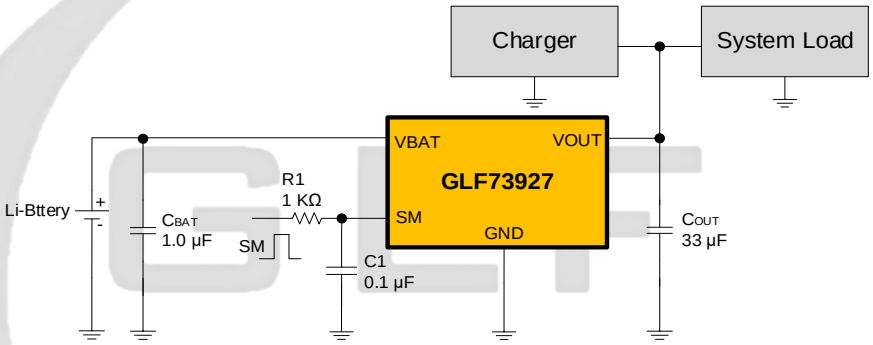

Figure 1. Application Diagram

OPERATION DIAGRAM

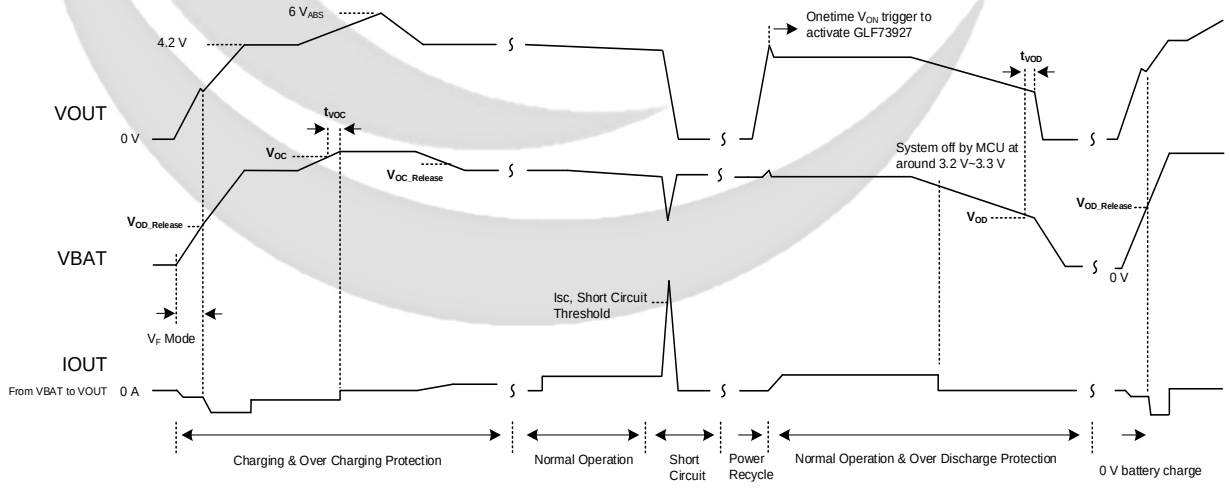

Figure 2. Operation Diagram

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SHIPPING MODE

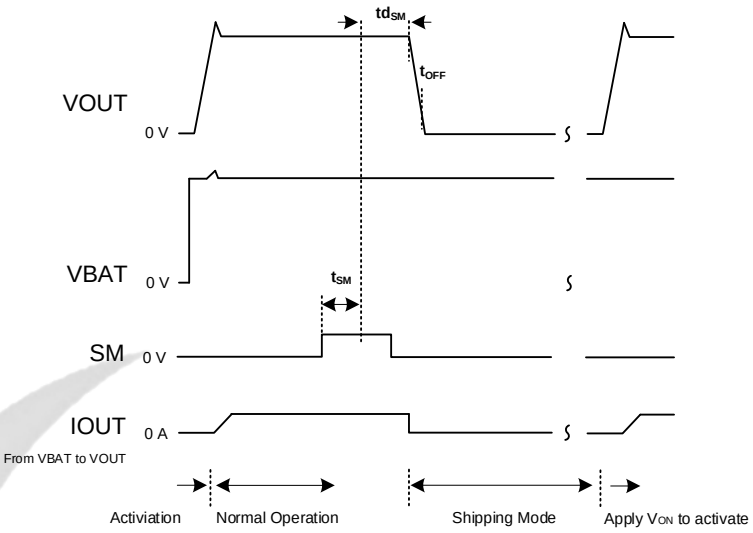


Figure 3. Shipping Mode Operation

FUNCTIONAL BLOCK DIAGRAM

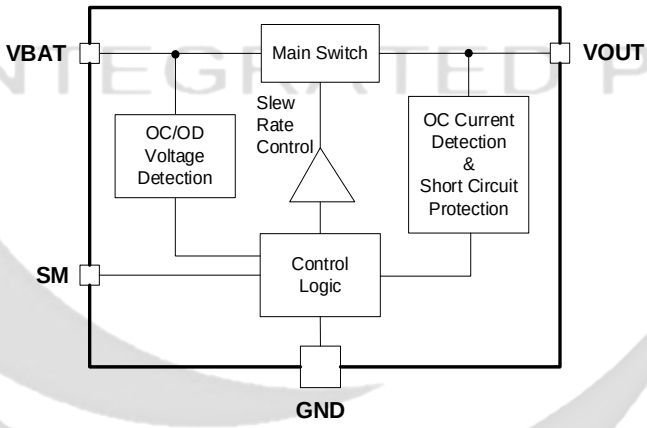
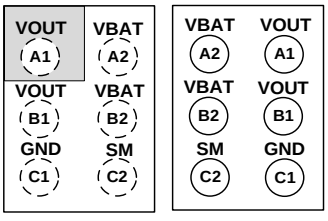


Figure 4. Functional Block Diagram

PIN CONFIGURATION



TOP VIEW BOTTOM VIEW

Figure 5. 0.97mm x 1.47mm x 0.55mm WLCSP

PIN DEFINITION

Pin #	Name	Description
A1, B1	VOUT	VOUT pin is connected to the charger output and system load. If the switch is in the off state, applying an appropriate voltage (V_{ON}) to V_{OUT} to turn the switch on.
A2, B2	VBAT	VBAT pin is connected to the positive terminal of a battery pack to monitor the battery voltage.
C1	GND	Ground
C2	SM	Shipping Mode Control. Active high.

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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_{BAT}, V_{OUT}, V_{SM}	Each Pin Voltage Range to GND		- 0.3	6	V
P_D	Power Dissipation at T_A = 25°C			1.2	W
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			80	°C/W
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	± 8		kV
		Charged Device Model, JESD22-C101	± 2		

ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{OC}	Over Charge Detection Voltage	GLF73927A GLF73927C	V_{BAT} increases until switch turns off	4.25	4.30	4.35	V
			T_A = 55 °C (1)		4.31		
		GLF73927B	V_{BAT} increases until switch turns off	4.40	4.45	4.50	
			T_A = 55 °C (1)		4.47		
V_{OC_HYS}	Over Charge Voltage Protection Release Hysteresis	V_{BAT} decreases and switch turns on			105		mV
t_{VOC}	Over Charge Voltage Protection Delay Time	V_{BAT} > V_{OC}, Blanking time until switch turns off		460	530	600	ms
V_{OD}	Over Discharge Detection Voltage	GLF73927A GLF73927B	V_{BAT} decreases until switch turns off	2.72	2.80	2.88	V
			T_A = 55 °C (1)		2.80		
		GLF73927C	V_{BAT} decreases until switch turns off	2.42	2.50	2.58	
			T_A = 55 °C (1)		2.49		
V_{OD_HYS}	Over Discharge Voltage Protection Release Hysteresis	V_{BAT} increases and switch turns on (3)			125		mV
t_{VOD}	Over Discharge Voltage Protection Delay Time	V_{BAT} < V_{OD}, Blanking time until switch turns off		10	60	150	µs
V_{ON}	ON Voltage applied to VOUT to turn on switch	V_{OUT} to turn on switch, V_{BAT} ≥ 3.1 V		3.7			V
I_{OC}	Over Charge Current Detection (1)	GLF73927A		1.6	1.9	2.2	A
		GLF73927B		1.9	2.15	2.4	A
		GLF73927C		1.0	1.2	1.4	A
t_{IOC}	Over Charge Current Detection Delay Time				40		ms
I_{SC}	Short Circuit Current Detection Threshold (1)			2.4	3.0		A
t_{SC}	Short Circuit Delay Time (1)	I_{SC}, Short Circuit Current ≥ 3 A			200		µs
I_Q	Quiescent Current with Switch On	V_{BAT} = 4.2 V, I_{OUT}= 0 mA, Switch = ON	T_A = 25 °C	1.2	1.7	2.2	µA
			T_A = 55 °C (1)		1.8		
		V_{BAT} = 3.6 V, I_{OUT}= 0 mA, Switch = ON		1.1	1.6	2.1	

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ELECTRICAL CHARACTERISTICS (CONTINUED)

Symbol	Parameter	Conditions		Min	Typ	Max	Units
I_{SD}	Shutdown Current from VBAT When Main Switch is Off	V_{BAT} = 4.2 V, V_{OUT} = 0 V, Shipping Mode			8	50	nA
		V_{BAT} = 3.6 V, V_{OUT} = 0 V, Shipping Mode			6		
		V_{BAT} = 2.5 V, V_{OUT} = 0 V	T_A = 25 °C		4		
			T_A = 55 °C (1)		20		
R_{ON}	On-Resistance	V_{BAT} = 4.2 V, I_{OUT}= 100 mA	T_A = 25 °C		29	40	mΩ
			T_A = 55 °C (1)		31		
		V_{BAT} = 3.6 V, I_{OUT}= 100 mA	T_A = 25 °C		32	42	
			T_A = 55 °C (1)		33		
t_{OFF} (1)	Turn-Off Time	C_{OUT} = 33 µF, R_{OUT}= 150 Ω, V_{OUT} = V_{OD} to 0 V			10		ms
V_{SM}	SM Input Logic High Voltage	V_{BAT} = 2.5 V to 5.5 V		1.2			V
t_{SM}	SM Pulse Width	V_{BAT} = 3.3 V to 4.2 V		15			ms
td_{SM}	Shipping Mode Delay	V_{BAT} = 3.3 V to 4.2 V		300	460	600	ms
R_{SM}	SM Pull Down Resistance	Internal Resistance			400		kΩ
V_F	Diode Forward Voltage	From VOUT to VBAT Pin, V_{BAT} < 3.1V			0.4		V

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

2. All values of delay timing were characterized but not tested in production.

3. Enabled charger is connected to the VOUT pin.

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TYPICAL PERFORMANCE CHARACTERISTICS

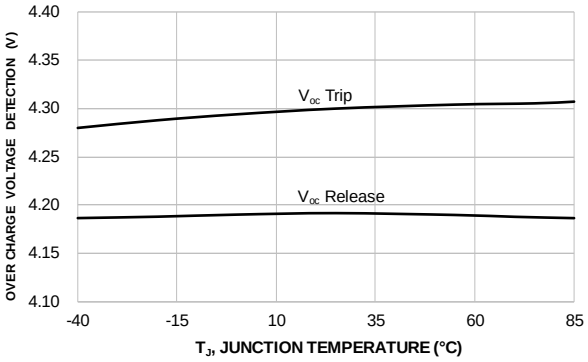

Figure 6. GLF73927A Over Charge Voltage Detection vs. Temperature

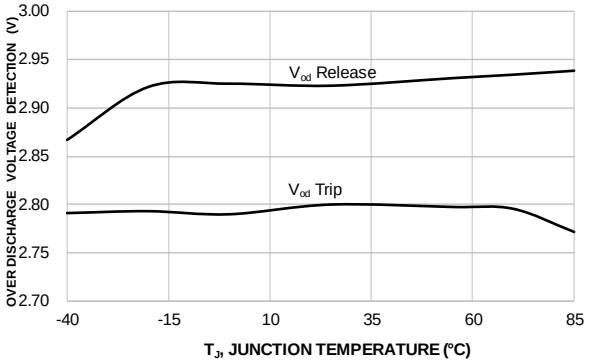

Figure 7. GLF73927A Over Discharge Voltage Detection vs. Temperature

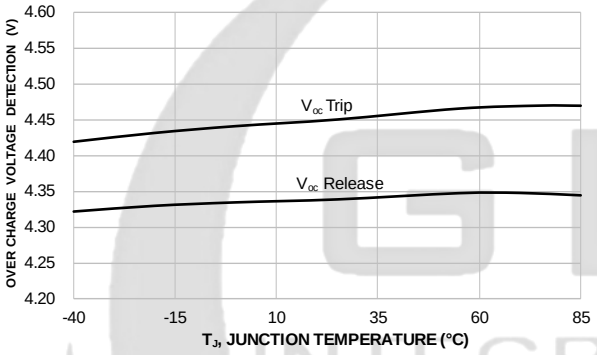

Figure 8. GLF73927B Over Charge Voltage Detection vs. Temperature

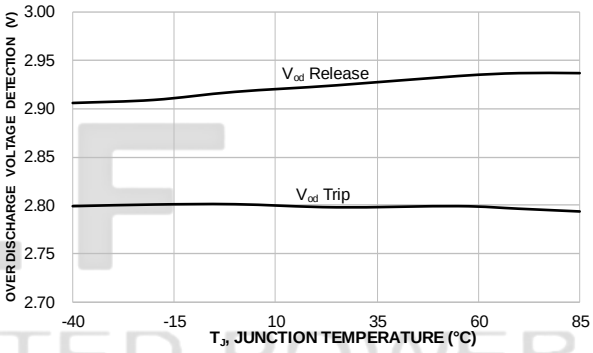

Figure 9. GLF73927B Over Discharge Voltage Detection vs. Temperature

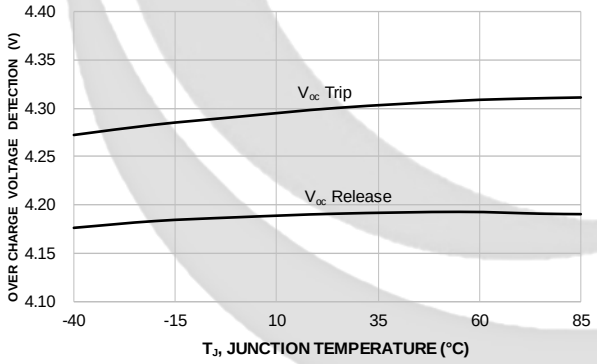

Figure 10. GLF73927C Over Charge Voltage Detection vs. Temperature

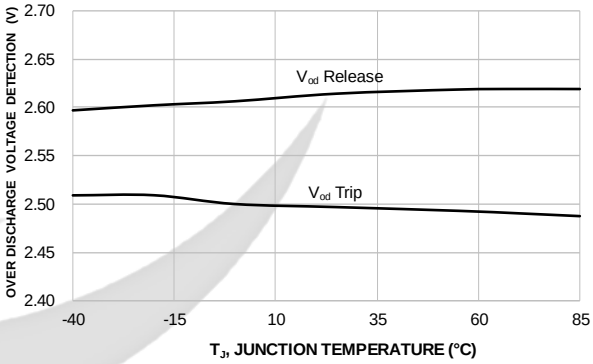

Figure 11. GLF73927C Over Discharge Voltage Detection vs. Temperature

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TYPICAL PERFORMANCE CHARACTERISTICS(CONTINUED)

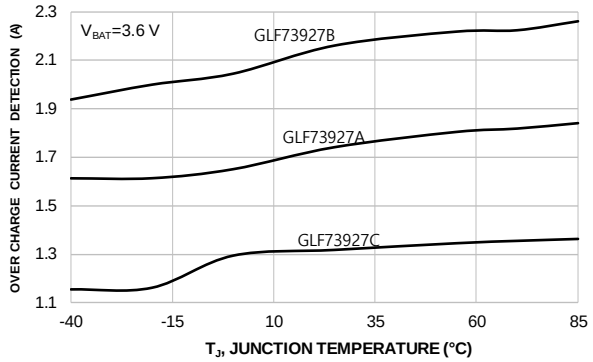

Figure 12. Over Charge Current Protection vs. Temperature

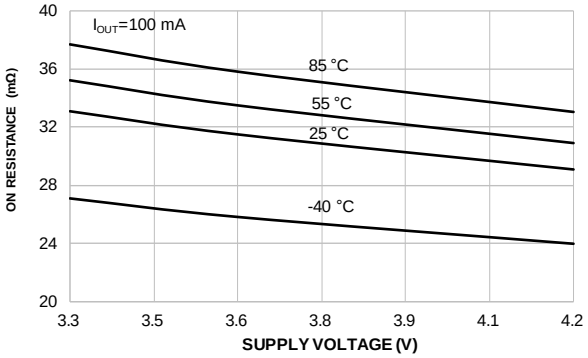

Figure 13. On-Resistance vs. Supply Voltage

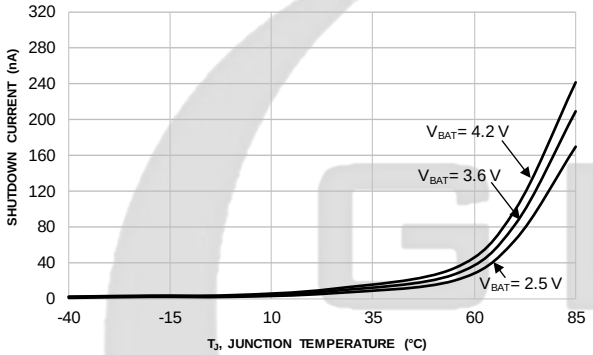

Figure 14. Shutdown Current vs. Temperature

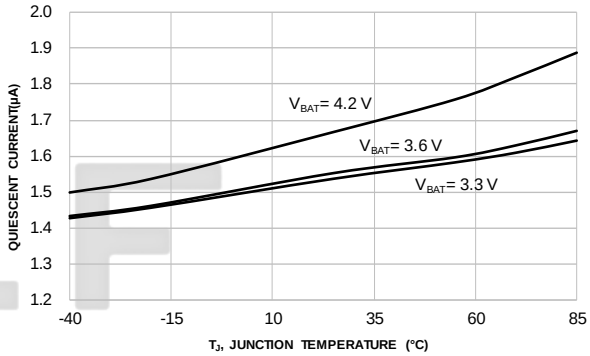

Figure 15. Quiescent Current vs. Temperature

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APPLICATION INFORMATION

Charging Activation and 0 V Battery Charging

GLF73927 activates the main charge and discharge switch by applying the turn-on voltage (V_{ON}) to the VOUT pin when the charger integrated circuit is enabled. The minimum battery voltage for charging is 0 V. During the battery's deep discharge, GLF73927 will not turn on the charge and discharge switches; however, pre-charge current can flow through the internal diode (V_F) until the battery voltage reaches (V_{OD} + V_{OD_HYS}) voltage. Once the battery voltage exceeds (V_{OD} + V_{OD_HYS}) voltage, the charge and discharge path switches will be fully activated.

Over Charging and Over Discharging Voltage Protection

When the battery voltage reaches the over-charge voltage detection level (V_{OC}), in order to prevent false triggering, the charging path will be turned off after a preset over charge detection delay time (t_{VOC}). If the battery voltage falls back below the detection level during the delay time, the charging path will not be turned off. When the battery voltage remains above V_{OC}, both the charging and discharging switches remain turned off, and the load current will flow through the internal diode, causing V_{OUT} to be about 400mV lower than V_{BAT}. When the battery voltage drops to the over-charge release voltage level (V_{OC} - V_{OC_HYS}), both the charging and discharging paths will turned on again. When the battery voltage falls to the over discharge detection voltage level (V_{OD}), the GLF73927 will immediately turned off the discharging path and enter latch off state, consuming ultra-low leakage current to protect the battery. GLF73927 will remain in the latch off state until the battery voltage reaches (V_{OD} + V_{OD_HYS}) voltage and the V_{ON} voltage is applied to the VOUT pin.

Over Charging and Short Circuit Protection

If over charge current (I_{OC}) is detected in constant current charging mode, the GLF73927 will turn off the charging path and enter latch off state after a preset detection delay time. When the charging current drops below I_{OC}, the charging path will not turn on again and can be activated by plugging out the charger and reconnecting with charging current lower than I_{OC}. When the GLF73927 detects that the load current exceeds the short circuit current detection threshold (I_{SC}), the discharge path will turn off after a preset short circuit delay time (t_{SC}) and enter latch off state. If the discharge current drops below I_{SC}, the discharge path will not turn on again until the V_{ON} voltage is connected to the VOUT pin.

Shipping Mode

The GLF73927 supports a Shipping Mode that fully disables both the charging and discharging paths to minimize current consumption and preserve the battery's pre-charged capacity during storage or shipment. Shipping Mode can be entered by applying a logic-high signal to the SM pin for a minimum of 15 ms, as specified by V_{SM} and t_{SM} in the Electrical Characteristics table. This function does not require a charger connection and can be initiated during normal operation by the system controller. While in Shipping Mode, the GLF73927 enters an ultra-low quiescent current state, effectively isolating the battery from the system. To exit Shipping Mode and re-enable the output, apply a static voltage of 3.7 V (V_{ON}) or higher voltage to the VOUT pin. Note that residual voltages below 2.3 V on VOUT will not trigger activation. To avoid unintended entry into Shipping Mode due to noise or transients on the SM pin, it is recommended to implement an RC filter at the SM input.

Input and Output Capacitors

A minimum input capacitor of 1.0 µF should be added to the VIN pin, and a minimum output capacitor of 33 µF should be added to the VOUT pin to reduce the V_{OUT} voltage drop during load transient events. If there is a load inductance, the output capacitor can improve the output voltage stability and system reliability. The output capacitor must be placed as close to the VOUT pin as possible.

Board Layout

All the external components should be placed to the GLF73927 as close as possible. All traces should be as short as possible to minimize parasitic inductance. Wide traces of VBAT, VOUT and GND can reduce parasitic effects under dynamic operations to improve thermal performance at high current loading.

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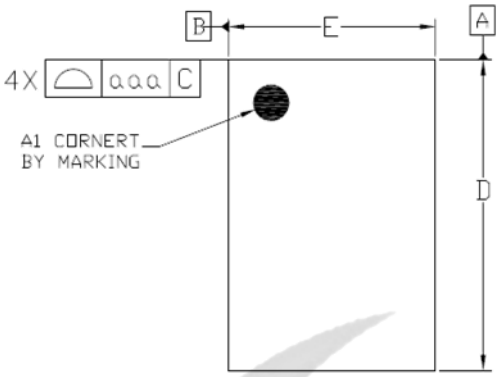
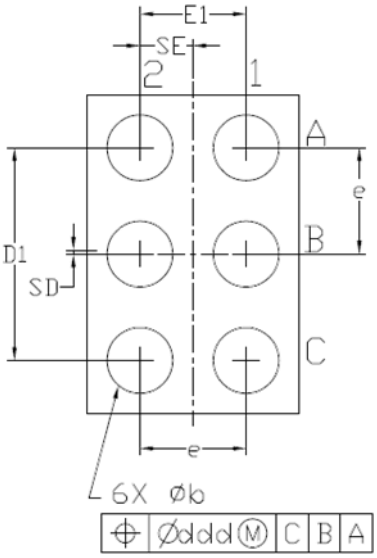
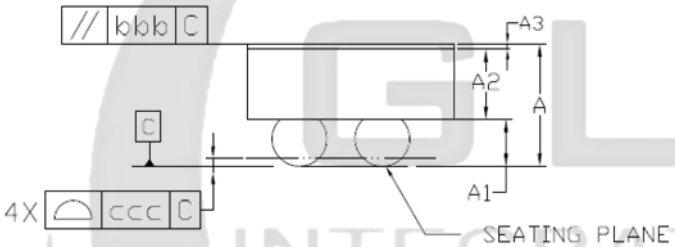
PACKAGE OUTLINE

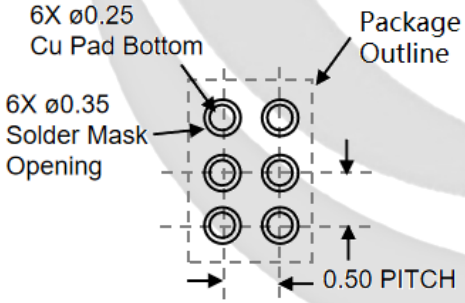






REF.	Dimensions Ref.		
	Min.	Nom.	Max.
A	0.500	0.550	0.600
A1	0.225	0.250	0.275
A2	0.250	0.275	0.300
A3	0.020	0.025	0.030
D	1.460	1.470	1.485
E	0.960	0.970	0.985
D1	0.950	1.000	1.050
E1	0.450	0.500	0.550
b	0.260	0.310	0.360
e	0.500 BSC		
SD	0.000 BSC		
SE	0.250 BSC		
Tol. of Form & Position			
aaa	0.10		
bbb	0.10		
ccc	0.05		
ddd	0.05		

Recommended Footprint



Notes

1. ALL DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES)
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.

PACKAGING INFORMATION

Part Number	Package	Pins	Pitch	Top Mark	Moisture Sensitivity Level	Environmental Information
GLF73927A-S37	0.97 mm x 1.47 mm x 0.55 mm WLCSP	6	0.5 mm	EU	MSL1	ROHS+HF
GLF73927B-S37				FU		
GLF73927C-S37				GU		

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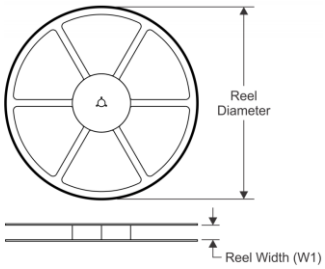
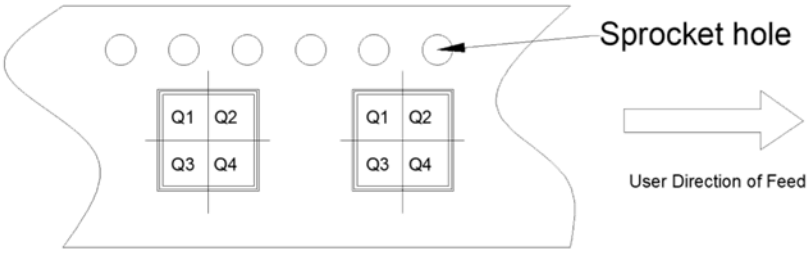
TAPE AND REEL INFORMATION

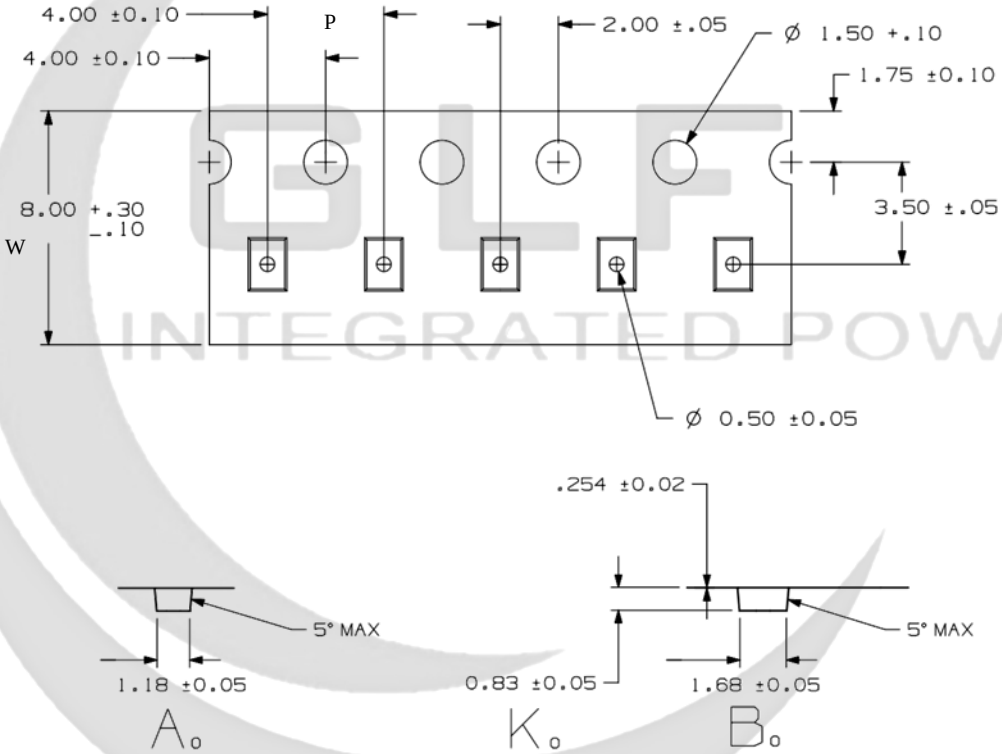
REEL DIMENSIONS



QUADRANT ASSIGNMENTS PIN 1 ORIENTATION TAPE



TAPE DIMENSIONS



Device	Package	Pins	SPQ	Reel Diameter (mm)	Reel Width W1	A0	B0	K0	P	W	Pin1
GLF73927A-S37	WLCSP	6	3000	180	9	1.18	1.68	0.83	4	8	Q1
GLF73927B-S37											
GLF73927C-S37											

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

P: 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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