GLF73612T

Ultra-Efficient, Optimized I_QSmart™ Battery Protection IC with Full Protections

Preliminary Specification

DESCRIPTION

The GLF73612T is a family of I_QSmart™ ultra-efficient ICs, with full battery protections which are accurate over charge/discharge voltage protection, over charge/discharge 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 over voltage detection level, the GLF73612T charging switches off in a preset delay time. As the battery voltage decreases lower than the over discharge detection voltage, the GLF73612T discharging switch is turned off immediately. In the off state, GLF73612T consumes an ultra-low leakage current (I_{SD}) to save the battery power. In addition, when the load current is higher than the I_{SC} short circuit protection current level, the GLF73612T 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 on the switch.

The GLF73612T 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 GLF73612T, and GLF73612T remains in the off state, the smart devices consume an ultra-low leakage current (I_{SD}). Note that the only way to active the GLF73612T is applying a charger output V_{ON} voltage to VOUT pin.

The GLF73612T also has 0 V battery charge inhibition function. When the battery voltage is lower than 0 V battery charging inhibited Voltage (V_{BCI}), the battery is not allowed to charge.

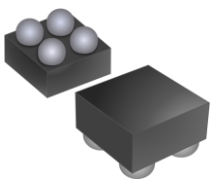
FEATURES

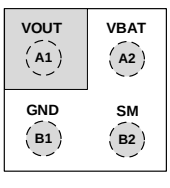
- Over Charge Detection Voltage, V_{OC}
  - GLF73612T detects VOUT to release V_{OC}
  - V_{OC} high accuracy: 4.575 V ±1 %
- Over Discharge Detection, V_{OD}: 2.9 V
  - GLF73612T detects VOUT to release V_{OD}
- Over Charge Current Detection, I_{OC} : 320 mA
- Over Discharge Current Detection, I_{OD} : 465 mA
- Short Circuit Protection
- Activated by Applying V_{ON} to the VOUT Pin from Charger
- Shipping Mode Implementation
- Low R_{ON} : 60 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} = 15 nA Typ. at V_{BAT} < V_{OD}
  - I_{SD} = 21 nA Typ. at V_{BAT} = 3.6 V, Shipping Mode
  - I_{SD} = 26 nA Typ. at V_{BAT} = 4.2 V, Shipping Mode
- Latch-off at Over Discharge Detection and Short Circuit Protection.
- 0 V Battery Charge Inhibition
- Patented Circuit Architecture

APPLICATIONS

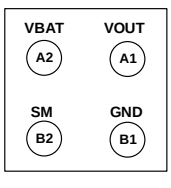
- BLE Wireless Earphone
- Hearing Aid
- Wearables and Smart IoT Devices

PACKAGE





TOP VIEW



BOTTOM VIEW

0.97 mm x 0.97 mm x 0.35 mm Thin WLCSP

Copyright © 2025 GLF Integrated Power. All Rights Reserved.

DEVICE INFORMATION

Part Number	R_{ON} (Typ.) V_{BAT}=3.6 V	Over Charge Detection V_{OC}	Over Discharge Detection V_{OD}	Over Charge Current I_{OC}	Over Discharge Current I_{OD}	Short Circuit Current I_{SC}
GLF73612T-S2G7	60 mΩ	4.575 V	2.90 V	320 mA	465 mA	1.25 A

APPLICATION DIAGRAM

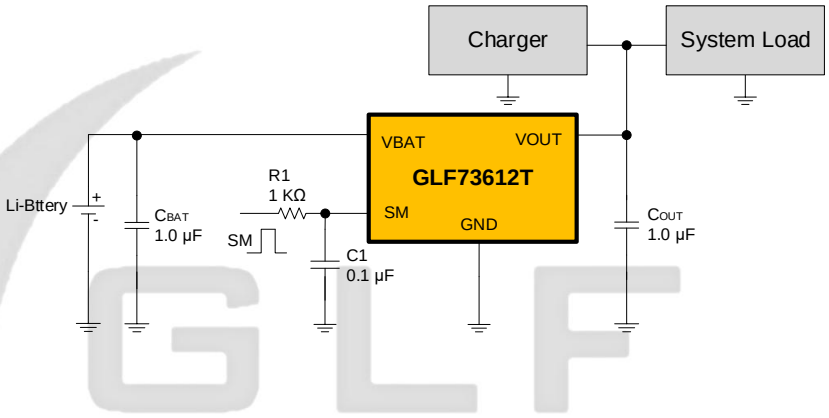


Figure 1. Application Diagram

OPERATION DIAGRAM

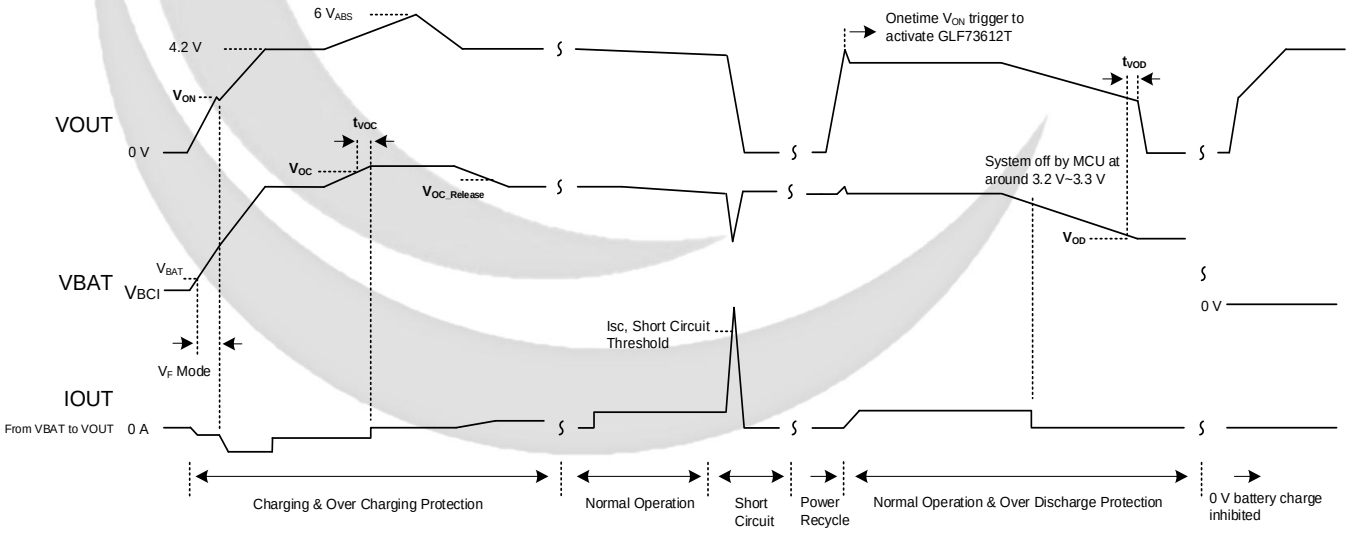


Figure 2. Operation Diagram

Copyright © 2025 GLF Integrated Power. All Rights Reserved.

FUNCTIONAL BLOCK DIAGRAM

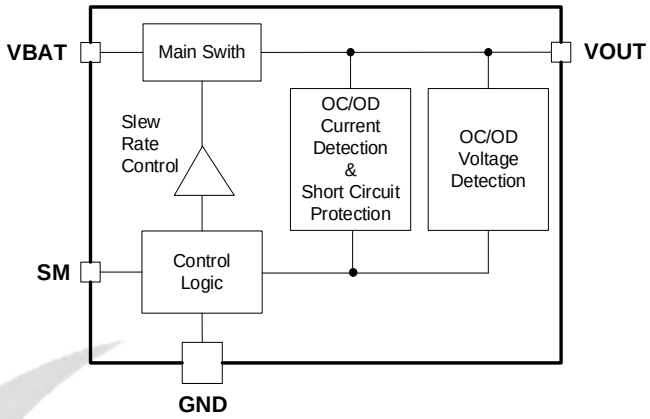


Figure 3. GLF73612T, V_{OC} and V_{OD} detect VOUT

PIN CONFIGURATION

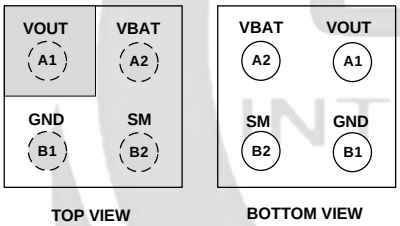


Figure 4. 0.97mm x 0.97mm x 0.35mm Thin WLCSP

PIN DEFINITION

Pin #	Name	Description
A1	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	VBAT	VBAT pin is connected to the positive terminal of a battery pack to monitor the battery voltage.
B1	GND	Ground
B2	SM	Shipping Mode Control. Active high.

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 Junction Temperature		- 65	150	°C
T_A	Operating Temperature Range		- 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	± 1		

Copyright © 2025 GLF Integrated Power. All Rights Reserved.

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 Voltage Detection	V_{BAT} increases until switch turns off		4.525	4.575	4.625	V
		T_A = 55 °C (1)			4.557		
V_{OC_HYS}	Over Charge Voltage Protection Release Hysteresis	V_{BAT} decreases and switch turns on			160		mV
t_{VOC}	Over Charge Voltage Protection Delay Time	V_{BAT} > V_{OC}, Blanking time until switch turns off		0.8	1.2	1.6	s
V_{OD}	Over Discharge Voltage Detection	V_{BAT} decreases until switch turns off		2.85	2.90	2.95	V
		T_A =55 °C (1)			2.89		
V_{OD_HYS}	Over Discharge Voltage Protection Release Hysteresis	V_{BAT} increases and switch turns on			130		mV
t_{VOD}	Over Discharge Voltage Protection Delay Time	V_{BAT} < V_{OD}, Blanking time until switch turns off		430	660	790	ms
V_{ON}	ON Voltage applied to VOUT to turn on switch	V_{OUT} to turn on switch, V_{BAT} ≥ 3.1 V			3.6		V
		T_A = 55 °C			3.6		
I_{OC}	Over Charge Current Detection			260	320	400	mA
t_{IOC}	Over Charge Current Detection Delay Time			6.5	9.5	12.5	ms
I_{OD}	Over Discharge Current Detection			400	465	500	mA
t_{IOD}	Over Discharge Current Detection Delay Time			6.5	9.5	12.5	ms
I_{SC}	Short Circuit Current Detection Threshold			1.0	1.25	1.5	A
t_{SC}	Short Circuit Delay Time	I_{SC}, Short Circuit Current ≥ 1.3 A		50	120	200	µs
V_{BCI}	0 V Battery Charge Inhibition Voltage	0 V Battery Charge Inhibited		1.2	1.32	1.5	V
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	
I_{SD}	Shutdown Current from VBAT When Main Switch is Off	V_{BAT} = 4.2 V, V_{OUT} = 0 V, Shipping Mode			26	100	nA
		V_{BAT} = 3.6 V, V_{OUT} = 0 V, Shipping Mode			21	80	
		V_{BAT} = 2.5 V, V_{OUT} = 0 V	T_A = 25 °C		15	70	
			T_A = 55 °C (1)		50		
R_{ON}	On-Resistance	V_{BAT} = 4.2 V, I_{OUT}= 70 mA	T_A = 25 °C		56	62	mΩ
			T_A = 55 °C (1)		60		
		V_{BAT} = 3.6 V, I_{OUT}= 70 mA	T_A = 25 °C		60	66	
			T_A = 55 °C (1)		65		
t_{OFF} (1)	Turn-Off Time	C_{OUT} = 1.0 µF, R_{OUT}= 150 Ω, V_{OUT} = V_{OD} to 0 V			300		µs
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		25			ms
td_{SM}	Shipping Mode Delay	V_{BAT} = 3.3 V to 4.2 V		0.8	1.2	1.6	s
R_{SM}	SM Pull Down Resistance	Internal Resistance			400		kΩ

Notes: 1. By design; characterized, not production tested.
2. All values of delay timing were characterized but not tested in production.

Copyright © 2025 GLF Integrated Power. All Rights Reserved.

TYPICAL PERFORMANCE CHARACTERISTICS

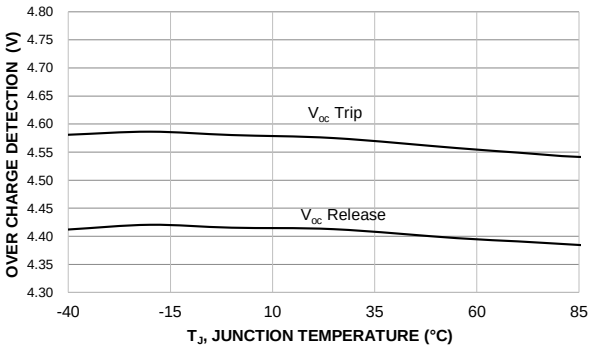


Figure 5. Over Charge Voltage Detection vs. Temperature

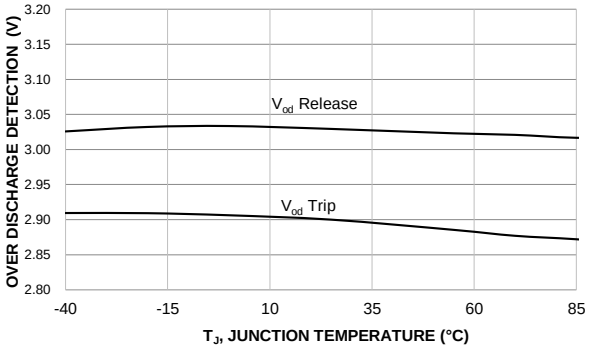


Figure 6. Over Discharge Voltage Detection vs. Temperature

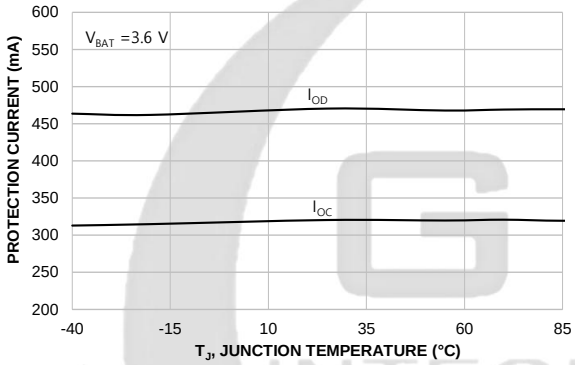


Figure 7. I_{OD} & I_{OC} Current Protection vs. Temperature

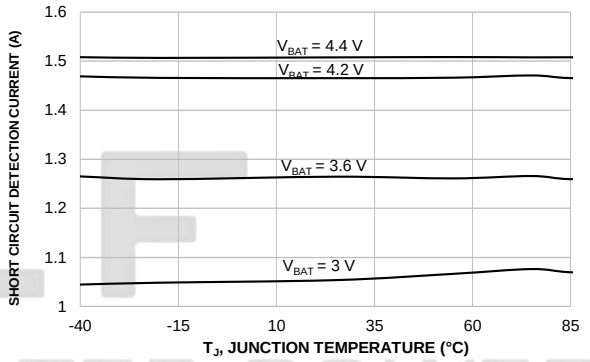


Figure 8. Short Circuit Detection Current vs. Temperature

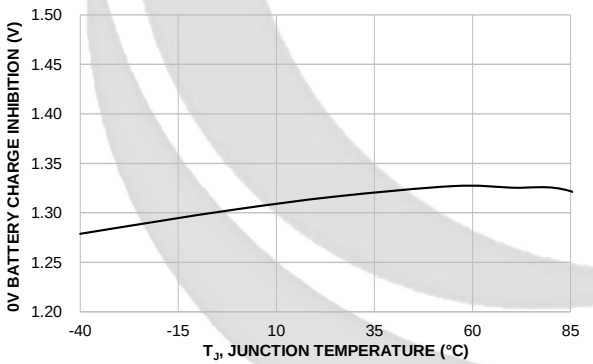


Figure 9. 0 V Battery Charge Inhibition vs. Temperature

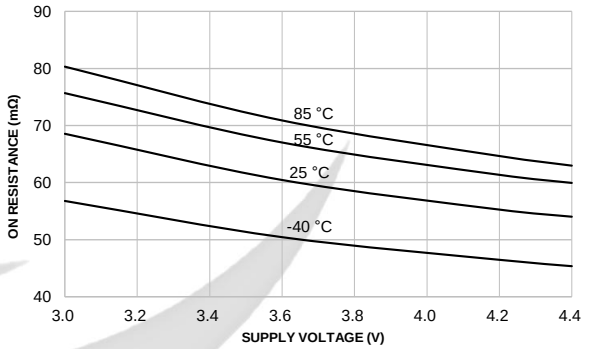


Figure 10. On-Resistance vs. Supply Voltage

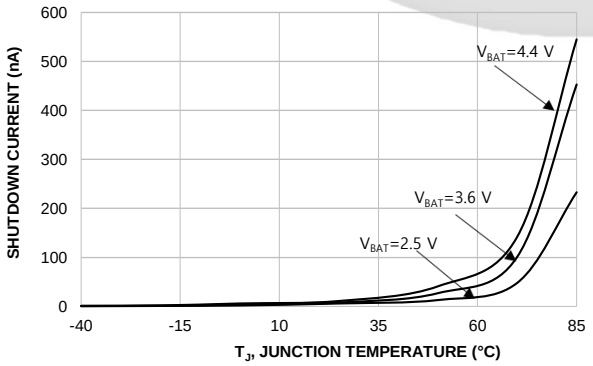


Figure 11. Shutdown Current vs. Temperature

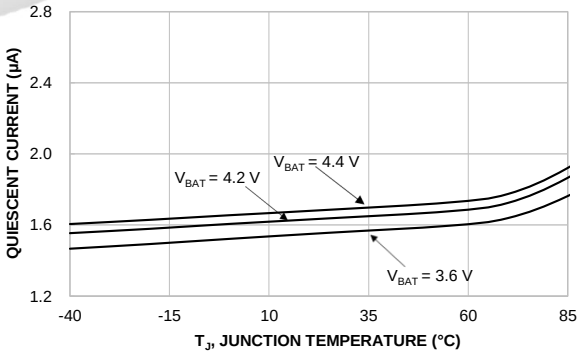


Figure 12. Quiescent Current vs. Temperature

Copyright © 2025 GLF Integrated Power. All Rights Reserved.

APPLICATION INFORMATION

Charging Activation and 0 V Battery Charging Inhibition

The GLF73612T is activated to turn on the main charging switch only by applying the on voltage (V_{ON}) to the VOUT pin when a charger IC is enabled. With a deeply discharged battery, the GLF73612T does not turn on both the charge and discharge path and the pre-charge current flows through an internal diode until the battery is charged up to the over discharge voltage detection level (V_{OD}). The GLF73612T provides a hiccup charging mode when the charge mode changes from the pre-charge to the constant current charge mode. The main switch of the GLF73612T turns on and off in 660 ms period and pulse current charges the battery until the charge mode is completely transferred to the constant current mode. As the battery voltage increases beyond the over discharge detection voltage, the main switch will be fully activated to reduce the voltage drop and save power dissipation during both constant-current and constant-voltage charge modes. When a battery is fully discharged lower than the 0 V battery charge inhibition voltage (V_{BCI}), the GLF73612T turns off the charge path to prevent it from being charged for safety.

Over Charging and Over Discharging Voltage Protection

When the voltage of a battery is higher than the over-charge voltage detection level (V_{OC}), the charge path is turned off to stop charging the battery. In order to avoid a false trigger, the GLF73612T turns off after a preset over charge detection delay time (t_{OC}). If the t_{OC} is longer than the period that battery voltage keeping higher than V_{OC}, the charging path is not turned off. For the GLF73612T, the charging path turns on back when the VOUT voltage decreases lower than the over charge release voltage level (V_{OC} - V_{OC_HYS}). When the voltage of a battery is lower than the over discharge detection voltage, the GLF73612T discharging path is turned off. In the off state, the GLF73612T consumes an ultra-low leakage current to save the battery power. The GLF73612T remains in the off state until a higher voltage applied to the VOUT pin.

Over Charging and Discharging Current, Short Circuit Protection

If an over-charging current is detected at the constant current charging mode, the GLF73612T will shut off the charging path after a preset detection delay time. When the over discharging current happens for the detection delay time (t_{IOD}), the discharge path turns off. If GLF73612T detects the discharge current over a short-circuit current detection threshold (I_{SC}), the discharge path 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. When the discharge current exceeds the maximum value of I_{OD} (500 mA) but is less than the minimum value of I_{SC} (1.0 A), the device will not trigger short circuit protection. When the discharge current is higher than 1.0 A, the device may trigger short circuit protection, otherwise, it will trigger over discharging current protection. After the over discharging current or short circuit protection event, the GLF73612T maintains the off state and need to enable the device again by applying the V_{ON} to VOUT pin.

Shipping Mode

The GLF73612T provides a shipping mode. When a single pulse higher than 1.2 V and longer than 25 ms is connected to the SM pin, the device will enter shipping mode after 1.2 s delay time. In shipping mode, the device will only consume ultra-low current to maintain battery capacity. When a charger is connected, GLF73612T can be reactivated by applying V_{ON} to the VOUT pin. An RC filter circuit can be added in front of SM to prevent interference when shipping mode is not enabled (See Figure 1).

Input and Output Capacitors

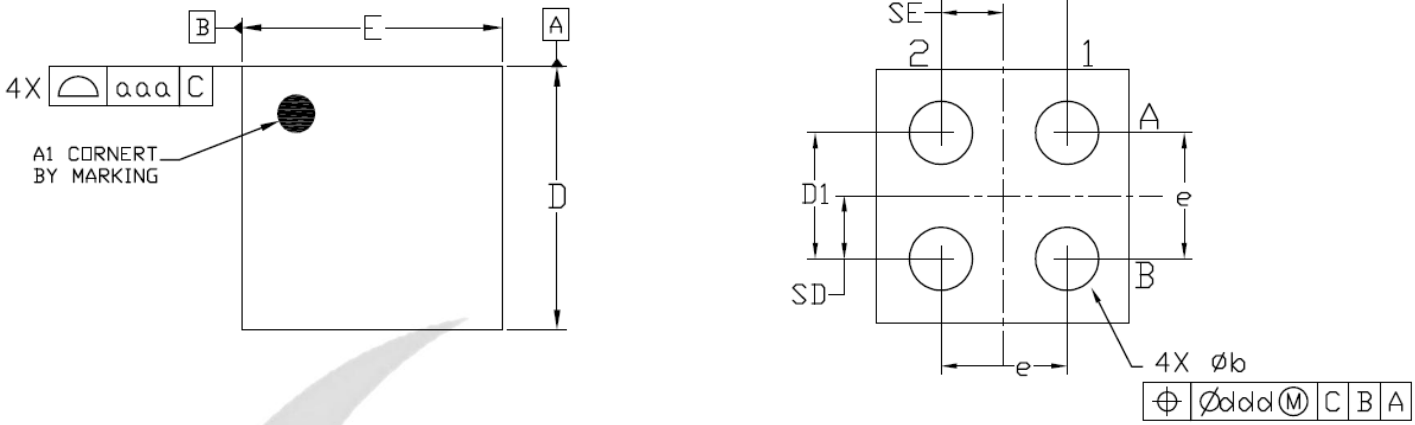
A minimum 1.0 µF input capacitor is recommended to place close to the VBAT and VOUT pins to reduce the voltage drop on the input power rail, which caused by transient inrush current at start-up. A higher input capacitance value is to attenuate the input voltage drop. Also, a minimum 1.0 µF output capacitor is recommended to minimize voltage undershoot happened at the output pin when the switch is turned off. Undershoot can be caused by parasitic inductance from board traces or intentional load inductances. If load inductances exist, an output capacitor can improve the output voltage stability and system reliability. The C_{OUT} capacitor must be placed to the VBAT and VOUT pins as close as possible.

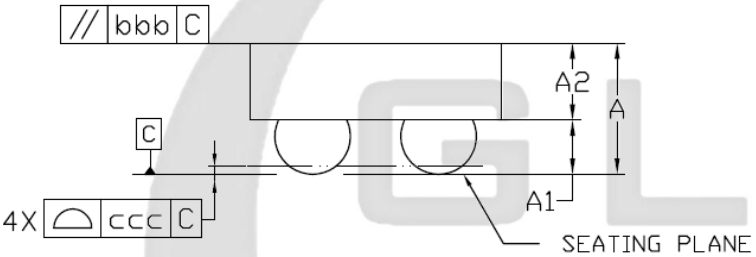
Board Layout

All the external components should be placed to the GLF73612T 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.

Copyright © 2025 GLF Integrated Power. All Rights Reserved.

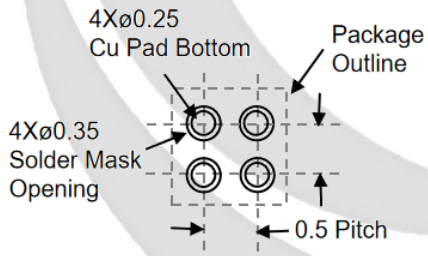
PACKAGE OUTLINE





Dimensional Ref.			
REF.	Min.	Nom.	Max.
A	0.300	0.350	0.400
A1	0.075	0.100	0.125
A2	0.225	0.250	0.275
D	0.955	0.970	0.985
E	0.955	0.970	0.985
D1	0.450	0.500	0.550
E1	0.450	0.500	0.550
b	0.200	0.250	0.300
e	0.500 BSC		
SD	0.250 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.

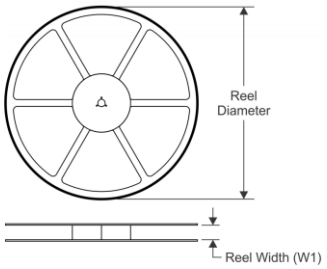
PACKAGING INFORMATION

Part Number	Package	Pins	Pitch	Top Mark	Moisture Sensitivity Level	Environmental Information
GLF73612T-S2G7	0.97 mm x 0.97 mm x 0.35 mm Thin WLCSP	4	0.5 mm	DU	MSL1	ROHS+HF

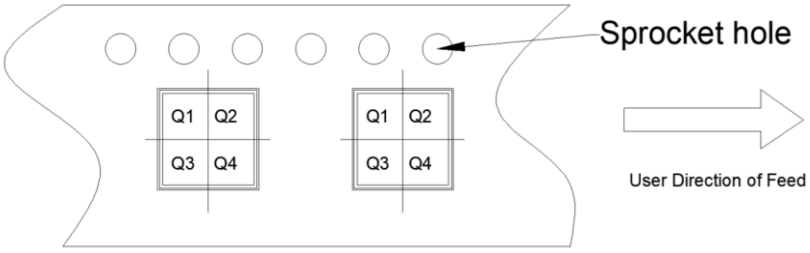
Copyright © 2025 GLF Integrated Power. All Rights Reserved.

TAPE AND REEL INFORMATION

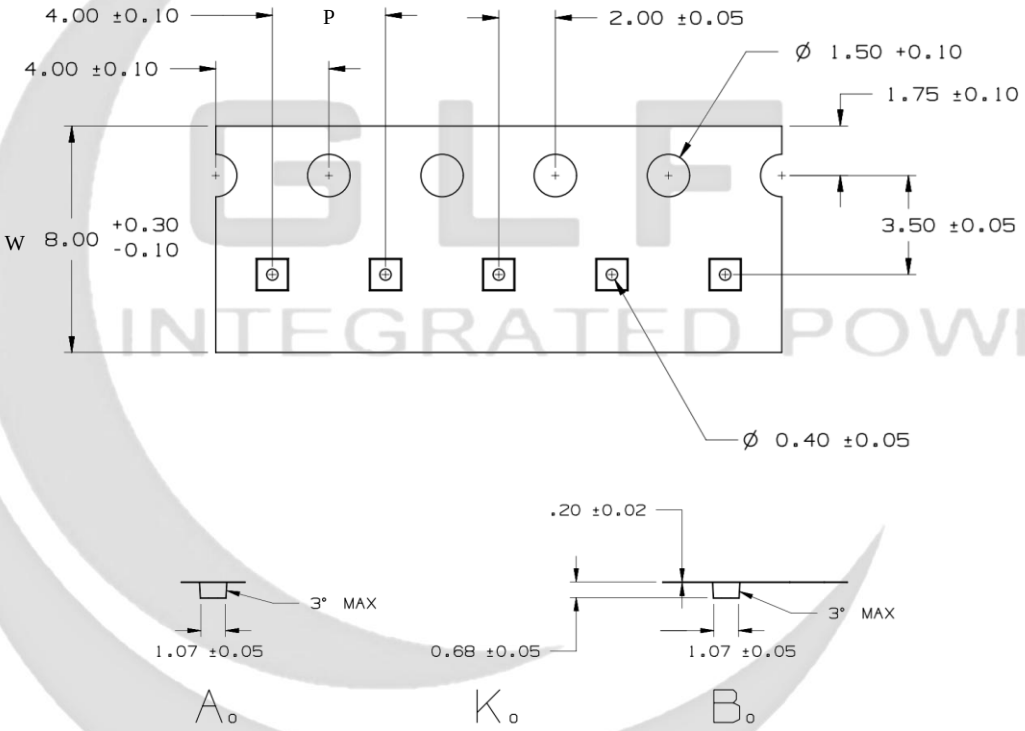
REEL DIMENSIONS



QUADRANT ASSIGNMENTS PIN 1 ORIENTATION TAPE



TAPE DIMENSIONS



Device	Package	Pins	SPQ	Reel Diameter (mm)	Reel Width W1	A0	B0	K0	P	W	Pin1
GLF73612T-S2G7	WLCSP	4	3000	180	9	1.07	1.07	0.68	4	8	Q1

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

Copyright © 2025 GLF Integrated Power. All Rights Reserved.

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

DISCLAIMERS

Information in this document is believed to be accurate and reliable, however GLF assumes no liability for errors or omissions. Device performance may be impacted by testing methods and application use cases. Users are responsible to independently evaluate the applicability, usability, and suitability of GLF devices in their application. In no case will GLF be liable for incidental, indirect, or consequential damages associated with the use, mis-use, or sale of its product. Customers are wholly responsible to assure GLF devices meet their system level and end product requirements. GLF retains the right to change the information provided in this data sheet without notice.

Copyright © 2025 GLF Integrated Power. All Rights Reserved.