GLF73614

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

Product Specification

DESCRIPTION

The GLF73614 is a family of I_QSmart™ ultra-efficient, full battery protection ICs with an accurate over charge/discharge voltage, shipping mode, over charge/discharge current, and short circuit protection for lithium-Ion/Polymer battery safety.

The overcharge and discharge voltage protections keep a rechargeable battery working within the desired safe operating condition. When the battery is charged past the over voltage detection level, the GLF73614 charging switch opens in a preset delay time. As the battery voltage decreases below the over discharge detection voltage level, the GLF73614 discharging switch is turned off immediately to cut off the battery power rail, consuming an ultra-low leakage current (I_{SD}) to save the battery. In addition, when the load current reaches the I_{SC} short circuit protection level, the GLF73614 is turned off and will maintain the off state to avoid any serious damage to system. The short circuit delay time avoids any false trigger which might open the switch.

The GLF73614 provides a shipping mode pin to prevent smart devices with a non-removable battery from discharging during the shipping period. When a charged battery cell is connected the GLF73614 remains in the off state and consumes an ultra-low leakage current (I_{SD}) until the V_{ON} voltage is applied to VOUT pin. Note that the GLF73614 is activated only by a V_{ON} voltage from a charger output.

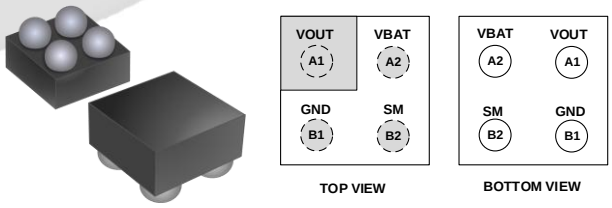
FEATURES

- Over Charge Detection Voltage, V_{OC}
  - Monitor VOUT to release V_{OC}
  - V_{OC} high accuracy: ± 75 mV (± 1.75 %)
- V_{OD}, Over Discharge Detection: 2.80 V_{OUT}
- I_{OC}, Over Charge Current Detection: 330 mA
- I_{OD}, Over Discharge Current Detection: 76 mA
- Short Circuit Protection
- Activated by Applying V_{ON} to the VOUT Pin
- Shipping Mode Implementation
- Low R_{ON}: 62 mΩ Typ. at 3.6 V_{BAT}
- I_Q = 1.48 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 Discharge Detection and Short Circuit Protection. Apply V_{ON} to VOUT pin to turn on
- 0 V Battery Minimum Voltage for Charging
- Patent Pending Circuit Architecture
- HBM: 8 kV, CDM: 2 kV
- 0.97 mm x 0.97 mm x 0.55 mm Chip Scale Package 4 Bumps, 0.5 mm Pitch

APPLICATIONS

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

PACKAGE



0.97 mm x 0.97 mm x 0.55 mm WLCSP

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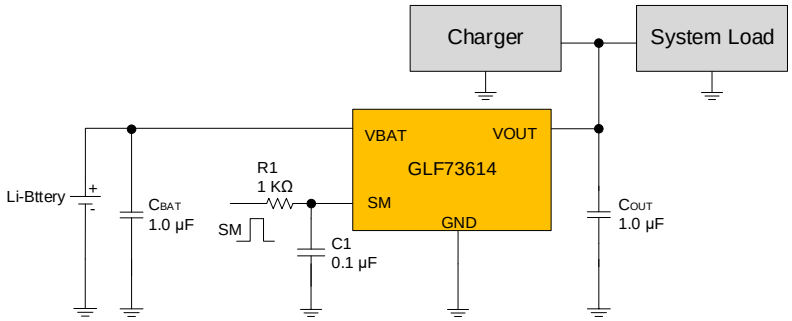
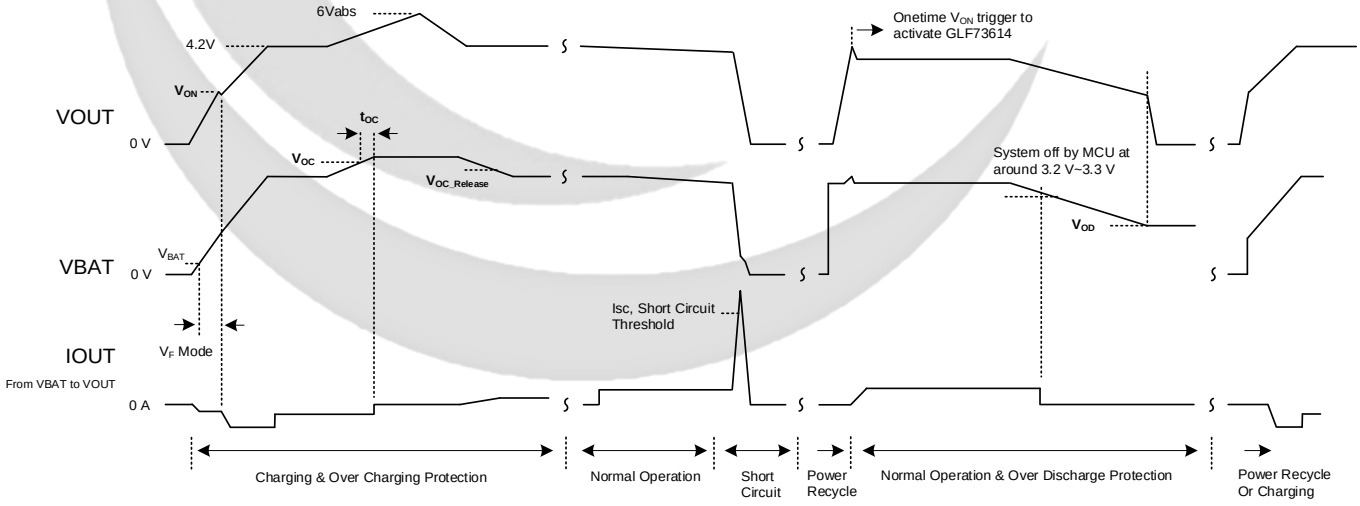
APPLICATION DIAGRAM



DEVICE INFORMATION

Part Number	Top Mark	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}
GLF73614-DE23C	FX	62 mΩ	4.275 V	2.80 V	330 mA	76 mA	250 mA
GLF73614-CE23C	EX		4.450 V				

OPERATION DIAGRAM



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FUNCTIONAL BLOCK DIAGRAM

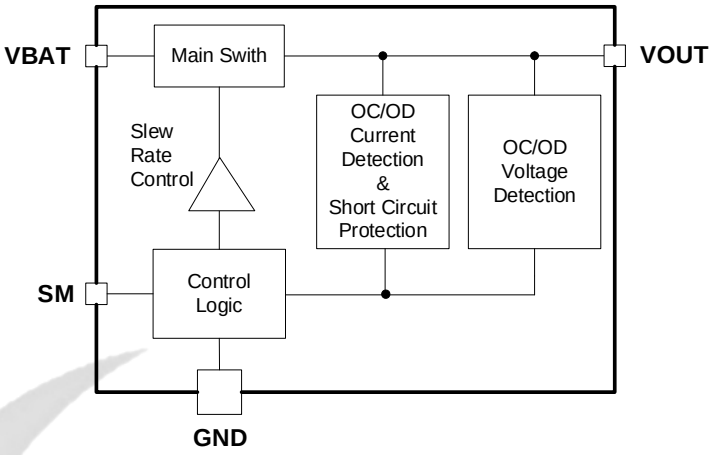

Figure 1. Functional Block Diagram

PIN CONFIGURATION

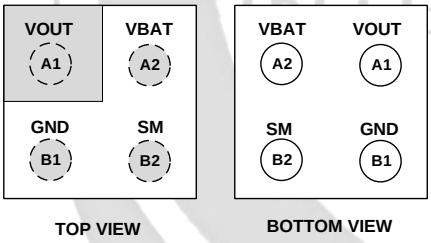

Figure 2. 0.97mm x 0.97mm x 0.55mm WLCSP

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 the appropriate voltage (V_{ON}) to V_{OUT} turns the switch back on.
A2	VBAT	VBAT pin is connected to the positive terminal of a battery pack to monitor the battery voltage. When the V_{BAT} voltage reaches the V_{OD}, the main switch is turned off and maintains the off state to save the battery from discharging.
B1	GND	Ground
B2	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 stress 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}, 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			85	°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 Voltage Detection	GLF73614-DE23C	V_{BAT} increases until switch turns off	4.200	4.275	4.350	V
			T_A = 55 °C (1)		4.268		
		GLF73614-CE23C	V_{BAT} increases until switch turns off	4.375	4.450	4.525	
			T_A = 55 °C (1)		4.444		
V_{OC_HYS}	Over Charge Voltage Protection Release Hysteresis	V_{BAT} decreases and switch turns on			150		mV
t_{VOC}	Over Charge Voltage Protection Delay Time	V_{BAT} > V_{OC}, Blanking time until switch turns off			560		ms
V_{OD}	Over Discharge Voltage Detection	V_{BAT} decreases until switch turns off		2.72	2.80	2.95	V
		T_A = 55 °C (1)			2.79		
V_{OD_HYS}	Over Discharge Voltage Protection Release Hysteresis	V_{BAT} increases and switch turns on			150		mV
t_{VOD}	Over Discharge Voltage Protection Delay Time	V_{BAT} < V_{OD}, Blanking time until switch turns off			40		ms
V_{ON} (1)	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	330	400	mA
t_{IOC}	Over Charge Current Detection Delay Time				40		ms
I_{OD}	Over Discharge Current Detection			30	76	120	mA
t_{IOD}	Over Discharge Current Detection Delay Time				20		ms
I_{SC}	Short Circuit Current Detection				250		mA
t_{SC}	Short Circuit Delay Time				400		µs
I_Q	Quiescent Current with Switch On	V_{BAT} = 3.6 V, I_{OUT}= 0 mA, Switch = ON			1.48		µA
		V_{BAT} = 4.2 V, I_{OUT} = 0 mA, Switch = ON			1.55	2.2	
		V_{BAT} = 4.2 V, I_{OUT} = 0 mA, Switch = ON T_A = 55°C (1)			1.66		

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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			10	90	nA
		V_{BAT} = 3.6 V, V_{OUT} = 0 V, Shipping Mode			8		
		V_{BAT} = 2.5 V, V_{OUT} = 0 V			6		
		V_{BAT} = 2.5 V, V_{OUT} = 0 V, T_A =55 °C (1)			8		
R_{ON}	On-Resistance	V_{BAT} = 4.2 V, I_{OUT} = 40 mA	T_A = 25 °C		58	68	mΩ
			T_A = 55 °C (1)		62		
		V_{BAT} = 3.6 V, I_{OUT} = 40 mA	T_A = 25 °C		62	72	
			T_A = 55 °C (1)		66		
		V_{BAT} = 3.3 V, I_{OUT} = 40 mA	T_A = 25 °C		67		
t_{OFF} (1)	Turn-Off Time	C_{OUT} = 1.0 µF, R_{OUT} = 150 Ω, V_{OUT} = V_{OD} to 0 V			340		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			20		ms
td_{SM}	Shipping Mode Delay	V_{BAT} = 3.3 V to 4.2 V		570	610	650	ms
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.

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TYPICAL PERFORMANCE CHARACTERISTICS

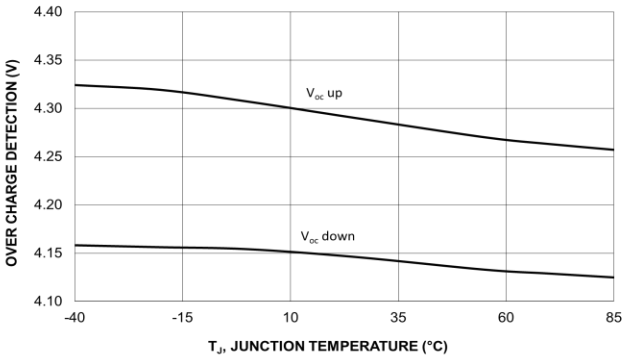

Figure 3. Over Charge Voltage Detection vs. Temperature, GLF73614-DE23C

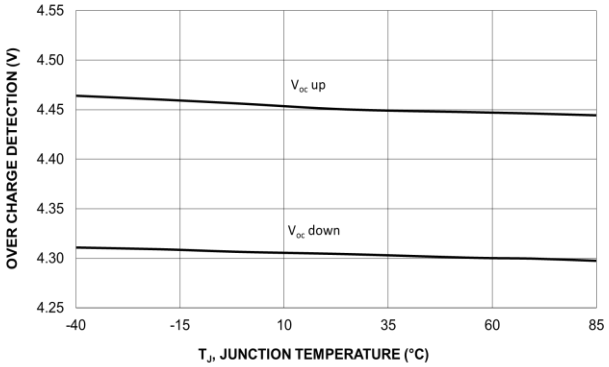

Figure 4. Over Charge Voltage Detection vs. Temperature, GLF73614-CE23C

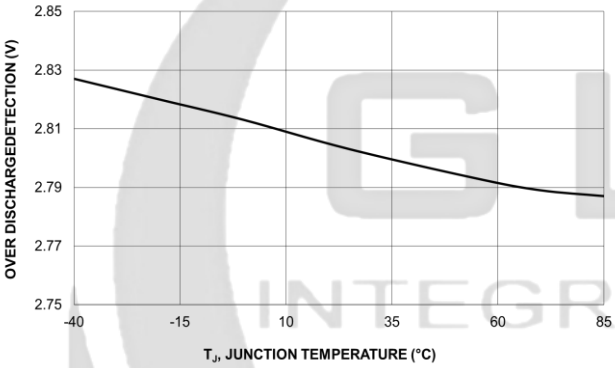

Figure 5. Over Discharge Voltage Detection vs. Temperature

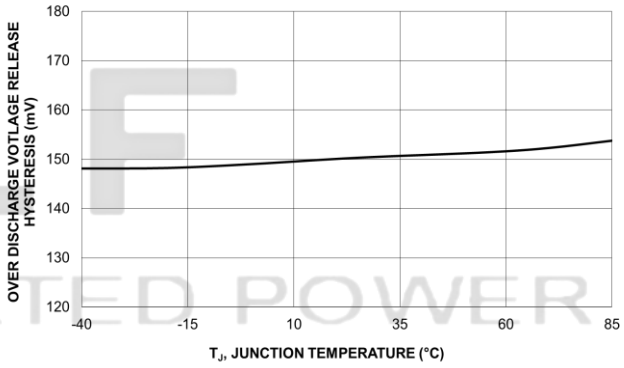

Figure 6. Over Discharge Voltage Detection Release Hysteresis vs. Temperature

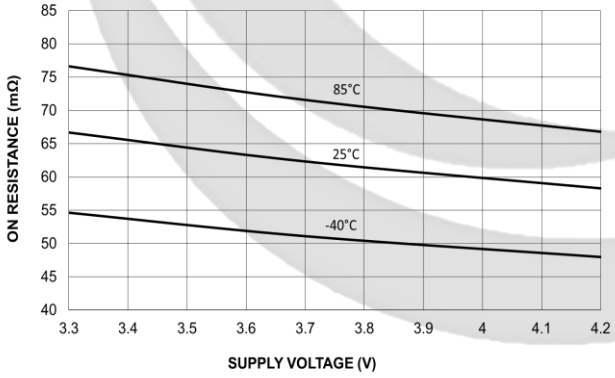

Figure 7. On-Resistance vs. Supply Voltage

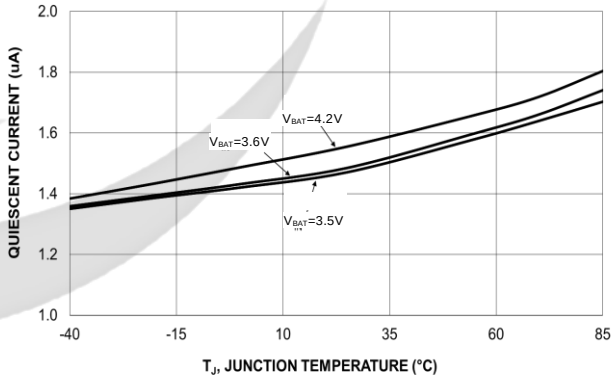

Figure 8. Quiescent Current vs. Temperature

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TYPICAL PERFORMANCE CHARACTERISTICS (CONTINUED)

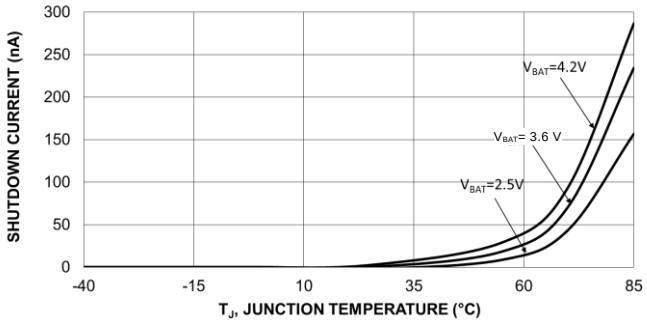

Figure 9. Shutdown Current vs. Temperature

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APPLICATION INFORMATION

GLF73614 is an I_QSmart™ ultra-efficient battery protection IC with the accurate over charge voltage, shipping mode, overcharge current, and short circuit protection for lithium-Ion/ Polymer battery safety. The best-in-class efficiency makes it ideal for the design of hearing devices, wearable devices, and tiny IoT devices.

Charging Activation and 0 V Battery Charging

The GLF73614 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. The minimum battery voltage to charge is 0 V. With a deeply discharged battery, the GLF73614 does not turn on both the charge and discharge path and the pre-charge current flows through an internal diode until the battery voltage reaches the over discharge voltage detection level (V_{OD}). The GLF73614 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 GLF73614 turns on and off in 60 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 voltage detection, the charge and discharge path switches will be fully activated to reduce the voltage drop and save power dissipation during both constant-current and constant-voltage charging modes.

Over Charging and Discharging Voltage Protection

When the voltage of a battery increases to the over-charge voltage detection level (V_{OC}), the charge path is turned off to stop charging the battery after a preset over-charge detection delay time (t_{OC}) to avoid a false trigger. The charging path is turned on again when the VOUT voltage falls by 150 mV. The charging path is not turned off if the battery voltage returns to a voltage less than the detection level within the delay time. The charging path turns on again as the battery voltage decreases below the over-charge release voltage level ($V_{OC} – V_{OC_HYS}$). When the voltage of a battery decreases to the over-discharge detection voltage level, the GLF73614 discharging path is turned off consuming an ultra-low leakage current to save the battery. The GLF73614 remains in the off state until a higher voltage is applied to the VOUT pin.

Over Charging and Discharging Current, Short Circuit Protection

If an over-charging current is detected during the constant current charging mode, the GLF73614 will shut off the charging path in a preset detection delay time. When the over-discharging current condition occurs for the detection delay(t_{IOD}), the discharge path turns off. During the operation, if the discharge current from the battery exceeds the short circuit detection level (I_{SC}), the discharging path will be turned off after a preset delay time (t_{SC}) to avoid a false detection. After the short circuit protection event, the GLF73614 maintains in the off state and needs a power recycle of a system to apply V_{ON} to VOUT pin to be reactivated.

Shipping Mode

The GLF73614 provides system designers with the SM pin to turn off safely both discharging and charging path to prevent a pre-charged battery capacity from discharging at all. During shipping mode when the GLF73614 is completely off, it consumes an ultra-low current to maintain the battery capacity. The GLF73614 is activated again by applying V_{ON} to the VOUT pin when a charger is applied. An RC filter circuit can be added in front of SM to prevent interference when the shipping mode is not enabled.

Input and Output Capacitors

Input and output capacitors are not required for GLF73614 operation. However, a 1.0μF capacitor is recommended to be placed close to the VBAT and VOUT pins to mitigate any unexpected electrical noise or the transient voltage peak caused by a hot-plugging voltage source.

Board Layout

All traces should be as short as possible to minimize parasitic inductance effects. Wide traces for VBAT, VOUT, 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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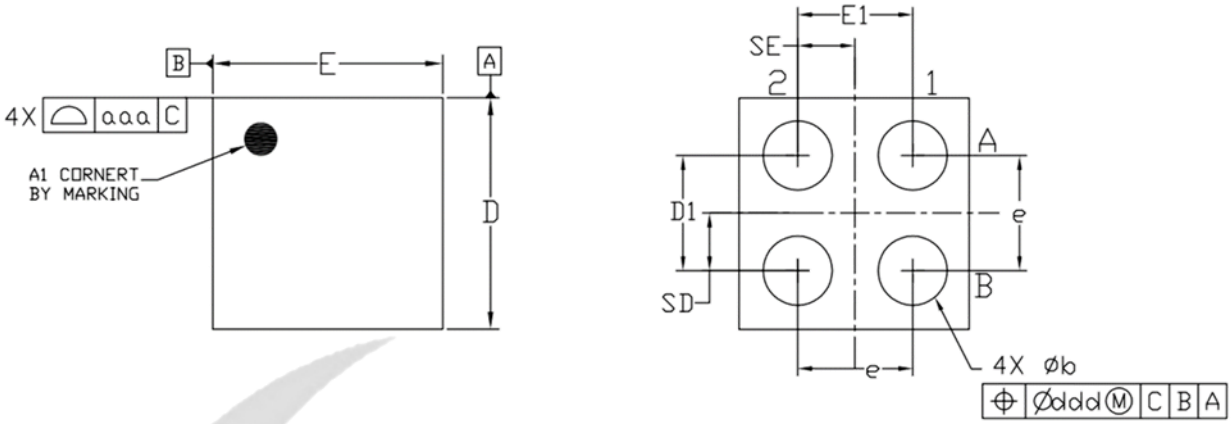
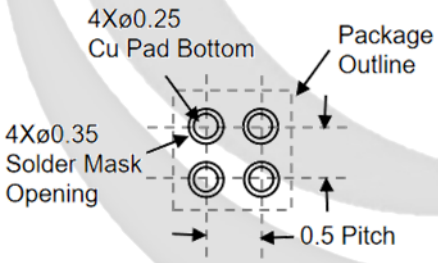
PACKAGE OUTLINE



Dimensional Ref.			
REF.	Min.	Nom.	Max.
A	0.500	0.550	0.600
A1	0.225	0.250	0.275
A2	0.255	0.275	0.300
A3	0.020	0.025	0.030
D	0.960	0.970	0.985
E	0.960	0.970	0.985
D1	0.450	0.500	0.550
E1	0.450	0.500	0.550
b	0.260	0.310	0.360
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.
3. A3: BACKSIDE LAMINATION

PACKAGING INFORMATION

Part Number	Package	Pins	Pitch	Top Mark	Moisture Sensitivity Level	Environmental Information
GLF73614-DE23C	0.97 mm x 0.97 mm x 0.55 mm WLCSP	4	0.5mm	FX	MSL1	ROHS+HF
GLF73614-CE23C				EX		

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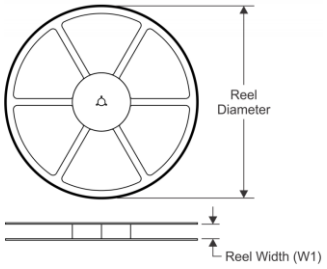
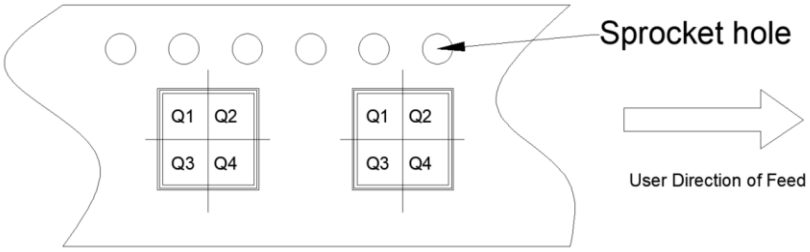
TAPE AND REEL INFORMATION

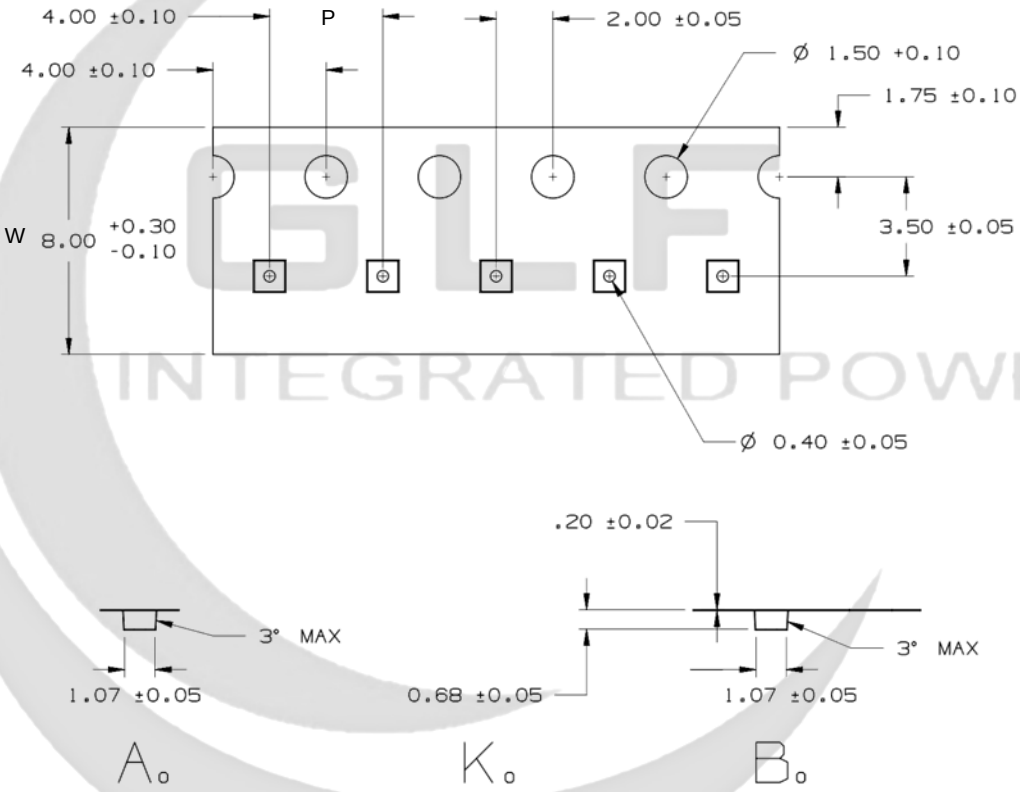
REEL DIMENSIONS



QUADRANT ASSIGNMENTS PIN 1 ORIENTATION TAPE



TAPE DIMENSIONS



Device	Package	Pins	SPQ	Reel Diameter (mm)	Reel Width W1	A0	B0	K0	P	W	Pin1
GLF73614	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

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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. Spec limits including typical, minimum, and maximum values are desired, or target, limits. GLF reserves the right to change limits at any time without warning or notification. A target specification in no way guarantees future production of the device in question.	Design / Development
Preliminary Specification	This is a draft version of a product specification. The specification is still 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 in no way guarantees future production of the device in question.	Qualification
Product Specification	This document represents the anticipated production performance characteristics of the device.	Production

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