

## DESCRIPTION

The GLF7210x product family is an advanced technology fully integrated I<sub>Q</sub>Smart™ load switch device with reverse current blocking (RCB) protection and slew rate control of the output voltage.

The GLF7210x product family offers industry leading reverse current blocking (RCB) protection performance, featuring an ultra-low threshold voltage. The GLF7210x product family minimizes reverse current flow in the event that the V<sub>OUT</sub> voltage exceeds the V<sub>IN</sub> voltage.

The GLF7210x product family has an industry leading power efficiency. The GLF7210x product family features an on-resistance (R<sub>ON</sub>) as low as 37 mΩ typical at 5.5 V, reducing power loss during conduction. The GLF7210x product family also features ultra-low shutdown current (I<sub>SD</sub>) to reduce power loss and battery drain in the off state. When EN is pulled low, and the output is grounded, the GLF7210x product family can achieve an I<sub>SD</sub> as low as 20 nA typical at 5.5 V.

The GLF7210x product family of load switch device supports an industry leading wide input voltage range that helps to improve system operating life and overall performance. One GLF7210x device can be used in multiple voltage rail applications which helps mitigate inventory management and reduces BOM cost.

The GLF7210x product family utilizes a chip scale package with 4 bumps in a 0.77 mm x 0.77 mm x 0.46 mm die size and a 0.4 mm pitch.

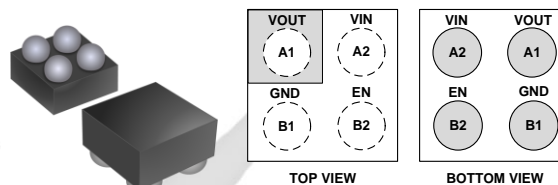
## FEATURES

- Wide Input Range: 1.5 V to 5.5 V  
6 V<sub>abs</sub> max
- Ultra-Low I<sub>Q</sub>: 0.45 μA Typ at 5.5 V<sub>IN</sub>
- Ultra-Low I<sub>SD</sub>: 20 nA Typ at 5.5 V<sub>IN</sub>
- Low R<sub>ON</sub>: 37 mΩ Typ at 5.5 V<sub>IN</sub>
- I<sub>OUT</sub> Max: 2 A
- Reverse Current Blocking Protection
- Controlled V<sub>OUT</sub> Rise Time
- Internal EN Pull-up/down Resistor on EN Pin
- Integrated Output Discharge Switch:  
GLF72101, GLF72103, GLF72105

## APPLICATIONS

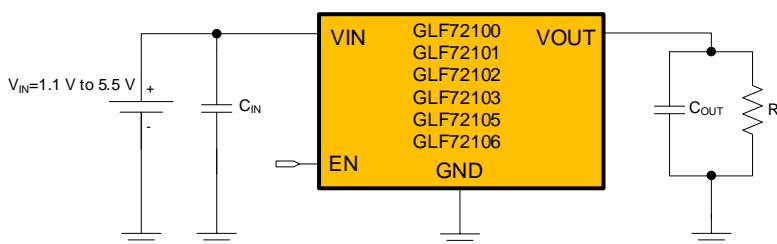
- Portable Devices
- Wearable Devices
- Low Power Subsystems
- Smart IoT Devices

## PACKAGE



0.77 mm x 0.77 mm x 0.46 mm WLCSP

## APPLICATION DIAGRAM

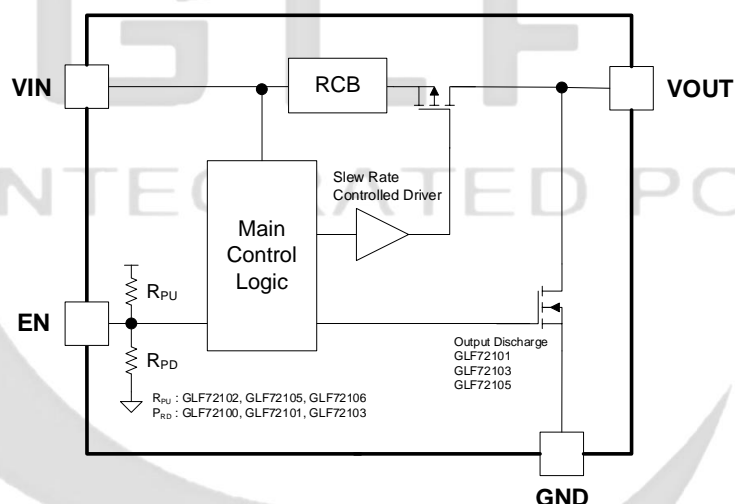


## ALTERNATE DEVICE OPTIONS

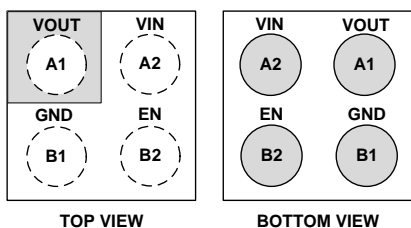
Part Number	Top Mark	R <sub>ON</sub> (Typ) at 5.5 V	Output Discharge	V <sub>OUT</sub> Rise Time t <sub>R</sub> (Typ) at 3.3 V	EN Activity	Package
GLF72100	J	37 mΩ	NA	570 μs	High	WLCSP
GLF72101	F		85 Ω		High	WLCSP
GLF72102 *	K		NA		Low	WLCSP
GLF72103	M		85 Ω	48 μs	High	WLCSP with Backside Laminate
GLF72105	N		85 Ω	890 μs	Low	WLCSP with Backside Laminate
GLF72106	d		NA			WLCSP with Backside Laminate

Note: GLF72102 is upon request

## FUNCTIONAL BLOCK DIAGRAM



## PIN CONFIGURATION



## PIN DEFINITION

Pin #	Name	Description
A1	VOUT	Switch Output
A2	VIN	Switch Input. Supply Voltage for IC
B1	GND	Ground
B2	EN	Enable to control the switch

Figure 2. 0.77 mm x 0.77 mm x 0.46 mm WLCSP

## 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 <sub>IN</sub> , V <sub>OUT</sub> , V <sub>EN</sub>	Each Pin Voltage Range to GND		-0.3	6	V
I <sub>OUT</sub>	Maximum Continuous Switch Current			2	A
P <sub>D</sub>	Power Dissipation at T <sub>A</sub> = 25 °C			1.2	W
T <sub>J</sub>	Maximum Junction Temperature			150	°C
T <sub>STG</sub>	Storage Junction Temperature		-65	150	°C
T <sub>A</sub>	Ambient Operating Temperature Range		-40	85	°C
θ <sub>JA</sub>	Thermal Resistance, Junction to Ambient			85	°C/W
ESD	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	±4		kV
		Charged Device Model, JESD22-C101	±2		

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min.	Max.	Unit
V <sub>IN</sub>	Supply Voltage	1.5	5.5	V
T <sub>A</sub>	Ambient Operating Temperature	-40	+85	°C

## ELECTRICAL CHARACTERISTICS

 Values are at  $V_{IN} = 3.3\text{ V}$  and  $T_A = 25\text{ °C}$  unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
Basic Operation						
I <sub>Q</sub>	Quiescent Current <sup>(1)</sup>	EN = Enable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.5 V		0.45	1	μA
		EN = Enable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.5 V, T <sub>A</sub> = 85 °C <sup>(4)</sup>		0.5		
I <sub>SD</sub>	Shut Down Current	EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 1.5 V		5		nA
		EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 3.3 V		9		
		EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 4.2 V		12		
		EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.5 V		20	100	
		EN = Disable, I <sub>OUT</sub> = 0 mA, V <sub>IN</sub> = 5.5 V, T <sub>A</sub> = 55 °C <sup>(4)</sup>		50		
R <sub>ON</sub>	On-Resistance	V <sub>IN</sub> = 5.5 V, I <sub>OUT</sub> = 500 mA	T <sub>A</sub> = 25 °C	37	42	mΩ
			T <sub>A</sub> = 85 °C <sup>(4)</sup>	43		
		V <sub>IN</sub> = 3.3 V, I <sub>OUT</sub> = 500 mA	T <sub>A</sub> = 25 °C	47	52	
			T <sub>A</sub> = 85 °C <sup>(4)</sup>	56		
		V <sub>IN</sub> = 1.8 V, I <sub>OUT</sub> = 300 mA	T <sub>A</sub> = 25 °C <sup>(4)</sup>	80		
		V <sub>IN</sub> = 1.5 V, I <sub>OUT</sub> = 100 mA	T <sub>A</sub> = 25 °C	100		
R <sub>DSC</sub>	Output Discharge Resistance	EN=Low , I <sub>FORCE</sub> = 10 mA for GLF72101, GLF72103, EN=High , I <sub>FORCE</sub> = 10 mA for GLF72105		85		Ω
V <sub>IH</sub>	EN Input Logic High Voltage	V <sub>IN</sub> = 1.5 V to 5.5 V	1.2			V
V <sub>IL</sub>	EN Input Logic Low Voltage	V <sub>IN</sub> = 1.5 V to 5.5 V			0.45	V
R <sub>EN</sub>	EN Internal Resistance	Pull-down Resistance: GLF72100, GLF72101, GLF72103 Pull-up Resistance: GLF72102, GLF72105, GLF72106		10		MΩ
I <sub>EN</sub>	EN Current	V <sub>EN</sub> = V <sub>IN</sub> or GND		0.5		μA
V <sub>RCB_TH</sub>	RCB Protection Threshold Voltage	V <sub>OUT</sub> – V <sub>IN</sub>		25		mV
V <sub>RCB_RL</sub>	RCB Protection Release Voltage	V <sub>IN</sub> – V <sub>OUT</sub>		30		mV
Switching Characteristics <sup>(2)</sup> : GLF72100, GLF72101						
t <sub>dON</sub>	Turn-On Delay	R <sub>L</sub> = 150 Ω, C <sub>OUT</sub> = 0.1 μF, GLF72100, GLF72101		430		μs
t <sub>r</sub>	V <sub>OUT</sub> Rise Time			570		
t <sub>dOFF</sub>	Turn-Off Delay <sup>(3), (4)</sup>	R <sub>L</sub> = 150 Ω, C <sub>OUT</sub> = 0.1 μF, GLF72100		17		
t <sub>f</sub>	V <sub>OUT</sub> Fall Time <sup>(3), (4)</sup>			30		
t <sub>dOFF</sub>	Turn-Off Delay <sup>(3), (4)</sup>	R <sub>L</sub> = 150 Ω, C <sub>OUT</sub> = 0.1 μF, GLF72101		17		
t <sub>f</sub>	V <sub>OUT</sub> Fall Time <sup>(3), (4)</sup>			15		
Switching Characteristics <sup>(2)</sup> : GLF72103						
t <sub>dON</sub>	Turn-On Delay	R <sub>L</sub> = 150 Ω, C <sub>OUT</sub> = 0.1 μF		50		μs
t <sub>r</sub>	V <sub>OUT</sub> Rise Time			48		
t <sub>dOFF</sub>	Turn-Off Delay <sup>(3), (4)</sup>			17		
t <sub>f</sub>	V <sub>OUT</sub> Fall Time <sup>(3), (4)</sup>			15		
Switching Characteristics <sup>(2)</sup> : GLF72105						
t <sub>dON</sub>	Turn-On Delay	R <sub>L</sub> = 150 Ω, C <sub>OUT</sub> = 0.1 μF		640		μs
t <sub>r</sub>	V <sub>OUT</sub> Rise Time			890		
t <sub>dOFF</sub>	Turn-Off Delay <sup>(3), (4)</sup>			16		
t <sub>f</sub>	V <sub>OUT</sub> Fall Time <sup>(3), (4)</sup>			10		
Switching Characteristics <sup>(2)</sup> : GLF72106						
t <sub>dON</sub>	Turn-On Delay	R <sub>L</sub> = 150 Ω, C <sub>OUT</sub> = 0.1 μF		640		μs
t <sub>r</sub>	V <sub>OUT</sub> Rise Time			890		
t <sub>dOFF</sub>	Turn-Off Delay <sup>(3), (4)</sup>			17		
t <sub>f</sub>	V <sub>OUT</sub> Fall Time <sup>(3), (4)</sup>			30		

 Notes: 1.  $I_Q$  does not include the enable pull down current ( $I_{EN}$ ) through the pull-down resistor  $R_{EN}$  of GLF72105 and GLF72106.

 2.  $t_{ON} = t_{dON} + t_R$ ,  $t_{OFF} = t_{dOFF} + t_F$ 

3. Output discharge path is enabled during off.

4. By design; characterized, not production tested.

## TIMING DIAGRAM

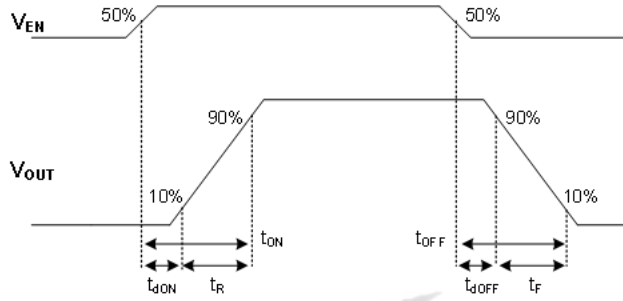


Figure 3. GLF72100, GLF72101 and GLF72103

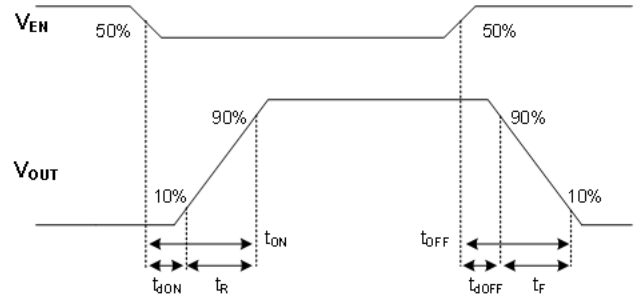


Figure 4. GLF72102, GLF72105 and GLF72106

## TYPICAL PERFORMANCE CHARACTERISTICS

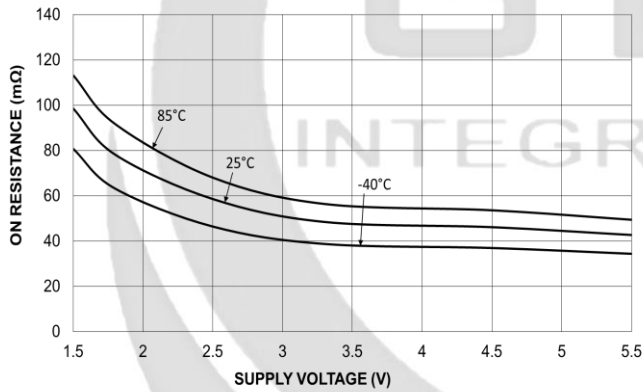


Figure 5. On-Resistance vs. Supply Voltage

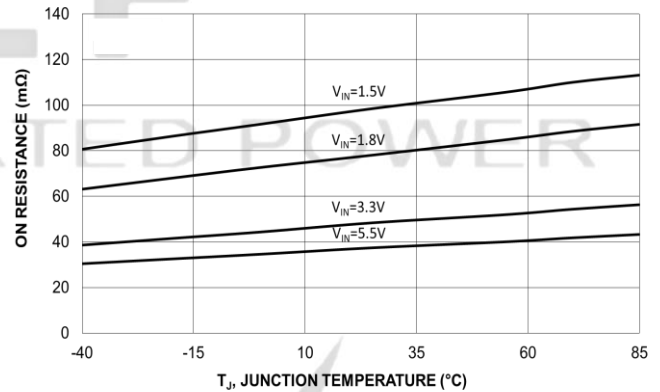


Figure 6. On-Resistance vs. Temperature

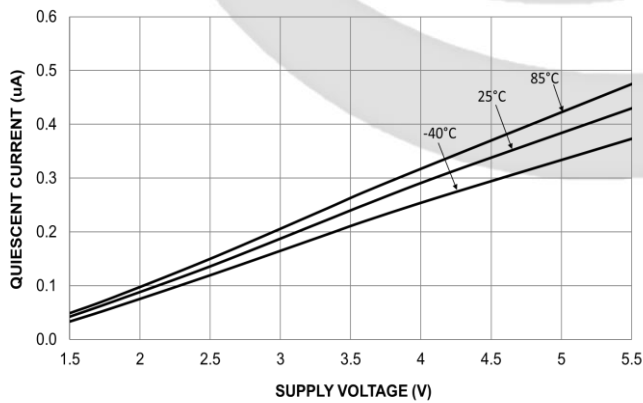


Figure 7. Quiescent Current vs. Supply Voltage

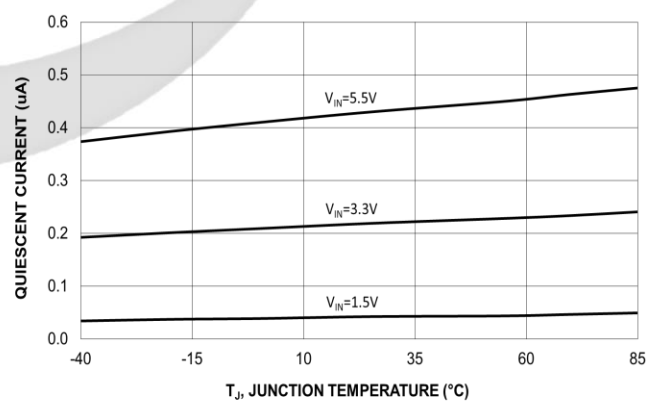
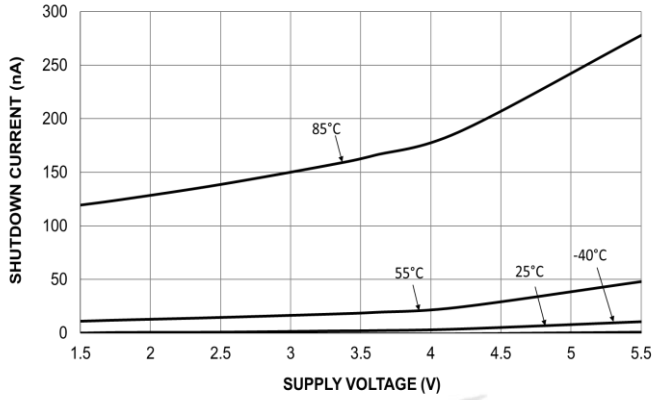
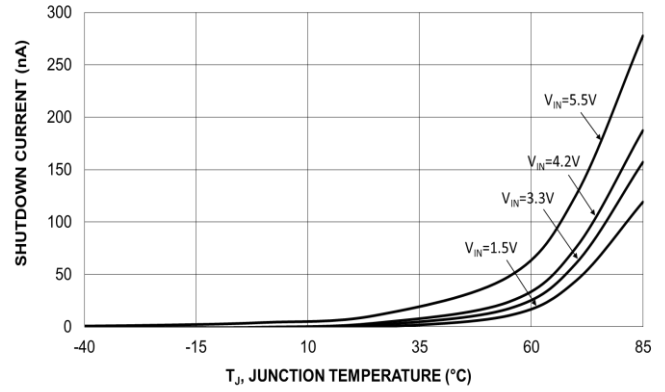


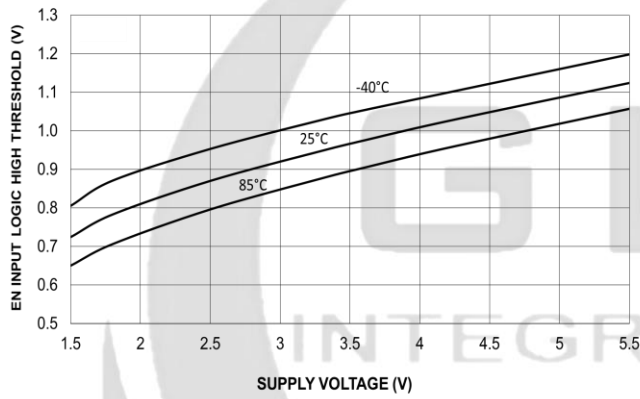
Figure 8. Quiescent Current vs. Temperature



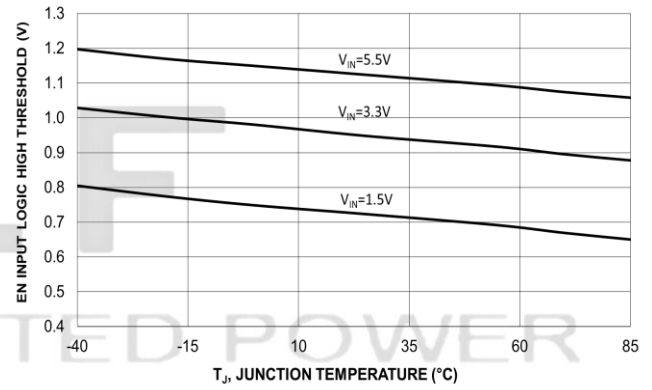
**Figure 9. Shutdown Current vs. Supply Voltage**



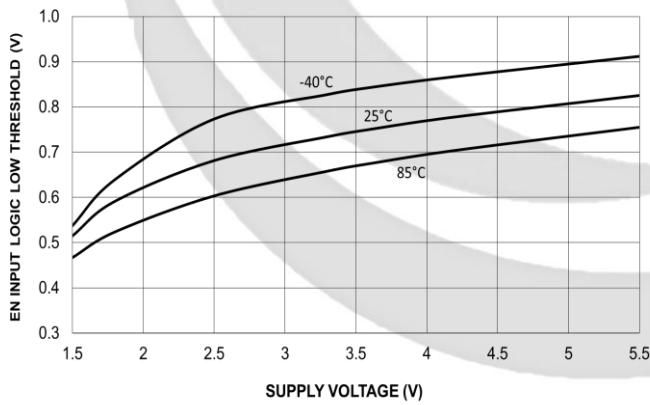
**Figure 10. Shutdown Current vs. Temperature**



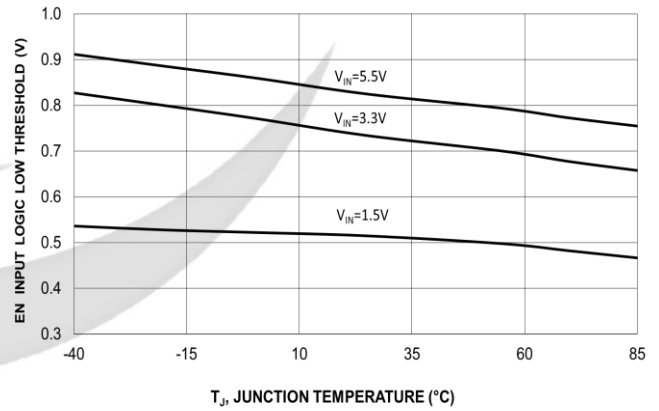
**Figure 11. EN Input Logic High Threshold**



**Figure 12. EN Input Logic High Threshold Vs. Temperature**



**Figure 13. EN Input Logic Low Threshold**



**Figure 14. EN Input Logic Low Threshold Vs. Temperature**

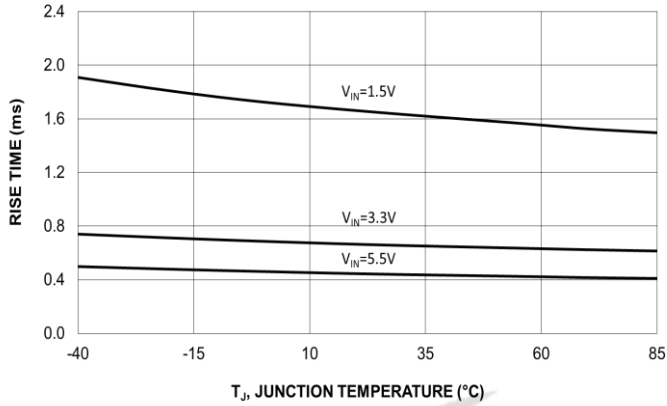


Figure 15. V<sub>OUT</sub> Rise Time vs. Temperature  
GLF72100 and GLF72101

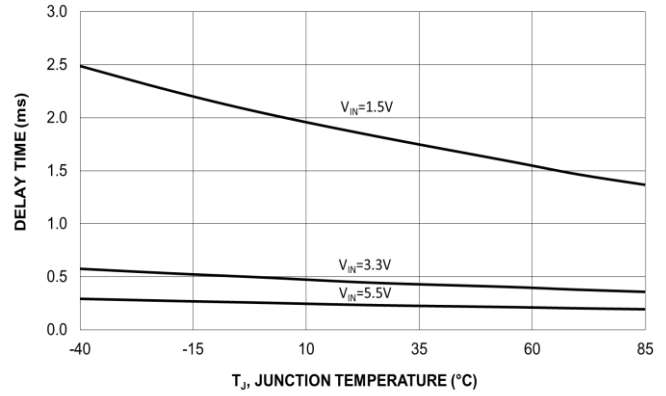


Figure 16. Turn-On Delay Time vs. Temperature  
GLF72100 and GLF72101

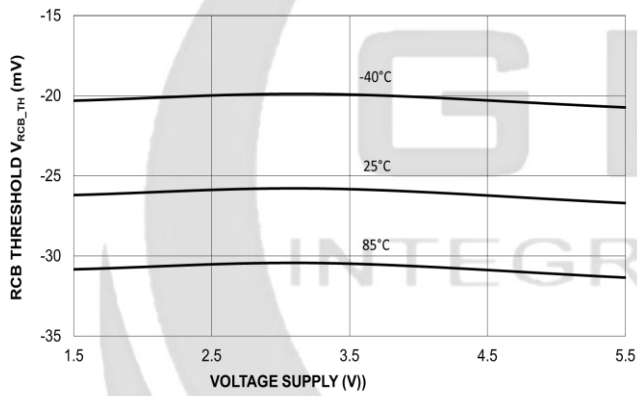


Figure 17. RCB Threshold Voltage vs. Supply Voltage

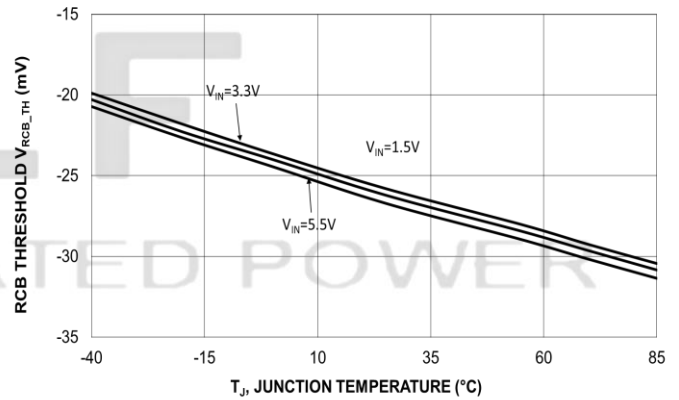


Figure 18. RCB Threshold Voltage vs. Temperature

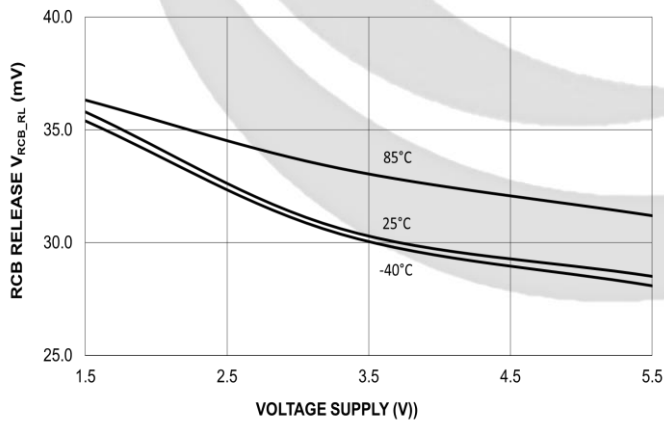


Figure 19. RCB Release Voltage vs. Supply Voltage

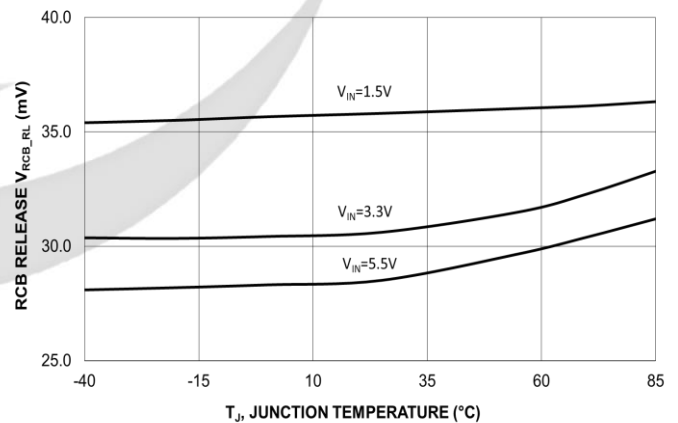
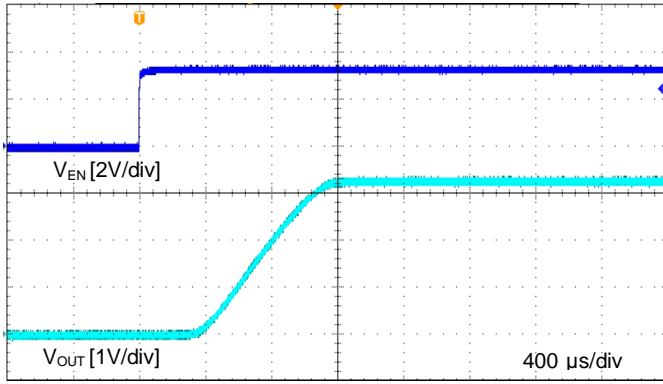
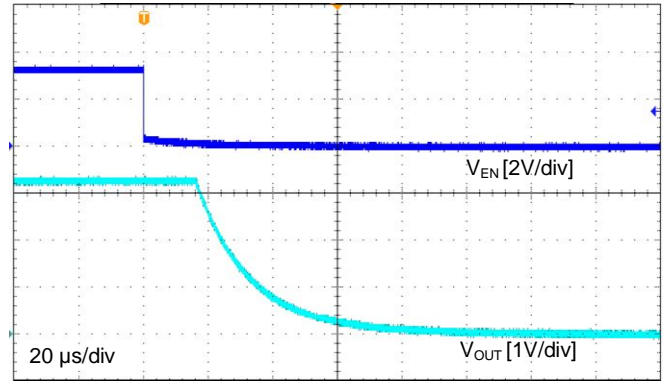


Figure 20. RCB Release Voltage vs. Temperature



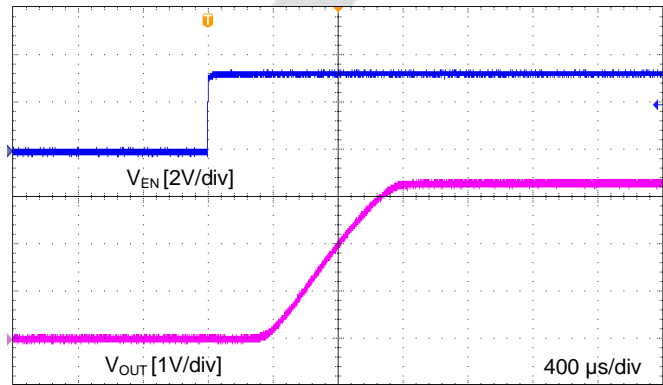
**Figure 21. Turn-On Response, GLF72100**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



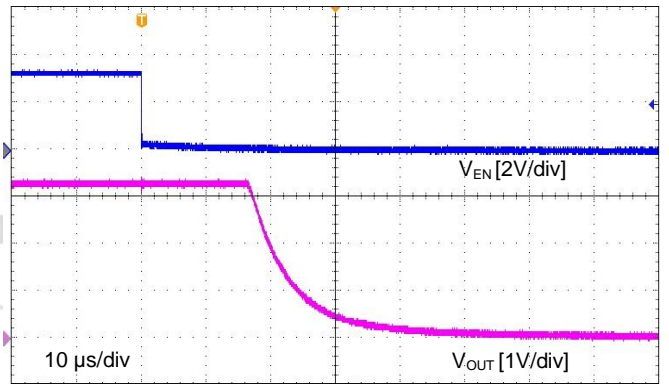
**Figure 22. Turn-Off Response, GLF72100, GLF72106**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



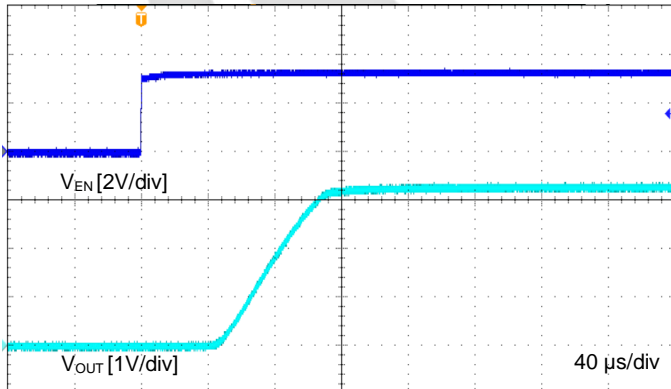
**Figure 23. Turn-On Response, GLF72101**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



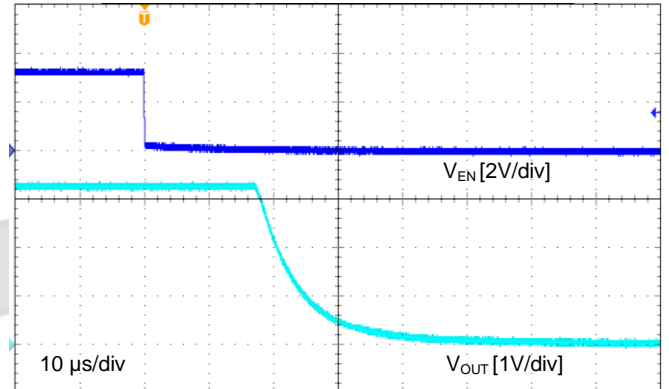
**Figure 24. Turn-Off Response, GLF72101**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



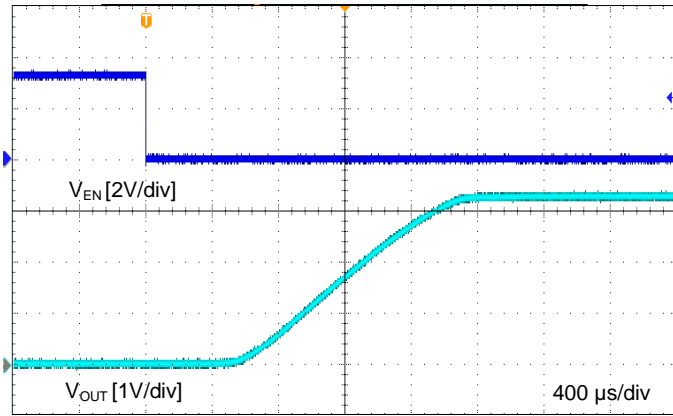
**Figure 25. Turn-On Response, GLF72103**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



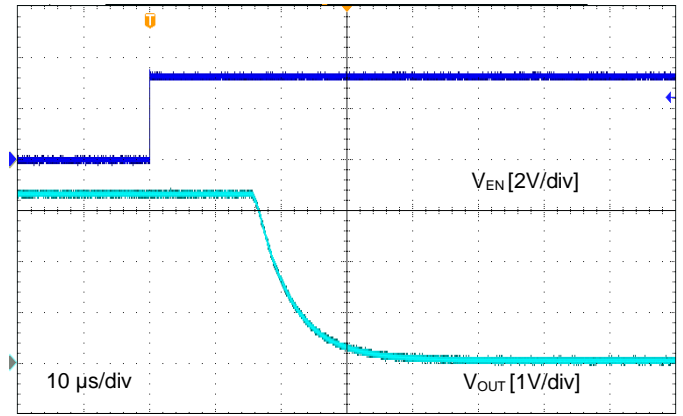
**Figure 26. Turn-Off Response, GLF72103**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



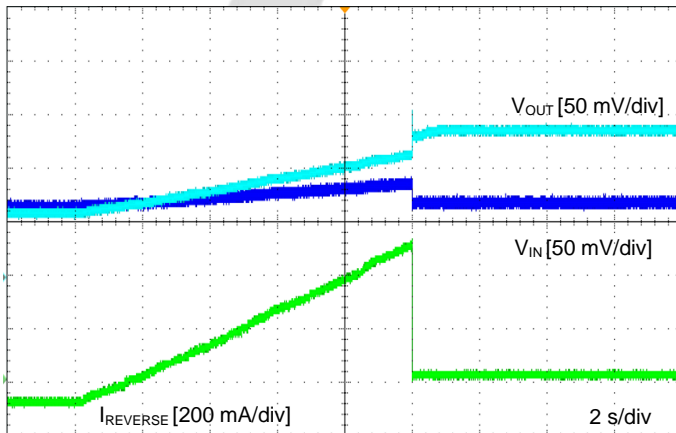
**Figure 27. Turn-On Response, GLF72105, GLF72106**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



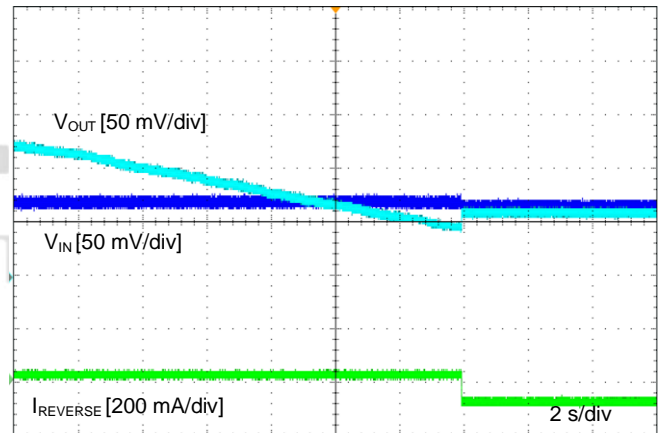
**Figure 28. Turn-Off Response, GLF72105**

$V_{IN}=3.3\text{ V}$ ,  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$ ,  $R_L=150\text{ }\Omega$



**Figure 29. Reverse Current Blocking Threshold**

$V_{IN}=3.3\text{ V}$ ,  $V_{OUT}=\text{Up to } 3.4\text{ V}$  in  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$



**Figure 30. Reverse Current Blocking Release**

$V_{IN}=3.3\text{ V}$ ,  $V_{OUT}=\text{Down to } 3.2\text{ V}$  in  $C_{IN}=0.1\text{ }\mu\text{F}$ ,  $C_{OUT}=0.1\text{ }\mu\text{F}$

## APPLICATION INFORMATION

The GLF7210x product family is an integrated 2 A, nano current leakage I<sub>Q</sub>Smart™ load switches with a fixed slew rate control to limit the inrush current during turn on. Each device is capable of operating over a wide input range from 1.5 V to 5.5 V with very low on-resistance to reduce conduction loss. In the off state, these devices consume very low leakage current to avoid unwanted standby current and save limited input power. The package is a 0.77 mm x 0.77 mm x 0.46 mm wafer level chip scale package, saving space in compact applications. It is constructed using 4 bumps, with a 0.4 mm pitch for manufacturability.

### Input Capacitor

The GLF7210x product family does not require an input capacitor. However, to reduce the voltage drop on the input power rail caused by transient inrush current at start-up, a 0.1  $\mu$ F capacitor is recommended to be placed close to the VIN pin. A higher input capacitor value can be used to further attenuate the input voltage drop.

### Output Capacitor

The GLF7210x product family does not require an output capacitor. However, use of an output capacitor is recommended to mitigate voltage undershoot on the output pin when the switch is turning off. Undershoot can be caused by parasitic inductance from board traces or intentional load inductances. If load inductances do exist, use of an output capacitor can improve output voltage stability and system reliability. The C<sub>OUT</sub> capacitor should be spaced close to the VOUT and GND pins.

### EN Pin

The GLF72100, GLF72101, and GLF72103 can be activated by forcing EN pin high level and the GLF72102, GLF72105, GLF72106 by EN pin low level. Note that the EN pin has an internal pull-down/ pull-up resistor to help pull the main switch to a known “off state” when no EN signal is applied from an external controller.

### Reverse Current Blocking

The GLF7210x product family has a built-in reverse current blocking protection which always monitors the output voltage level regardless of the status of EN pin to check if it is greater than the input voltage. When the output voltage goes beyond the input voltage by 25 mV, that is the reverse current blocking protection threshold voltage ( $V_{RCB\_TH}$ ), the reverse current blocking function block turns off the switch. Note that some reverse current can occur until the  $V_{RCB\_TH}$  is triggered. The main switch will resume normal operation when the output voltage drops below the input source by the reverse current blocking protection release voltage ( $V_{RCB\_RL}$ ).

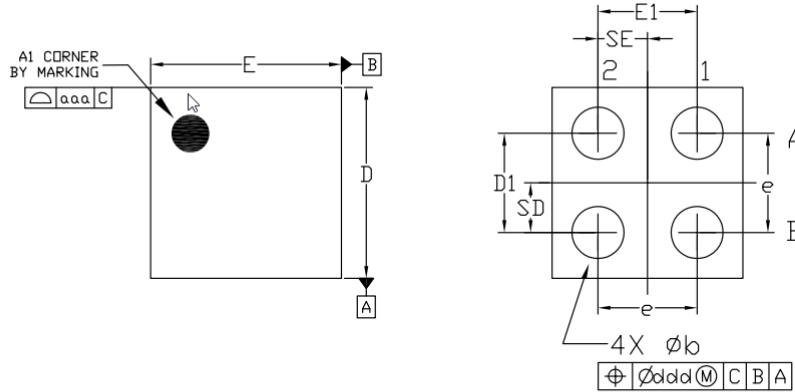
### Output Discharge Function

The GLF72101, GLF72103, and GLF72105 have an internal discharge N-channel FET switch on the VOUT pin. When EN signal turns the main power FET to an off state, the N-channel switch turns on to discharge an output capacitor quickly.

### Board Layout

All traces should be as short as possible to minimize parasitic inductance effects. Wide traces for VIN, VOUT, and GND will help reduce signal degradation and parasitic effects during dynamic operation as well as improve the thermal performance at high load current.

## PACKAGE OUTLINE

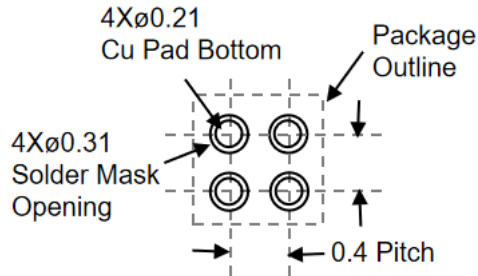


Dimensional Ref.			
REF.	Min.	Nom.	Max.
A	0.410	0.460	0.510
A1	0.135	0.160	0.185
A2	0.250	0.275	0.300
A3	0.020	0.025	0.030
D	0.755	0.770	0.785
E	0.755	0.770	0.785
D1	0.350	0.400	0.450
E1	0.350	0.400	0.450
b	0.170	0.210	0.250
e	0.400 BSC		
SD	0.200 BSC		
SE	0.200 BSC		
Tol. of Form&Position			
aaa	0.10		
bbb	0.10		
ccc	0.05		
ddd	0.05		

### Notes

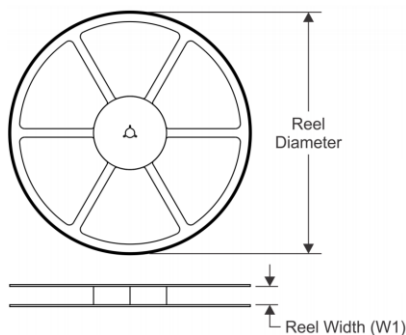
1. ALL DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES)
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
3. A3: BACKSIDE LAMINATION

### Recommended Footprint

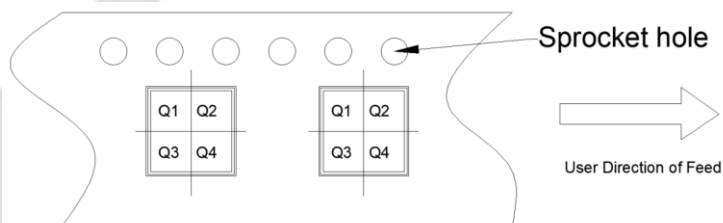


## TAPE AND REEL INFORMATION

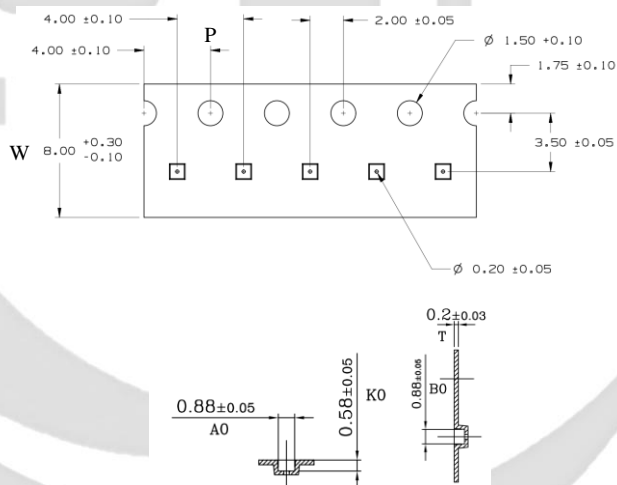
### Reel Dimensions



### Quadrant Assignments PIN1 Orientation Tape



### Tape Dimensions



Device	Package	Pins	SPQ	Reel Diameter (mm)	Reel Width W1	A0	B0	K0	P	W	Pin1
GLF72100	WLCSP	4	4000	179	9	0.88	0.88	0.58	4	8	Q1
GLF72101	WLCSP	4	4000	179	9	0.88	0.88	0.58	4	8	Q1
GLF72102	WLCSP	4	4000	179	9	0.88	0.88	0.58	4	8	Q1
GLF72103	WLCSP	4	4000	179	9	0.88	0.88	0.58	4	8	Q1
GLF72105	WLCSP	4	4000	179	9	0.88	0.88	0.58	4	8	Q1
GLF72106	WLCSP	4	4000	179	9	0.88	0.88	0.58	4	8	Q1

#### Remark:

- A0: Dimension designed to accommodate the component width
- B0: Dimension designed to accommodate the component length
- C0: Dimension designed to accommodate the component thickness
- W: Overall width of the carrier tape
- P1: Pitch between successive cavity centers

## 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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