

## Input High Withstand Voltage 500mA Linear Lithium Battery Charger

Check for Samples: [LGS4084](#)

### Features

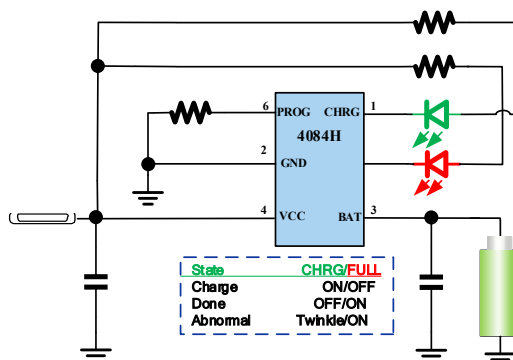
**NEW** Built in Linear Charger with High Input Voltage and Adjustable Charging Current:

- Input Voltage Range: 4V~24V (surge voltage up to 28V)
- The Maximum Charging Current Under Constant Current can reach 500mA, and It supports Real-time Configuration of Charging Current by External Resistance
- Compatible with 5V USB Power Source and AC Adapter, and provides Hot Plug Protection
- Supports 4.2V/4.35V Lithium Battery Types
- Intelligent Regulation of Charging Current according to Battery Temperature and Input Voltage
- With Anti Backflow Function of Battery, The Leakage of Battery Terminal is less than 1uA
- Perfect Charge State Indication and Abnormal Indication such as Battery not connected
- Protection function: UVLO/OTP/OVP/ Charging Current Thermal Regulation/ Constant Current Charging Soft Start
- Junction Temperature Range From -40°C To +85°C
- All Pin Have ±2000V (HBM) ESD Protection

### Applications

- Mobile multimedia device, MP3, MP4
- Portable device with lithium battery power and USB input

### Typical Application



Picture 1 Typical Application Topology

### Description

LGS4084 is a linear lithium battery charge management chip integrating lithium battery charge management and battery charge status indication, providing a complete power supply solution for a single lithium battery. LGS4084 has four charging processes: short-circuit current (SC), trickle current (TC), constant current (CC) and constant voltage (CV): short circuit charging (SC) can charge 0V battery; Trickle charging (TC) can pre charge the fully discharged battery; Constant current charging (CC) can quickly charge the battery; Constant voltage charging (CV) ensures safe charging of the battery. The charging cutoff voltage of LGS4084 is 4.2V by default. The charging current can be set through an external resistor. The maximum charging current is 500mA. When the charging current drops to 1 / 10 of the set charging cutoff voltage, LGS4084 will automatically end the charging process, continuously detect the battery voltage, and automatically recharge when it falls to a certain threshold. When the input voltage (USB source or AC adapter) is removed, it will automatically enter the low power consumption mode, and the leakage at the battery end is below 1uA.

### Purchasing Information

LGS4084H □□ - □□□

Package  
B5: SOT23-5  
B6: SOT23-6

Battery Voltage  
Default: 4.20V  
4.35: 4.35V

Part	Package	Top Mark
LGS4084HB5	SOT23-5	4084
LGS4084HB6	SOT23-6	4084

## Revision History <sup>(†)</sup>

Rev. C V0.1 16. Aug. 2021	Page
<hr/>	
※ Version B begins. The relevant parameters in this manual are only for the description and recognition of the relevant indicators in version B	ALL
Rev. C V0.2 14. Feb. 2022	Page
<hr/>	
※ Revision B. The content error correction and parameter adjustment are made for the initial version of version B	ALL
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	Page

† NOTE: The page number of the previous version may be different from that of the current version.

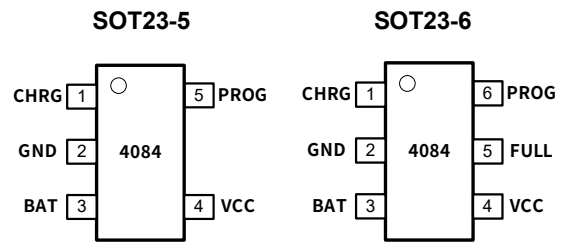
## Absolute Maximum Ratings ( † )

**Table 3.1**

Parameters	Range
Pin to GND Voltage (VCC, CHRG ,FULL)	-0.3V~24V
Pin to GND Voltage (BAT, PROG)	-0.3V~6V
Storage temperature	-65°C to 150°C
Operating temperature	-40°C to 125°C
ESD Rated Value (HBM)	±2000V
ESD Rated Value (CDM)	±1000V

† Note: if the working condition of the device exceeds the above "absolute maximum value", it may cause permanent damage to the device. This is only a limit parameter, and it is not recommended that the device work at or above the limit value. The reliability of the device may be affected if it works under the limit conditions for a long time.

## Package Information

**Picture 3. Pin Arrangement**

 $T_{MAX}=125^{\circ}C, \theta_{JA}=173^{\circ}C/W$ 

## ESD warning



### ESD (electrostatic discharge) sensitive device

Live devices and circuit boards can be electrically charged without being noticed. Although this product has a patented or proprietary protection circuit, the device may be damaged in the event of high energy ESD. Therefore, appropriate ESD preventive measures should be taken to avoid device performance degradation or function loss.

**Table 3.2 Pin Function Description**

SOT23-6 Pin number	SOT23-5 Pin number	Name	Description
1	1	CHRG	Charging indicator pin. Connected to the negative electrode of the LED lamp. When the battery is charged, the pin outputs low level and the indicator light is on.
2	2	GND	Chip ground.
3	3	BAT	Battery charging output pin. Connect to the positive electrode of the battery and place a ceramic capacitor with an effective value of at least 10uF to the ground.
4	4	VCC	Power input pin. Connect to the positive electrode of the power supply, and use a ceramic capacitor of at least 10uF effective value to bypass VCC and GND as close as possible.
5		FULL	Full indicator pin. Connected to the negative electrode of the LED lamp, when the battery is full, the pin outputs low level and the indicator light is on.
6	5	PROG	Constant current charging current setting and charging current monitoring pins. Connect an external 1% precision resistor to ground to set the charging current. The formula for setting values above 300mA is set as follows: $I_{BAT} = 1000 / R_{PROG}$ , while for values below 300mA, it is set as $I_{BAT} = 900 / R_{PROG}$ . Example: 1K corresponds to 1A charging; 2K corresponds to 0.5A charging; 9K corresponds to 0.1A charging.

## Technical Specifications

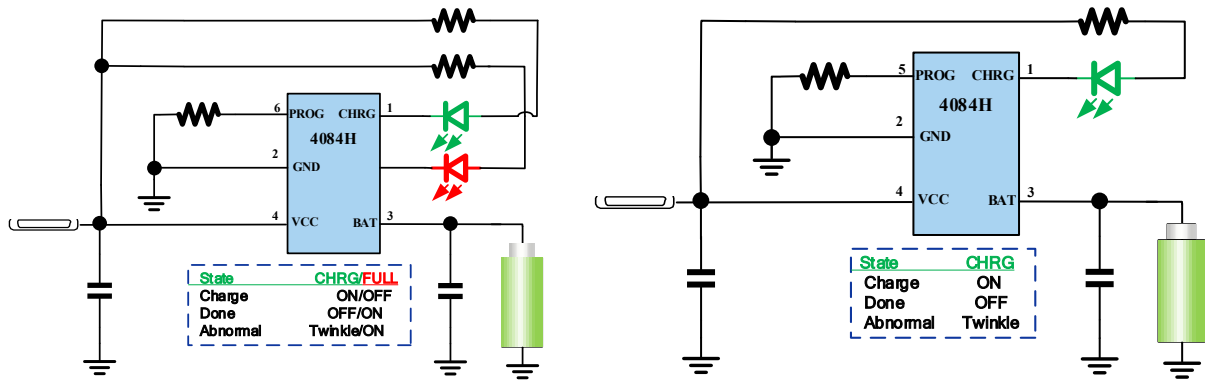
Unless otherwise specified, the following data only represent the most possible parameter specifications when  $T_J = 25\text{ }^\circ\text{C}$ , for reference only. All voltages are relative to GND. The minimum and maximum limits are specified by test, verification and statistical correlation.

**Table 4.**

Parameter	Test Conditions	MIN	TYE	MAX	UNIT	
<b>(Linear Charging Characteristics)</b>						
$V_{CC}$	VCC Operation Voltage		5		V	
	VCC Threshold Voltage	Rising, $V_{BAT}=3V$	4.0		V	
Falling, $V_{BAT}=3V$		3.9		V		
$V_{OVP}$	Input Overvoltage Protection		6.5		V	
$I_Q$	VCC Quiescent Current	VCC=5V, BAT Suspended	150		$\mu\text{A}$	
	BAT current	VCC=0V, $V_{BAT}=4.0V$		1	$\mu\text{A}$	
	BAT current	VCC=5V, $V_{BAT}=4.0V$		1000	nA	
$I_{SHORT}^{(1)}$	Short circuit charging (SC) current	$V_{BAT} < V_{SHORT}$	5%	7%	$I_{CC}$	
$V_{SHORT}$	Short circuit charging (SC) threshold voltage	Less than this threshold	0.6		V	
$V_{SHORT\_HYS}$	Short circuit charging (SC) hysteresis voltage		0.1		V	
$I_{TC}^{(1)}$	Trickle charging (TC) current	$V_{SHORT} < V_{BAT} < V_{PRE}$	10%	14%	$I_{CC}$	
$V_{TC}$	Trickle charge (TC) threshold voltage	Less than this threshold	2.65	2.90	3.15	V
$V_{TC\_HYS}$	Trickle charging (TC) hysteresis voltage		0.5		V	
$I_{CC}^{(1)}$	Constant current charging (CC) ( $V_{BAT}=3.7V$ )	$R_{PROG}=2K$	500		mA	
		$R_{PROG}=9K$	100		mA	
$V_{CV}^{(1)}$	Constant voltage charging (CV) floating charge voltage	$T_J=25\text{ }^\circ\text{C}$	4.15	4.20	4.25	V
$I_{TERM}$	Constant voltage charging (CV) cut-off charging current		1/10		$I_{CC}$	
$V_{RECHRG}$	Recharging threshold after full battery		95.7%		$V_{CV}$	
$R_{DS(ON)}$	PMOS $R_{DS(ON)}$		1200		m $\Omega$	
<b>Control logic signal</b>						
Global thermal protection and battery temperature control characteristics						
$T_{OTP}$	Over temperature protection	$T_J$	150		$^\circ\text{C}$	
<b>Indicator Light (LED)</b>						
$I_{CHRG}$	LED drive current		5		mA	
$I_{FULL}$	LED drive current		5		mA	

(1) In order to protect the battery during charging, the chip will detect the battery voltage and perform four different charging stages, short charge → trickle charge → constant current charge → constant voltage charge → charging stop.

## Application Information: Typical Application Circuit



Picture 5 Typical Application Topology

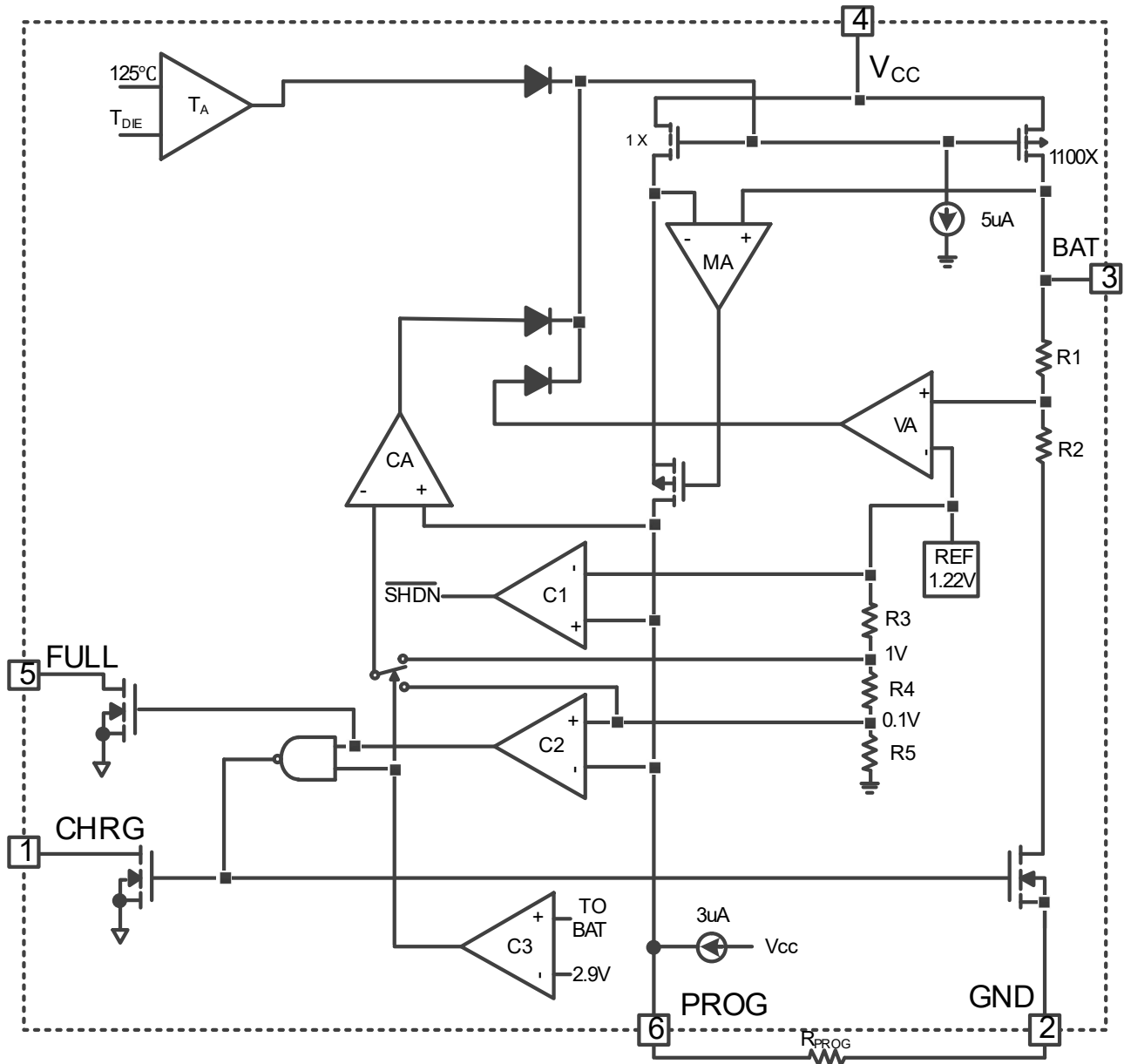
### NOTE:

- Charging input pin V<sub>CC</sub>. Need 10 µF stabilized ceramic capacitor.
- When using the LED indicator light, it is recommended to connect a 1K current limiting resistor to V<sub>CC</sub>. Do not use the charging indicator function, the corresponding pin needs to be grounded. If CHRG and DONE are connected to other power supplies through resistors, it is necessary to ensure that the power supply will not have pulses or fluctuations when V<sub>CC</sub> is powered on. If there are pulses at the DONE pin when starting V<sub>CC</sub> power on, the system will not work. Current limiting resistors must be used separately.

## Component Selection Recommendation

Symbol	Meaning	Requirement
C <sub>VCC</sub>	USB charging input constant voltage capacitor	10µF (effective value) ceramic capacitor
C <sub>BAT</sub>	Battery charging output voltage stabilizing capacitor	10µF(effective value) ceramic capacitor
R <sub>LED</sub>	LED Current limiting resistor	Choose according to the brightness demand of the lamp, 1K or more
R <sub>PROG</sub>	Constant current charging current setting resistance	Accuracy: 1%, by formula $I_{BAT} = (V_{PROG} / R_{PROG}) \times 1000$ setting is completed.

## Functional Block Diagram



Picture 6. Internal Functional Block Diagram

# Application Information: Linear Lithium Battery Charger

## Summary

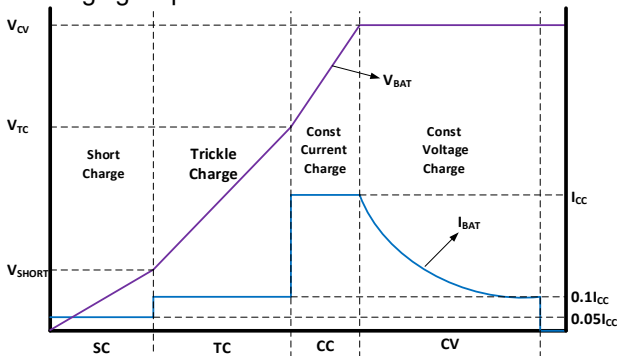
LGS4084 is a lithium battery linear charge management IC that integrates lithium battery charge management, battery charge state indication and 24V input withstand voltage, providing a complete power supply solution for a single lithium battery. LGS4084 has four charging processes: short circuit (SC), trickle current (TC), constant current (CC) and constant voltage (CV): short circuit charging (SC) can charge 0V battery; Trickle charging (TC) can pre charge the fully discharged battery; Constant current charging (CC) can quickly charge the battery; Constant voltage charging (CV) ensures safe charging of the battery.

The charging cutoff voltage of LGS4084 is 4.2V by default. The charging current can be set through an external resistor. The maximum charging current is 500mA. When the charging current drops to 1 / 10 of the set value, the LGS4084 will automatically end the charging process, then continuously detect the battery voltage, and automatically recharge when it falls to a certain threshold. When the input voltage (USB source or AC adapter) is removed, it will automatically enter the low power consumption mode, and the leakage at the battery end is below 1uA. LGS4084 integrates charging and full charge prompts, and battery not connected indication.

## Normal Charging Cycle

When the  $V_{CC}$  voltage of LGS4084 is greater than UVLO, wait for the internal power supply of the chip to start, and then start a charging cycle.

In order to protect the battery during charging, the chip will detect the battery voltage and perform different charging stages, such as short charge → trickle charge → constant current charge → constant voltage charge → charging stop.



Picture 7. Battery Charging Cycle

When the voltage on BAT is lower than  $V_{SHORT}$  (typical value 0.6V), in order to prevent the deep discharged lithium-ion battery from being damaged or even dangerous during fast charging, 5% preset charging current will be used to wake up at this stage.

When the voltage on the BAT is lower than  $V_{TC}$  (typical value 2.9v) and higher than  $V_{SHORT}$  (typical value 0.6V), the charging cell will enter the trickle charging mode (also known as the pre charging mode of lithium battery) to recover the battery cell. In this mode, the charging current will be reduced to 10% of the preset charging current.

When the battery voltage rises above  $V_{PRE}$  (typical value 2.9v), the charging current will rise to the full speed preset current for constant current charging mode.

When the preset charging voltage  $V_{CV}$  (4.2 / 4.3 / 4.35) is reached, the LGS4084 will enter into constant voltage charging, and the charging current will start to drop until it reaches  $I_{TERM}$  (typical value 1 / 10  $I_{CC}$ ), then the charging will be stopped.

After the charging is stopped, the chip enters the standby state and continuously detects the BAT voltage. When the bat voltage drops to  $V_{RECHRG}$  (recharging

threshold), it will automatically enter a new charging cycle to ensure that the battery is at the full charge level.

## Set Output Current

The charging current of LGS4056H can be set through a resistor connected between the ROG pin and ground. Determine the resistance of the resistor based on the required charging current. In all modes of the charging process, the charging current can be estimated by measuring the voltage of this pin. Formula for setting above 300mA: Formula:

$$I_{BAT} = (V_{PROG} / R_{PROG}) \times 1000 \text{ (mA)}$$

Formula for setting below 300mA: Formula:

$$I_{BAT} = (V_{PROG} / R_{PROG}) \times 900 \text{ (mA)}$$

Example: 1K corresponds to 1A charging; 2K corresponds to 0.5A charging; 9K corresponds to 0.1A charging.

To achieve 1A charging, the input/output voltage difference needs to be greater than 1.2V and sufficient heat dissipation is required to maintain maximum current charging.

## Charge Status Indicator

The LGS4084 integrates charging and full charge prompts, and three charging status indicators of battery not connected. When the battery is not connected, the LED will enter the flashing alarm state. LGS4084 has two open drain state output terminals: CHRГ and FULL, when charging is in progress, CHRГ is pulled to a low level, and FULL is in a high resistance state; After charging, CHRГ is in high resistance state and FULL is pulled to low level. **If the status indication function is not used, the unused status indication output terminal is grounded.**

The following figure shows the summary of status indication function:

STATE	CHRG	FULL
Charge	ON	OFF
FULL	OFF	ON
Abnormal	Twinkle	ON
Undervoltage, Temperature Too High Or Too Low	OFF	OFF

## Application Information: Linear Lithium Battery Charger

### Overheat Regulation Charging Current

The built-in over temperature loop of LGS4084 during charging can effectively regulate the charging current. By reducing the charging current ( $85\text{ }^{\circ}\text{C} \leq T_J \leq 125\text{ }^{\circ}\text{C}$ ) and briefly turning off the charging ( $125\text{ }^{\circ}\text{C} \leq T_J \leq 150\text{ }^{\circ}\text{C}$ ), the junction temperature of the chip will not be too high and the continuous increase of the chip temperature will be avoided. This also means that the charging current in the constant current mode is not necessarily the set ICC, but will be subject to the temperature.

The LGS4084 integrates the intelligent temperature control function. When  $85\text{ }^{\circ}\text{C} \leq T_J \leq 125\text{ }^{\circ}\text{C}$ , the charging current will be linearly reduced; When  $125\text{ }^{\circ}\text{C}$

$\leq T_J \leq 150\text{ }^{\circ}\text{C}$ , turn off the chip for charging briefly. This function allows the user to increase the upper limit of the power processing capacity of a given circuit board without the risk of damaging the LGS4084. On the premise that the charger will automatically reduce the current under the worst-case conditions, the charging current can be set according to the typical (not the worst-case) ambient temperature.

### High voltage hot plugging

If a spike higher than the input VCC withstand voltage can be seen when the USB interface is powered on in the overall plan, a  $1\ \Omega$  resistor can be connected in series with the VCC capacitor to filter out the spike.

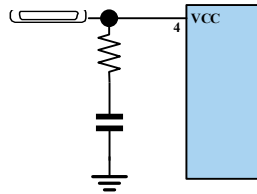


Figure 5. Hot swappable Type-C high-voltage interface

## Application Information: Linear Lithium Battery Charge Management Chip (Chart)

Figure 9. Electrical Characteristics (Unless otherwise stated, TA=25°C)

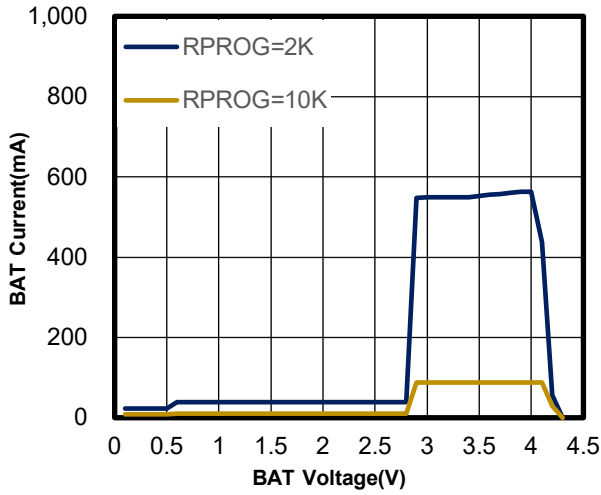


Figure 9.a BAT Current vs BAT Voltage

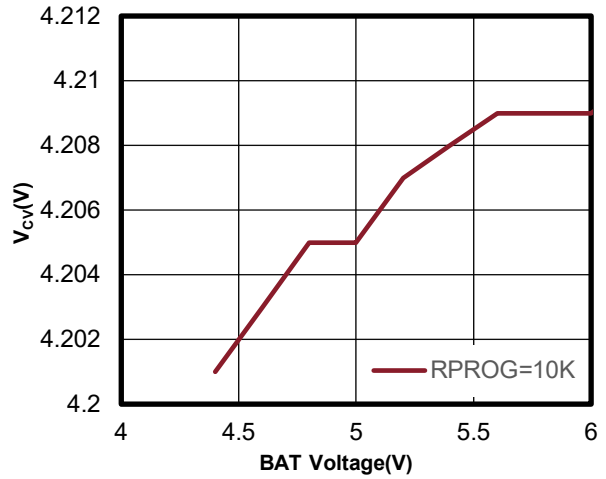


Figure 9.b  $V_{CV}$  vs  $V_{IN}$  Voltage

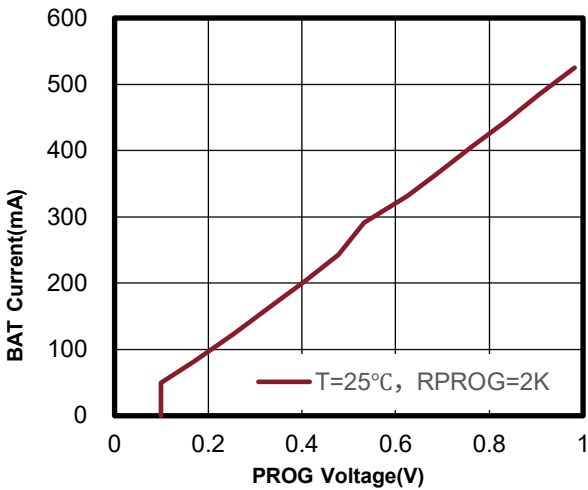


Figure 9.c PROG Voltage vs Temperature

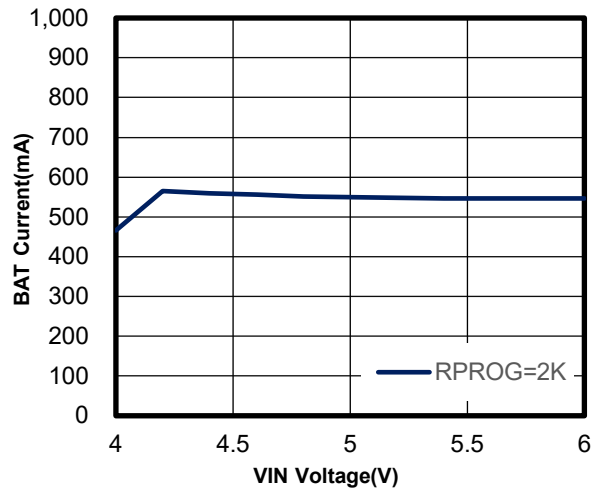


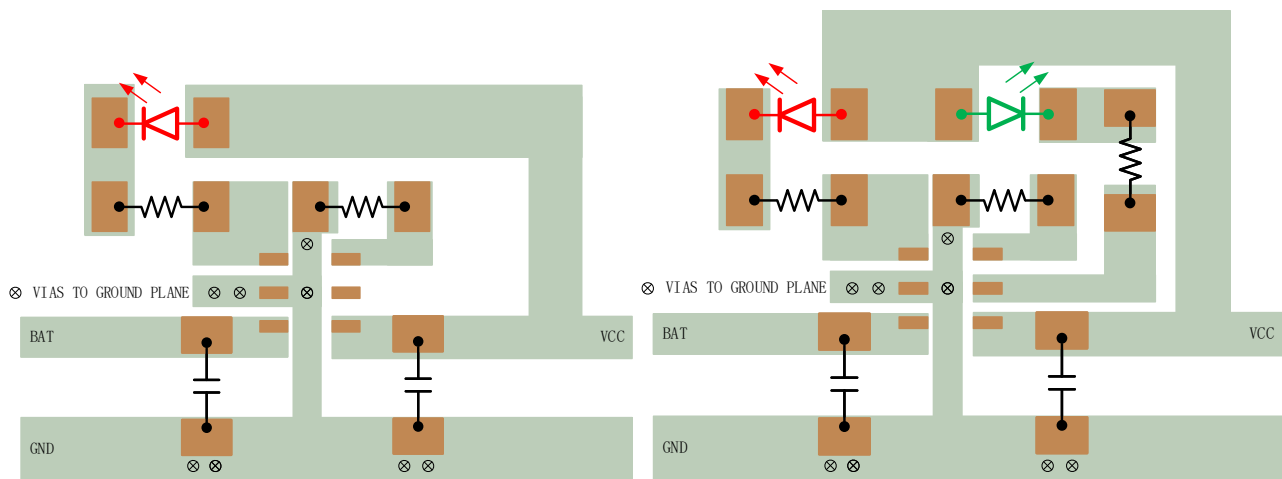
Figure 9.d  $V_{IN}$  Voltage vs  $R_{PROG}$

# Application Information: Reference Layout Example

## Summary

Poor layout will affect the performance of LGS4084, resulting in electromagnetic interference (EMI), poor electromagnetic compatibility (EMC), ground jump and voltage loss, which will further affect voltage regulation and stability. In order to optimize its electrical and thermal performance, the following rules should be applied to achieve good PCB layout and wiring to ensure the best performance:

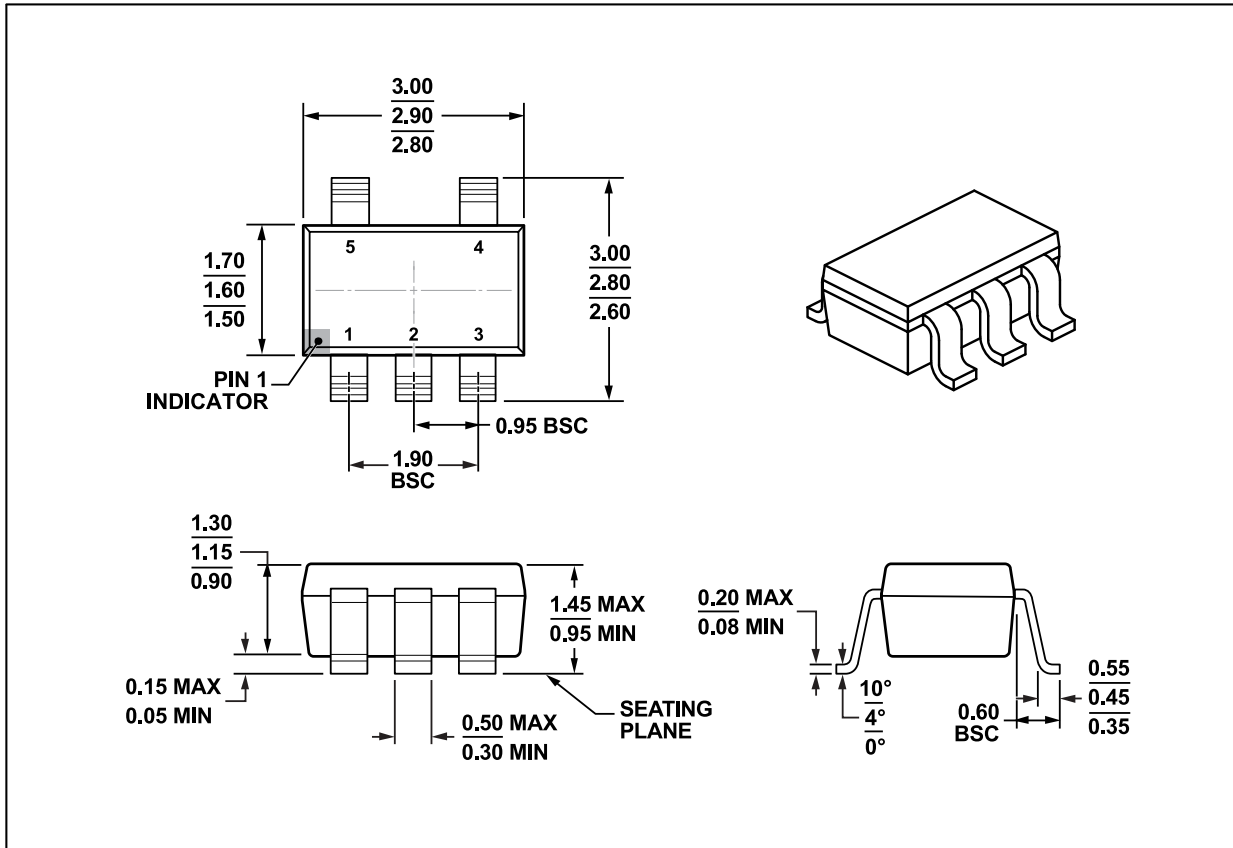
- the input capacitor C<sub>IN</sub> shall be placed close to the VCC (PIN3) and GND (PIN2) pins. In order to minimize the high-frequency noise, it is recommended to connect a 0.1uF ceramic capacitor at the bat terminal and the VCC input terminal, and the wiring is very close to the IC pin.
- For high current paths, large PCB copper-clad area and pad direct connection mode should be used, including GND pin (PIN2). This helps minimize PCB conduction loss and thermal stress.
- In order to minimize the conduction loss of vias and reduce the thermal stress of the module, multiple vias should be used to realize the interconnection between the top layer and other power layers or layers. (The bonding pad at the bottom of the chip and the via window can help the chip heat dissipation and improve the performance)
- The PROG pin impedance is high, and the lead track of R<sub>PROG</sub> should be as short as possible when it is far from the heat source of the chip to reduce the interference to the charging current setting.



Picture 10 Recommended PCB Layout Example

## Footprint description

### 1.45MM high 5-pin SOT-23 plastic encapsulated SOIC

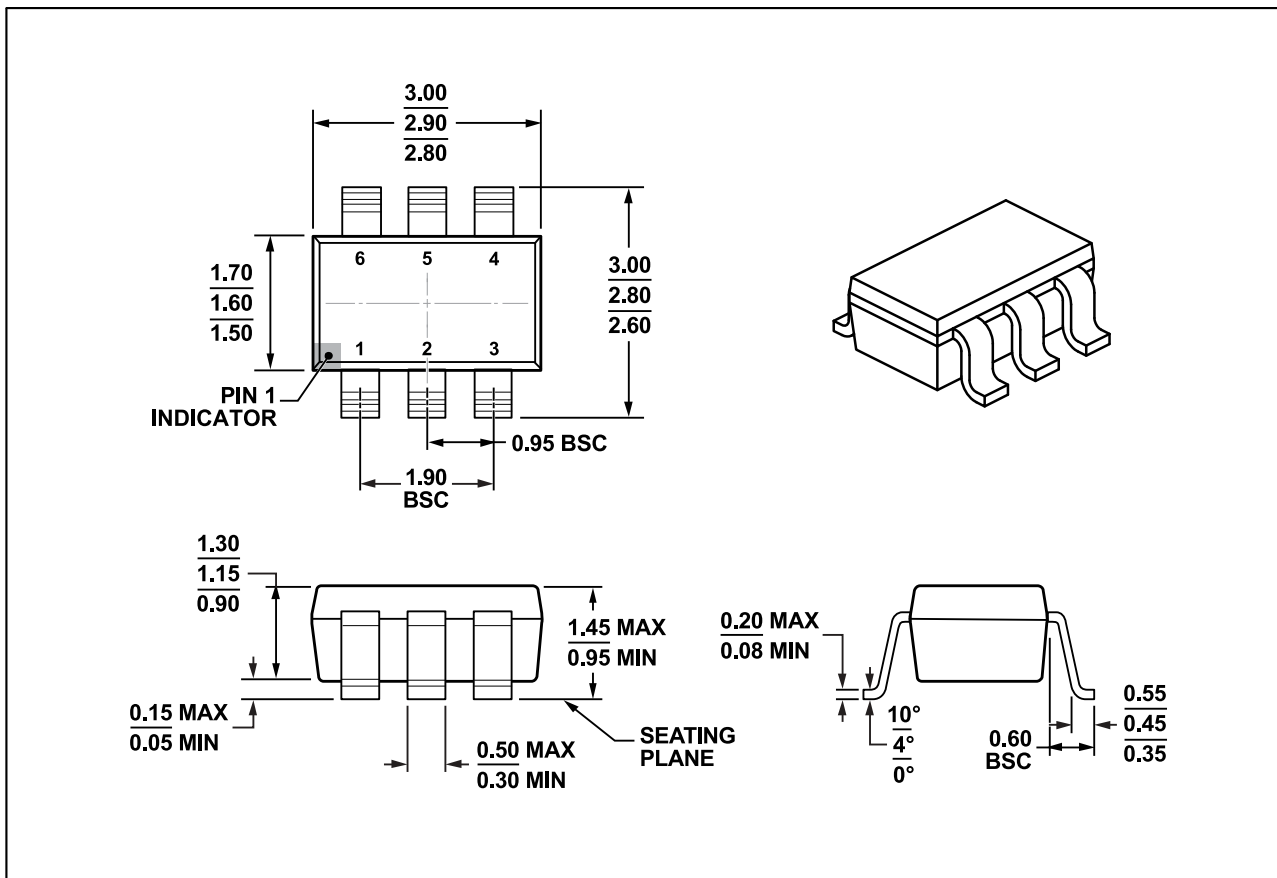


Note:

- 1) All data units are in mm. Any dimension in brackets is for reference only. Dimensions and tolerances shall conform to ASME Y14.5M
- 2) This drawing is subject to change without notice.
- 3) This size does not include mold burrs, protrusions, or nozzle burrs. The burr or protrusion on each side of the mold shall not exceed 0.15mm.
- 4) This size does not include the burr of the mold, and the burr or protrusion on each side of the mold shall not exceed 0.25mm.

## Example of device package pad layout

### 1.45MM high 6-pin SOT-23 plastic encapsulated SOIC

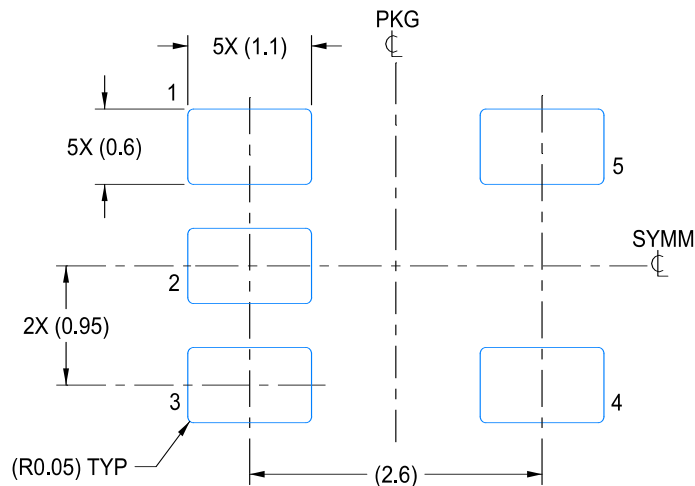


Note:

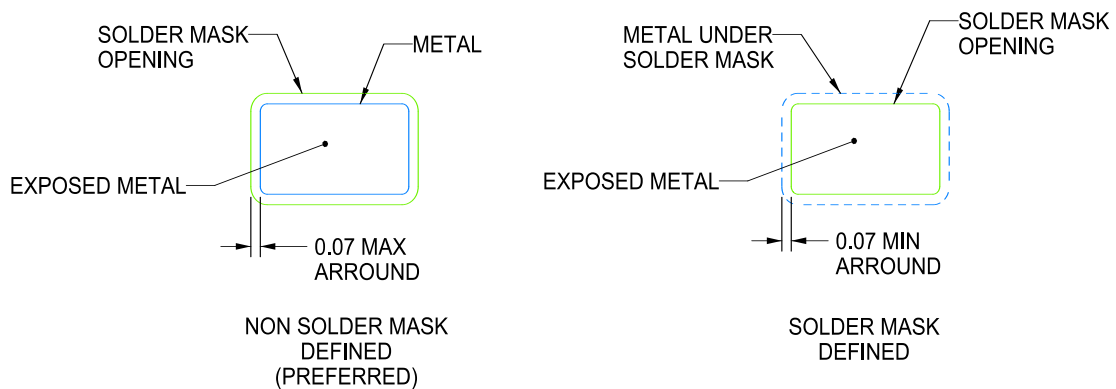
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## Example of device package pad layout

### 1.45MM high 5-pin SOT-23 plastic encapsulated SOIC



Example of device package pad layout  
SCALE:15X



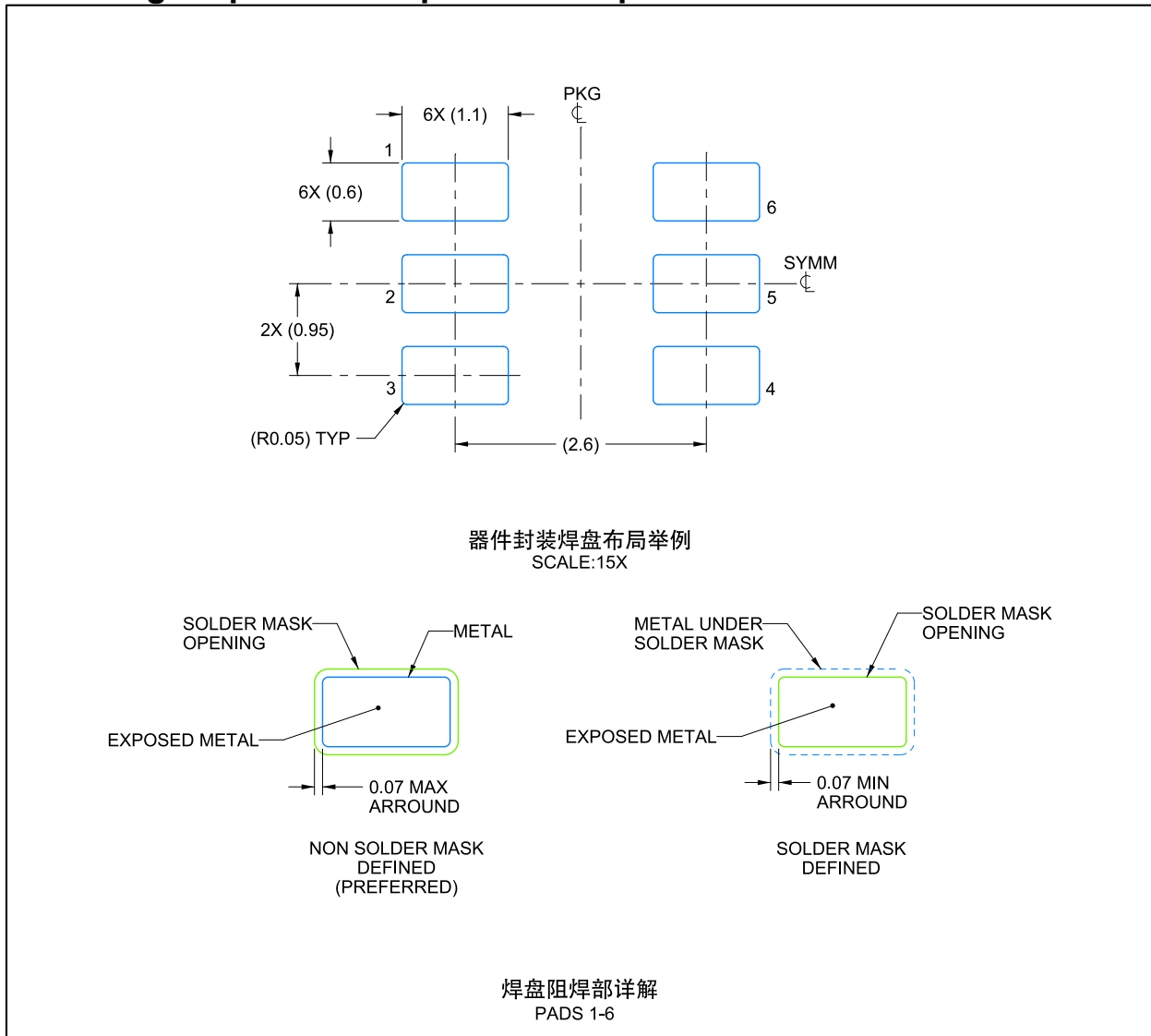
Detailed explanation of pad solder resist  
PADS 1-6

Note:

- 1) Based on IPC-7351, the pad pattern is accurately calculated by relying on proven mathematical algorithms and taking into account manufacturing, assembly and component tolerance.
- 2) The solder mask tolerances between and around the signal pads may vary depending on the circuit board manufacturing.

## Example of device package pad layout

## 1.45MM high 6-pin SOT-23 plastic encapsulated SOIC



Note:

- 1) Based on IPC-7351, the pad pattern is accurately calculated by relying on proven mathematical algorithms and taking into account manufacturing, assembly and component tolerance.
- 2) The solder mask tolerances between and around the signal pads may vary depending on the circuit board manufacturing.

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