Input High Withstand Voltage 500mA Linear Lithium Battery Charger

Check for Samples: LGS7381

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/4.25v/4.3v/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
- Protection Function: UVLO/OTP/OVP/ Charging Current Thermal Regulation/ Constant Current Charging Soft Start
- Junction Temperature Range from -40℃ To +85℃
- All Pin have ±2000v (HBM) ESD Protection

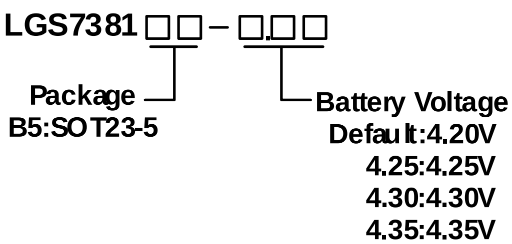
Description

LGS7381 is a linear lithium battery charge management chip integrating lithium battery charge management, providing a complete power supply solution for a single lithium battery. LGS7381 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 LGS7381 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, LGS7381 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.

Applications

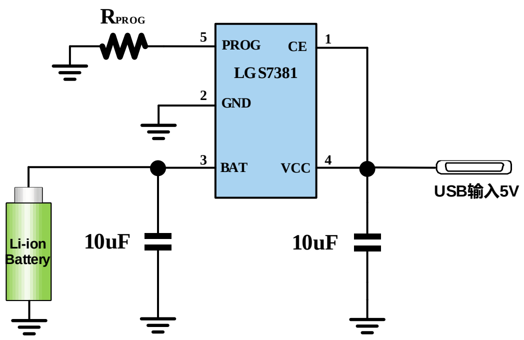
- Mobile multimedia device, MP3, MP4
- Portable device with lithium battery power and USB input

Purchasing Information



Part	Package	Top Mark
LGS7381B5	SOT23-5	LGS7381 YW
Y: Year code.	W: Week code	

Typical Application



Picture 1 Typical Application Topology

Revision History (†)

Rev. C V0.1 16. Aug. 2021	Page
※ 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**
※ Revision B. The content error correction and parameter adjustment are made for the initial version of version B.	ALL
Rev. C V0.3 18. Feb. 2022	**Page**

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

Absolute Maximum Ratings（†）

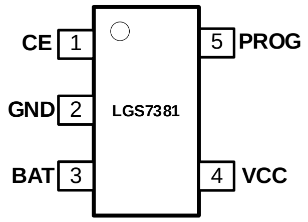
Table 3.1

Parameters	Range
Pin to GND Voltage (VCC， CE)	-0.3V~24V
Pin to GND Voltage（BAT，PROG)	-0.3V~6V
Storage temperature	-65℃ to 150℃
Operating temperature	-40℃ to 125℃
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℃,θ $_{JA}$=173℃/W

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**

PIN	Name	Description
1	CE	Enable input pin. Connected to V_{CC} or MCU control, high level enables charging and low level turns off charging.
2	GND	Chip ground.
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	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 V_{CC} and GND as close as possible.
5	PROG	Constant current charging current setting and charging current monitoring pin. Externally connect a 1% accuracy resistor to the ground to set the charging current. Under short-circuit charging (SC), the voltage of this pin is fixed at 0.05v; Under trickle charging (TC), the voltage of this pin is fixed at 0.1V; Under constant current charging (CC), the voltage of this pin is fixed at 1V. In all modes of the charging process, the charging current can be estimated by measuring the voltage of this pin. The formula is: $I_{BAT}=(V_{PROG}/R_{PROG})\times 1000$。

Technical Specifications

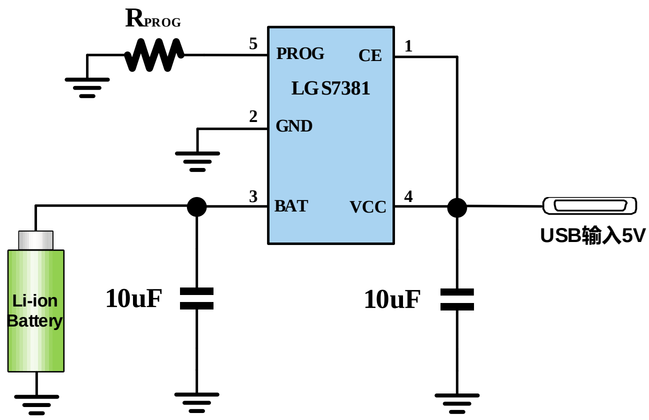
Unless otherwise specified, the following data only represent the most possible parameter specifications when T_J = 25 ℃, for reference only. All voltages are relative to GND. The minimum and maximum limits are specified by test, verification and statistical correlation.

Table 4.

Parameter		Test Conditions	MIN	TYE	MAX	UNIT
(Linear Charging Characteristics)						
V_{CC}	VCC Operation Voltage		4	5	6	V
	VCC Threshold Voltage	Rising, V_{BAT}=3V, EN=1		4.0		V
		Falling, V_{BAT}=3V, EN=1		3.9		V
V_{OVP}	Input Overvoltage Protection			6.25		V
I_Q	VCC Quiescent Current	VCC=5V, EN=1, BAT Suspended		150		μA
	VCC Current	VCC=5V, EN=0, BAT Suspended		40		μA
	BAT current	VCC=0V, V_{BAT}=4.0V			1	μA
	BAT current	VCC=5V, V_{BAT}=4.0V		300	500	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}	Constant current charging (CC) (VBAT=3.7V)	R_{PROG}=2K		500		mA
		R_{PROG}=10K		100		mA
V_{CV} (1)	Constant voltage charging (CV) floating charge voltage	T_J=25℃	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 $R_{DS(ON)}$			800		mΩ
Control logic signal						
V_{CE}	CE high level input voltage	CE Rising		1.37		V
	CE low level input voltage	CE Falling		1.16		V
Global thermal protection						
T_{OTP}	Over temperature protection	T_J		150		℃

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

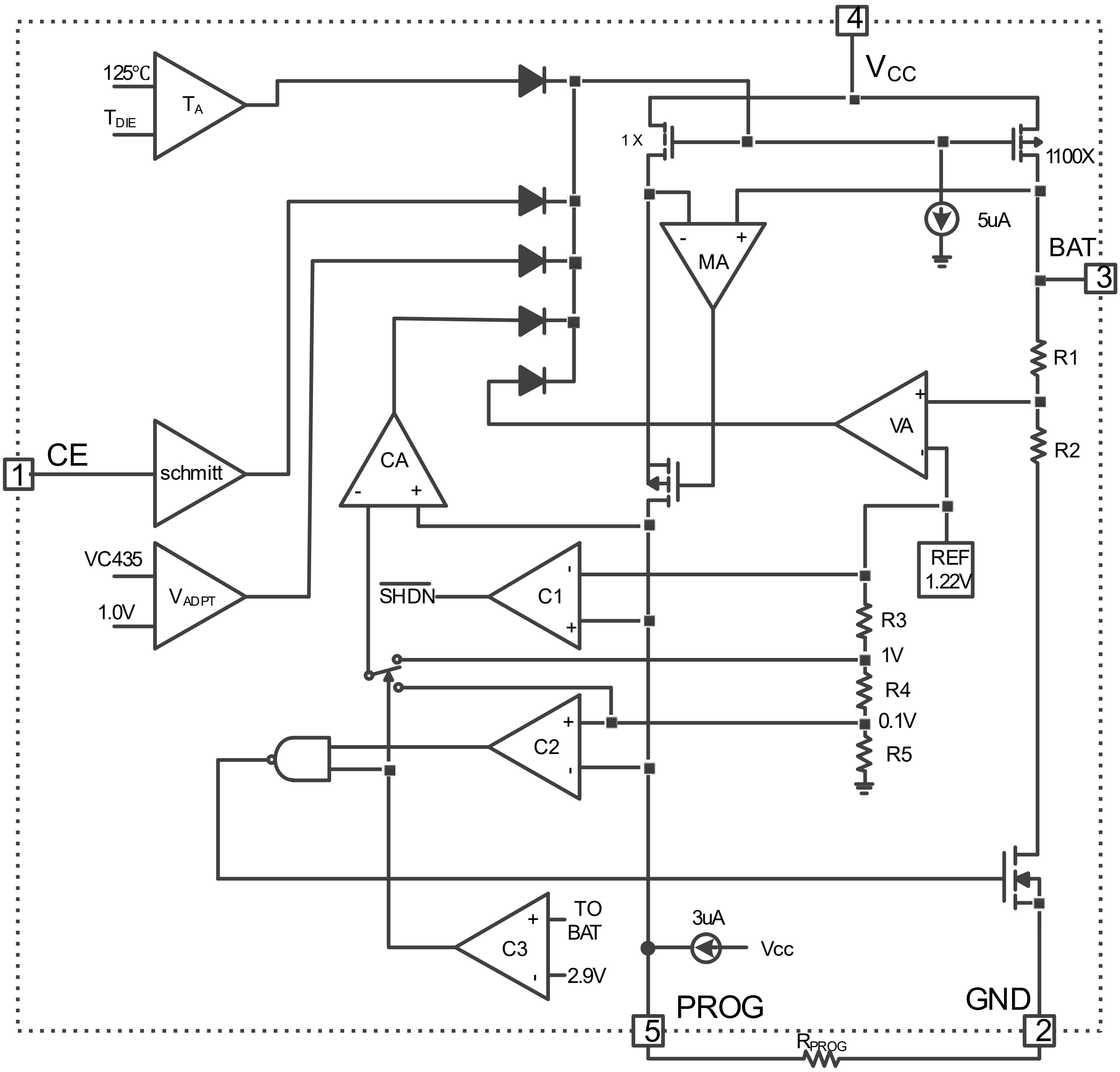
NOTE：

- Charging input pin V_{CC}. Need 10 µF stabilized ceramic capacitor.

Component Selection Recommendation

Symbol	Meaning	Requirement
C_{VCC}	USB charging input constant voltage capacitor	10µF (effective value) ceramic capacitor
C_{BAT}	Battery charging output voltage stabilizing capacitor	10µF(effective value) ceramic capacitor
R_{PROG}	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

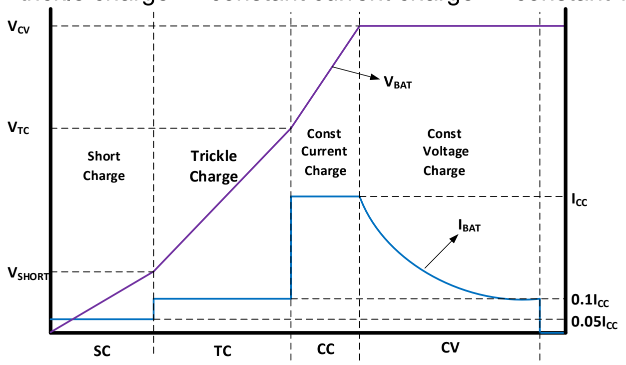
Application Information: Linear Lithium Battery Charger

Summary

LGS7381 is a lithium battery linear charge management IC that integrates lithium battery charge management, providing a complete power supply solution for a single lithium battery. LGS7381 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 LGS7381 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 LGS7381 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.

Normal Charging Cycle

When the V_{CC} voltage of LGS7381 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 LGS7381 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. When 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 LGS7381 charging current can be set by a resistor connected between the PROG pin and the ground. The resistance value of the resistor is determined according to 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: $I_{BAT}=(V_{PROG}/R_{PROG}) \times 1000$ 。

Application Information: Linear Lithium Battery Charger

CE Controlled Charging

At any time in the charging cycle, the LGS7381 can be placed in the shutdown mode by setting the CE terminal to the low potential or removing the R_{PROG} (thereby floating the PROG pin). This reduces the battery leakage current to 1 μ A or less, and the power supply current drops to 40 μ A or less. Reset the CE terminal to high potential or connect the setting resistor to start a new charging cycle.

Overheat Regulation Charging Current

The built-in over temperature loop of LGS7381 during charging can effectively regulate the charging current. By reducing the charging current (85 ℃ $\leqslant T_J \leqslant$ 125 ℃) and briefly turning off the charging (125 ℃ $\leqslant T_J \leqslant$ 150 ℃), 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 LGS7381 integrates the intelligent temperature control function. When 85 ℃ $\leqslant T_J \leqslant$ 125 ℃, the charging current will be linearly reduced; When 125 ℃ $\leqslant T_J \leqslant$ 150 ℃, 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 LGS7381. 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.

Application Information: Linear Lithium Battery Charge IC (Chart)

Figure 9.Electrical Characteristics(Unless Otherwise Specified, T_A = 25 ℃)

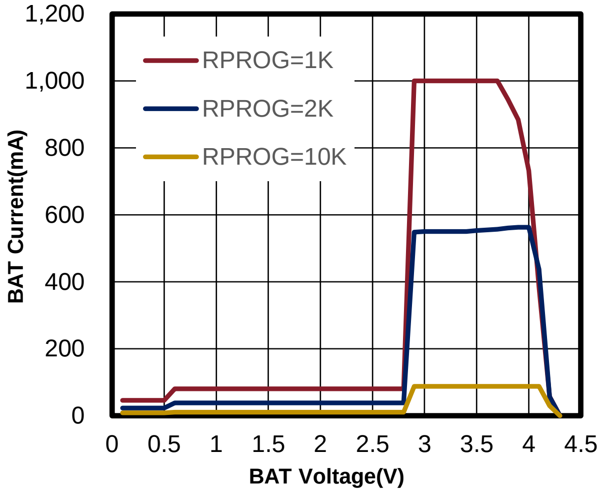


Figure 10.a BAT Current vs BAT Voltage

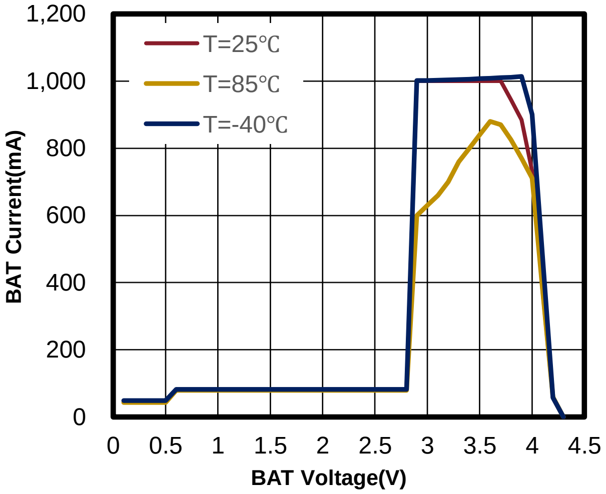


Figure 10.b BAT Current vs Temperature

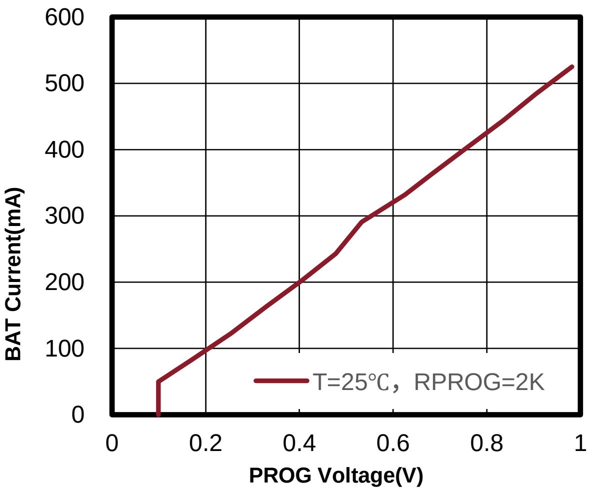


Figure 10.c PROG Voltage vs Temperature

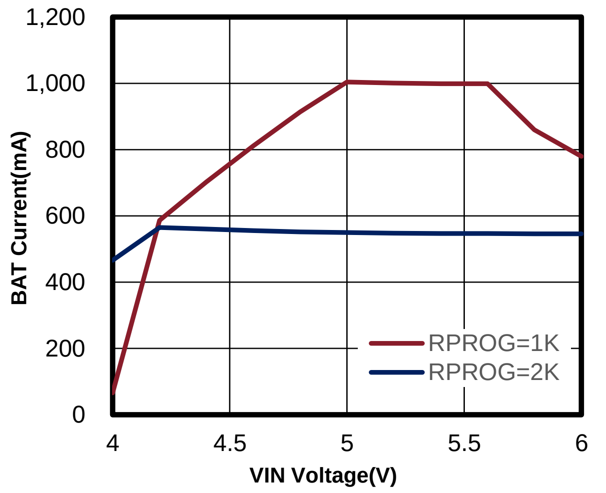


Figure 10.d VIN Voltage vs RPROG

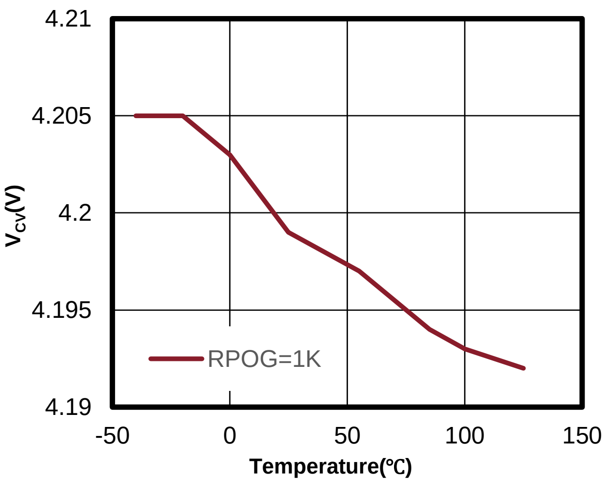


Figure 10.e V_{CV} vs Temperature

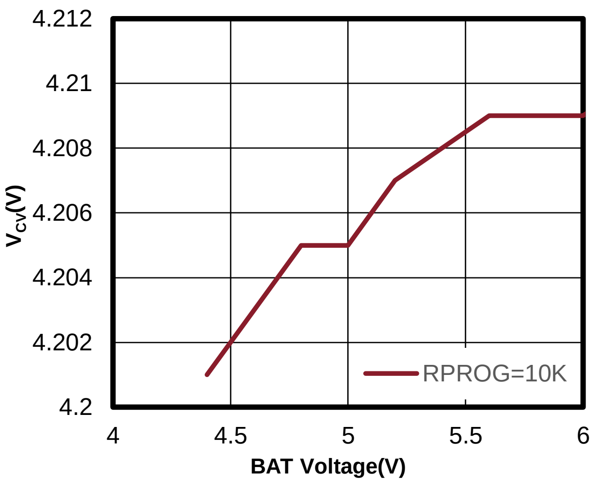


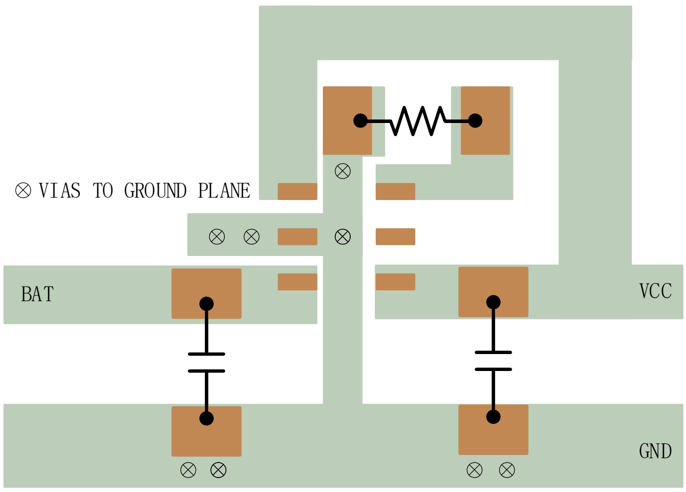
Figure 10.f V_{CV} vs VIN Voltage

Application Information: Reference Layout Example

Summary

Poor layout will affect the performance of LGS7381, 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:

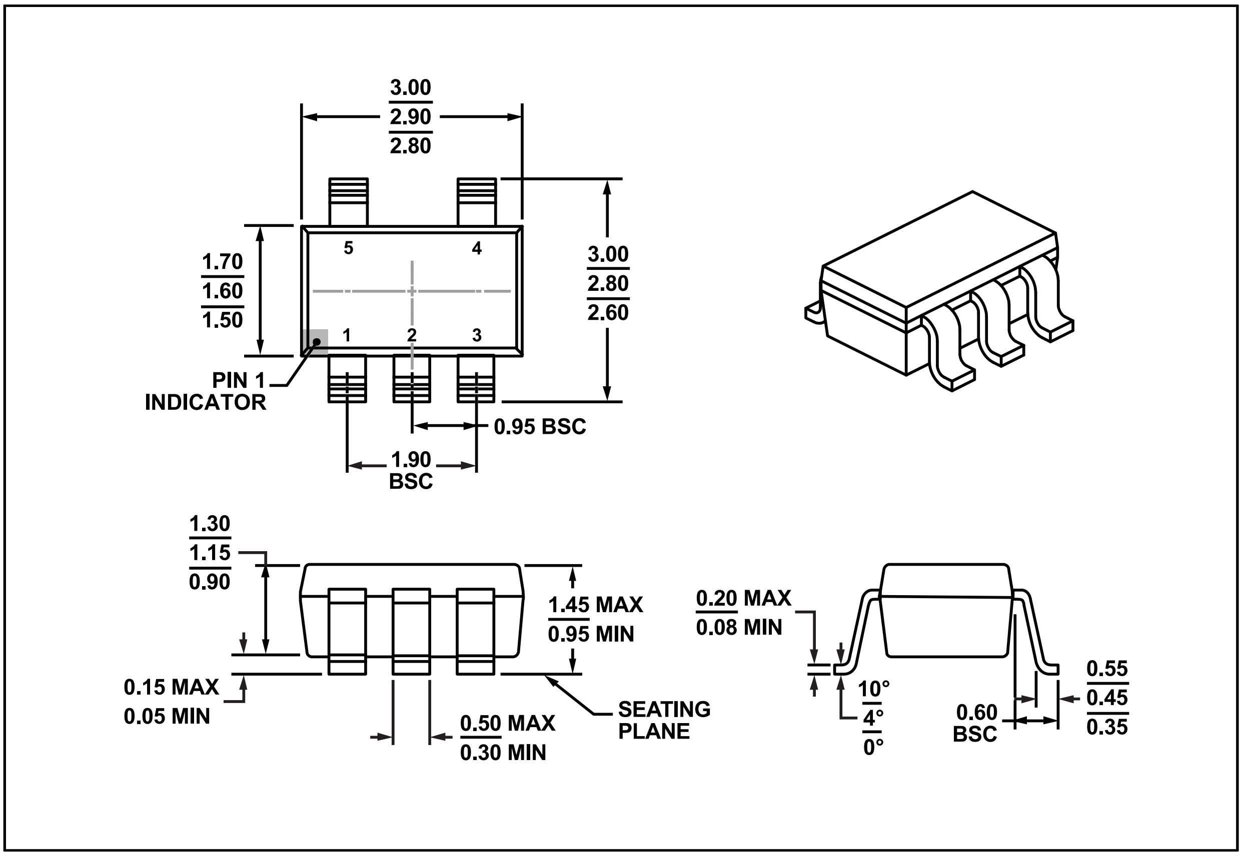
- the input capacitor C_{IN} shall be placed close to the V_{CC} (PIN4) and GND (PIN2) pins. In order to minimize the high-frequency noise, it is recommended to connect a 0.1uF ceramic capacitor at the bat terminal and the V_{CC} input terminal, and the wiring is very close to the IC pin.
- In order 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 PROG pin impedance is high, and the lead track of R_{PROG} 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

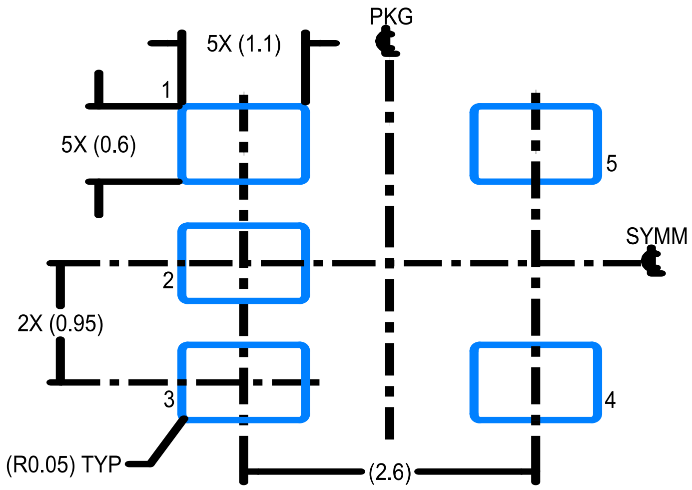


Note:

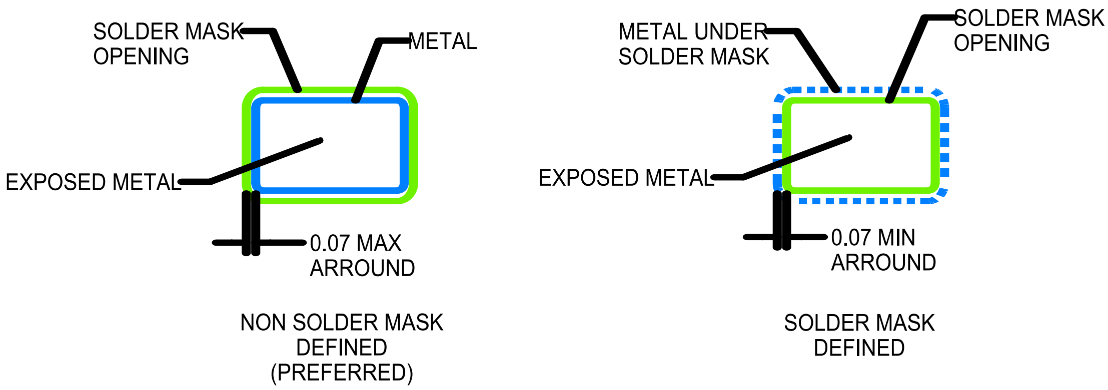
1) All data units are in mm. Any dimension in brackets is for reference only. Dimensions and tolerances shall conform to ASME Y14.5M
2) This drawing is subject to change without notice.
3) This size does not include mold burrs, protrusions, or nozzle burrs. The burr or protrusion on each side of the 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 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.
4) The solder mask tolerances between and around the signal pads may vary depending on the circuit board manufacturing.

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