Input high voltage 1A linear lithium battery charge management chip

Check for Samples: LGS4056H

characteristic

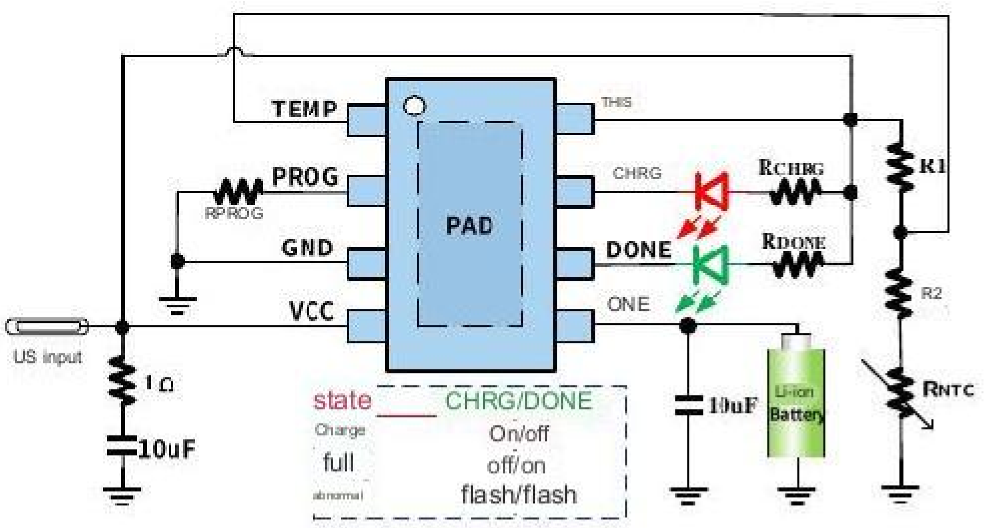
NEW Built-in linear charger that supports input high withstand voltage and adjustable current:

- Built-in 24V power tube, can withstand surge voltage up to 28V
- The maximum charging current can reach 1A under constant current, and supports real-time configuration of charging current by external resistor
- Compatible with 5V USB power source and AC adapter, and provides hot-swappable protection
- Supports 4.2V/4.25V/4.3V/4.35V lithium battery type (the default version without suffix is 4.2V version)
- Default 4.2V±1% charging float voltage
- Intelligently adjust charging current according to battery temperature and input voltage
- With battery anti-backflow function, battery terminal leakage is less than 1uA
- Integrated charging and full prompts, as well as battery not connected indication
- Perfect protection: input overvoltage, input undervoltage, charging current thermal adjustment, chip thermal protection, constant current charging soft start
- Junction temperature range is -40°C to +85°C
- All ports have ±2000V (HBM) ESD protection

application

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

Typical application topology



describe

LGS4056H is a linear lithium battery charge management chip that integrates lithium battery charge management and battery charge status indication, providing a complete power solution for single-cell lithium batteries. LGS4056H has four charging processes: short circuit (SC), trickle current (TC), constant current (CC) and constant voltage (CV): short circuit charging (SC) can charge OV batteries; trickle charging (TC) can precharge Restores a fully discharged battery; constant current charging (CC) can quickly recharge the battery; constant voltage charging (CV) can ensure safe recharging of the battery.

The charging cut-off voltage of LGS4056H is 4.2V by default, and the charging current can be set through an external resistor. The maximum charging current is 1A. When the charging current drops to 1/10 of the set value, LGS4056H will automatically end the charging process, continue to detect the battery voltage, and automatically recharge when it drops to a certain threshold. When the input power supply (USB source or AC adapter) is removed, it automatically enters low power consumption mode, and the battery leakage is less than 1uA.

LGS4056H integrates charging and full prompts, as well as battery not connected indication.

Purchasing Information

LGS4056H□□-□□□

Packaging information one — EP: ESOP8; DA: DFN2x2-8; DB: DFN3x3-8

full voltage — Default: 4.20V; 4.30:4.30V; 4.35:4.35V; 4.40:4.40V

Part	Package	Top Mark
LGS4056HEP	ESOP8	4056H YWX
LGS4056HDA	DFN2x2-8	4056H
LGS4056HDB	DFN3x3-8	4056H

Y: Year of production W: Week of production X: Version number

Application Information: Typical Application Circuit

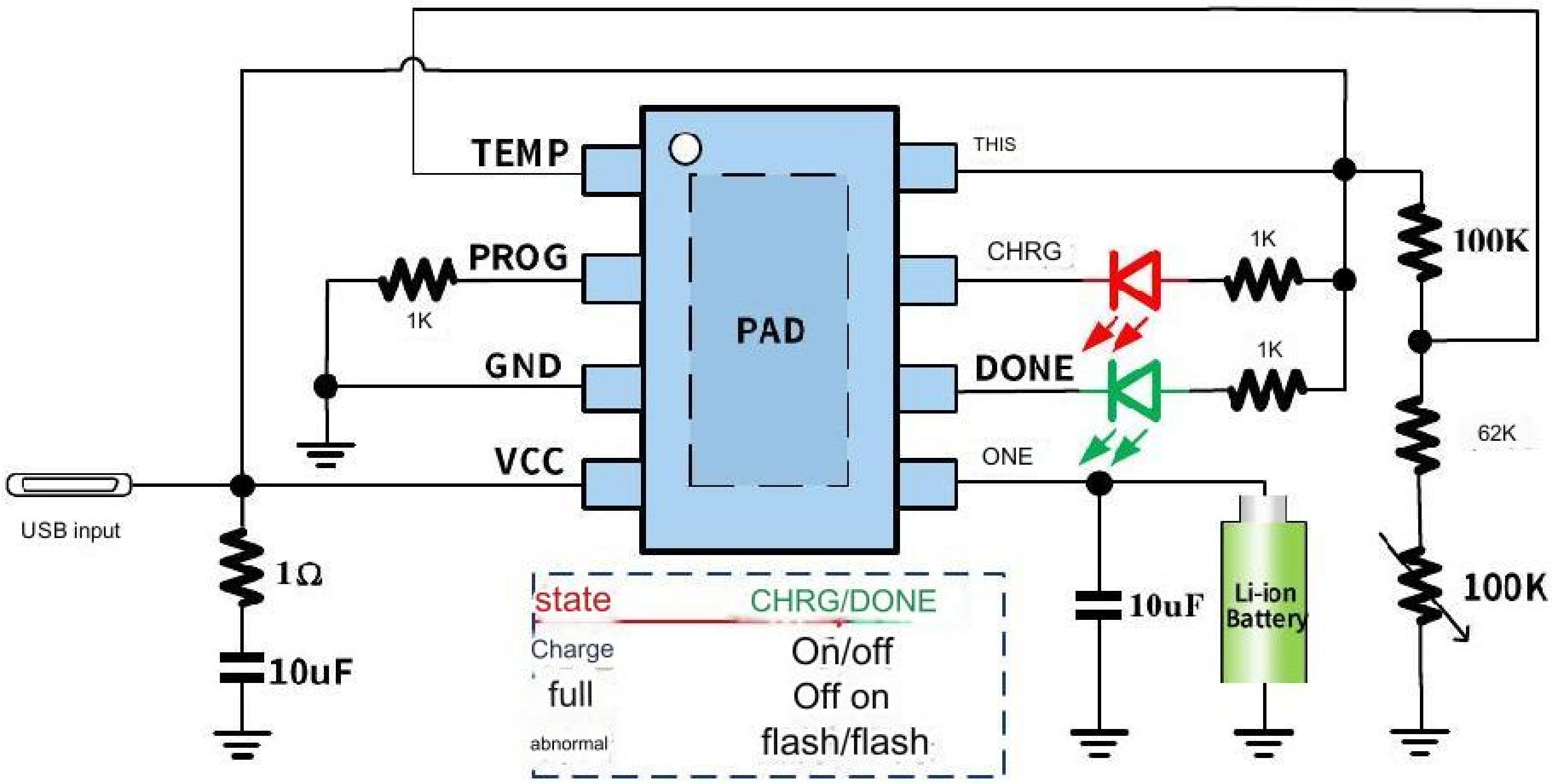


Figure 5 Typical application topology

NOTE：

- Charging input pin VCC. A 10μF voltage stabilizing ceramic capacitor is required, but since extremely high transient voltage signals may be generated under certain startup conditions, adding a 12Ω resistor in series with the ceramic capacitor will minimize the startup voltage transient signal.
- If the NTC function is not used, just leave the TEMP pin floating. The NTC resistor is generally located inside the battery, but can also be located outside. In a typical application, a 100K NTC resistor with a B value of 4250K is used in series with a 62K resistor and then connected in series with a 100K resistor from VCC to ground. This combination can ensure that the battery is charged and protected below 0°C and above 60°C. Battery. If other combinations are used or other models, please refer to the battery temperature detection function on page 8 for reasonable design or consult our FAE, they will give reasonable suggestions and combinations. Note: Since the VCC pin is a high-voltage pin, and the TEMP pin is connected to ground through the VCC voltage dividing resistor, it is necessary to ensure that the resistance between the VCC and TEMP pins should be greater than 10K, so that it 让在 VCC can withstand high voltage. The TEMP loop current is limited and the TEMP potential is clamped at a safe voltage.
- For the heat dissipation pad at the bottom of the chip, a larger copper area should be used to connect to the PCB ground plane. This will help minimize PCB conduction losses and thermal stress, and prevent the charging current from decreasing due to excessive chip temperature.
- It is recommended to connect a 1K current limiting resistor when using the LED indicator light. If the charging indication function is not used, just float the corresponding pin.

Component selection recommendations

symbol	meaning	Require
C_{VCC}	USB charging input voltage stabilizing capacitor	10μF (rms) ceramic capacitor
CRAT	Battery charging output voltage stabilizing capacitor	10μF (rms) ceramic capacitor
RCHRG RDONE	LED current limiting resistor	Choose according to the brightness requirements of the lamp, above 1K
RPROG	Constant current charging current setting resistor	Accuracy: 1%, according to the formula /BAT = (VPROG/RPROG)×1000 setting completed.
R_{NTC}	NTC thermistor	100K, B value: 4250K, accuracy: 1%

Absolute maximum (+)

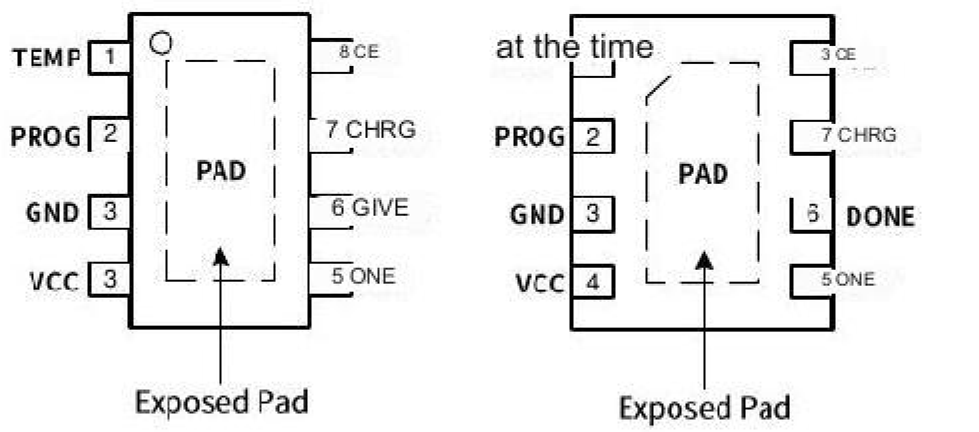
Form 3.1

parameter	scope
Pin to GND voltage (VCC, CHRG DONE, CE)	-0.3V~28V
Pin to GND voltage (BAT, TEMP PROG)	-0.3V~6V
Storage temperature	-65℃ to 150℃
Operating temperature	-40℃ to 125℃
ESD Rating (HBM)	±2000V
ESD Rating (CDM)	±1000V

† Note: If the device operating conditions exceed the above "absolute maximum values", it may cause permanent damage to the device. This is only a limit parameter, and it is not recommended that the device operates at the limit value or exceeds the above limit value. Operating the device under extreme conditions for a long time may affect its reliability.

Pinout

Figure 3. Pinout



ESD (electrostatic discharge) sensitive devices.

Charged devices and circuit boards can discharge without being aware of it. Although this product has patented or proprietary protection circuitry, the device may be damaged when exposed to high-energy ESD. Therefore, appropriate ESD precautions should be taken to avoid device performance degradation or loss of functionality.

Table 3.2 Pin function description

Pin number	Pin name	illustrate
1	TEMP	Battery temperature detection pin. Connect the TEMP pin to the output of the battery's NTC sensor. If the voltage of the TEMP pin is less than 45% of the input voltage or greater than 80% of the input voltage, it means that the battery temperature is too low or too high, and charging is suspended. If the TEMP pin is grounded or floating, the battery temperature detection function is canceled and other charging functions are normal.
2	PROG	Constant current charging current setting and charging current monitoring pin. Externally connect a 1% resistor to ground to set the charge current. The setting formula for 300mA and above: IBAT = 1000/RPROG, the setting for 300mA and below is IBAT = 900/RPROGO. Example: 1K corresponds to 1A charging; 2K corresponds to 0.5A charging; 3K corresponds to 0.3A charging.
3	GND	chip ground.
4	VCC	Power input pin. Connect to the positive terminal of the power supply and use a ceramic capacitor with at least 10uF rms value as close as possible to bypass VCC and GND.
5	ONE	Battery charging output pin. Connect to the positive terminal of the battery and place a ceramic capacitor of at least 10uF rms to ground.
6	DONE	Full indicator pin. Connect to the negative pole of the LED light. When the battery is full, the pin outputs low level and the indicator light turns on.
7	CHRG	Charging indicator pin. Connect to the negative pole of the LED light. When the battery is charging, the pin outputs low level and the indicator light turns on.
8	THIS	Enable input pin. Connect to VCC or MCU control, high level enables charging, low level turns off charging.
EP	PAD	The heat dissipation pad at the bottom of the package can be connected to the chip ( ) and to a large copper-clad plane to achieve better heat dissipation.

Technical specifications

Unless otherwise specified, the following data only represent the most likely parameter specifications when T = 25°C and are for reference only. All voltages are relative to GND. Minimum and maximum limits are specified through testing, verification and statistical correlation.

Table 4.

parameter		Test Conditions	minimum value	Typical value	maximum value	unit
Charging characteristics (Linear Charger)						
V_{CC}	Recommended input operating voltage range		4	5	6	IN
	Input undervoltage lockout	Rising, V_{BAT}=3V, EN=1		4.0		IN
		Falling, VBAT=3V, EN=1		3.9		IN
VOVP	Input overvoltage protection			6.25		IN
it	Quiescent current VCC current	VCC=5V, EN=1, BAT floating		150		MA
	VCC current	VCC=5V, EN=0, BAT floating		40		MA
	BAT current	VCC=0V, V_{BAT}=4.0V			1	MA
	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		IN
V_{SHORT_HYS}	Short circuit charge (SC) hysteresis voltage			0.1		IN
I_{TC} (1)	Trickle charge (TC) current	VSHORT VBAT<VPRE		10%	14%	I_{CC}
VTC	Trickle Charge (TC) Threshold Voltage	less than this threshold	2.65	2.90	3.15	IN
VTC HYS	Trickle charge (TC) hysteresis voltage			0.5		IN
I_{CC} (1)	Constant current charging (CC) (VBAT=3.7V)	RPROG=1K		1000		mA
		R_{PROG}=1.2K		800		mA
		R_{PROG}=2K		500		mA
		R_{PROG}=10K		100		mA
V_{CV} (1)	Constant voltage charging (CV) float charging voltage	T_J=25°C	4.15	4.20	4.25	IN
I_{TERM}	Constant voltage charging (CV) cut-off charging current			1/10		I_{CC}
V_{RECHRG}	Recharge threshold after battery is fully charged			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		IN
	CE low level input voltage	CE Falling		1.16		IN
Global thermal protection and battery temperature control features						
VTEM-H (2)	Battery overheating NTC threshold	Greater than this threshold, turn off charging		80%		VCC
VTEMP-L (2)	Battery overcooling NTC threshold	Less than this threshold, charging is turned off		45%		VCC
	Turn off NTC function	NTC pin floating or grounded				
TOTP	Over temperature protection	T_J		150		℃
Indicator light (LED)						
ICHRG	LED drive current			5		mA
EYES	LED drive current			5		mA

(1) In order to protect the battery during the charging process, the chip will detect the battery voltage and execute four different charging stages, short circuit charge (Short Charge) → trickle charge (tricle charge) → constant current charge (Const Current Charge) → constant voltage Charging (Const Voltage Charge)→Charging stops.

(2) Battery temperature control, the chip will detect the voltage on the TEMP pin to determine the battery temperature. The NTC resistor used is generally located inside the battery. In typical NTC applications, the NTC resistor built into the battery is connected in series with resistor R2 and then connected in series with resistor R1 from VCC to ground. Other combinations can be used according to the NTC hot and cold thresholds. Please refer to the NTC voltage and temperature thresholds for design.

Functional block diagram

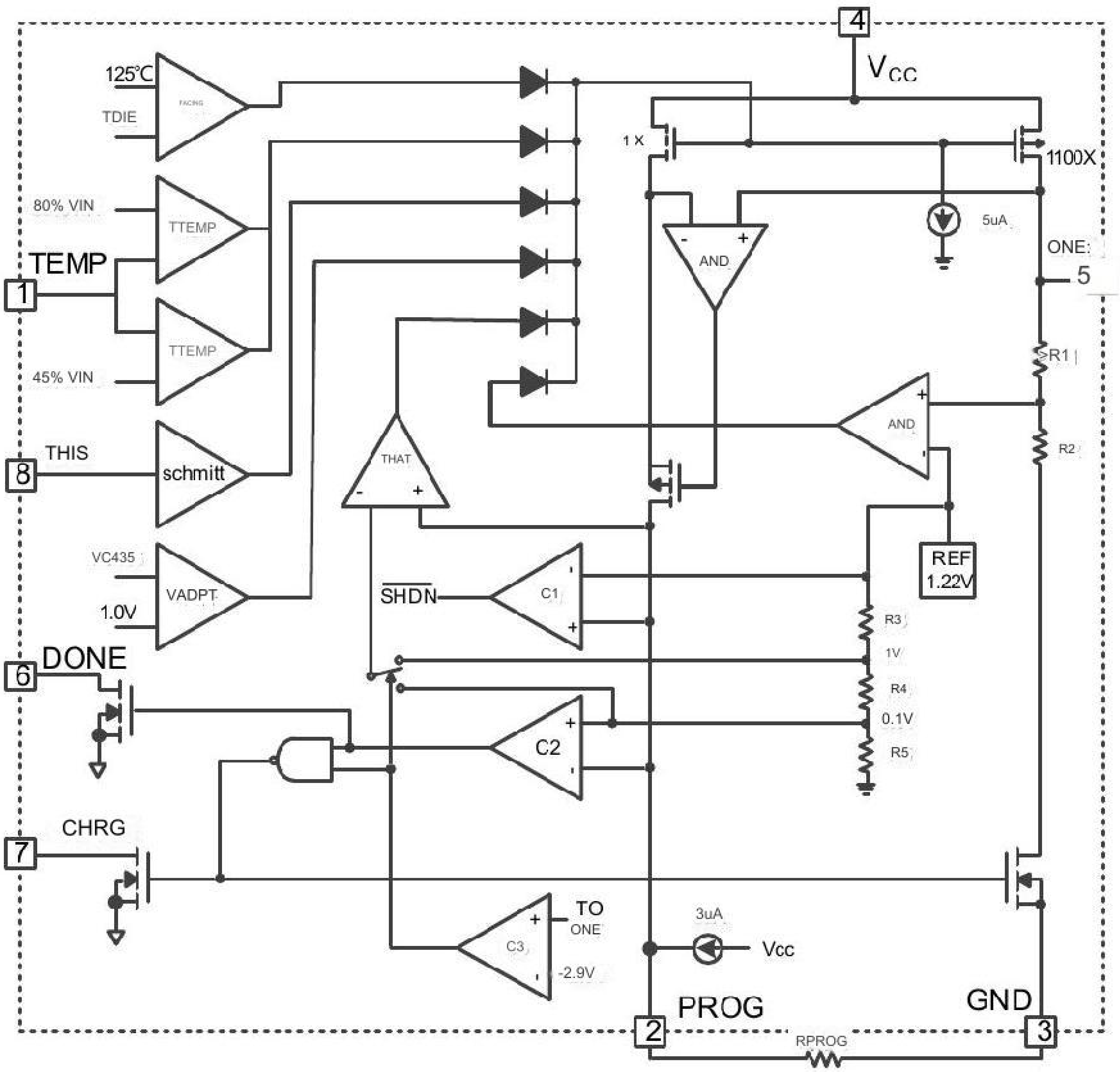


Figure 6. Internal functional block diagram

Application Information: Linear Lithium Battery Charging Management Chip (Charging Overview)

Overview

LGS4056H is a lithium battery linear charging management chip that integrates lithium battery charging management and battery charging status indication, providing a complete charging solution for single-cell lithium batteries. LGS4056H has four charging processes: short circuit (SC), trickle current (TC), constant current (CC) and constant voltage (CV): short circuit charging (SC) can charge OV batteries; trickle charging (TC) can precharge Restores a fully discharged battery; Constant Current Charging (CC) can quickly recharge the battery; Constant Voltage Charging (CV) can ensure safe recharging of the battery.

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Normal charging cycle

When the VCC voltage of LGS4056H is greater than UVLO, wait for the chip's internal power supply to start up, and then start a charging cycle.

In order to protect the battery during the charging process, the chip will detect the battery voltage and perform different charging stages, short circuit charge (Short Charge) → trickle charge (tricle charge) → constant current charge (Const Current Charge) → constant voltage charge (Const Voltage Charge))→Charging stops.

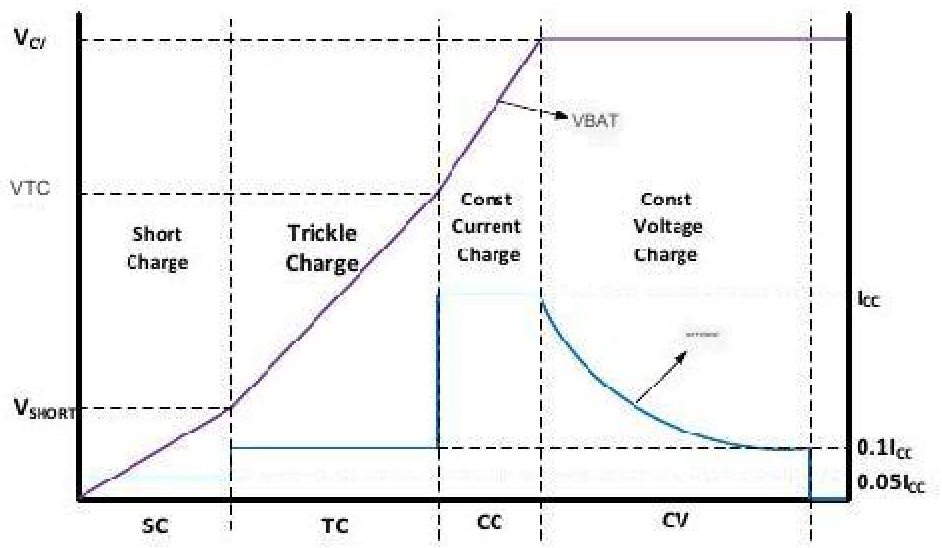


Figure 7. Battery charging cycle

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

When the voltage on BAT is lower than VTC (typ. 2.9V) and greater than VSHORT (typ. value 0.6V), the rechargeable battery will enter the trickle charging mode (also known as the lithium battery's Precharge mode) performs restorative charging on the battery unit. In this mode, The charging current will be reduced to 10% of the preset charging current.

When the battery voltage rises above VPRE (typical value 2.9V), the charging current will rise to the full-speed preset current for constant current charging mode.

When reaching the preset charging voltage Vcv (4.2V), LGS4056H will enter constant When the voltage is charged, the charging current begins to decrease until it drops to ITERM (typical value 1/10 Icc), then stop charging.

After stopping charging, the chip enters standby mode and will continue to detect the BAT voltage. When the BAT voltage drops to VRECHRG (recharge threshold 4V), it will automatically Enter a new charging cycle to ensure that the battery is at a full charge level.

Set output current

LGS4056H charging current can be connected between PROG pin and ground. The resistor between them is set. Determine the resistance according to the required charging current The resistance of the device. In all modes of charging process, this can be measured by pin voltage to estimate the charging current. Setting formula for 300mA and above:

IBAT = 1000/RPROG, below 300mA is set to IBAT = 900/RPROGO Example: 1K corresponds to 1A charging; 2K corresponds to 0.5A charging Power; 3K corresponds to 0.3A charging.

CE controlled charging

At any time during the charge cycle, the CE pin can be set low or Remove RPROG (thereby floating the PROG pin) to convert the LGS4056H Put into shutdown mode. This reduces battery leakage current to less than 1μA, and the battery Source current drops below 40μA. Set the CE terminal to high potential again or connect Connect the setting resistor to start a new charging cycle.

Application Information: Linear Lithium Battery Charging Management Chip (Charging Overview)

Charging status indicator light

LGS4056H integrates charging and full prompts, as well as three charging status indicators when the battery is not connected. When the battery is not connected, the LED light will enter the flashing alarm state. LGS4056H has two open-drain state output terminals: CHRG and DONE. When charging is in progress, CHRG is pulled to low level and DONE is in high-impedance state; after charging is completed, CHRG is in high-impedance state and DONE is pulled to low level. flat. If the status indication function is not used, connect the unused status indication output terminal to ground.

charging	CHRG	DONE
Charging	Bright	destroy
finished charging	destroy	Bright
Battery not connected	flashing	Bright
Under voltage, temperature too high or too low	destroy	destroy

Thermal Considerations for Packages

The small form factor of the ESOP8 package makes it important to have a thermally designed PCB layout to maximize the usable charging current. The thermal path used to dissipate the heat generated by the IC runs from the chip to the lead frame and through the bottom heat sink to the PCB copper surface. The copper-clad surface of the PCB board is a heat sink. The copper area where the heat sink is connected should be as wide as possible and extend outward into the larger copper area to dissipate heat to the surrounding environment. Vias to internal or back copper circuit layers are also useful in improving the overall thermal performance of the charger. When designing the PCB board layout, other heat sources on the circuit board that are not related to the charger must also be considered because they will have an impact on the overall temperature rise and the maximum charging current.

Overheating regulates charging current

The built-in over-temperature loop of LGS4084H can effectively adjust the charging current during the charging process. By reducing the charging current, the junction temperature of the chip will not be too high and the chip temperature will not continue to increase. This also means that the charging current in constant current mode may not be the set Icc and will be subject to temperature. This feature allows the user to increase the upper limit of a given board's power handling capabilities without risking damage to the LGS4084H. Under the premise of ensuring that the charger will automatically reduce the current under worst-case conditions, it can be based on typical (not is the worst case) ambient temperature to set the charging current.

High voltage hot swap

If you can see spikes higher than the input VCC withstand voltage when the USB interface is powered on in the overall solution, you can add a 10Ω resistor in series to the VCC capacitor to filter the spikes.

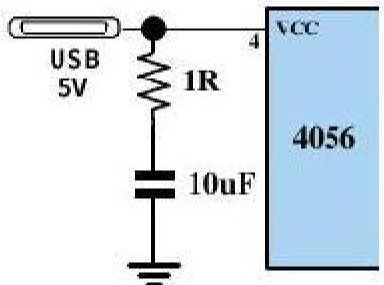


Figure 5.c Type-C high voltage interface hot swap

Series NTC resistor selection (series type)

In order to prevent damage to the battery caused by too high or too low temperature, LGS4056H integrates a battery temperature monitoring circuit. battery temperature monitor The measurement is achieved by monitoring the voltage of the TEMP pin. The TEMP pin The voltage is determined by the NTC thermistor within the battery and a resistor divider network Implementation, as shown in the typical application circuit or in the figure below. LGS4056H will The voltage of the TEMP pin is the same as the two internal thresholds of the chip, VTEMP-H and VTEMP-L is compared to confirm whether the battery temperature is outside the normal range. VTEMP-L=45%×VCC, VIEMP-H=80%×Vcc. If TEMP tube The voltage of the pin is VTEMP<VTEMF-L or VTEMP>VTEMP-H, which means the voltage If the temperature of the battery is too high or too low, the charging process will be terminated; if it is not needed If you want the battery temperature monitoring function, the TEMP pin must be left floating or grounded. That's it.

Example: Set the battery low temperature threshold to 0℃, the over temperature threshold is set to 60℃

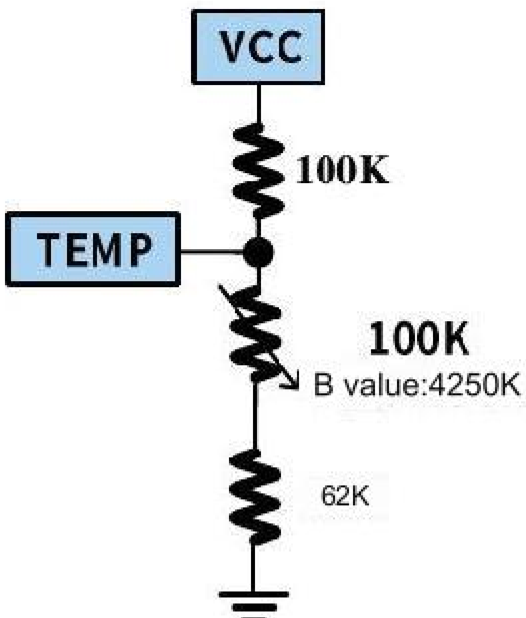
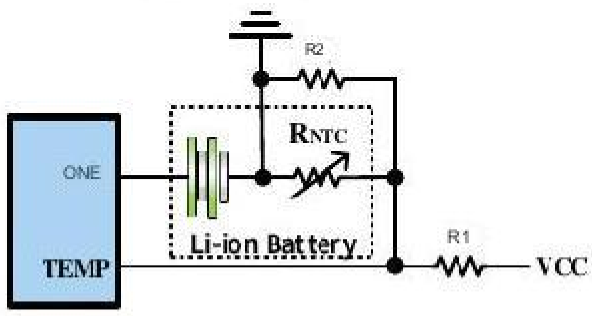


Figure 8.TEMP pin resistance configuration (series type)

Application Information: Parallel NTC Resistor Selection (Parallel Type)

In order to prevent damage to the battery caused by too high or too low temperature, LGS4056H monitors the battery temperature by measuring the NTC voltage. When the rate K (K=VNTC/VDD) reaches the UTP (KUT) or OTP (KOT) threshold, the controller triggers UTP or OTP. If the voltage of the NTC pin is less than 45% of the VOD voltage or greater than 80% of the VDD voltage, it means that the battery temperature is too low or too high, and charging is suspended. It is compatible with the parallel temperature sensing network of 4056 commonly used in the market, as shown in the figure below. Select R2 and R1 to program the appropriate UTP and OTP temperature threshold points.



calculation steps:

1. Define KJT, KUT=73%~83%, typical value is 80%
2. Definition Kᴏᴛ, KOT=42%~48%, typical value 45%
3. Assume that the battery NTC thermistor is RUT at the UTP threshold and ROTO at the OTP threshold.
4. Calculate R1

$$R1 = \frac{\text{ROTRUT (KUT - Kot)}}{\text{(RUT-ROT) KUT KOT}}$$

5. Calculate R2

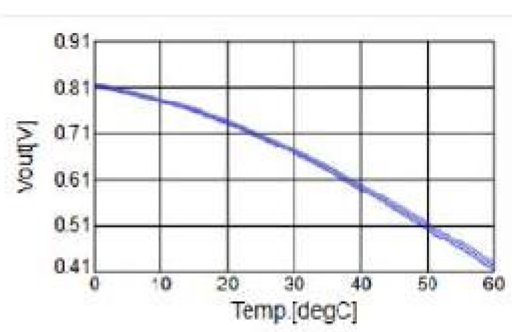
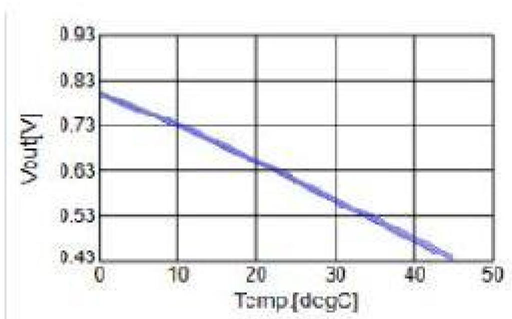
$$R2 = \frac{\text{ROTRUT (KUT-- Cat)}}{\text{ROT (Cat - CatKUT)-RUT (KUT - Cat Kit)}}$$

If the typical values KUT=80% and KOT=45% are selected, then

$$R_1 = \frac{0.97 R_{OT} R_{UT}}{(R_{UT} - R_{OT})}$$

$$R2 = \frac{\text{0.35ROOT RUT}}{\text{0.09 RED-0.44RUT}}$$

We choose the market

temperature	R_{NTC}	Resistor B value	R1	R2	Model
0℃~60℃	10K, accuracy 1%	3380K	3.9K	**51K**	
0℃~60℃	100K, accuracy 1%	**4250K**	27K	**180K**	
-10℃~60℃	10K, accuracy 1%	3380K	3.6K	**24K**	
0℃~45℃	10K, accuracy 1%	3380K	6.2K	330K	
0℃~45℃	100K, accuracy 1%	**4250K**	**47K**	**470K**	
0℃~45℃	10K, accuracy 1%	3380K	6.2K	**0K**	

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

Figure 9.Electrical Characteristics (Unless otherwise stated, VCC=5V, TA=25 °C)

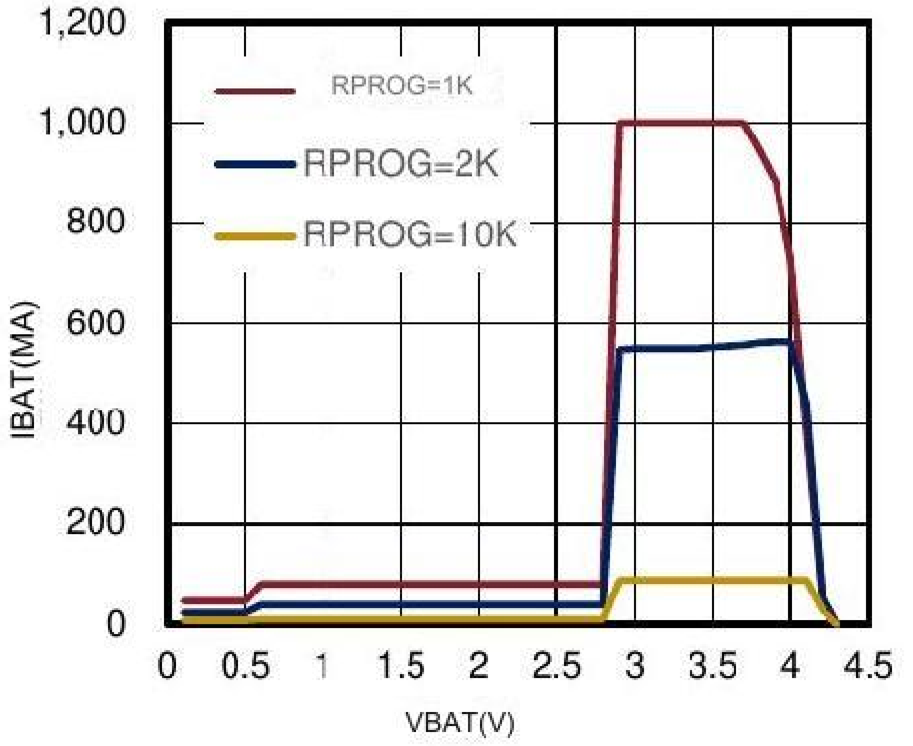


Figure 9.a I_{BAT} vs V_{BAT}

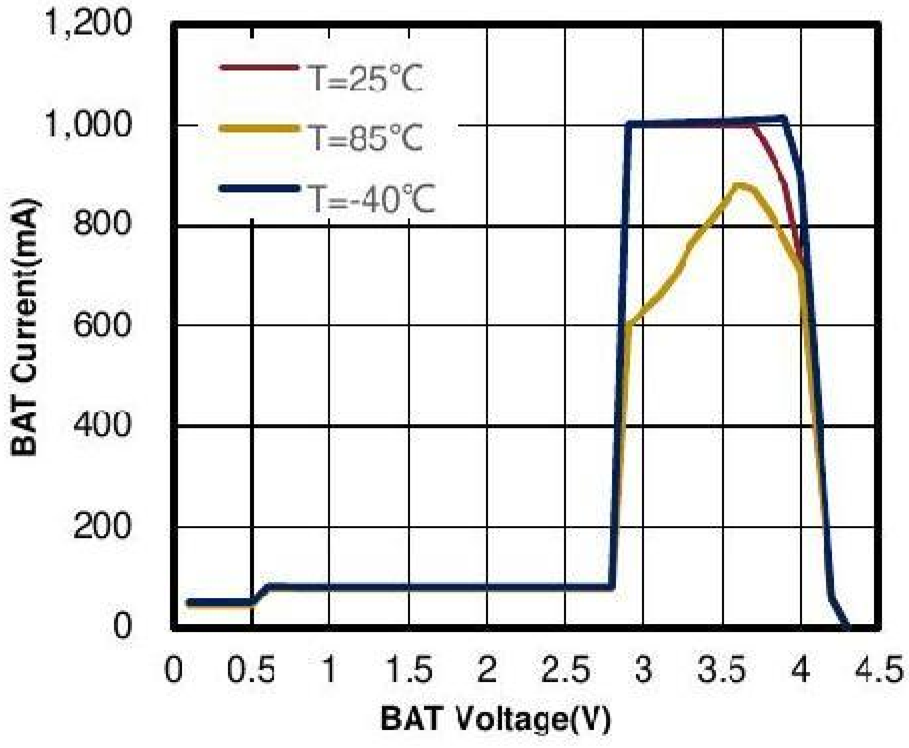


Figure 9.b IBAT VS VBAT (RPROG=1K)

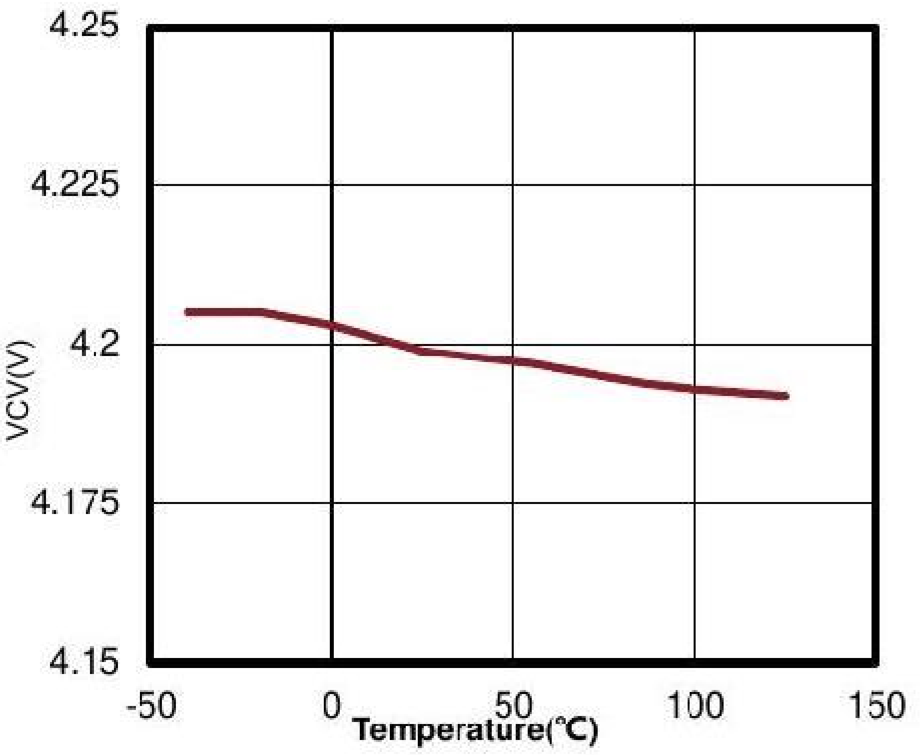


Figure 9.c V_{CV} vs Temperature

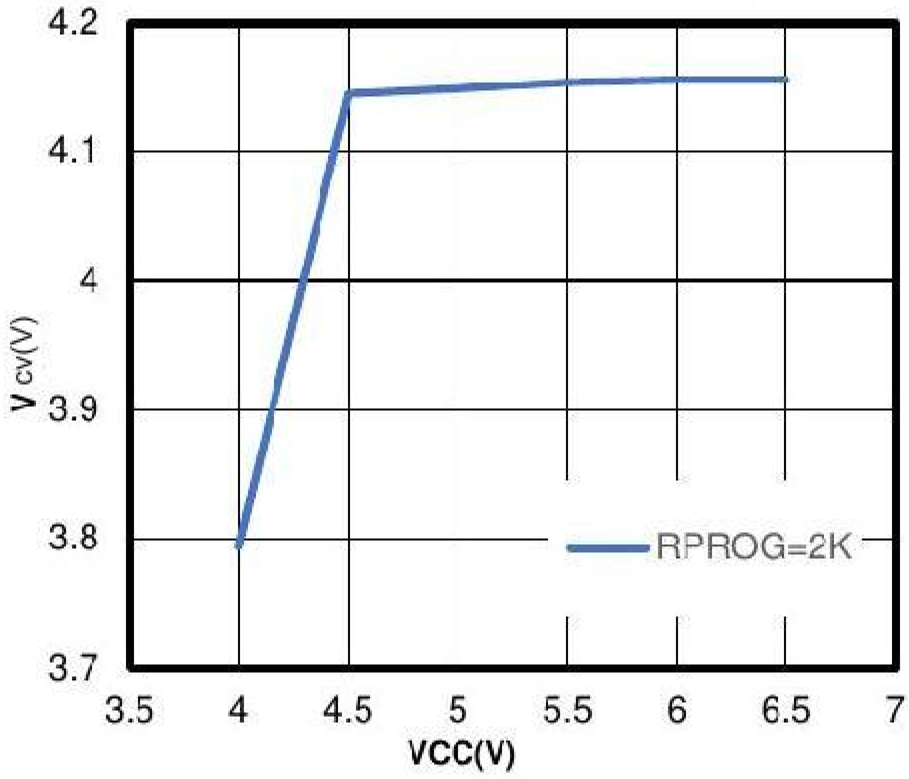


Figure 9.d V_{CV} vs VCC

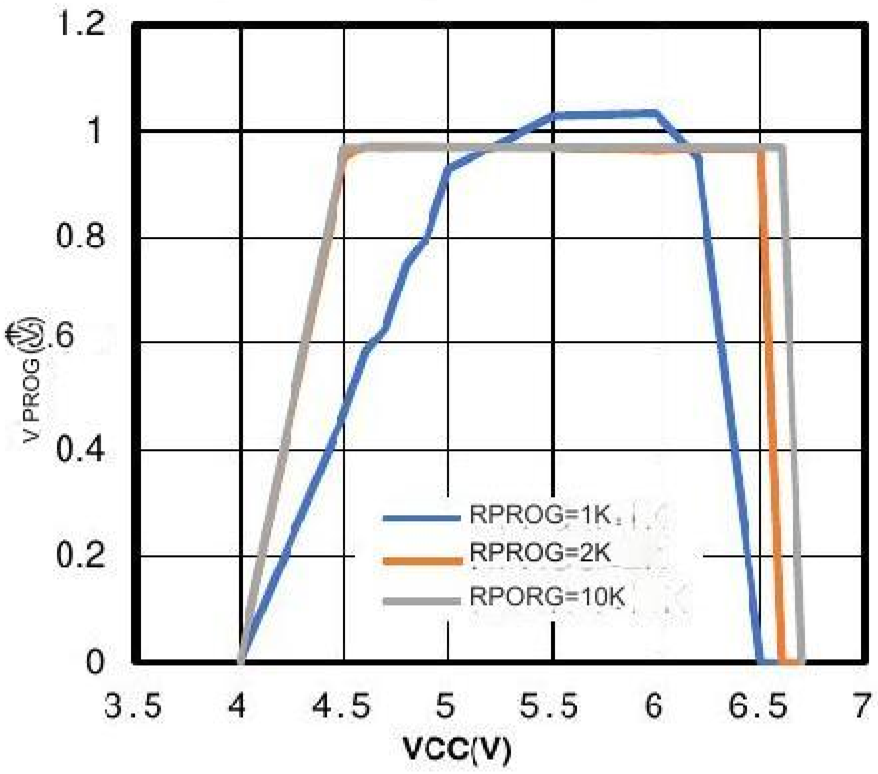


Figure 9.e V_{PROG} vs VCC

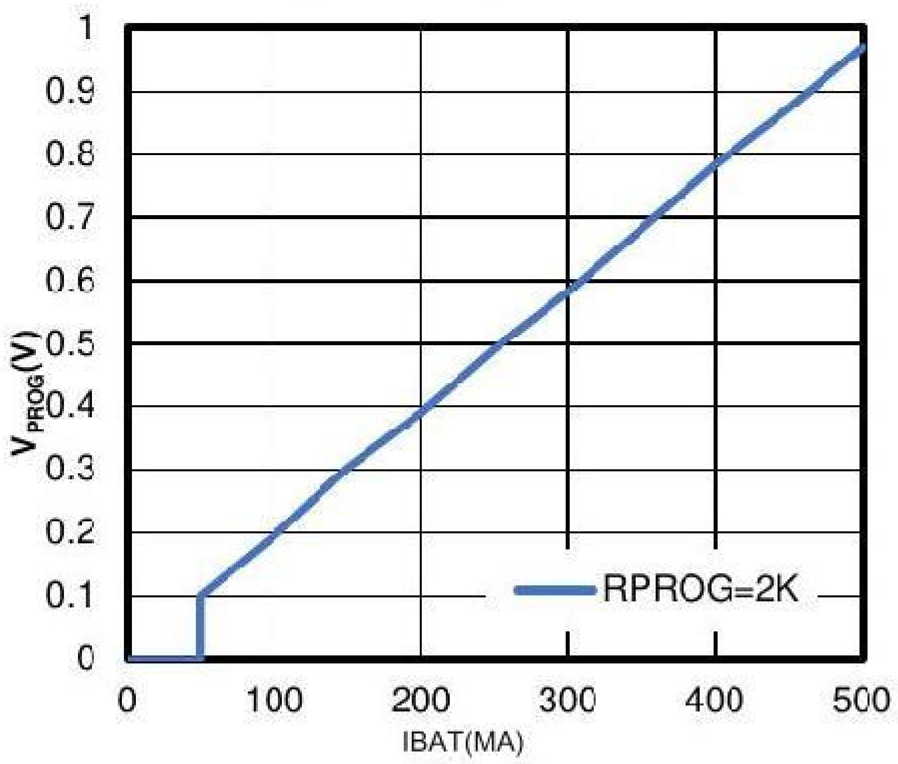


Figure 9.f VPROG VS IBAT

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

Figure 10.Electrical Characteristics (Unless otherwise stated, VCC=5V, TA=25 °C)

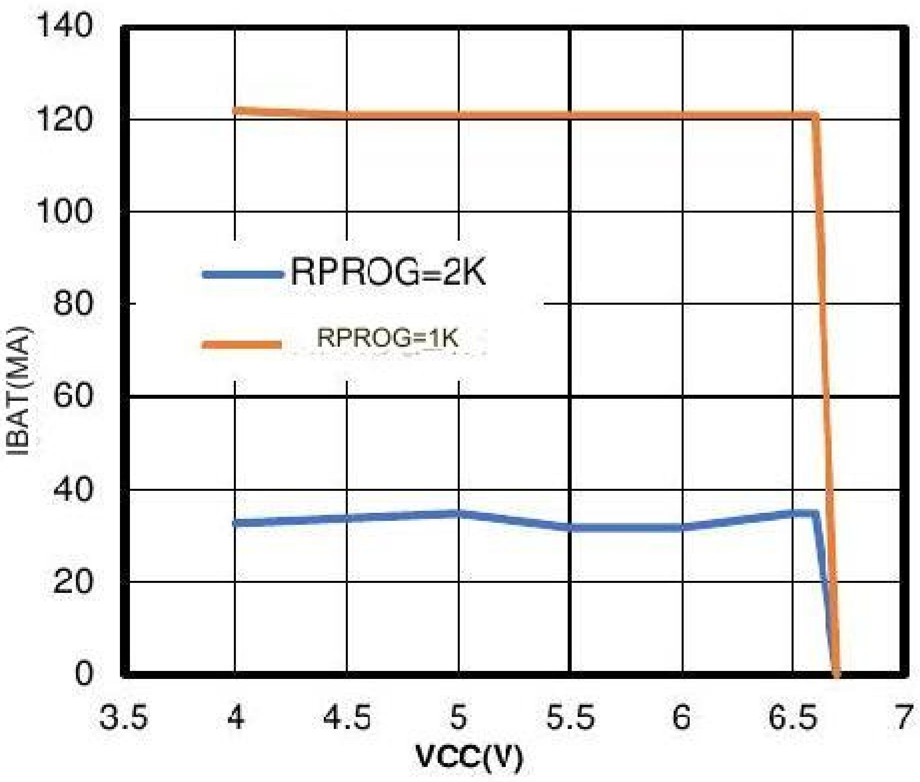


Figure 10.a I_{BAT} vs VCC (V_{BAT}=2.5V)

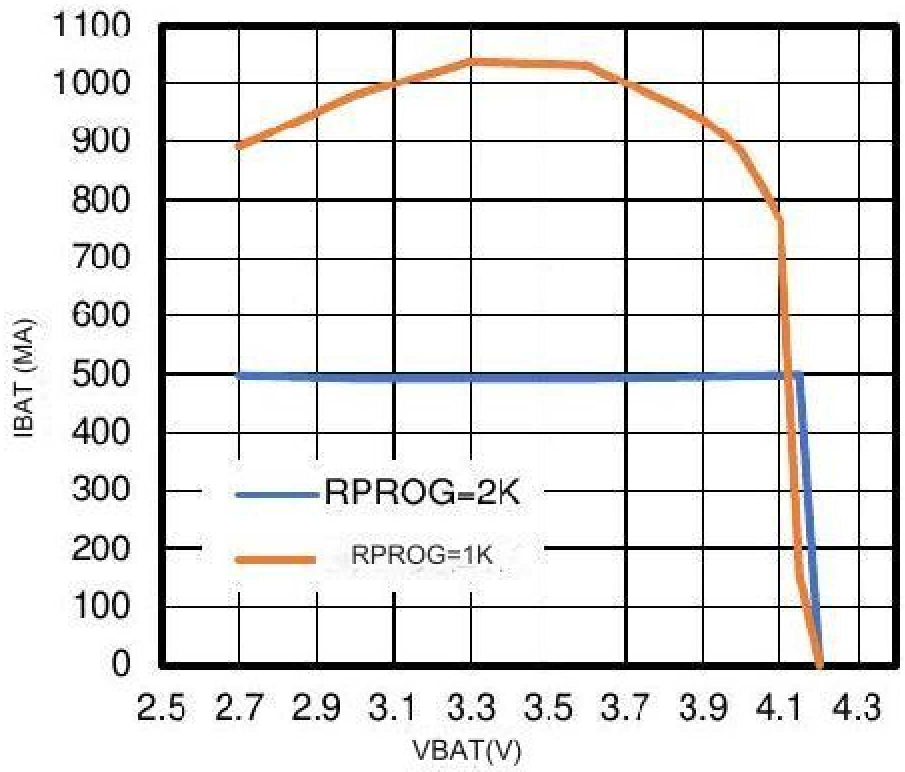


Figure 10.6 IBAT VS VBAT

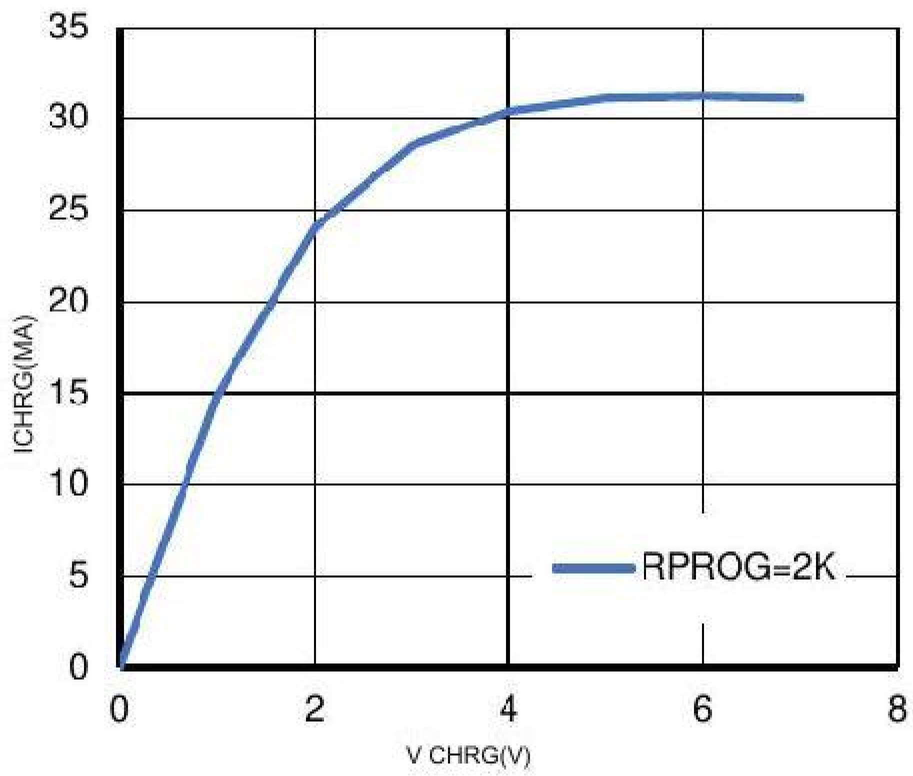


Figure 10.C ICHRG VS VCHRG (VBAT=4V)

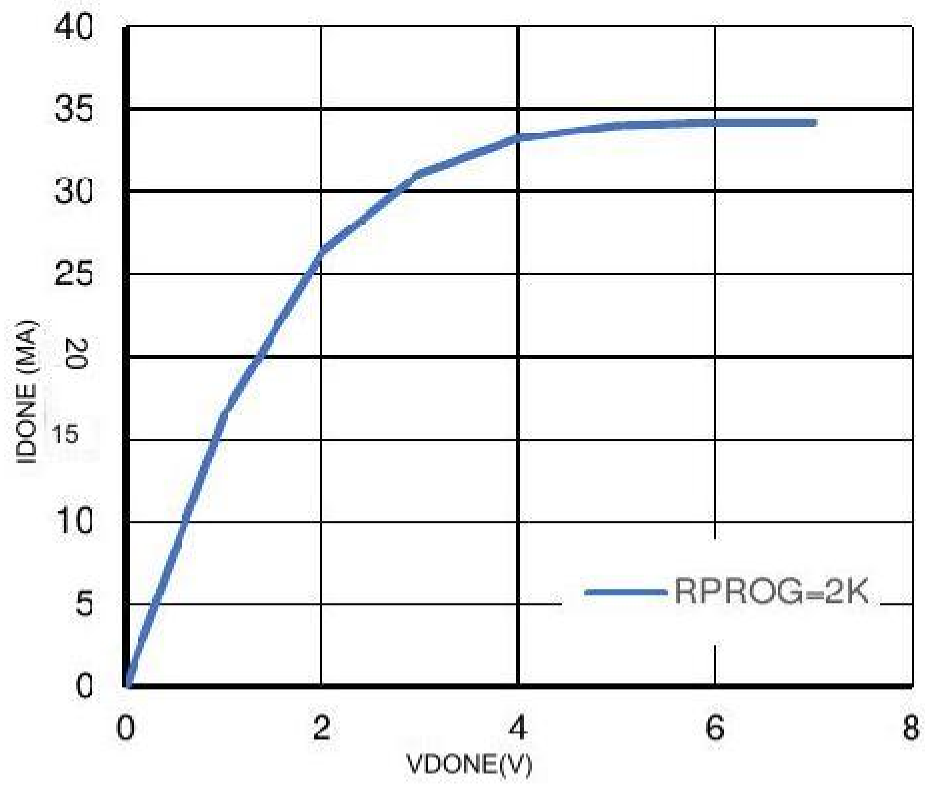


Figure 10.d I_{DONE} vs V_{DONE} (V_{BAT}=4.3V)

Application Information: Reference layout examples

Overview

Poor layout will affect the performance of LGS4056H, causing electromagnetic interference (EMI), poor electromagnetic compatibility (EMC), ground jump and voltage loss, which will affect voltage regulation and stability. To optimize its electrical and thermal performance, the following rules should be applied for good PCB layout to ensure optimal performance:

- Place the input capacitor CIN as close as possible to the VCC (PIN4) and GND (PIN3) pins. In order to reduce high-frequency noise as much as possible, it is recommended to connect a 0.1uF ceramic capacitor to the BAT terminal and the VCC input terminal, and the wiring is very close to the chip pins.
- Use larger PCB copper areas and direct pad connections for high current paths, including the GND pin (PIN3). This helps minimize PCB conduction losses and thermal stress.
- To minimize via conduction losses and reduce module thermal stress, multiple vias should be used to provide interconnections between the top layer and other power or ground planes. (Added via openings on the bottom pad of the chip help to dissipate heat from the chip and improve performance)
- The PROG pin has high impedance, and the lead trace of RPROG should be as short as possible when it is far away from the heat source of the chip to reduce interference with the charging current setting.

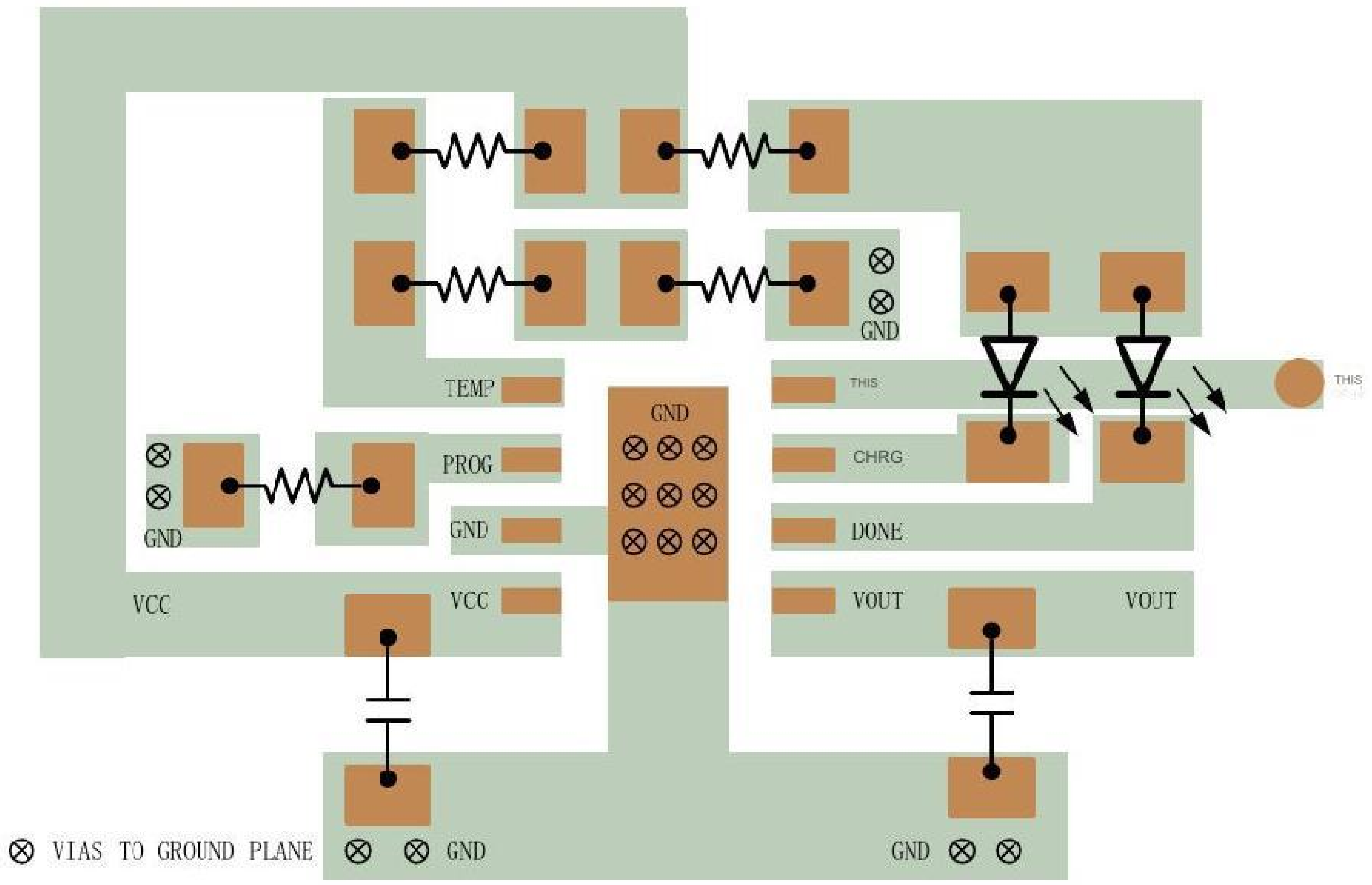
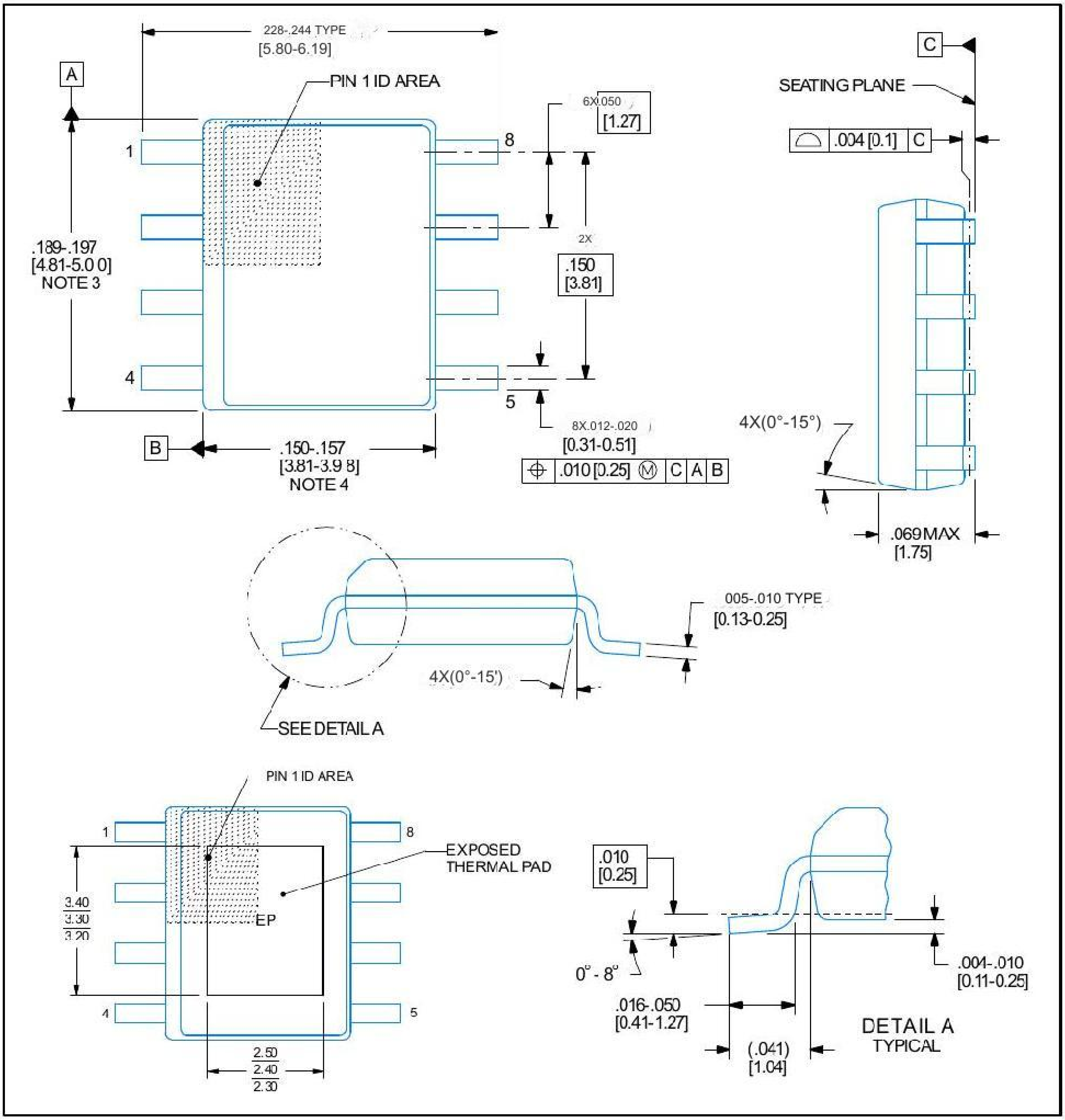


Figure 10 Recommended PCB layout example

Package outline description (ESOP8)

8-pin plastic SOIC with bottom EPAD



Note:

(1) Any dimensions in brackets are for reference only.

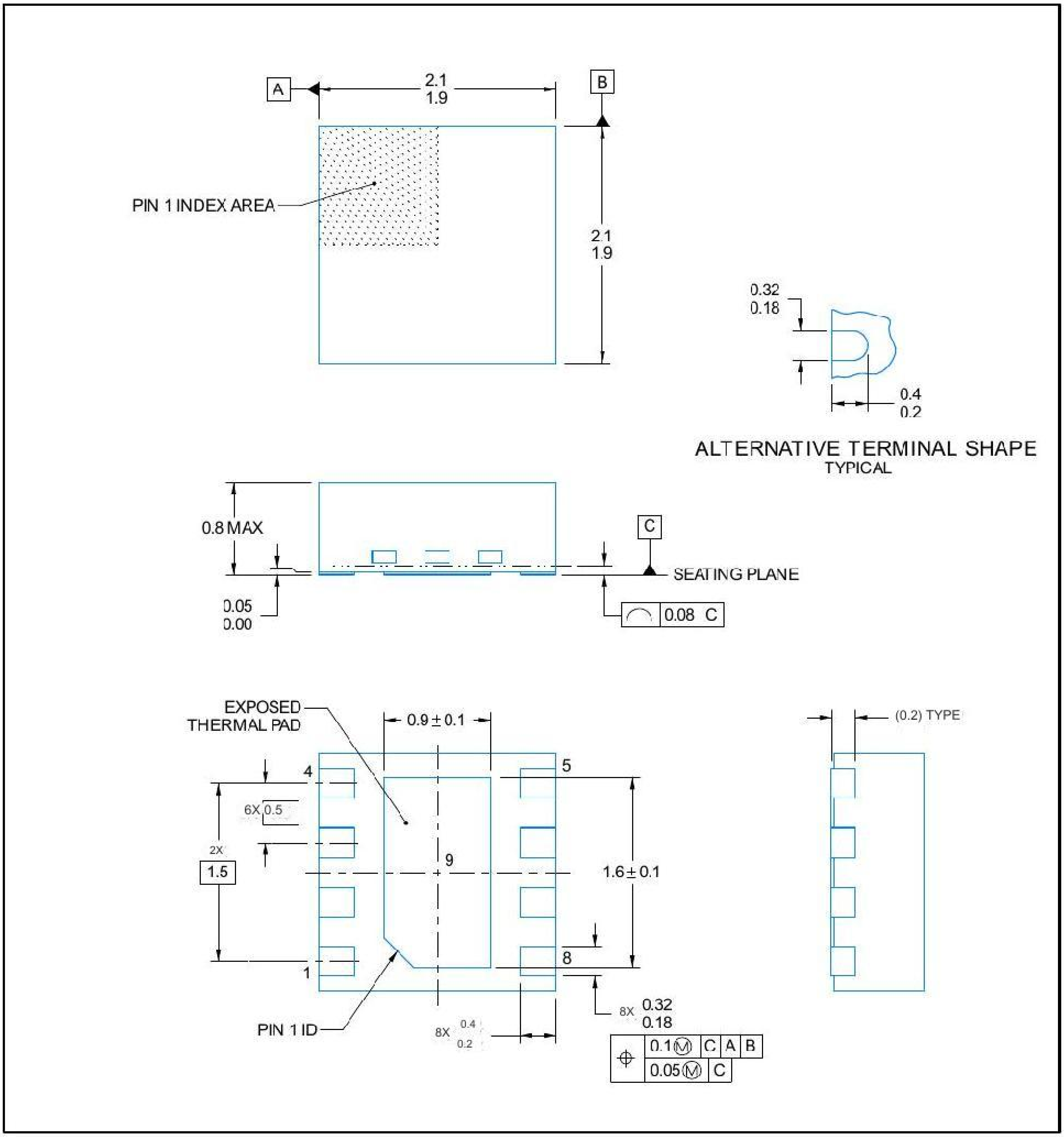
(2) This picture is subject to change without prior notice.

(3) This size does not include mold burrs, protrusions, or nozzle burrs.

(4) These dimensions do not include mold burrs.

Package outline description (DFN8-2.0*2.0)

8-pin plastic SOIC with bottom PAD



Note:

(1) All data are in millimeters, any dimensions in brackets are for reference only.

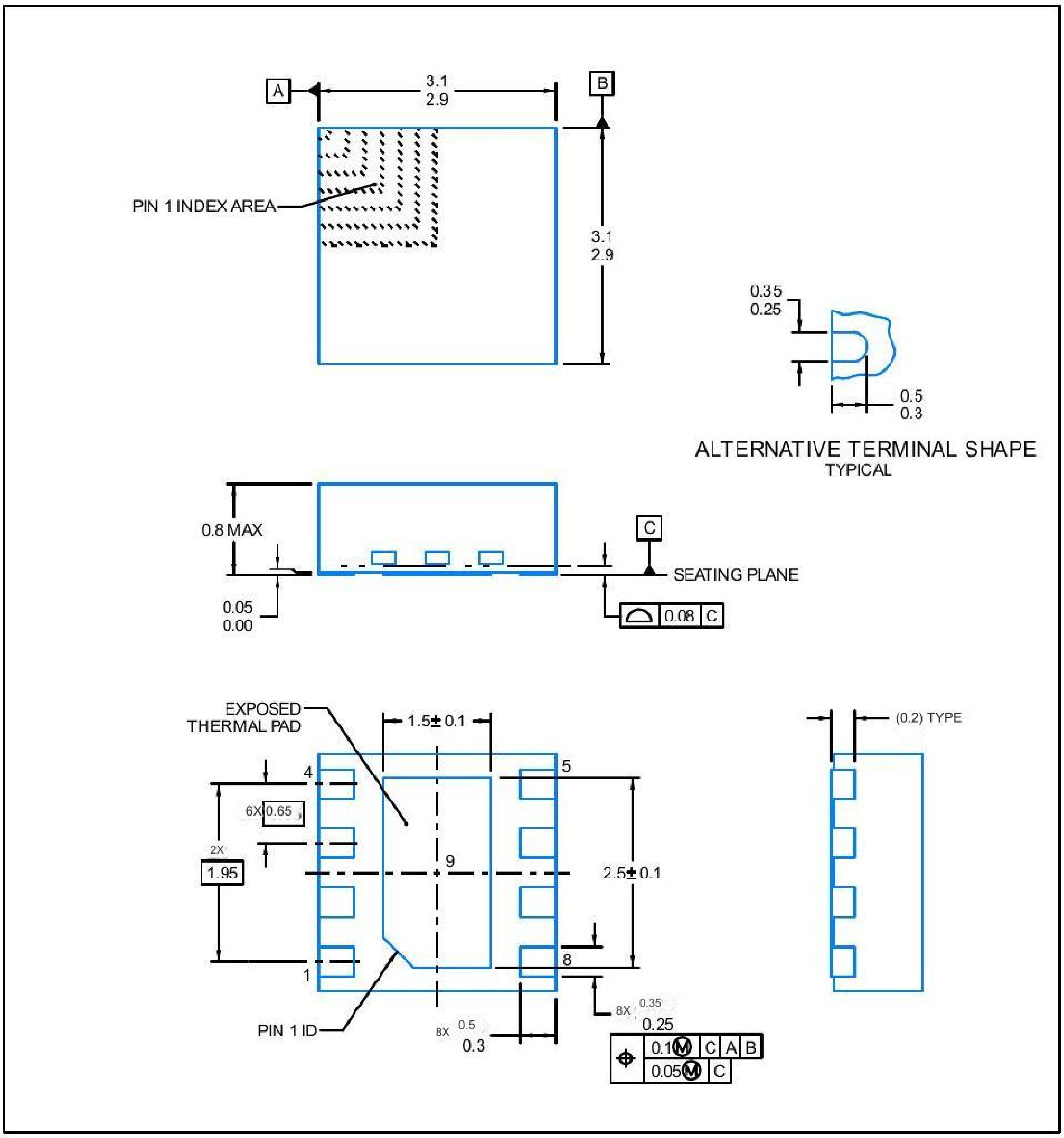
(2) This picture is subject to change without prior notice.

(3) This size does not include mold burrs, protrusions, or nozzle burrs.

(4) These dimensions do not include mold burrs.

Package outline description (DFN8-3.0*3.0)

8-pin plastic SOIC with bottom PAD



Note:

(5) All data are in millimeters, any dimensions in brackets are for reference only.

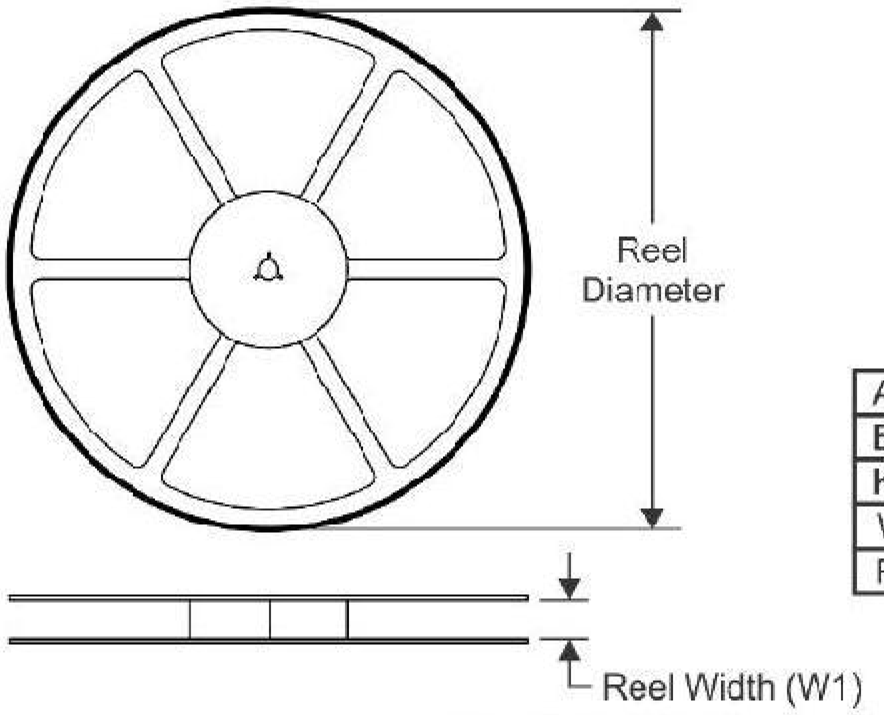
(6) This picture is subject to change without prior notice.

(7) This size does not include mold burrs, protrusions, or nozzle burrs.

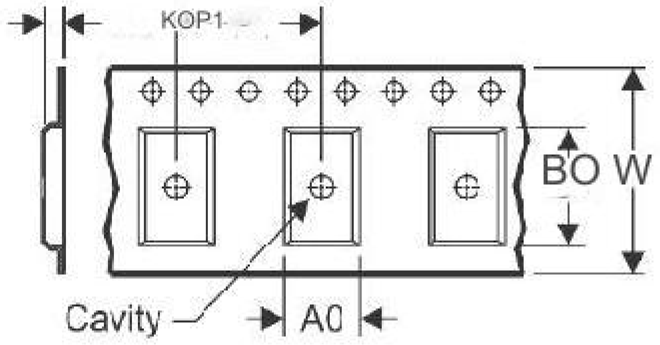
(8) These dimensions do not include mold burrs.

TAPE AND REEL INFORMALEGEND-SION

REEL DIMENSIONS

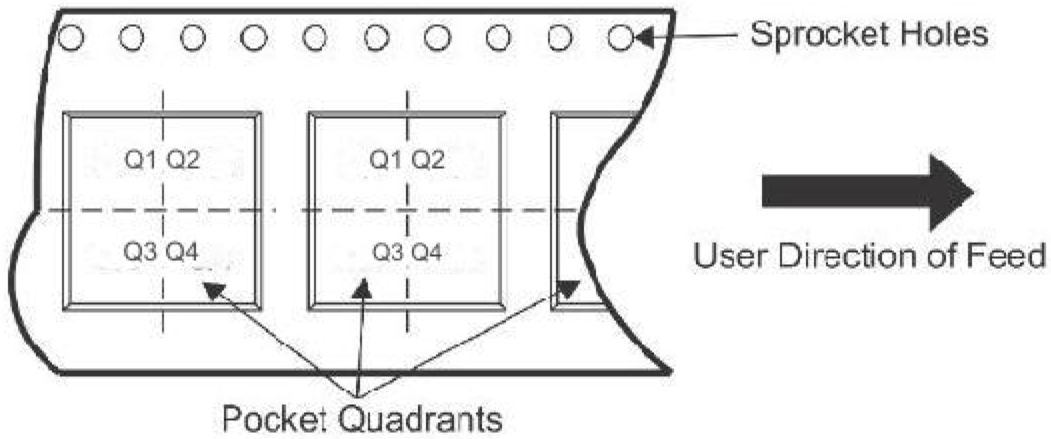


TAPE DIMENSIONS



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
P1	Pitch between successive cavity centers

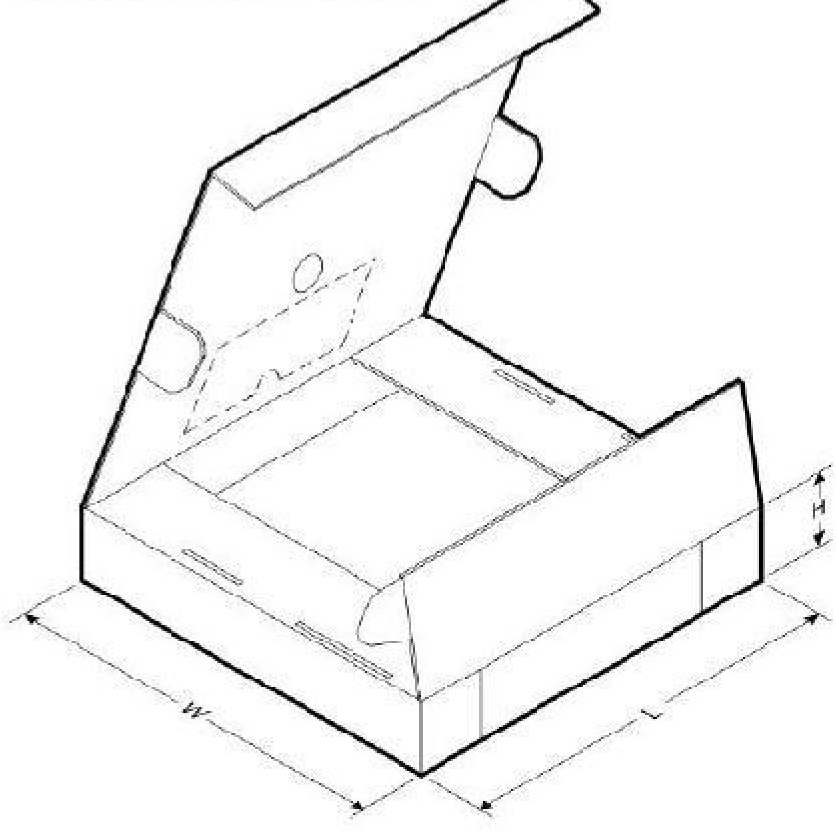
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*ALL dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LGS4056H	ESOP8	EP	8	4000	330	15	6	8	1.5	8	12	Q1
LGS4056H	DFN8-2*2	AND	8	3000	175	10	2.5	2.5	0.8	3.5	8	Q1
LGS4056H	DFN8-3*3	DB	8	3000	490	10.5	3.25	3.40	0.85	4.0	8	Q1

TAPE AND REEL BOX DIMENSIONS



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