600mA Single Cell Linear Li-Ion Battery Charger

1 Feature

- Input Withstand Voltage 36V
- Input Overvoltage Protection 6.8V
- Standby Current Less Than 1μA
- High-Precision Full Charge Detection Voltage Threshold
- Support 0V Battery Charging
- Up to 600mA Programmable Charge Current
- Trickle /Constant Current/ Constant Voltage Three-Stage Charging
- 2.8V Trickle Switching Threshold
- Full Charge Voltage 4.2V and 4.35V Optional
- Automatic Recharging
- Battery Reverse Polarity Protection
- Adjustable Charging Current with Intelligent Thermal Regulation
- LED Status Indication Output Pin
- SOT23-5 Package
- RoHS Compliant

2 Application

- Capacitive Sensors
- Toy
- Bluetooth Applications
- Lithium-ion Battery Powered Devices

3 Description

GD30BC1502 is a 600mA single-cell lithium-ion battery linear charger with an input withstand voltage of 36V and a power supply OVP function. It adopts a constant current/constant voltage charging mode.

GD30BC1502 adopts P-MOSFET architecture inside, with anti-reverse charging circuit, and does not require external isolation diode. Thermal feedback can adaptively adjust the charging current to limit the chip charging current under high power operation or high ambient temperature conditions. The full cut-off voltage can be divided into two levels: 4.2V and 4.35V. The charging current can be set externally through a resistor.

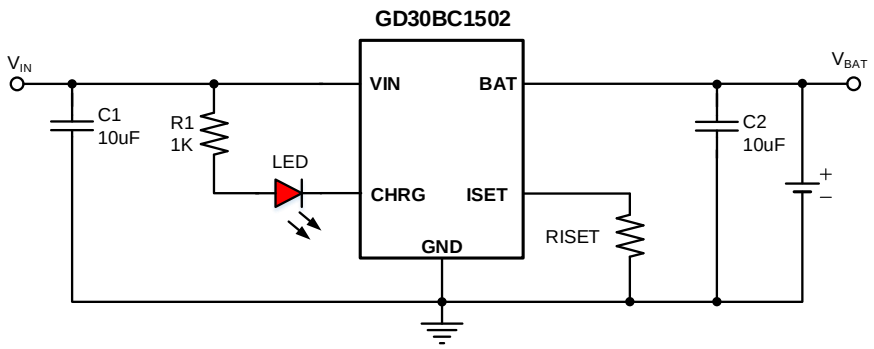
When the input voltage drops, the GD30BC1502 automatically enters a low current state, and the battery leakage current drops below 0.1μA. Other features of the GD30BC1502 include under-voltage lockout, automatic recharge, and a status pin for indicating the end of charging and input voltage access. The GD30BC1502 can be used for USB power and adapter power .

Device Information[1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
GD30BC1502	SOT23-5	2.92mm x 1.62mm

1. For packaging details, please refer to the *Packaging information*section.

Simplified Application Schematic



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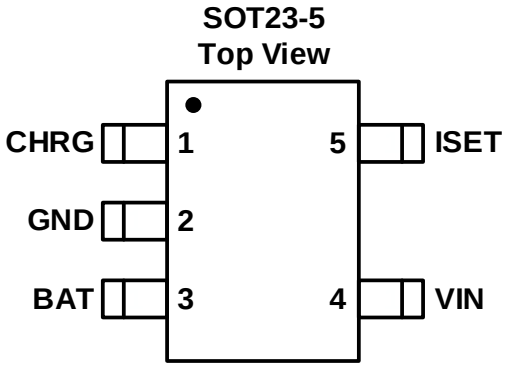
4.1 Pinout and Pin Assignment



4.2 Pin Description

PINS		PIN TYPE[1]	FUNCTION
NAME	SOT 23-5		
CHRG	1	O	Open-drain output for charging status indicator.
GND	2	G	Ground pin.
BAT	3	P	Charging current output pin.
VIN	4	P	Power input pin, connected to the adapter.
ISET	5	I	Charge current programming, by connecting a 1% resistor (R_{ISET}) to ground to program the charge current.

1. I input, P = power, G = ground.

5 Parameter information

5.1 Absolute Maximum Ratings

Exceeding the operating temperature range(unless otherwise noted)[1]

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{IN}	Input voltage	−0.3	36	V
V_{CHRG}	Status indication pin withstand voltage	−0.3	36	V
V_{BAT}	Battery voltage	−5	10	V
V_{ISET}	I SET pin withstand voltage	−0.3	6	V
T_J	Junction temperature	−40	150	°C
T_{STG}	Storage temperature range	−55	150	°C

1. Stresses exceeding these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only and functional operation of the device at these or any other conditions beyond those specified is not implied.

5.2 Recommended Operating Conditions

SYMBOL	PARAMETER	MIN	TYP	MAX	UNIT
V_{IN}	Input voltage range		5		V
I_{CH}	Constant current charging current			0.6	A
T_J	Operating junction temperature[1]	–40		125	°C
T_A	Working environment temperature [1]	−40		85	°C

1. Power consumption and thermal limitations must be considered.

5.3 Electrical Characteristics

SYMBOL	CONDITIONS	VALUE	UNIT
$V_{ESD(HBM)}$	Human Body Model (HBM), ANSI/ ESDA / JEDEC JS-001-2017[1]	±2000	V
$V_{ESD(CDM)}$	Charged Device Model (CDM), ANSI/ ESDA / JEDEC JS-002-2022[2]	±200	V

1. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
2. JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.4 Thermal Resistance

SYMBOL[1]	CONDITIONS	PACKAGE	VALUE	UNIT
Θ_{JA}	Natural convection, 2S2P PCB	SOT23-5	240	°C/W

1. Thermal characteristics are based on simulation, and meet JEDEC document JESD51-7.

5.5 Electrical Characteristics

V_{IN} = 5 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
V_{IN}	Input voltage range			5		V
I_{IN}	Input power current	Charging Mode (R_{ISET} = 10K)		300		μA
		Standby mode, charging termination		100		
		Stop mode (ISET not connected, $V_{IN} < V_{BAT}$ or $V_{IN} < V_{UV}$)		60		
V_{OVP}	Input overvoltage protection	V_{IN} rises		6.8		V
V_{OVP_HYS}	Input overvoltage protection hysteresis			500		mV
V_{UVLO}	VIN undervoltage lockout threshold	V_{IN} drops		3.8		V
V_{UVLO_HYS}	VIN undervoltage lockout threshold hysteresis			280		mV
V_{ASD}	V_{IN} - V_{BAT} lockout threshold voltage	V_{IN} from low to high		2 00		mV
		V_{IN} from high to low		1 00		mV
BATTERY CHARGING						
V_{FLOAT}	Stable output (full charge voltage)	V_{BAT} from low to high (0°C ≤ T_A ≤ 85°C)	4.158	4.2	4.242	V
			4.3	4.35	4.4	
$\triangle V_{RCHG}$	Recharge hysteresis voltage	$V_{FLOAT} - V_{RCHG}$		1 00		mV
T_{RECHG}	Recharge comparator filter time	VBAT High to Low		1		mS
T_{SS}	Soft start time	I_{BAT} = 0 to I_{BAT} setting value		2 0		μS
R_{DS_ON}	Power tube conduction internal resistance			1100		mΩ
I_{BAT}	BAT pin current	R_{ISET} = 10K, current mode		95		mA
		R_{ISET} = 1.8K, current mode		5 30		
		Standby mode, $V_{BAT} = V_{FLOAT}$		−2	−6	μA
		Stop mode (R_{ISET} not connected)		±1	±2	μA
		Sleep mode, V_{IN} = 0V		±1	±2	μA
V_{TRIKL}	Trickle charge threshold voltage	V_{BAT} rises		2.8		V
V_{RIKL_HYS}	Trickle charge threshold voltage hysteresis			350		mV
I_{TRIKL}	Trickle charge current	$V_{BAT} < V_{TRIKL}$		10%* I_{CH}		mA
I_{TERM}	Termination charge current threshold			10%* I_{CH}		mA

Electrical characteristics(Continued)

V_{IN} = 5 V, T_A = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
T_{TERM}	Comparator filter time for charge termination	I_{BAT} drops below I_{CH} /10		2.5		mS
V_{ISET}	ISET pin voltage during constant current charging	V_{IN} = 5V, R_{ISET} = 2K	0.9	1	1 .1	V
I_{SET}	ISET pin pull-up current			0.3		μA
LED INDICATION						
V_{CHRG}	CHRG pin outputs a low level	I_{CRG} = 5mA		0.6		V
INTERNAL TEMPERATURE COMPENSATION						
T_{OTC}	Internal temperature compensation			140		°C

6 Functional Description

6.1 Block Diagram

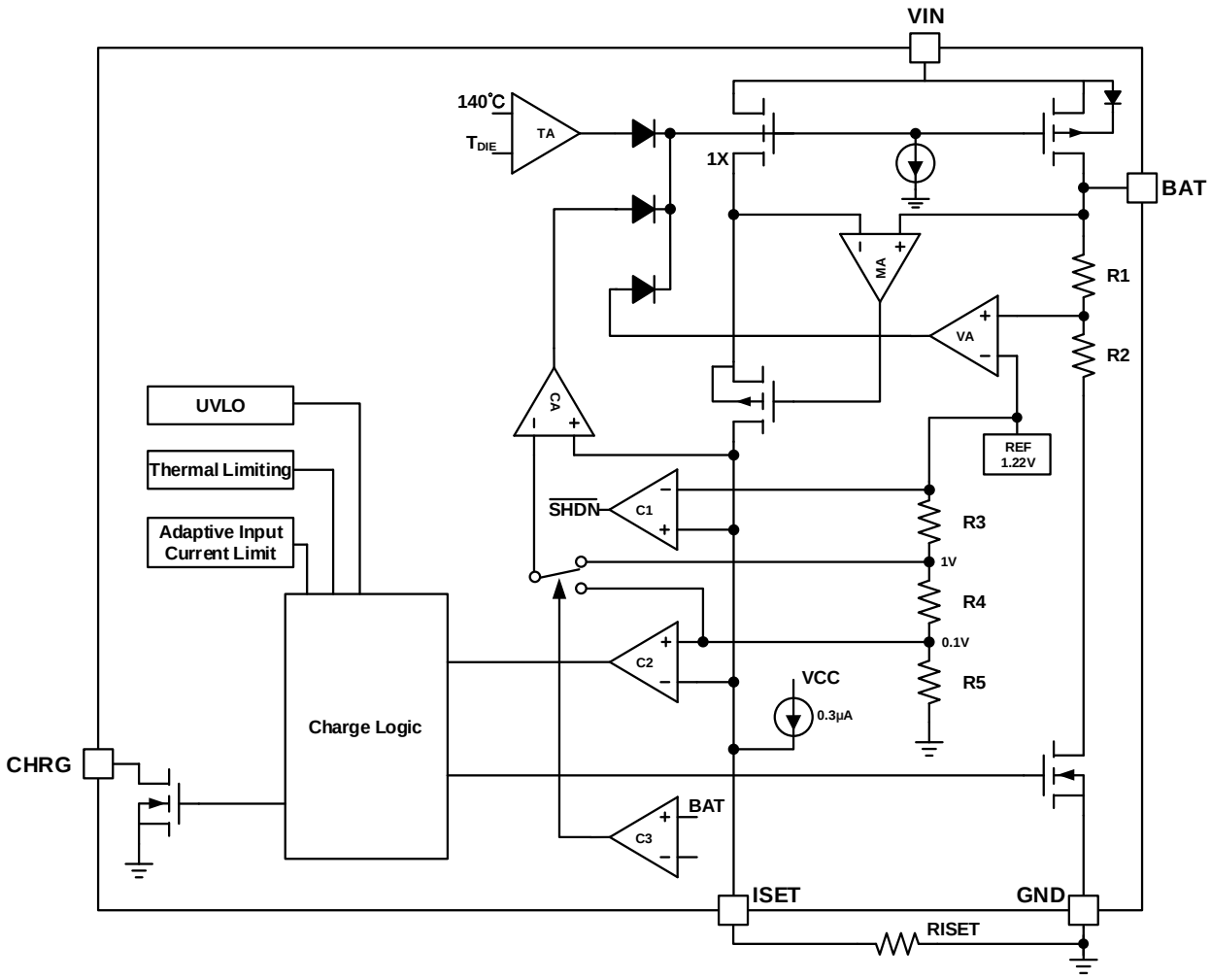


Figure 1. GD30BC1502 functional block diagram

6.2 Overview

The GD30BC1502 is a complete constant current/constant voltage linear charger for single-cell lithium batteries . Its compact package and low external component count make the GD30BC1502 ideal for portable applications. The thermal feedback can adjust the charging current to limit the power consumption of the chip under high-power operation or high-temperature environment conditions. The complete charging process includes trickle pre-charging, constant current charging, constant voltage charging and automatic recharging, as shown in Figure 2. The full charge voltage is fixed at 4.2V or 4.35V, and the constant current charging current can be programmed through the ISET external resistor. When the final full charge voltage is reached, the charging current drops to 1/10 When the constant current is used, the GD30BC1502 will automatically terminate the charge cycle. When the input voltage source is removed, the GD30BC1502 automatically enters a low power state, and the leakage current of the port connected to the battery drops below 0.1μA. Other features include charge current monitor, undervoltage lockout, automatic charging and status pin.

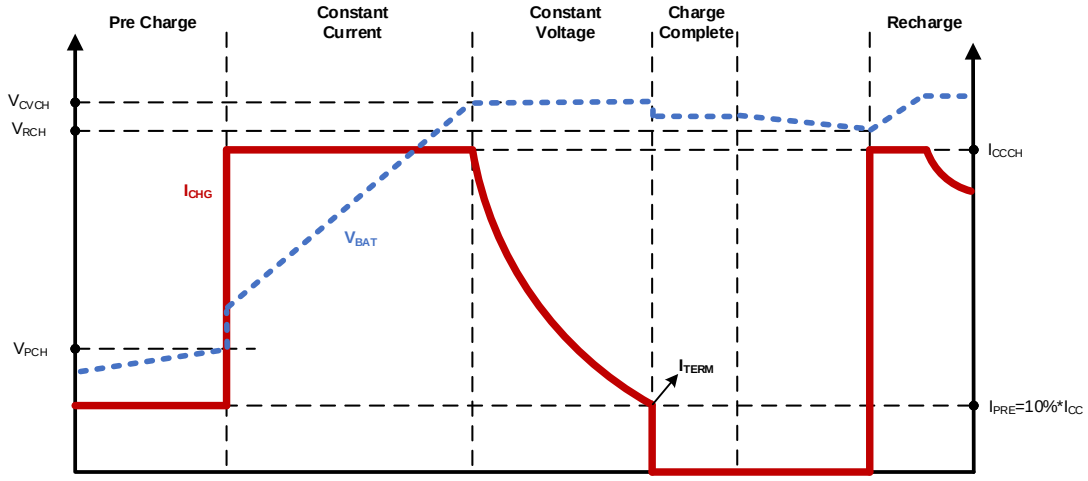


Figure 2. Lithium Battery Cycle Charging Process

6.2.1 Charging

When the input voltage is below 3.8V or above 6.8V, the charger IC will automatically disable. When a battery is connected to the charger output and the voltage at the VIN pin rises above 4.5V, a charging cycle begins. If the BAT pin voltage is below 2.8V, the charger enters trickle charge mode. In this mode, the GD30BC1502 provides approximately 1/10 of the ISET programmed charging current to bring the battery voltage to a safe level for full current charging. When the BAT pin voltage rises above 2.8V , the charger enters constant current mode (CC), and the ISET programmed charging current is supplied to the battery. When the BAT pin voltage approaches the final full charge voltage, the GD30BC1502 enters constant voltage mode (CV), and the charging current gradually decreases. When the charging current in CV mode decreases to 1/10 of the programmed current, the battery is fully charged. The status is indicated.

6.2.2 Charge Termination

The charge cycle is terminated when the charge current drops to 1/10 of the set value after reaching the final float voltage. This condition is detected by monitoring the ISET pin with an internal filter comparator . When the ISET pin voltage drops below 100mV for more than T_{TERM} (typically 2.5ms), charging is terminated. (C/10 termination is invalid in trickle charge and thermal limit modes). When charging, a transient load on the BAT pin can cause the ISET pin voltage to drop below 100mV briefly before the DC charge current drops to 1/10 of the set value. Once the average charge current drops below 1/10 of the set value, the GD30BC1502 terminates the charge cycle and stops supplying any current through the BAT pin. In this state, all loads on the BAT pin must be powered by the battery. In standby mode, the GD30BC1502 continuously monitors the BAT pin voltage. If the pin voltage drops below the recharge threshold, the charge cycle begins and supplies current to the battery again.

6.2.3 Charging Current

set by a resistor connected between the ISET pin and ground. Users can select the appropriate R_{ISET} resistor. In order to ensure the stability and temperature characteristics of the system, R_{ISET} recommends using a metal film resistor with an accuracy of 1%. In specific applications, the charging current can be reasonably set according to the actual system requirements and ambient temperature. The relationship between R_{ISET} and the charging current is as follows:

R_{ISET} (KΩ)	I_{CH} (mA)
30	2 8
10	9 5
5.1	1 90
2	4 80
1.8	5 30
1.6	6 00

6.2.4 Automatic Recharging

Once the charge cycle is terminated, the GD30BC1502 continuously monitors the voltage on the BAT pin using a comparator with a 1ms filter time . When the battery voltage drops below VRECHG , the charge cycle restarts. This ensures that the battery is maintained at (or close to) a fully charged state and eliminates the need for periodic charge cycle starts. During the recharge cycle, the CHRG pin output re-enters a strong pull-down state.

6.2.5 Undervoltage Lockout

The built-in undervoltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until VIN rises above the undervoltage lockout threshold. The UVLO circuit will keep the charger in shutdown mode. If the UVLO comparator is tripped, the charger will not exit shutdown mode until VIN rises 200mV above the battery voltage .

6.2.6 Stop Mode

At any time during the charge cycle, the GD30BC1502 can be placed in shutdown mode by removing R_{ISET} (thus leaving the ISET pin floating). This reduces the battery drain current to less than 0.1μA and the supply current to less than 60μA , and a new charge cycle can be started by reconnecting the resistor.

6.2.7 Reverse Battery Protection

GD30BC1502 integrates a reverse battery protection circuit, which can effectively prevent chip damage caused by reverse battery connection during assembly or application. When the BAT pin voltage is 200mV lower than the GND voltage, the internal charging circuit is closed; when the BAT pin voltage rises back to 10mV lower than the GND voltage, it is judged that the battery is connected normally, and the charging cycle is restarted.

6.2.8 LED Status Indicator

There are two different charging states, one is charging and the other is charging completed. The CHRG pin is pulled low in the charging state and becomes high impedance in the charging completed state.

CHARGING STATUS	RED LED (CHRG)
Charge	Bright
Fully charged	Destroy
Battery not connected	Flash (T = 1 ~ 2S)
Undervoltage lockout, overvoltage and other faults	Destroy
Over temperature protection	Bright

6.2.9 Intelligent temperature control

If the chip temperature rises above a preset value of 140°C, an internal thermal feedback loop will reduce the charge current. This feature prevents the GD30BC1502 from overheating and allows the user to increase the upper limit of a given board's power handling capability without the risk of damaging the GD30BC1502. The charge current can be set based on typical (rather than worst-case) ambient temperature, with the assurance that the charger will automatically reduce the current in the worst case.

6.2.10 Power consumption

The chip junction temperature depends on many factors such as ambient temperature, PCB layout, load and package type. The power consumption and chip junction temperature can be calculated according to the following Equation(1):

$$P_D = R_{DS(ON)} x I_{OUT}^2 \quad (1)$$

According to the PD junction temperature, it can be calculated by the following Equation(2):

$$T_J = P_D x \theta_{JA} + T_A \quad (2)$$

Where:

T_J is the chip junction temperature, T_A is the ambient temperature, θ_{JA} is the package thermal resistance.

7 Application Information

GD30BC1502 is a linear charger for single-cell lithium-ion batteries. It has a 36V input voltage, a typical input voltage of 5V, and a lithium-ion battery full charge voltage of 4.2V or 4.35V.

7.1 Typical Application Circuit

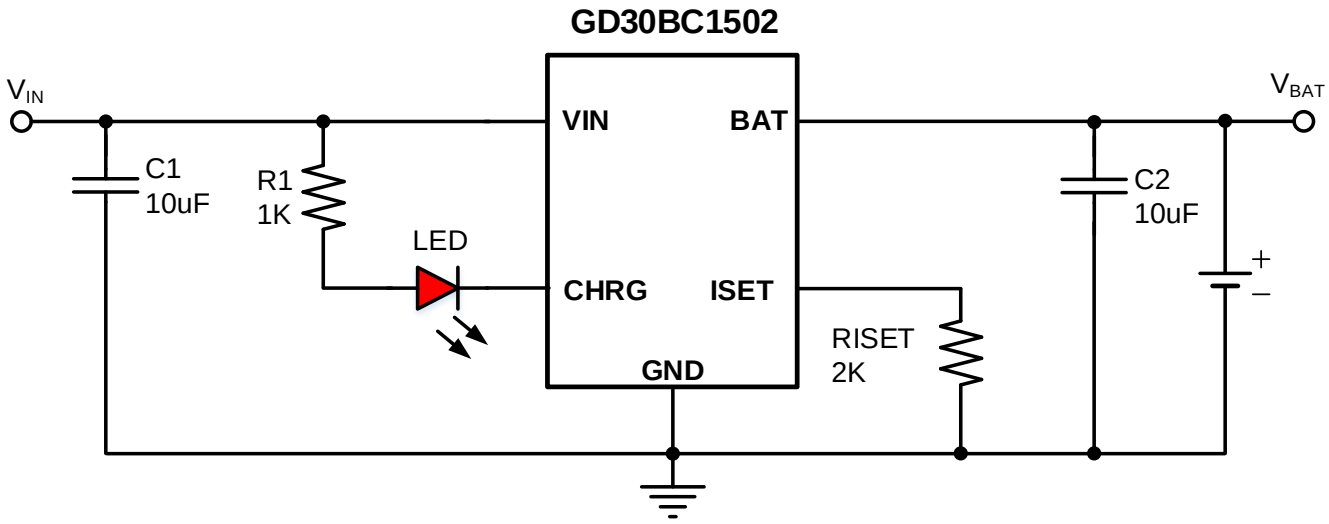


Figure 3. 480mA Constant Current Charging Reference Circuit

8 Layout Guidelines and Example

For the best finishing performance, place all circuit components on the same layer of the circuit board and as close to the chip pins as possible. The input and output capacitor return paths and the chip GND pins are connected to the same ground plane, which needs to be widened, and the input and output capacitors are placed as close to the chip pins as possible. It is not recommended to use vias and long traces for input and output capacitors, which will have a negative impact on system performance. The grounding scheme shown in Figure 4 minimizes parasitic inductance, thereby reducing load current transients, minimizing noise, and improving circuit stability.

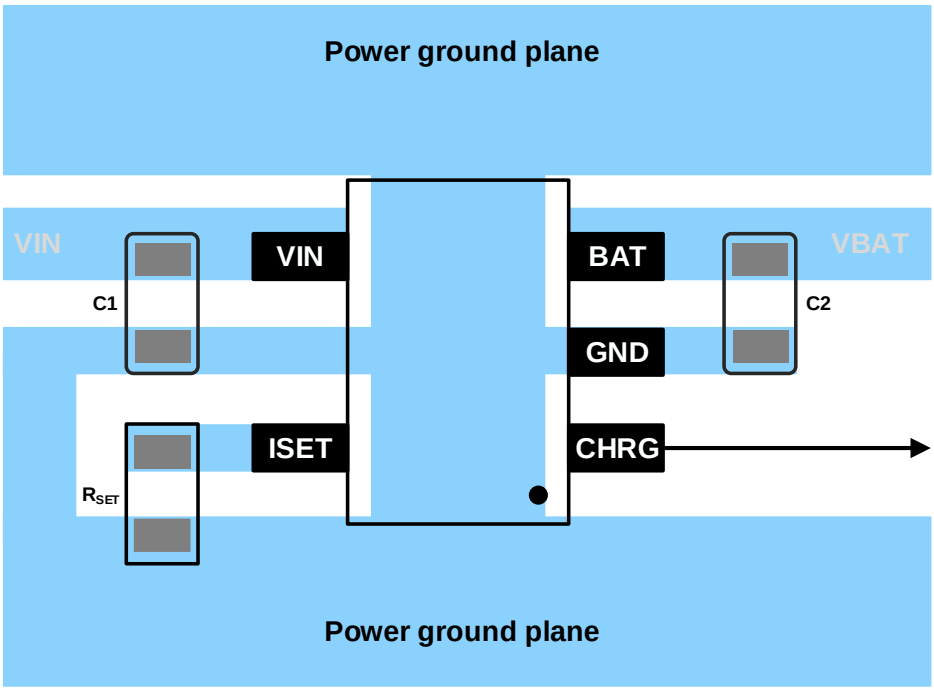
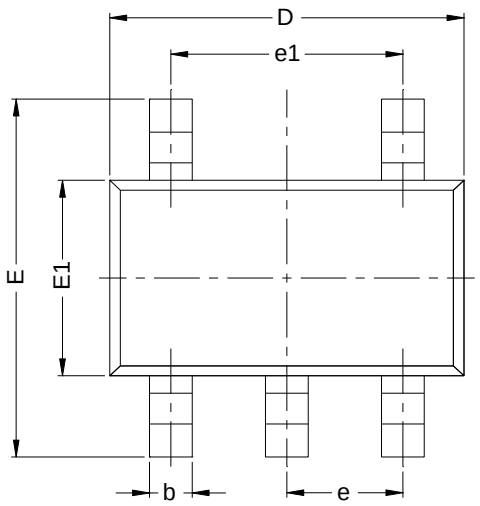


Figure 4. Layout example

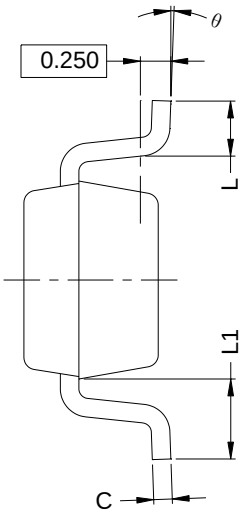
9 Packaging information

9.1 Outline Dimensions

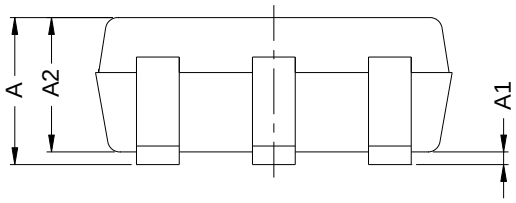
SOT23-5 package diagram



TOP VIEW



SIDE VIEW



FRONT VIEW

Note :

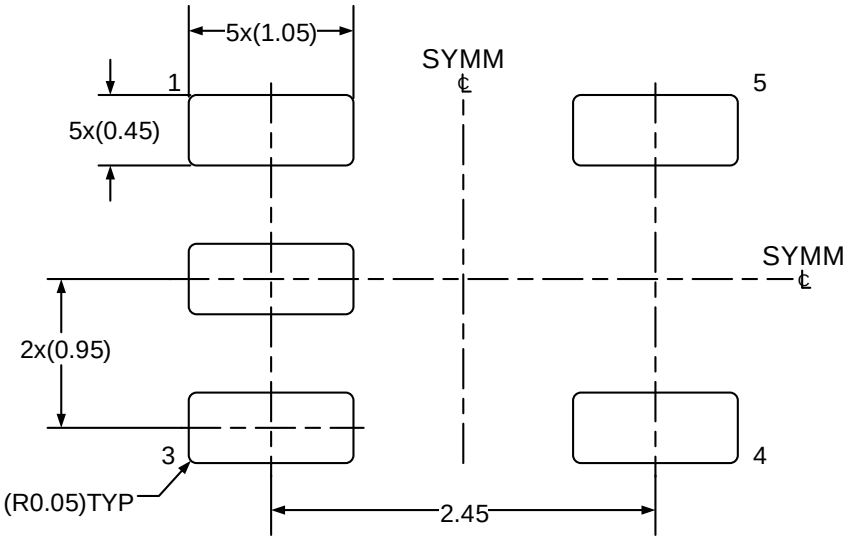
1. All dimensions are in millimeters.
2. Package dimensions does not include mold flash, protrusions, or gate burrs.
3. Refer to Table 1. SOT23-5 *dimensions (mm)*.

Table 1. SOT23-5 dimensions (mm)

SYMBOL	MIN	NOM	MAX
A			1.25
A1	0.03	0.08	0.15
A2	1.05	1.10	1.15
b	0.27		0.35
c	0.135		0.23
D	2.82	2.92	3.02
E	2.60	2.90	3.00
E1	1.50	1.62	1.70
e	0.95 BSC		
e1	1.90 BSC		
L	0.35	0.45	0.55
L1	0.49	0.64	0.79
θ	0°		8°

9.2 Recommended Land Pattern

SOT23-5 Land Pattern Example



Note :

1. Refer to the IPC-7351 can also help you complete the designs.
2. Exposed metal shown.
3. Drawing is 20X scale.

10 Ordering Information

Ordering Code	Package Type	ECO Plan	Packaging Type	MOQ	OP Temp(°C)
GD30BC1502NSTR-I	SOT23-5	Green	Tape & Reel	3000	−40°C to +125°C
GD30BC1502NSTR-I1D	SOT23-5	Green	Tape & Reel	3000	−40°C to +125°C

1. GD30BC1502NSTR-I full charge voltage 4.2 V.
2. GD30BC1502NSTR-I1D full charge voltage 4.35 V.

11 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial release and device details	2024

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