1A 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 1A Programmable Charge Current
- Trickle/Constant Current/Constant Voltage Three-Stage Charging
- 2.8 V 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
- ESOP-8 , DFN2x2-8 , DFN 3x3-8 Packages
- RoHS Compliant

2 Applications

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

3 Description

GD30BC1501 is a complete constant current/constant voltage linear charger for single-cell lithium batteries. Its compact package and low number of external components make GD30BC1501 very suitable for portable applications. It adopts P-MOSFET architecture and anti-backflow circuit internally, so no external detection resistor and isolation diode are required. Thermal feedback can regulate the charging current to limit the power consumption of the chip under high power operation or high temperature environment conditions. The full charge voltage is fixed at 4.2V or 4.35V , and the charging current can be programmed by the ISET external resistor.

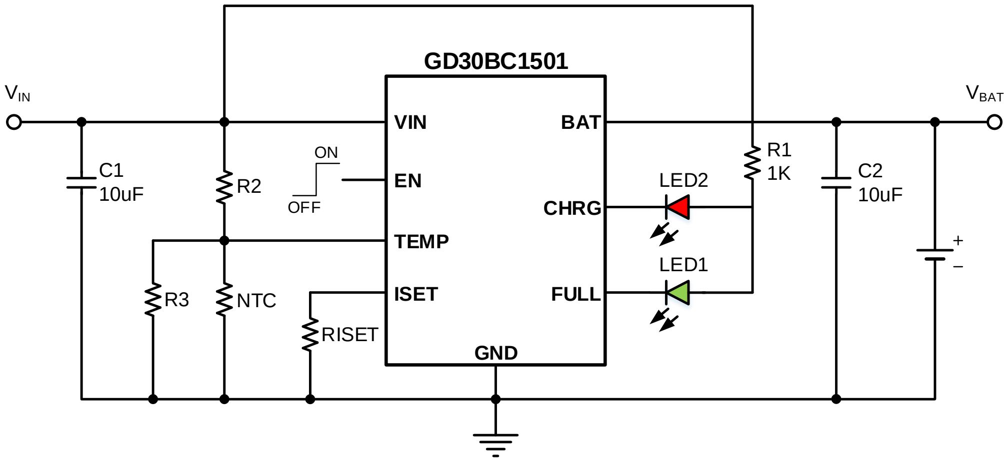
When the final full charge voltage is reached and the charge current drops to 1/10 of the set current, the GD30BC1501 will automatically terminate the charge cycle. When the input voltage source is removed, the GD30BC1501 automatically enters a low power state and the port leakage current connected to the battery drops below 1μA. Other features include charge current monitor, under-voltage lockout, automatic charging and status pins.

Device Information [1]

PART NUMBER	PACKAGE	BODY SIZE (NOM)
GD30BC1501	ESOP-8	4.90mm x 3.90mm
	DFN8	2.00mm x 2.00mm
		3.00mm x 3.00mm

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

Simplified Application Schematic



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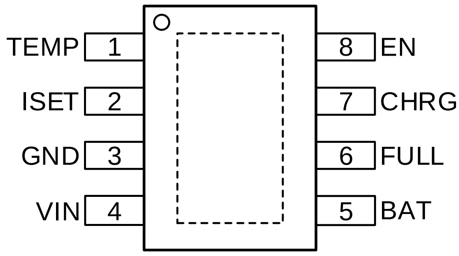
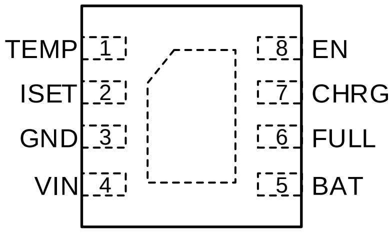
4 Device Overview

4.1 Pinout and Pin Assignment

ESOP-8
Top View



DFN2x2/3x3-8
Top View



4.2 Pin Description

PIN NUMBER			PIN TYPE[1]	FUNCTION
NAMe	ESOP8	DFN8		
TEMP	1	1	I	External temperature sensing pin, grounded when not in use.
ISET	2	2	I	Charge current programming, by connecting a 1% resistor (R_{ISET}) to ground to program the charge current.
GND	3	3	G	Ground pin.
VIN	4	4	P	Power input pin, connected to the adapter.
BAT	5	5	P	Charging current output pin.
FULL	6	6	O	Open-drain output for charging completion indicator.
CHRG	7	7	O	Open-drain output for charging status indicator.
EN	8	8	I	The chip enable pin is internally pulled high by default, and charging can be performed with it left floating. Connect it to a low level to disable operation.

1. I = Input, O = Output, 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_{EN}	Enable pin withstand voltage	–0.3	30	V
V_{CHRG}	Status indication pin withstand voltage	–0.3	36	V
V_{FULL}	Status indication pin withstand voltage	–0.3	36	V
V_{BAT}	Battery voltage	–5	12	V
V_{ISET}	ISET pin withstand voltage	–0.3	6	V
V_{TEMP}	Temperature sensing pin withstand voltage	–0.3	15	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	4.5	5	6	V
I_{CH}	Constant current charging current			1	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 Sensitivity

SYMBOL	CONDITIONS	VALUE	UNIT
$V_{ESD(HBM)}$	Human-body model (HBM), ANSI/ESDA/JEDEC JS-001-2017[1]	±2000	V
$V_{ESD(CDM)}$	Charge-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	ESOP8	60	°C/W

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

5.5 Electrical Characteristics

V_{IN} = 5 V, C_1 = 10μF, C_2 = 10μF, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
V_{IN}	Input voltage range		4.5	5	6	V
I_{IN} -I_{BAT}	Input power current	Charging Mode (R_{ISET} = 1K)		240	360	μA
		Standby mode, charging termination		70	120	
		Shutdown mode , (R_{ISET} not connected , V_{IN} < V_{BAT})		50	100	
V_{OVP}	Input overvoltage protection	V_{IN} rises	6.3	6.8	7.3	V
V_{OVP_HYS}	Input overvoltage protection hysteresis			500		mV
V_{UVLO}	VIN under-voltage lockout threshold	V_{IN} drops		3.8		V
V_{UVLO_HYS}	VIN under-voltage lockout threshold hysteresis			200		mV
BATTERY CHARGING						
V_{FLOAT}	Stable output (full charge voltage)	V_{BAT} from low to high	4.158	4.2	4.242	V
			4.307	4.35	4.394	
$\triangle V_{RCHG}$	Recharge hysteresis voltage	V_{FLOAT} -V_{RCHG}		1 50		mV
t_R	Recharge comparator filter time	V_{BAT} High to Low	0.8	2	4	mS
R_{DS_ON}	Power tube conduction internal resistance	V_{BAT} = 3.8V, R_{ISET} = 1kΩ		700		mΩ
I_{CH}	Constant current charging current	V_{IN} = 5V, V_{BAT} = 3.6V, R_{ISET} = 1kΩ		1000		mA
I_{BAT}	BAT pin current	V_{IN} is left floating, V_{BAT} = 4.0V		0.5	1	μA
V_{TRIKL}	Trickle charge threshold voltage	V_{BAT} rises		2.8		V
V_{TRIKL_HYS}	Trickle charge threshold voltage hysteresis			150		mV
I_{TRIKL}	Trickle charge current	V_{BAT} < V_{TRIKL}		10%*I_{CH}		mA
I_{EOC}	Termination charge current threshold			10%*I_{CH}		mA
V_{ISET}	ISET pin voltage during constant current charging	V_{IN} = 5V, R_{ISET} = 1K	0.85	1	1.15	V
LED INDICATION						
I_{sink}	CHRG /FULL pin pull-down current	V_{IN} = 5V, V_{CHRG} = 1V / V_{FULL} = 1V	1	2.5	5	μA

Electrical Characteristics (Continued)

V_{IN} = 5 V, C_1 = 10μF, C_2 = 10μF, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
ENABLE						
V_{EN_H}	Enable high level threshold		1.4			V
V_{EN_L}	Enable low level threshold				0.4	V
INTERNAL TEMPERATURE COMPENSATION						
T_{OTC}	Internal temperature compensation			140		°C
T_{OTPH}	Over temperature detection threshold	TEMP connects to NTC resistor	43%*V_{IN}	45%*V_{IN}		V
T_{OTPL}	Low temperature detection threshold	TEMP connects to NTC resistor		80%*V_{IN}	82%*V_{IN}	V

6 Functional Description

6.1 Block Diagram

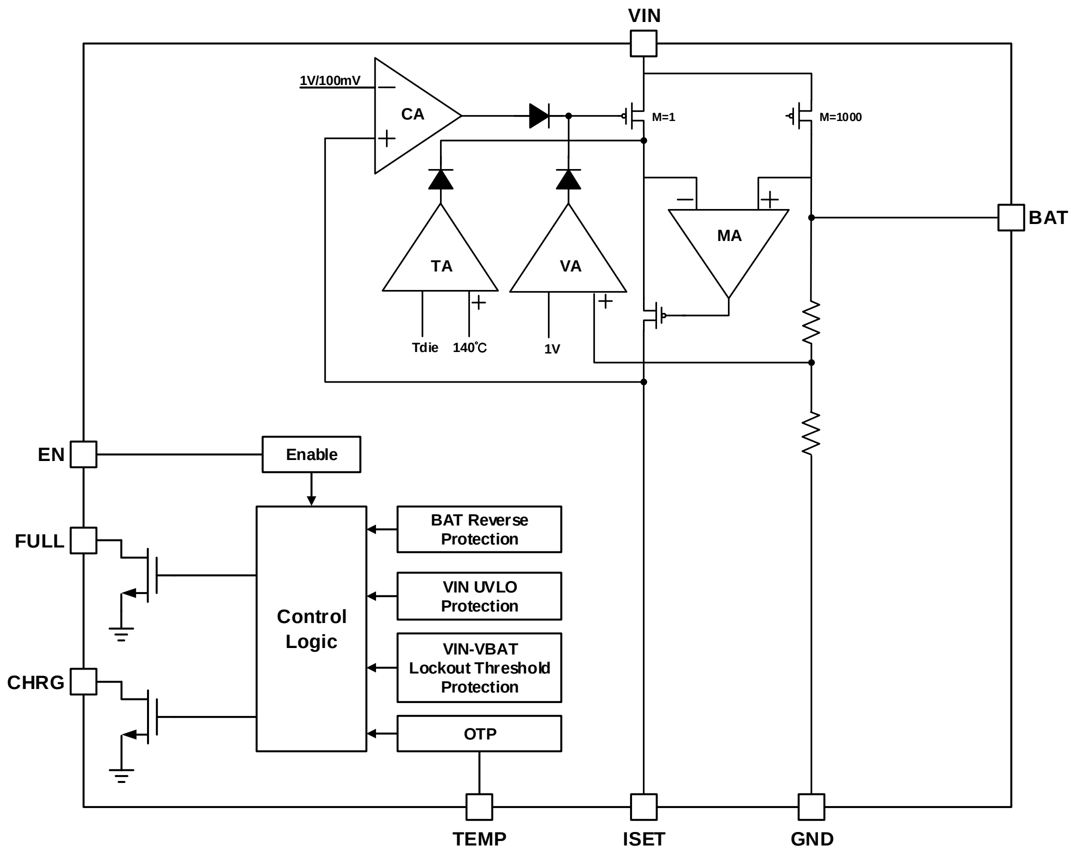


Figure 1. GD30BC1501 Functional Block Diagram

6.2 Overview

The GD30BC1501 is a complete constant current/constant voltage linear charger for single-cell lithium batteries. Its compact package and low external component count make the GD30BC1501 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 GD30BC1501 will automatically terminate the charge cycle. When the input voltage source is removed, the GD30BC1501 automatically enters a low power state, and the leakage current of the port connected to the battery drops below 1μA. Other features include charge current monitor, undervoltage lockout, automatic charging and status pin.

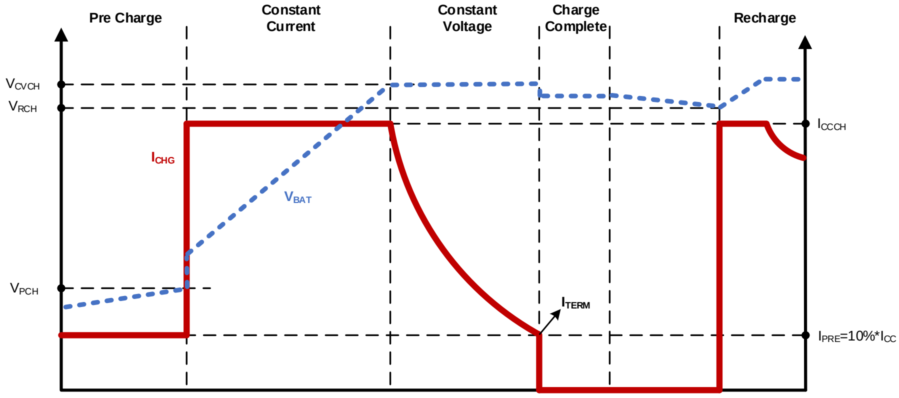


Figure 2. Lithium Battery Cycle Charging Process

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 GD30BC1501 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 GD30BC1501 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 charging cycle is terminated when the charging current drops to 1/10 of the set value after reaching the final full charge voltage .

6.2.3 ISET Programmable Charge Current

Set by a resistor connected between the ISET pin and ground. The set resistor and charge current are calculated using the following Equation(1), where R_{ISET} is in ohms (Ω).

$$I_{BAT} = \frac{1000}{R_{ISET}} \quad (1)$$

In order to ensure the stability and temperature characteristics of the system, it is recommended to use a metal film resistor with an accuracy of 1% for R_{ISET}. 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)
1	1 000
1 .2	8 30
1.5	6 66
5	2 00

6.2.4 Automatic Recharging

Once the charge cycle is terminated, the GD30BC1501 continuously monitors the voltage on the BAT pin using a comparator with a 2.0ms filter time . When the battery voltage drops below 4.05V (roughly corresponding to 80% to 90% of the battery capacity), 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 initiations.

6.2.5 Enable Function

GD30BC1501 has an enable / disable function. When the EN pin is input high level, the IC will be enabled. To ensure the normal operation of the charger, the EN turn-on level must be higher than 1.4V. When the voltage on the EN pin is lower than 0.4V, the IC will enter shutdown mode.

6.2.6 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 .

6.2.7 Reverse Battery Protection

GD30BC1501 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. The FULL pin works in the opposite way, it is pulled low after charging is completed and is high impedance during charging.

CHARGING STATUS	RED LED (CHRG)	GREEN LED (FULL)
Charge	Bright	Destroy
Fully charged	Destroy	Bright
Undervoltage lockout, overvoltage, abnormal battery temperature	Destroy	Destroy
VIN connected, battery not connected	Flash	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 GD30BC1501 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 GD30BC1501 . 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(2):

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

According to the PD junction temperature, it can be calculated by the following Equation(3):

$$T_J = P_D x \theta_{JA} + T_A \tag{3}$$

Where:

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

7 Application Information

GD30BC1501 is a linear charger for single-cell lithium-ion batteries, with a maximum charging current of 1A, a withstand input voltage of 36V, a typical input voltage of 5V, and a full charge voltage of 4.2V or 4.35V for lithium-ion batteries. C1 and C2 capacitors are recommended to use chip ceramic capacitors with a capacitance of 1μF/25V or above.

7.1 Typical Application Circuit

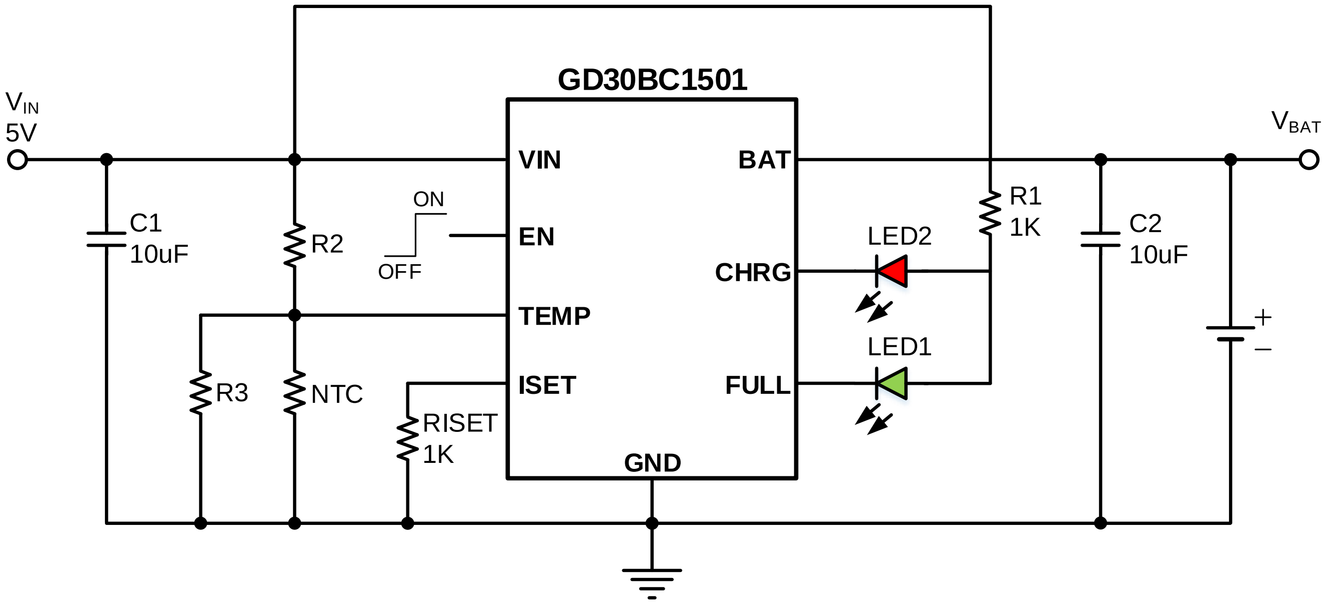


Figure 3. 1A constant Current Charging Reference Circuit

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.

It is also recommended that the ground reference plane be connected to the thermal pad on the bottom of the chip. This reference plane is used to ensure the accuracy of the output voltage, shield noise, and when connected to the thermal pad, it can conduct or absorb the heat of the chip. In most applications, this ground plane is necessary to meet thermal requirements.

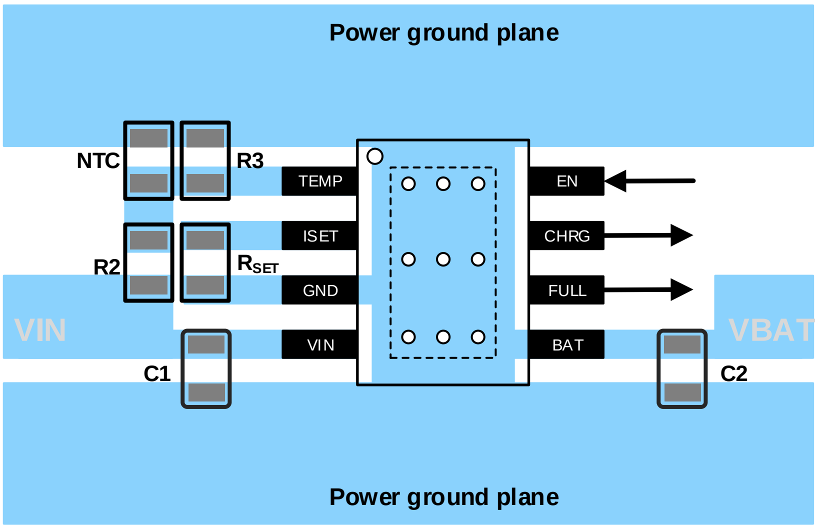
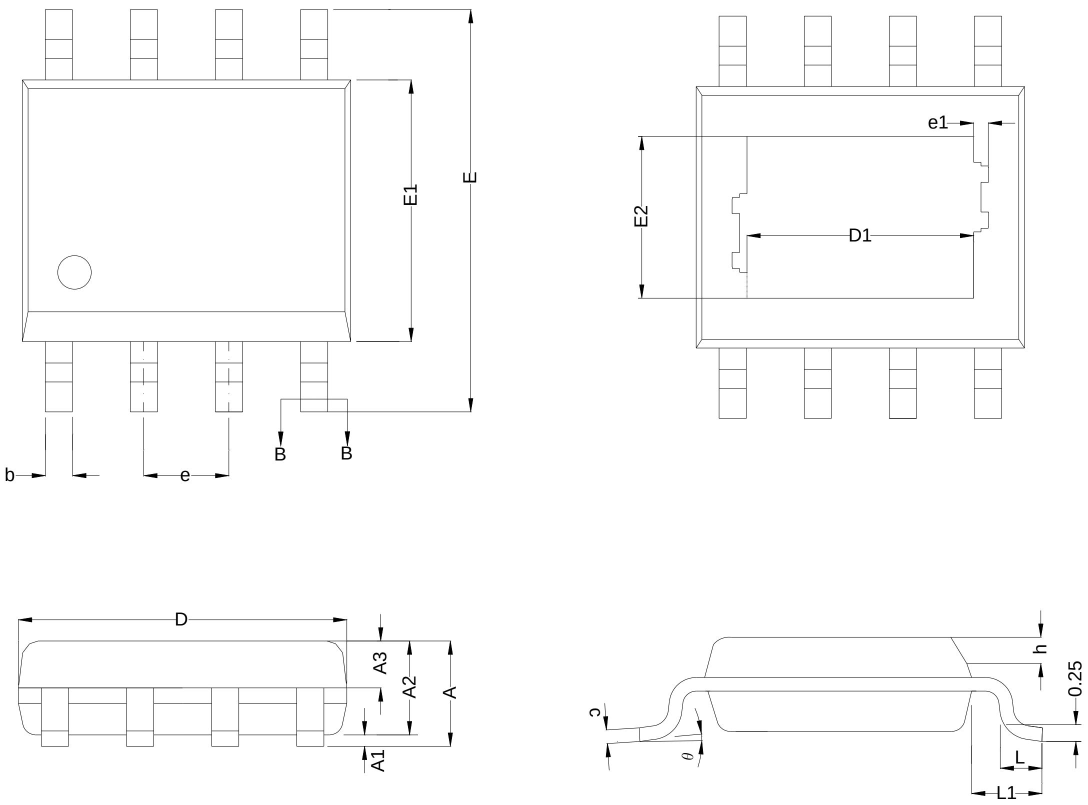


Figure 4. ESOP8 Example Layout

9 Packaging information

9.1 Outline Dimensions

ESOP8 Package Diagram



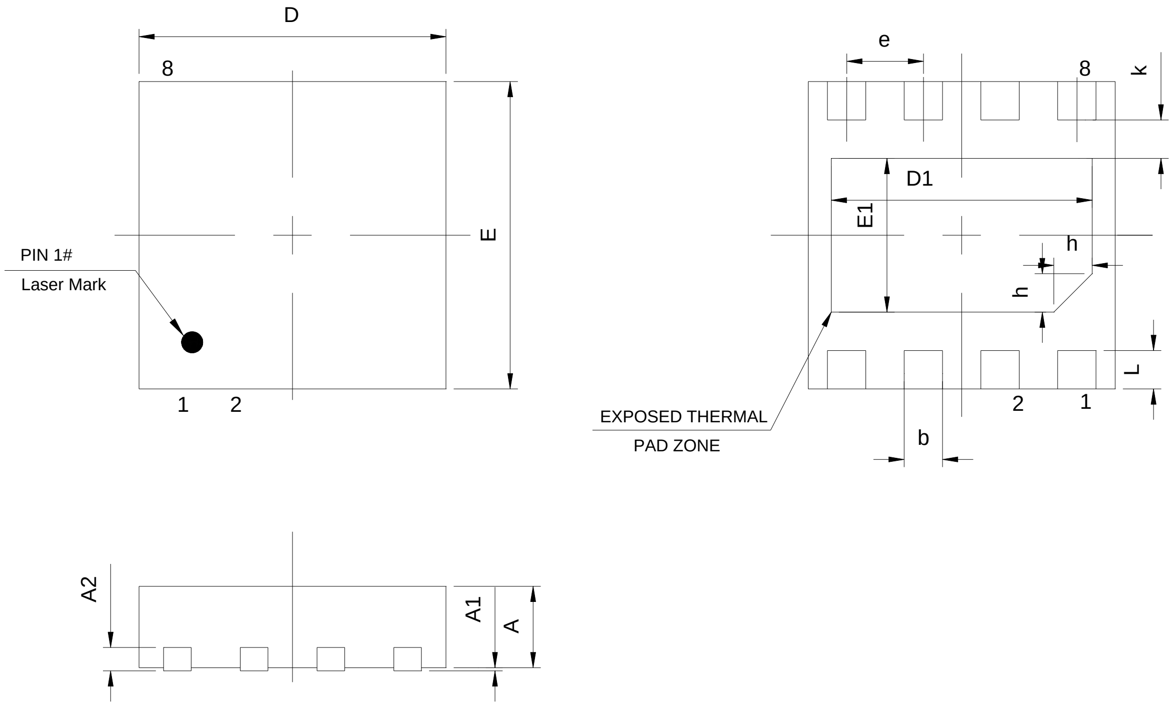
Note :

1. All dimensions are in millimeters.
2. Package dimensions does not include mold flash, protrusions, or gate burrs.
3. Refer to Table 1ESOP8 *Dimensions (mm)*.

Table 1ESOP8 Dimensions (mm)

SYMBOL	MIN	MAX
A	1.350	1.750
A1	0.050	0.150
A2	1.350	1.550
b	0.330	0.510
c	0.170	0.250
D	4.700	5.100
E	5.800	6.200
E1	3.800	4.000
E2	2.313	2.513
e	1.270 BSC	
L	0.400	1.270
θ	0°	8°

DFN2x2-8 Package Diagram



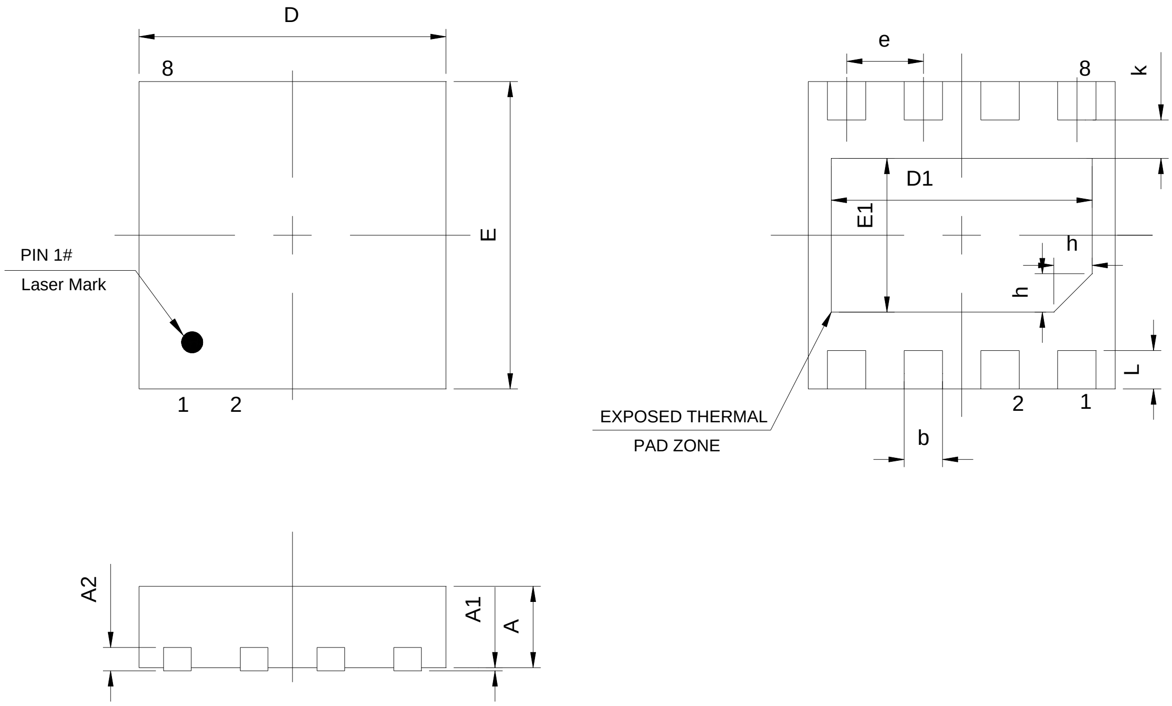
Note: (Continued)

1. Reference Table 2DFN2x2-8 *Dimensions (mm)*.

Table 2DFN2x2-8 Dimensions (mm)

SYMBOL	MIN	NOM	MAX
A	0.700	0.750	0.800
A1	0.000		0.050
A2		0.203 REF	
D	1.950	2.000	2.050
E	1.950	2.000	2.050
D1	1.175	1.200	1.225
E1	0.675	0.700	0.725
e		0.500 BSC	
b		0.250 BSC	
k		0.300	
L	0.300	0.350	0.400
h		0.200	

DFN3x3-8 Package Diagram



Note: (Continued)

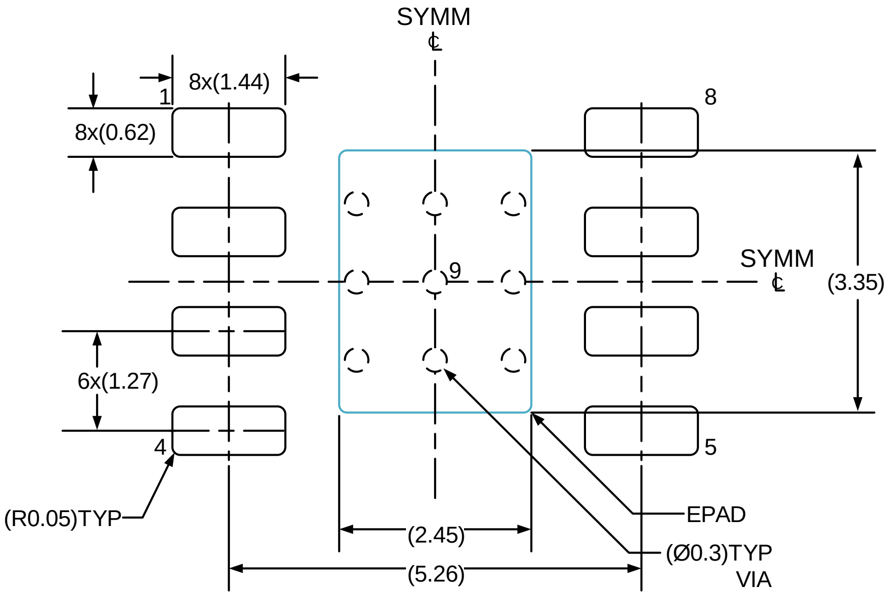
1. Reference Table 3DFN3x3-8 *dimensions (mm)*.

Table 3DFN3x3-8 dimensions (mm)

SYMBOL	MIN	NOM	MAX
A	0.700	0.750	0.800
A1	0.000		0.050
A2		0.203 REF	
D	2.950	3.000	3.050
E	2.950	3.000	3.050
D1	1.475	1.500	1.525
E1	2.275	2.300	2.325
e		0.650 BSC	
b		0.300 BSC	
k		0.350	
L	0.375	0.400	0.425
h		0.200	

9.2 Recommended Land Pattern

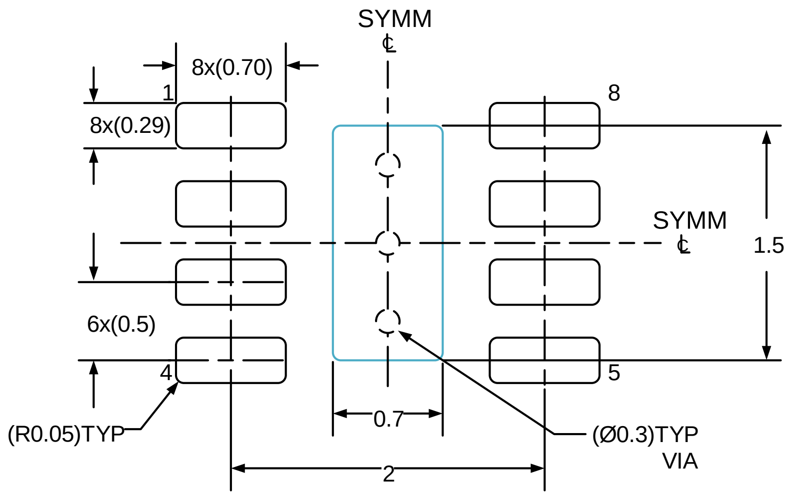
ESOP8 Land Pattern Example



Note :

1. Refer to the IPC-7351 can also help you complete the designs.
2. Exposed metal shown.
3. Drawing is 10X scale.

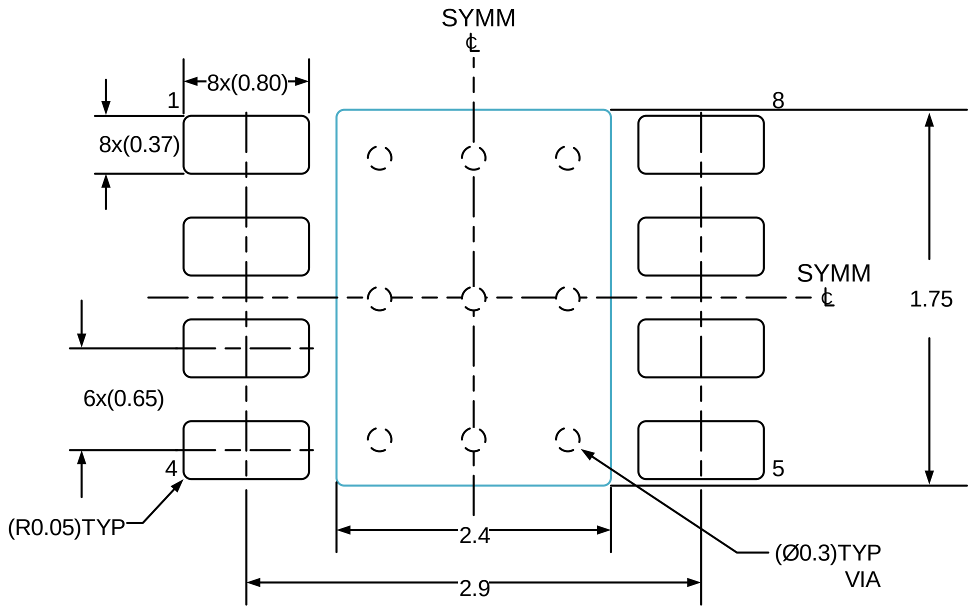
DFN2x2-8 Land Pattern Example



Note : (Continued)

1. Drawing is 20X scale.

DFN3x3-8 Land Pattern Example



Note : (Continued)

1. Drawing is 20X scale.

10 Ordering Information

Ordering Code	Package Type	ECO Plan	Packaging Type	MOQ	OP Temp(°C)
GD30BC1501WGTR-I	ESOP8	Green	Tape & Reel	4000	–40°C to +125°C
GD30BC1501WGTR-I1D	ESOP8	Green	Tape & Reel	4000	–40°C to +125°C
GD30BC1501WFTR-I	DFN2x2-8	Green	Tape & Reel	3000	–40°C to +125°C
GD30BC1501WFTR-I1D	DFN2x2-8	Green	Tape & Reel	3000	–40°C to +125°C
GD30BC1501WETR-I	DFN3x3-8	Green	Tape & Reel	5000	–40°C to +125°C
GD30BC1501WETR-I1D	DFN3x3-8	Green	Tape & Reel	5000	–40°C to +125°C

1. GD30BC1501WXTR-I Full charge voltage 4.2V
2. GD30BC1501WXTR-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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