

GigaDevice Semiconductor Inc.

**GD30DC2300x
1MHz High Current Boost Converter**

Datasheet

Table of Contents

Table of Contents	2
List of Figures	4
List of Tables	5
1 Features.....	6
2 Applications	6
3 General description	6
4 Device overview.....	7
4.1 Device information	7
4.2 Block diagram.....	7
4.3 Pinout and pin assignment	8
4.4 Pin definitions.....	8
5 Functional description	9
5.1 Operation mode.....	9
5.1.1 Current limit.....	9
5.1.2 Chip enable.....	9
5.1.3 Protection features.....	9
6 Application information.....	10
6.1 Setting up the output	10
6.2 Selecting the External Capacitors	10
6.3 Input capacitor selection	10
6.4 Output capacitor selection	11
6.5 Diode selection	11
6.6 Inductor selection	11
6.7 Duty Cycle.....	12
7 Electrical characteristics.....	13
7.1 Absolute maximum ratings	13
7.2 Recommended operation conditions	13
7.3 Electrical sensitivity	13
7.4 Power supplies voltages and currents.....	14
7.5 EN characteristics	14



7.6	Switching regulator characteristics	14
7.7	Typical characteristics.....	15
8	Typical application circuit	17
9	Layout guideline	18
10	Package information	19
10.1	SOT23-6 package outline dimensions	19
10.2	Thermal characteristics.....	21
11	Ordering information.....	22
12	Revision history.....	23

List of Figures

Figure 4-1 Block diagram for GD30DC2300x	7
Figure 4-2 GD30DC2300x SOT23-6 pinouts	8
Figure 6-1 Feedback resistor divider	10
Figure 8-1 Typical GD30DC2300x application circuit.....	17
Figure 9-1 Typical GD30DC2300x layout guideline	18
Figure 10-1 SOT23-6 package outline.....	19
Figure 10-2 SOT23-6 recommend footprint	20

List of Tables

Table 4-1. GD30DC2300x SOT23-6 pin definitions	7
Table 4-2. GD30DC2300x SOT23-6 pin definitions	8
Table 6-1 Absolute maximum ratings	13
Table 7-2 Recommended operation conditions.....	13
Table 7-3 Electrostatic Discharge and Latch-up characteristics.....	13
Table 7-4 Power supplies voltages and currents	14
Table 7-5 EN characteristics	14
Table 7-6 Switching regulator characteristics	14
Table 10-1 SOT23-6 dimensions	19
Table 10-2. Package thermal characteristics ⁽¹⁾	21
Table 11-1 Part order code for GD30DC2300x devices	22
Table 12-1 Revision history	23

1 Features

- 2.5V to 18V Input Voltage Range
- 1MHz Fixed Switching Frequency
- Accurate Reference Voltage 0.6V
- Up to 30V Output Voltage
- Integrated 150mΩ Power MOSFET
- Internal 3A Switch Current Limit
- Internal Soft-start Limits the Inrush Current
- Thermal Shutdown Protection
- RoHS Compliant and Halogen Free
- Available in SOT23-6 Package

2 Applications

- Portable and mobile devices
- TWS Case
- Low voltage I/O system power

3 General description

The GD30DC2300x is a high frequency current mode step-up switching regulator with integrated switch of 150mΩ. The device operates from an input voltage from 2.5V up to 18V and an output voltage up to 30V. The device has a high switching current limit of 3A. Fault protections include cycle-by-cycle current limit and thermal shutdown.

The switching frequency is set at 1MHz to allow the use of small external components. The GD30DC2300x is available with space saving SOT23-6 package and requires minimal number of external components. Together with its low quiescent current, the GD30DC2300x is ideal for one-cell Li-ion battery applications, wearable IoT device, portable or mobile devices.

4 Device overview

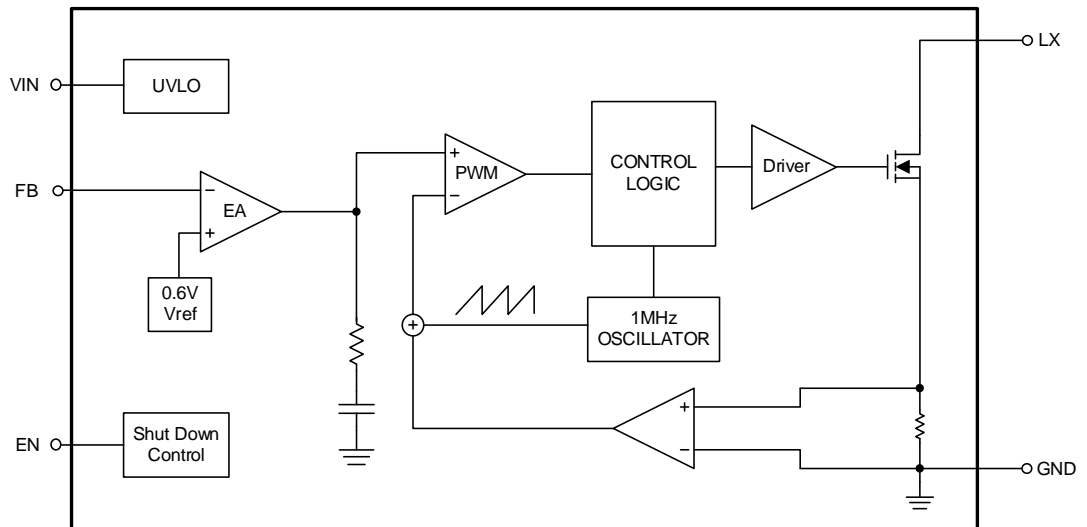
4.1 Device information

Table 4-1. GD30DC2300x SOT23-6 pin definitions

Part Number	Package	Function	Description
GD30DC2300x	SOT23-6	Boost	1MHz High Current Step-Up Regulator

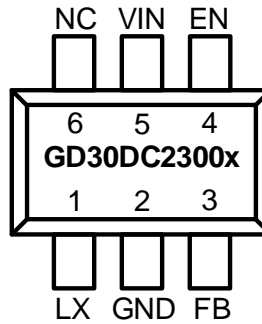
4.2 Block diagram

Figure 4-1 Block diagram for GD30DC2300x



4.3 Pinout and pin assignment

Figure 4-2 GD30DC2300x SOT23-6 pinouts



4.4 Pin definitions

Table 4-2. GD30DC2300x SOT23-6 pin definitions

Pin Name	Pins	Pin Type	Functions description
LX	1	P	Switch pin connected to the main switch and inductor terminal.
GND	2	G	Device ground.
FB	3	I	Feedback pin for the internal control loop. Connect this pin to the external feedback divider.
EN	4	I/O	Chip enable, pull high to enable the output.
VIN	5	P	Power supply voltage input.
NC	6	NC	Not Connected.

Notes:

(1) Type: I = input, O = output, OD = open drain output, I/O = input or output, P = power, G = Ground.

5 Functional description

5.1 Operation mode

The GD30DC2300x is a current mode step-up DCDC converter with 1MHz operation frequency. The input voltage range is 2.5V to 18V and the output voltage up to 30V. The GD30DC2300x automatically transits from PWM to burst mode during light load condition which can maintain a high efficiency.

5.1.1 Current limit

The GD30DC2300x has a typical 3A. During the ON-time, once the inductor exceeds the current limit, the internal LX switch turns off immediately and shortens the duty cycle. The switch current limit prevents the device from high inductor current and drawing excessive current from a battery or input voltage rail. Excessive current might occur with a heavy load or shorted output circuit condition.

5.1.2 Chip enable

When the input voltage is greater than the under-voltage lockout (UVLO) threshold (typically 2.2V), the GD30DC2300x can be enabled by pulling EN higher than 1.5V. Pulling it down to ground disables the GD30DC2300x.

5.1.3 Protection features

UVLO: To avoid malfunction of the device at low input voltages, the GD30DC2300x shuts down at voltages lower than V_{UVLO} , typical of 2.2V with V_{HYS_UVLO} hysteresis.

Thermal Protection: The GD30DC2300x enters thermal shutdown once the junction temperature exceeds typically T_{OT} . Once the device temperature falls below the threshold with hysteresis, the device returns to normal operation automatically.

6 Application information

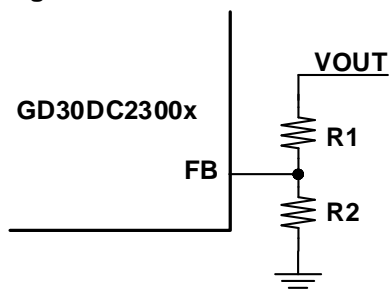
6.1 Setting up the output

An external resistor divider is used to set output voltage. By selecting R1 and R2, the output voltage is programmed to the desired value. When the output voltage is regulated, the typical voltage at the FB pin is $V_{FB}=0.6V$.

$$V_{OUT} = V_{FB} * \left(1 + \frac{R_1}{R_2}\right)$$

Selecting large resistance values for both R1 and R2 to minimize the power consumption. For the best accuracy, should be kept R2 smaller than 200KΩ.

Figure 6-1 Feedback resistor divider



6.2 Selecting the External Capacitors

The best capacitors for use with the GD30DC2300x are ceramic capacitors. These capacitors have the lowest ESR and highest resonance frequency which makes them optimum for use with high-frequency switching converters.

When selecting a ceramic capacitor, only ceramic capacitors with X5R and X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. Other types such as Z5U and Y5F have such severe loss of capacitance due to effects of temperature variation and applied voltage, they may provide as little as 20% of rated capacitance in many typical applications. Always consult capacitor manufacturer's data curves before selecting a capacitor. High-quality ceramic capacitors can be obtained from Taiyo-Yuden, Murata, and TDK.

6.3 Input capacitor selection

The input current to the step-up converter is discontinuous and therefore requires a capacitor to supply AC current to the step-down converter while maintaining the DC input voltage. For best performance, use extremely low ESR capacitors. For most applications, GD recommends a nominal value of 10uF, but larger values can be used.

The input capacitor requires an adequate ripple current rating since it absorbs the input

switching current. For simplification, choose an input capacitor with an RMS current rating greater than half of the maximum load current.

6.4 Output capacitor selection

The output capacitor is selected to handle the output ripple noise requirements. Both steady state ripple and transient requirements must be taken into consideration when selecting this capacitor. For the best performance, it is recommended to use X5R or X7R ceramic capacitor with one 22uF or two pcs 10uF.

6.5 Diode selection

Schottky diode is a good choice for high efficiency operation because of its low forward voltage drop and fast reverse recovery. The schottky diode average current rating must be greater than the maximum load current expected, and the peak current rating must be greater than the peak inductor current. During short circuit testing, or if short circuit conditions are possible in the application, the diode current rating must exceed the switch current limit. The schottky diode reverse breakdown voltage should be larger than output voltage.

6.6 Inductor selection

The inductance value of the inductor determines its ripple current. It is recommended that the peak-to-peak ripple current be set to 20%–40% of the DC current. A 2.2μH to 10μH inductor is recommended for most applications, For a specific application, a more exact value can be calculated by the following equations:

$$L = \left(\frac{V_{IN}}{V_{OUT}} \right)^2 \frac{V_{OUT} - V_{IN}}{(0.2 \text{ to } 0.4) \times I_{OUT_MAX} \times f_S}$$

where:

L is inductor value; I_{OUT_MAX} is maximum output current of the boost converter; f_S is switching frequency.

Using an inductor with a smaller inductance value forces discontinuous PWM where the inductor current ramps down to zero before the end of each switching cycle. This reduces the boost converter's maximum output current, causes large input voltage ripple and reduces efficiency. In general, inductors with large inductance and low DCR values provide much more output current and higher conversion efficiency. Inductors with smaller inductance values can give better load transient response. The converter's maximum output current for different applications can be calculated by the following equations:

$$\Delta I_L = \frac{V_{IN} \times D}{f_S \times L}$$

$$I_{OUT_MAX} = \frac{V_{IN} \times (I_{LIM} - \Delta I_L / 2) \times \eta}{V_{OUT}}$$

where:

ΔI_L is inductor peak to peak ripple current; D is duty cycle of the switching regulator; I_{LIM} is switch current limit; η is convert efficiency.

The selection of the inductor affects steady state operation as well as transient behavior and loop stability. These factors make it the most important component in power regulator design. There are three important inductor specifications: inductor value, DC resistance (DCR) and saturation current. Considering inductor value alone is not enough.

6.7 Duty Cycle

The maximum duty cycle of the switching regulator determines the maximum boost ratio of output-to-input voltage that the converter can attain in continuous mode of operation. The duty cycle for a given boost application is defined as:

$$D = \frac{V_{OUT} + V_D - V_{IN}}{V_{OUT} + V_D - V_{SW}}$$

This is applies for continuous conduction mode operation.

7 Electrical characteristics

7.1 Absolute maximum ratings

The maximum ratings are the limits to which the device can be subjected without permanently damaging the device. Note that the device is not guaranteed to operate properly at the maximum ratings. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

Table 6-1 Absolute maximum ratings

Symbol	Parameter	Min	Max	Unit
V _{VIN}	Power supply pin voltage	-0.3	20	V
V _{EN}	FB pin voltage	-0.3	20	V
V _{LX}	Switching node voltage	-0.3	40	V
V _{FB}	FB pin voltage	-0.3	6	V
Thermal characteristics				
T _J	Operating junction temperature	-40	150	°C
T _{stg}	Storage temperature	-55	150	°C
P _{max}	Maximum power dissipation @T _A =25°C	—	0.4	W

7.2 Recommended operation conditions

Table 7-2 Recommended operation conditions

Symbol	Parameter	Min	Typ	Max	Unit
V _{VIN}	Power supply pin	2.5	—	18	V
V _{LX}	Switching node voltage (LX)	—	—	30	V
V _{IO}	I/O pin voltage (FB)	0	—	5.5	V
	I/O pin voltage (EN)	0	—	18	V
Thermal characteristics					
T _J	Operating junction temperature	-40	—	125	°C

7.3 Electrical sensitivity

The device is strained in order to determine its performance in terms of electrical sensitivity. Electrostatic discharges (ESD) are applied directly to the pins of the sample. Static latch-up (LU) test is based on I-test methods.

Table 7-3 Electrostatic Discharge and Latch-up characteristics

Symbol	Parameter	Conditions	Value	Unit
V _{ESD(HBM)}	Electrostatic discharge voltage (human body model)	T _A = 25 °C; JS-001-2017	±2000	V

$V_{ESD(CDM)}$	Electrostatic discharge voltage (charge device model)	$T_A = 25\text{ }^\circ\text{C}$; JS-002-2018	± 1000	V
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7.4 Power supplies voltages and currents

Table 7-4 Power supplies voltages and currents

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_Q	Quiescent current	$V_{VIN} = 5V$, No switching, $T_J = 25^\circ\text{C}$	—	110	200	μA
I_{SHDN}	Shutdown current	EN=0, $V_{IN}=2.5$ to $5.5V$	—	1.5	10	μA
V_{UVLO}	VIN under voltage lockout	VIN voltage falling	—	2.2	—	V
V_{UVLO_HYS}	VIN under voltage lockout hysteresis	VIN rising to falling threshold	—	200	—	mV

7.5 EN characteristics

Table 7-5 EN characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{ENL}	EN logic low voltage	—	—	—	0.4	V
V_{ENH}	EN logic high voltage	—	1.5	—	—	V
I_{EN}	EN pin current	—	—	0.3	1	μA

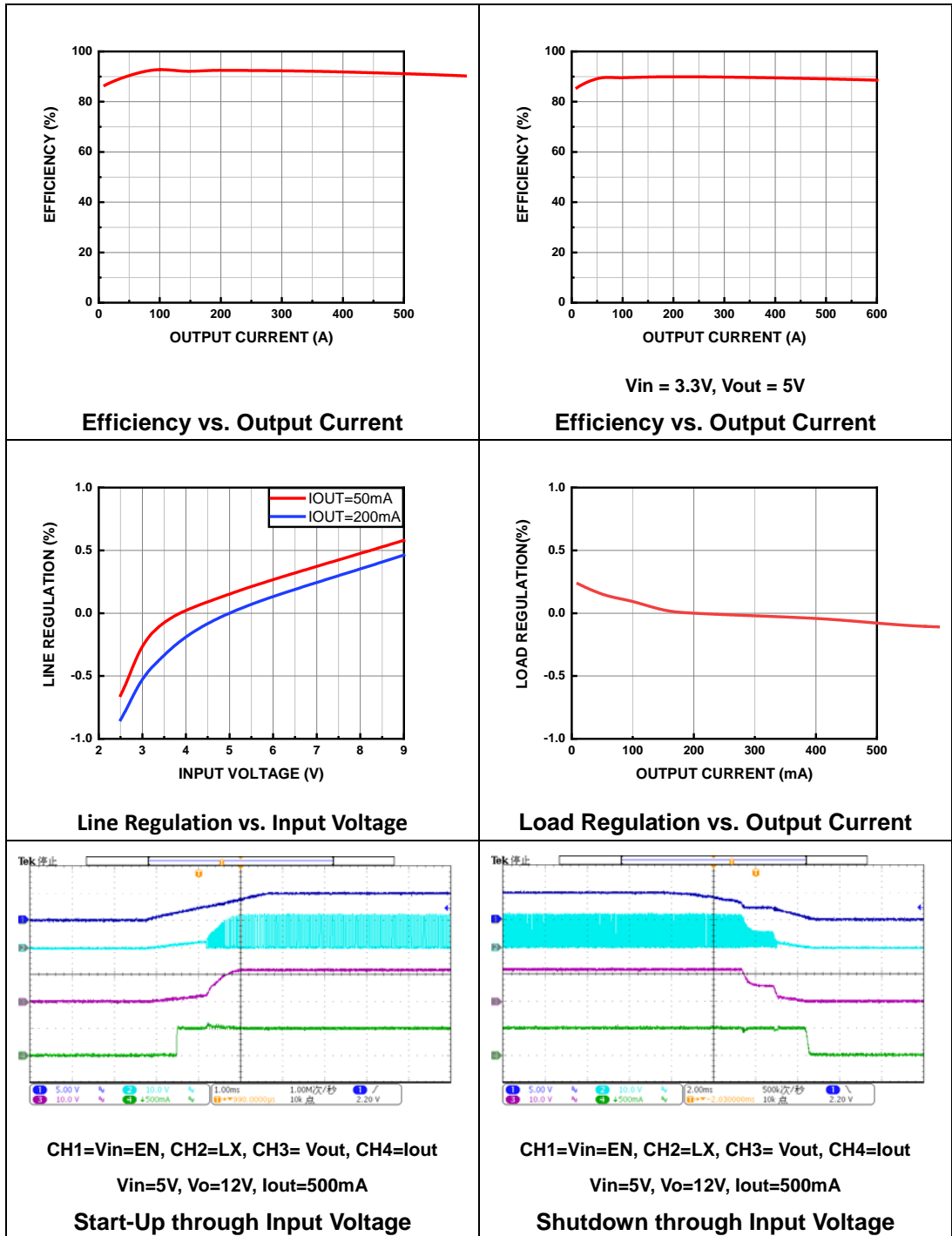
7.6 Switching regulator characteristics

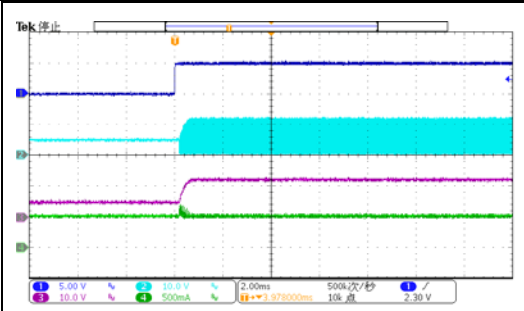
Table 7-6 Switching regulator characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{FB}	Feedback voltage	$V_{IN}=2.5$ to $5.5V$, $T_J = 25^\circ\text{C}$	0.588	0.6	0.612	V
I_{FB}	FB leakage current	—	—	—	1	μA
R_{NMOS}	Main NMOS switch	$V_{IN}=5V$, $T_J = 25^\circ\text{C}$	—	150	250	m Ω
F_{SW}	Switching frequency	$V_{IN}=2.5$ to $5.5V$, $T_J = 25^\circ\text{C}$	—	1	—	MHz
D_{MAX}	Max duty	—	—	88	—	%
T_{MIN}	Min On Time	—	—	100	—	nS
I_{LIM}	NMOS peak current limit	sourcing	—	3	—	A
T_{OT}	Thermal shutdown temperature	Die temperature, T_J	—	150	—	$^\circ\text{C}$
T_{HYS}	Thermal hysteresis	Die temperature, T_J	—	20	—	$^\circ\text{C}$

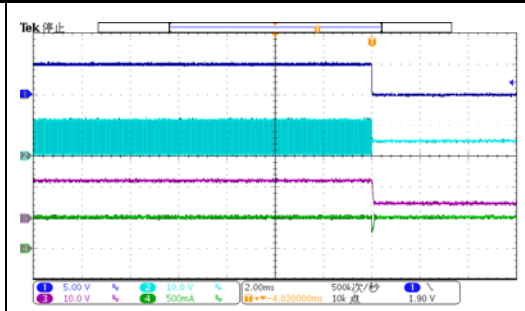
7.7 Typical characteristics

$V_{in} = 5V$, $V_{out} = 12V$, $L = 4.7\mu H$, $T_A = +25^\circ C$, unless otherwise noted

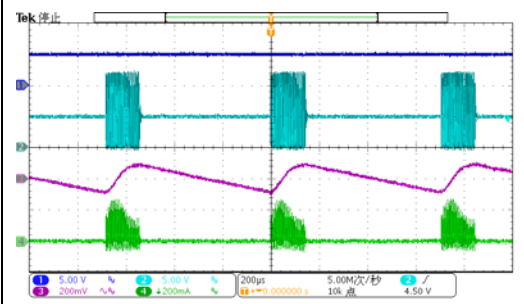




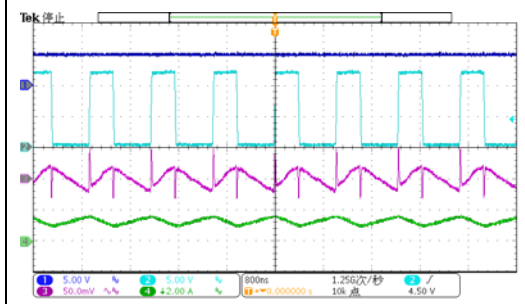
CH1=Vin=EN, CH2=LX, CH3= Vout, CH4=Iout
 Vin=5V, Vo=12V, Iout=500mA
Start-Up through Enable



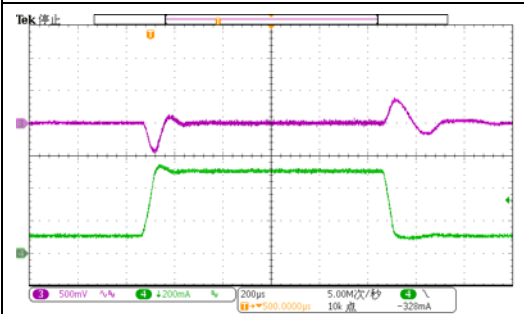
CH1=Vin=EN, CH2=LX, CH3= Vout, CH4=Iout
 Vin=5V, Vo=12V, Iout=500mA
Shutdown through Enable



CH1=Vin, CH2=Vo/AC, CH3=LX, CH4=IL
 Vin=5V, Vo=12V, Io=3mA
Output Voltage Ripple



CH1=Vin, CH2=Vo/AC, CH3=LX, CH4=IL
 Vin=5V, Vo=12V, Io=500mA
Output Voltage Ripple



CH3=Vout/AC, CH4=Iout
 Vin=5V, Vout=12V
Load Transient

8 Typical application circuit

Figure 8-1 Typical GD30DC2300x application circuit

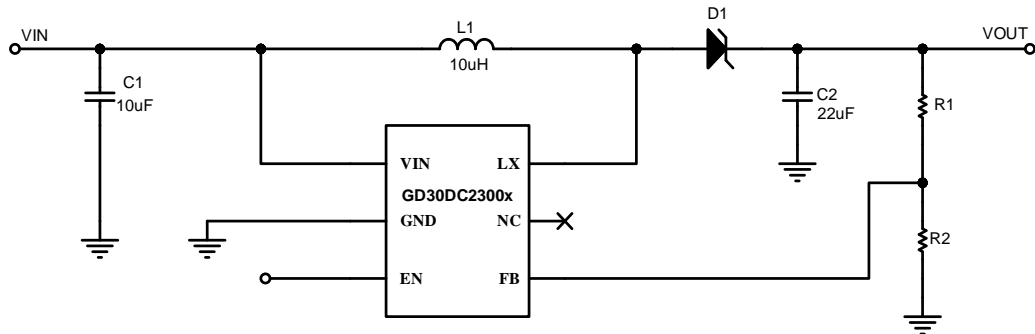
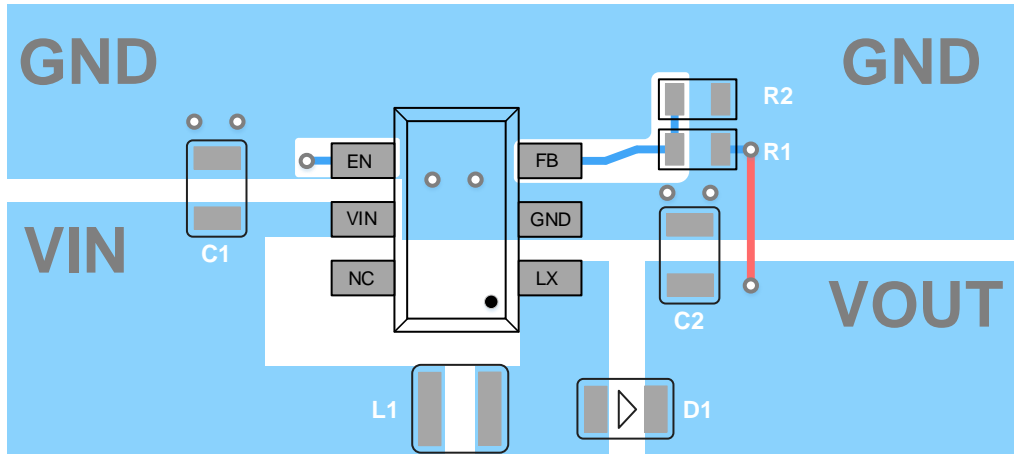


Table 7-1 Components parameter recommend

VOUT	C1	C2	R1	R2	L1
5V	10uF MLCC	22uF MLCC	73kΩ	10kΩ	2.2uH
12V	10uF MLCC	22uF MLCC	190kΩ	10kΩ	4.7uH
24V	10uF MLCC	22uF MLCC	390kΩ	10kΩ	10uH

9 Layout guideline

Figure 9-1 Typical GD30DC2300x layout guideline



Efficient PCB layout is critical for stable operation. For the high-frequency switching converter, a poor layout design can result in poor line or load regulation and stability issues. For best results, follow the guidelines below.

Notes:

- 1) Place the high-current paths (GND, VIN, and LX) very close to the device with short, direct, and wide traces.
- 2) Place the input capacitor as close to VIN and GND as possible.
- 3) Place the external feedback resistors next to FB.
- 4) Keep the switching node LX short and away from the feedback network.
- 5) Keep the VOUT sense line as short as possible or keep it away from the power inductor.

10 Package information

10.1 SOT23-6 package outline dimensions

Figure 10-1 SOT23-6 package outline

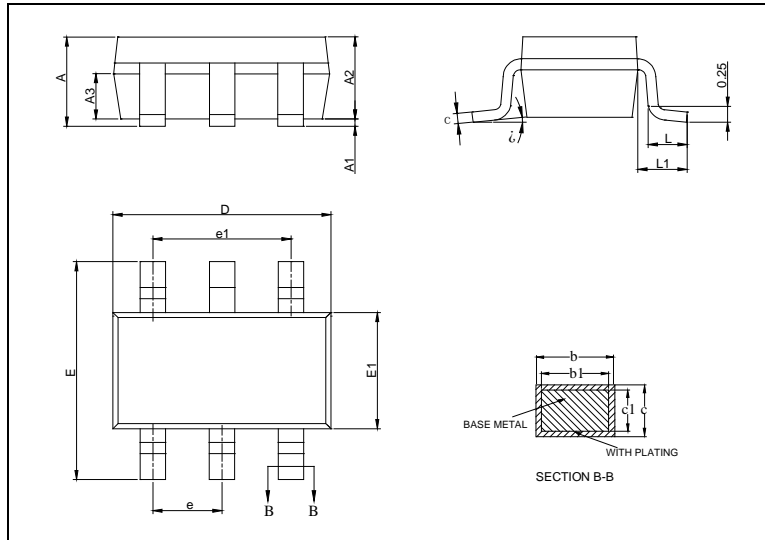
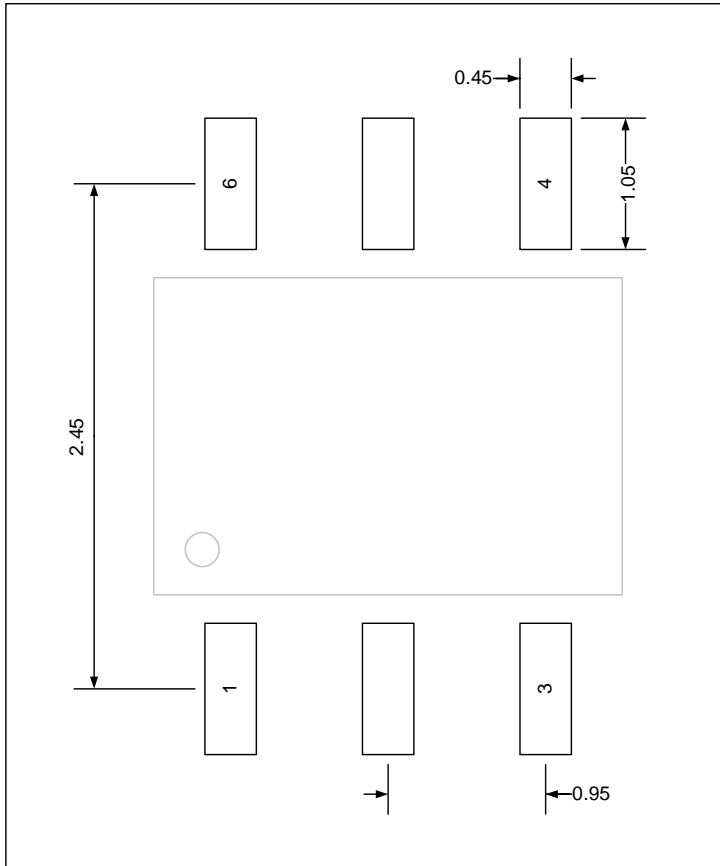


Table 10-1 SOT23-6 dimensions

Symbol	Min	Typ	Max
A	—	—	1.25
A1	0.04	—	0.10
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.33	—	0.41
b1	0.32	0.35	0.38
c	0.15	—	0.19
c1	0.14	0.15	0.16
D	2.82	2.92	3.02
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
e	—	0.95	—
e1	—	1.90	—
L	0.30	—	0.60
L1	—	0.60	—
θ	0°	—	8°

(Original dimensions are in millimeters)

Figure 10-2 SOT23-6 recommend footprint



(Original dimensions are in millimeters)

10.2 Thermal characteristics

Thermal resistance is used to characterize the thermal performance of the package device, which is represented by the Greek letter “ Θ ”. For semiconductor devices, thermal resistance represents the steady-state temperature rise of the chip junction due to the heat dissipated on the chip surface.

Θ_{JA} : Thermal resistance, junction-to-ambient.

Θ_{JB} : Thermal resistance, junction-to-board.

Θ_{JC} : Thermal resistance, junction-to-case.

Ψ_{JB} : Thermal characterization parameter, junction-to-board.

Ψ_{JT} : Thermal characterization parameter, junction-to-top center.

$$\Theta_{JA} = (T_J - T_A)/P_D$$

$$\Theta_{JB} = (T_J - T_B)/P_D$$

$$\Theta_{JC} = (T_J - T_C)/P_D$$

Where, T_J = Junction temperature.

T_A = Ambient temperature

T_B = Board temperature

T_C = Case temperature which is monitoring on package surface

P_D = Total power dissipation

Θ_{JA} represents the resistance of the heat flows from the heating junction to ambient air. It is an indicator of package heat dissipation capability. Lower Θ_{JA} can be considerate as better overall thermal performance. Θ_{JA} is generally used to estimate junction temperature.

Θ_{JB} is used to measure the heat flow resistance between the chip surface and the PCB board.

Θ_{JC} represents the thermal resistance between the chip surface and the package top case.

Θ_{JC} is mainly used to estimate the heat dissipation of the system (using heat sink or other heat dissipation methods outside the device package).

Table 10-2. Package thermal characteristics⁽¹⁾

Symbol	Condition	Package	Value	Unit
Θ_{JA}	Natural convection, 2S2P PCB	SOT23-6	104.1	°C/W
Θ_{JB}	Cold plate, 2S2P PCB	SOT23-6	64.1	°C/W
Θ_{JC}	Cold plate, 2S2P PCB	SOT23-6	46.1	°C/W
Ψ_{JB}	Natural convection, 2S2P PCB	SOT23-6	63.9	°C/W
Ψ_{JT}	Natural convection, 2S2P PCB	SOT23-6	2.69	°C/W

(1) Thermal characteristics are based on simulation, and meet JEDEC specification.

11 Ordering information

Table 11-1 Part order code for GD30DC2300x devices

Ordering Code	Package	Package Type	Packing Type	MOQ	Temperature Junction Range
GD30DC2300SSTR-N	SOT23-6	Green	Tape&Reel	3000	Industrial -20°C to +85°C

12 Revision history

Table 12-1 Revision history

Revision No.	Description	Date
1.0	Initial Release	Jun. 02, 2023

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