GigaDevice Semiconductor Inc.

GD30DR3000x
H-Bridge Motor Driver

Datasheet

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- Wide 6-40V Supply Voltage
- Adjustable Regulated Drive Current Limit, up to 3.2A
- PWM Input Control
- Low $R_{DS(ON)}$ Integrated MOSFET
- Low Power Standby Mode
- Thermally-Enhanced: SOP-8 with exposed pad
- Protection Features:
  - Over current protection
  - MOSFET Shoot-Through Prevention
  - Overtemperature Shutdown
  - VP Under Voltage Lock-Out (UVLO)

2 Applications

- DC Brush Motors
- Home Appliances
- Printers
- Industrial Automation
- Sweeping Robot

3 General description

The GD30DR3000x is an H-bridge driver, and is designed to drive one DC brush motor or other inductive loads. The driver can support up to 3.2A source and sink current. The GD30DR3000x can operate with a single power supply ranging from 6V to 40V.

The H-bridge is composed of 4 high voltage MOSFET. Two input terminals are provided to control the MOSFETs, and therefore control the speed and direction of the DC motor with externally applied PWM control signals. Integrated current rectification allows the motor driver to regulate the motor current during start up and high load. It also lowers the power dissipation during PWM operation.

The device uses a programmable dead-time and automatic handshaking to prevent the high-side and low-side MOSFET from shoot-through when switching. Internal protection includes overcurrent protection, VP undervoltage lock-out and over temperature shutdown.

The versatile features of the IC allow for it to be used in a broad range of applications, such as brush motors, home appliances, etc. The GD30DR3000x is available in a low profile 8-pin SOP with thermal exposed pad.

4 Device overview

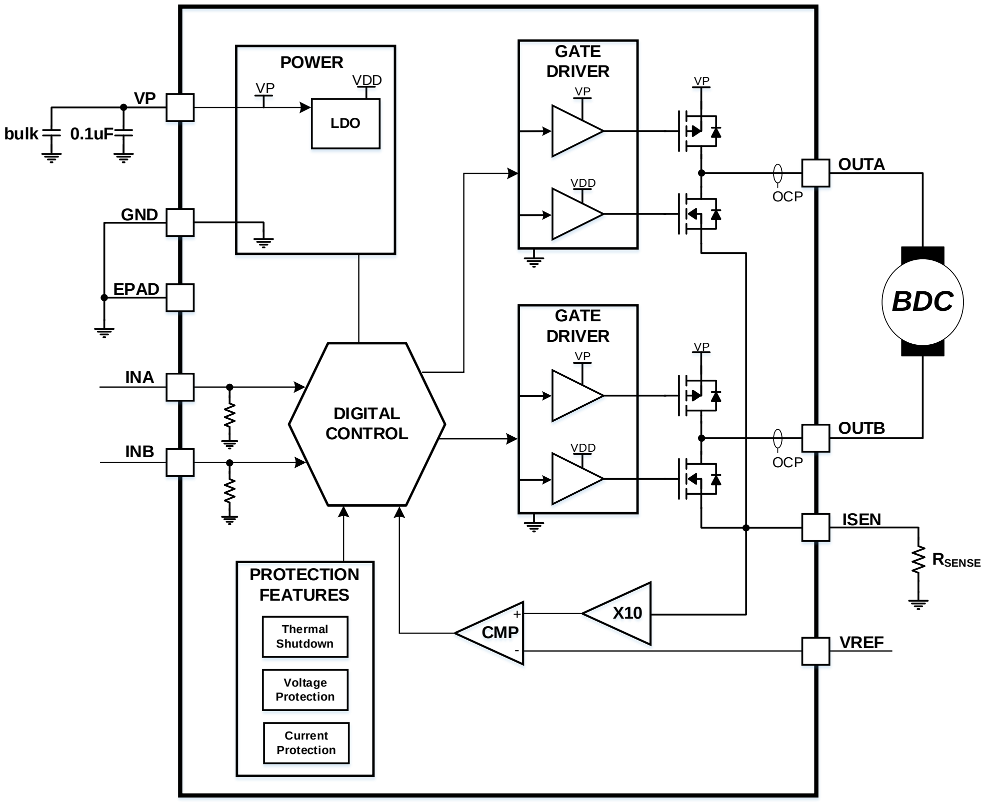
4.1 Device information

Table 4-1 Device information for GD30DR3000x

Part Number	Package	Function	Description
GD30DR3000x	SOP8	PWM Mode	H-Bridge Motor Driver

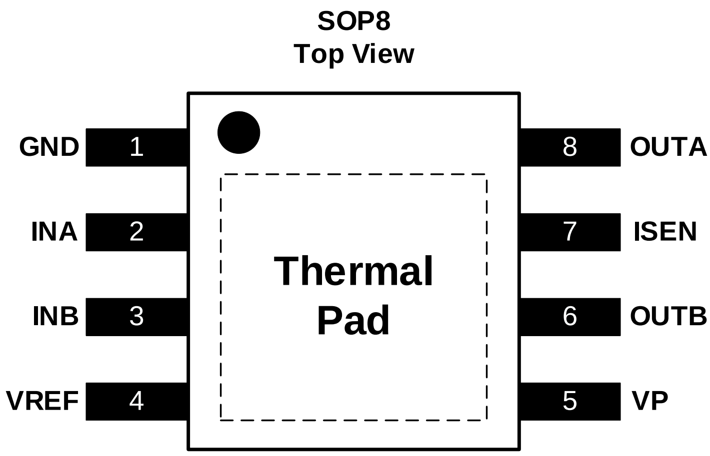
4.2 Block diagram

Figure 4-1 Block diagram for GD30DR3000x



4.3 Pinout and pin assignment

Figure 4-2 GD30DR3000x SOP8 Pinouts



4.4 Pin definitions

Table 4-2 GD30DR3000x pin configuration

PIN		TYPE	DESCRIPTION
NAME	NO.		
GND	1	P	Device logic ground, connect to board ground.
INA	2	I	PWM input A/B, control signal of H-bridge, internal pulldown.(See Table 5-1).
INB	3		
VREF	4	I	Analog refence voltage for current regulation, apply a voltage between 0.3 to 5V. For information on current regulation, see the *Current regulation* section.
VP	5	P	Power supply, connect a 0.1uF bypass capacitor to ground, as well as sufficient bulk capacitance, rated for the VP voltage.
OUTB	6	O	H-bridge output A/B, connect to the DC motor or other inductive load.
OUTA	8		
ISEN	7	I	Current path to ground, connect a sense resistor to ground to set the current regulation or directly to ground when not using regulation.
PGND	Thermal	P	Power ground, connect to board ground, use large ground plane for good thermal dissipation, and multiple nearby vias connecting those planes.

5 Functional description

5.1 H-Bridge Drive

The GD30DR3000x is a H-bridge motor driver with 4 integrated MOSFETs. Two inputs control the logic of the H-bridge driver with the single power supply VP. Motor speed can be controlled with PWM control up to 100KHz. When both logic inputs are low for a 1ms period, the device will be set into standby mode and consume less power. Protection features such as OCP, OTSD and UVLO are implemented to prevent the device and system from fault and damage.

5.1.1 PWM Mode

In GD30DR3000x, the device operates in PWM mode. H-bridge in PWM mode supports four output states: coast (Hi-Z), forward, reverse and brake. They are controlled by INA/INB according to Table 5-1. The inputs can be set to static voltage for 100% duty cycle drive, or PWM for variable motor speed. When using PWM, it typically works best to switch between driving and braking. The driver outputs and current are shown in the following Figure 5-1.

Figure 5-1 The driver outputs and current path

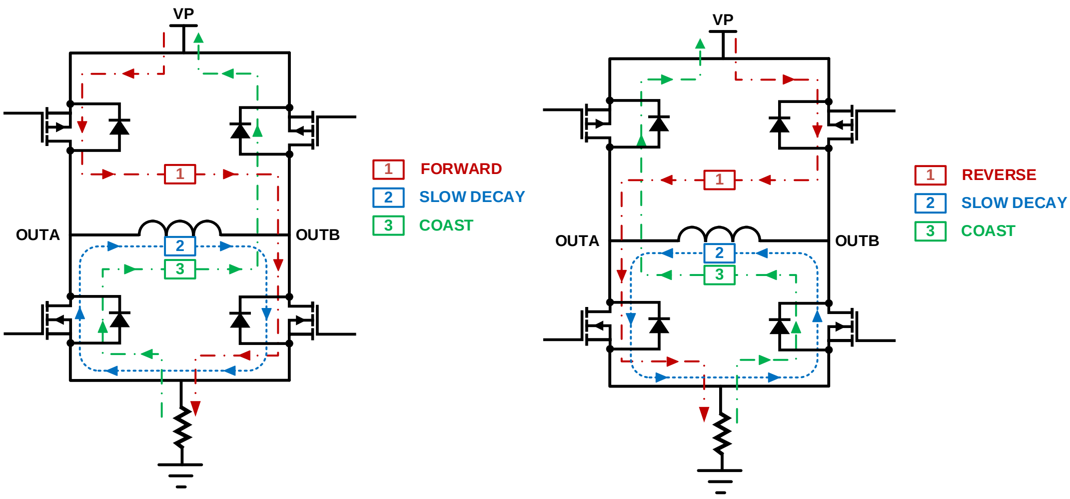


Table 5-1 PWM mode truth table

INA	INB	OUTA	OUTB	Description
0	0	Hi-Z	Hi-Z	Coast; H-bridge disabled to High-Z
0	1	L	H	Reverse (Current from OUTB to OUTA)
1	0	H	L	Forward (Current from OUTA to OUTB)
1	1	L	L	Brake; low-side slow decay

5.1.2 Standby Mode

The GD30DR3000x enters standby mode when INA and INB are both low for more than t_{sleep} (typically 1ms). The outputs will remain High-Z. After INA or INB are high for at least 5us, the device will be operational 60us (t_{wake}) later.

5.1.3 Dead time

An internal handshaking scheme is used to prevent shoot-through between the high side and low side MOSFETs. A typical dead time of 200ns is inserted when transitioning between MOSFETs in each half-bridge.

5.1.4 Current regulation

The output current is regulated at a limit set by an analog input V_{REF} and the resistor R_{SEN} connected from ISEN to ground, according to the equation:

$$I_{TRIP} = \frac{V_{REF}(V)}{A_V \times R_{REF}(\Omega)} = \frac{V_{REF}(V)}{10 \times R_{SEN}(\Omega)}(A)$$

For example, if V_{REF}=3.3V and R_{SEN}=0.15, the GD30DR3000x will limit motor current limit to 2.2A no matter how much load torque is applied.

Usually I_{TRIP} is set above the normal motor operating current, and high enough to achieve adequate spin-up time, and low enough to constrain current to a desired level.

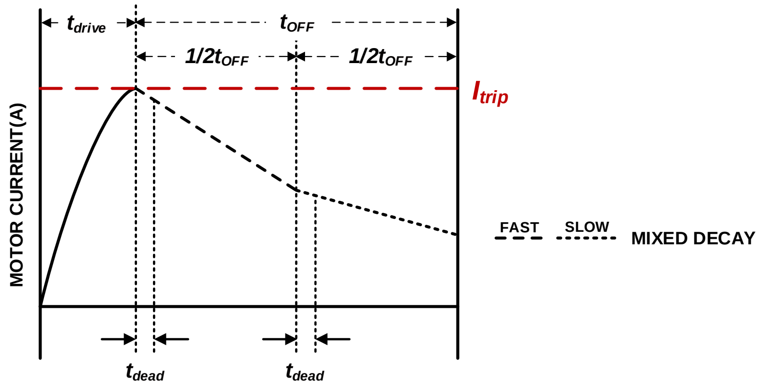
If I_{SEN} is connected to ground directly, the current regulation function is disabled. V_{REF} should still be applied to a value which could provide high noise margin. The output current could go up to 3.2A for a few hundred milli-second. Over current protection and over temperature protection may be triggered to protect the IC and system.

5.1.5 Mixed current decay

When current regulation is triggered, IC will enter a fixed time PWM off cycle to re-circulate the current. By default, the device enforces slow current decay by enabling both low-side MOSFETs for the fixed off time (t_{OFF}, 25us typical).

A mixed current decay mode is implemented as an option only in GD30DR3000x. In this mode, when current regulation is triggered, the driver outputs are switched to opposite polarity (High to Low, or Low to High) for the first half t_{OFF}. In the latter half of t_{OFF}, the driver is switched back to slow-decay mode. Mixed current decay are explained in Figure 5-2.

Figure 5-2 Mixed current decay



5.1.6 Internal power supply

A regulated 5V VDD derived from the VP supplies the gate to source voltage for the low-side NMOSFET. However, The driving voltage between the PMOSFET gate and source is the external power supply.

5.2 Protection features

5.2.1 Over temperature shutdown

If the die temperature exceeds the trip point of the thermal shutdown limit (T_{OTSD}, typical 150°C), all the MOSFETs are disabled, the internal power supplies are shut down. Normal operation starts again when the temperature falls below the hysteresis and the over temperature condition clears.

5.2.2 Over current protection

The individual currents go through the MOSFETs (high-side and low-side) are monitored cycle by cycle. In case any current is over the over-current limit (4A typical), all the MOSFETs are disabled and the internal power supply will be shutdown. The recycle of the PWM control will be retried after a delay time of 3ms and normal operation will be resumed if the OCP events are cleared.

5.2.3 Power supply undervoltage lockout (UVLO)

At any time if the voltage on the power supply VP falls below the UVLO threshold, all the internal MOSFETs in the H-bridge will be disabled. Normal operation will resume when VP rises above UVLO threshold.

6 Electrical characteristics

6.1 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_{VP}	Power supply pin voltage (VP)	–0.3	45	V
	Voltage differential between ground pins (GND, PGND)	–0.3	0.3	V
V_{REF}	Reference voltage	–0.3	6	V
$V_{INA/B}$	PWM input signal	–0.3	7	V
$V_{OUTA/B}$	H-bridge output drive	–1.0	V_{VP}+0.7	V
V_{ISEN}	Current path to ground	–0.7	1.0	V
I_{LIM}	Internal current limit	—	4	A
Thermal characteristics				
T_J	Operating junction temperature,	–40	150	°C
T_{stg}	Storage temperature,	–65	150	°C

6.2 Recommended operation conditions

Table 6-2 Recommended operation conditions

Symbol	Parameter	Min	Max	Unit
V_{VP}	Power supply voltage (VP)	6	40	V
$V_{INA/B}$	Input PWM voltage (INA/INB)	0	5.5	V
$f_{INA/B}$	Applied input PWM signal frequency	0	100	kHz
$I_{OUTA/B}$	H-bridge drive current (OUTA/OUTB)	0	3.2	A
V_{ISEN}	Current path to ground	–0.7	1.0	V
V_{REF}	Reference voltage input (REF)	0.3	5	V
Thermal characteristics				
T_A	Operating ambient temperature	–40	125	°C

6.3 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.

Table 6-3 Electrostatic discharge

Symbol	Parameter	Conditions	Value	Unit
$V_{ESD(HBM)}$	human body model	T_A = 25 °C; JS-001-2017	±2000	V
$V_{ESD(CDM)}$	charge device model	T_A = 25 °C; JS-002-2018	±1000	V

6.4 Power supplies and current consumption

All parameters are tested at T_A = –40°C to +125°C, V_{VP} = 6 to 40 V (unless otherwise noted).

Table 6-4 Power supplies and currents

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{VP}	VP operating supply current	V_{VP} = 12 V, PWMHx/PWMLx = 0 V	—	3	10	mA
I_{VPQ}	VP standby mode current	V_{VP} = 12 V, T_A = 25°C	—	—	10	μA
t_{WAKE}	Turn-on time	V_{VP} > V_{UVLO}, INA or INB high	—	60	—	μs
t_{SLEEP}	Turn-off delay time	INA=INB=0 to device standby mode	—	1	1.5	ms

6.5 Logic inputs characteristics

Logic input pins include **INA, INB.**

All parameters are tested at T_A = –40°C to +125°C, V_{VP} = 6 to 40 V (unless otherwise noted).

Table 6-5 Logic input characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IL}	Input logic low voltage	—	0	—	0.8	V
V_{IH}	Input logic high voltage	—	1.5	—	5.5	V
V_{HYS}	Input logic hysteresis	—	—	300	—	mV
I_{IL}	Input logic low current	VINA/B = 0 V	–1	—	1	μA
I_{IH}	Input logic high current	VINA/B = 3.3 V	—	33	100	μA
R_{PD}	Pulldown resistance	To GND	100	—	—	kΩ
t_{PD}	Propagation delay	INA/INB transition to OUTA/OUTB transition	—	60	—	ns

6.6 Motor driver characteristics

Related motor driver pins include **OUTA, OUTB.**

All parameters are tested at T_A = –40°C to +125°C, V_{VP} = 6 to 40 V (unless otherwise noted).

Table 6-6 Gate driver characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{DT}	Output drive dead time	VP=24V, Guaranteed by design	—	200	—	ns
t_{RISE}/t_{FALL}	Output rise or fall time	VP=24V, Guaranteed by design	—	50	—	ns
R_{DSON_H}	High side MOSFET R_{DSON}	VP=24V, I=1A, T=25°C	—	430	—	mΩ
R_{DSON_L}	Low side MOSFET R_{DSON}	VP=24V, I=1A, T=25°C	—	210	—	mΩ
V_{DIODE}	Body diode forward voltage	I=1A, T=25°C	—	0.8	1	V

6.7 Current regulation

The related pins include **REF, ISEN.**

All parameters are tested at T_A = –40°C to +125°C, V_{VP} = 6 to 40 V (unless otherwise noted).

Table 6-7 Open drain output characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
A_V	ISEN gain	REF = 2.5V	9.6	10	10.4	V/V
t_{OFF}	Fixed PWM off-time	—	18	25	32	µs
t_{BLANK}	PWM blanking time	—	—	2	—	µs

6.8 Protection features

Protection features include over current protection, under voltage lockout and thermal shutdown.

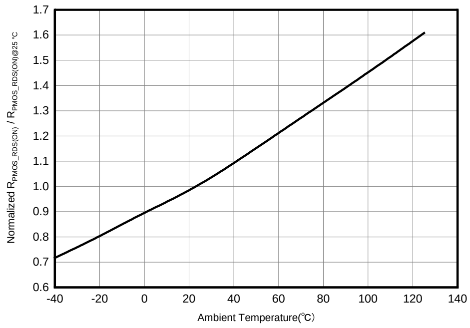
All parameters are tested at T_A = –40°C to +125°C, V_{VP} = 6 to 40 V (unless otherwise noted).

Table 6-8 Protection features characteristics

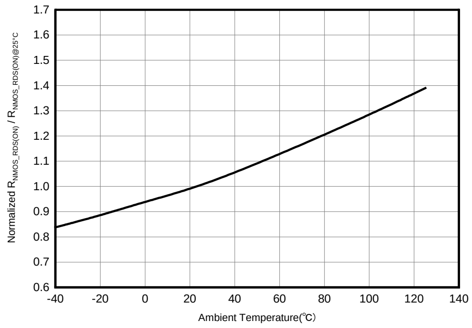
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{UVLO}	VP undervoltage lockout	VP falling, UVLO report	6.0	6.1	6.2	V
V_{UVLO_HYS}	VP undervoltage hysteresis	Rising to falling threshold	—	200	—	mV
t_{UVLO_DEG}	VP undervoltage deglitch time	VP falling, UVLO report	—	10	—	µs
I_{OCP}	Over current protection	OCP report	—	4.0	—	A
t_{OCP_DEG}	Over current deglitch time	OCP report	—	1.5	—	µs

t_{OCP_RST}	OCP retry time	OCP to normal retry	—	3	—	ms
T_{OTSD}	Thermal shutdown temperature	Die temperature, TJ	—	150	—	°C
T_{HYS}	Thermal shutdown hysteresis	Die temperature, TJ	—	30	—	°C

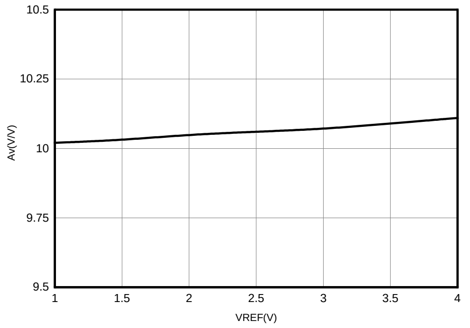
6.9 Typical Characteristics



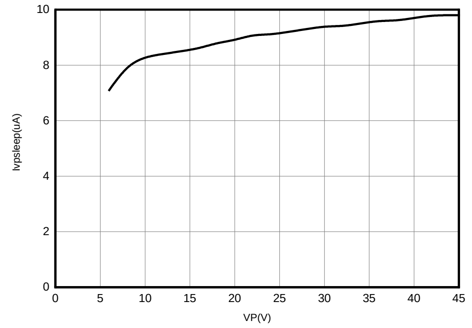
PMOS $R_{DS(ON)}$ vs Temperature



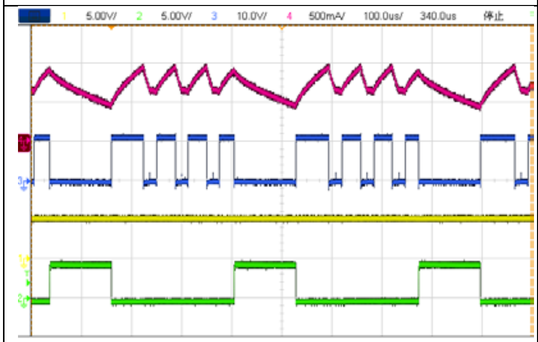
NMOS $R_{DS(ON)}$ vs Temperature



A_V vs VREF

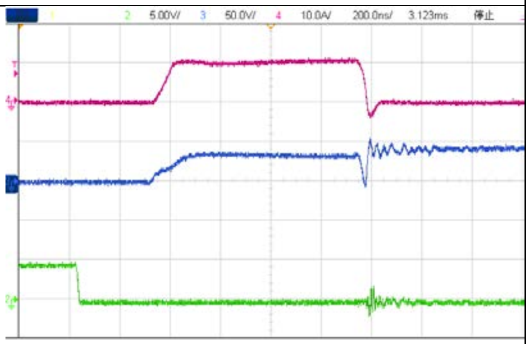


$I_{VPSLEEP}$ vs VP at 25°C



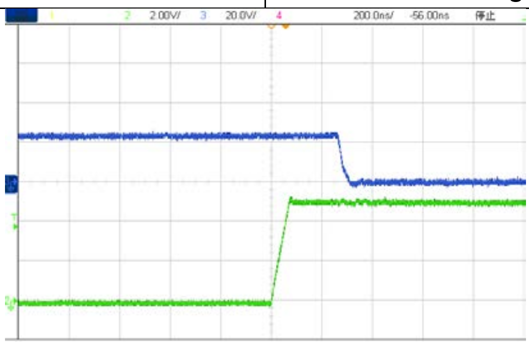
CH1 = INA, CH2 = INB, CH3 = OUTA, CH4 = IOUTA

Current Regulation With VREF = 2V and 150mΩ



CH2 = INB, CH3 = OUTA, CH4 = IOUTA

OCP With 45V and the Outputs Shorted Together



CH2 = INB, CH3 = OUTA

tpd

7 Typical application circuit

The GD30DR3000x is typically used to driver one brused DC motor.

Figure 7-1 Typical GD30DR3000x application circuit

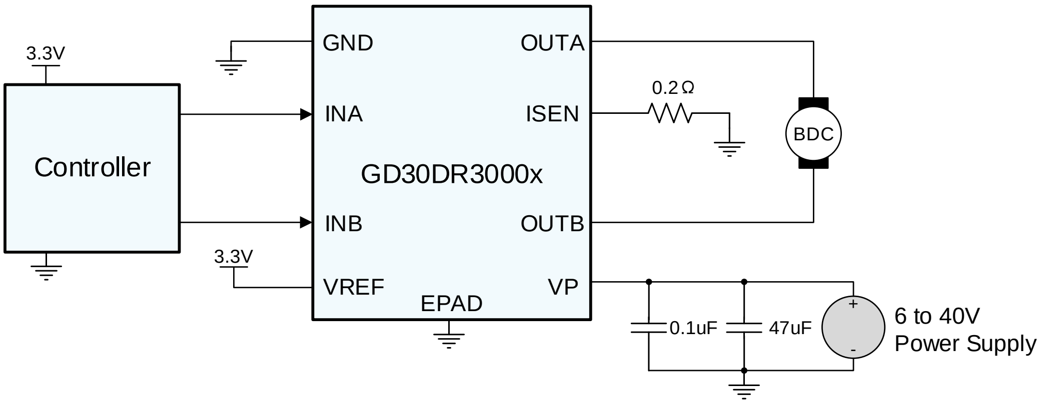
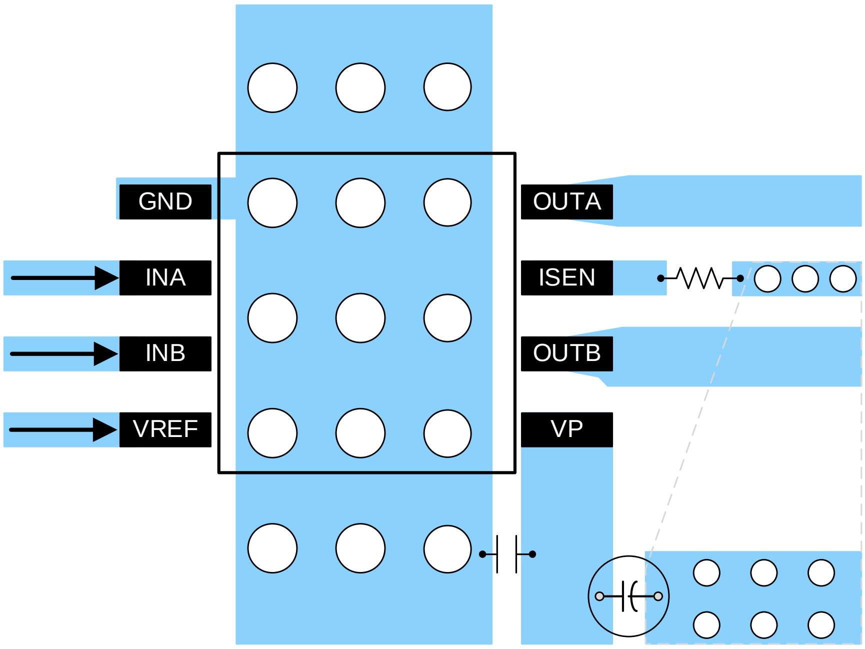


Table 7-1 Design Parameters

DESIGN PARAMETER	REFERENCE	EXAMPLE VALUE
Motor voltage	V_{M}	24 V
Motor RMS current	I_{RMS}	0.8 A
Motor startup current	I_{START}	2 A
Motor current trip point	I_{TRIP}	2.2 A
VREF voltage	V_{REF}	3.3 V
Sense resistance	R_{SEN}	0.15 Ω
PWM frequency	F_{PWM}	2 KHz

8 Layout guideline

Figure 8-1 Typical GD30DR3000x layout guideline



Notes:

1. For devices with high currents passing through, wide traces or copper paving are recommended.
2. To shorten the distance of the driver high-current path, bulk capacitors should be placed.
3. Ceramic capacitors with small capacitance values need to be close to the chip pins.
4. In order to increase the heat dissipation effect, multiple ground vias should be added to the thermal pad, and it is recommended to do window treatment on the bottom layer of the PCB.

9 Package information

9.1 SOP8-EP package outline and dimensions

Figure 9-1 SOP8-EP package outline

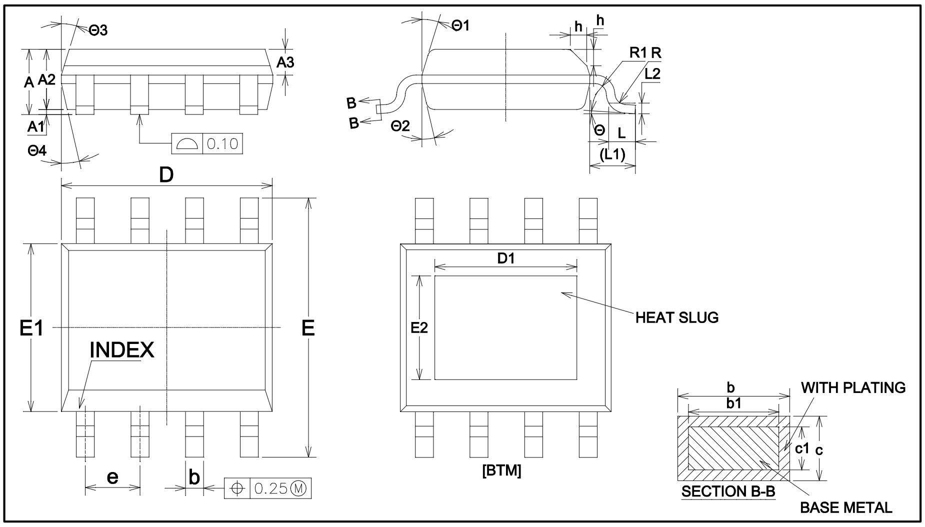
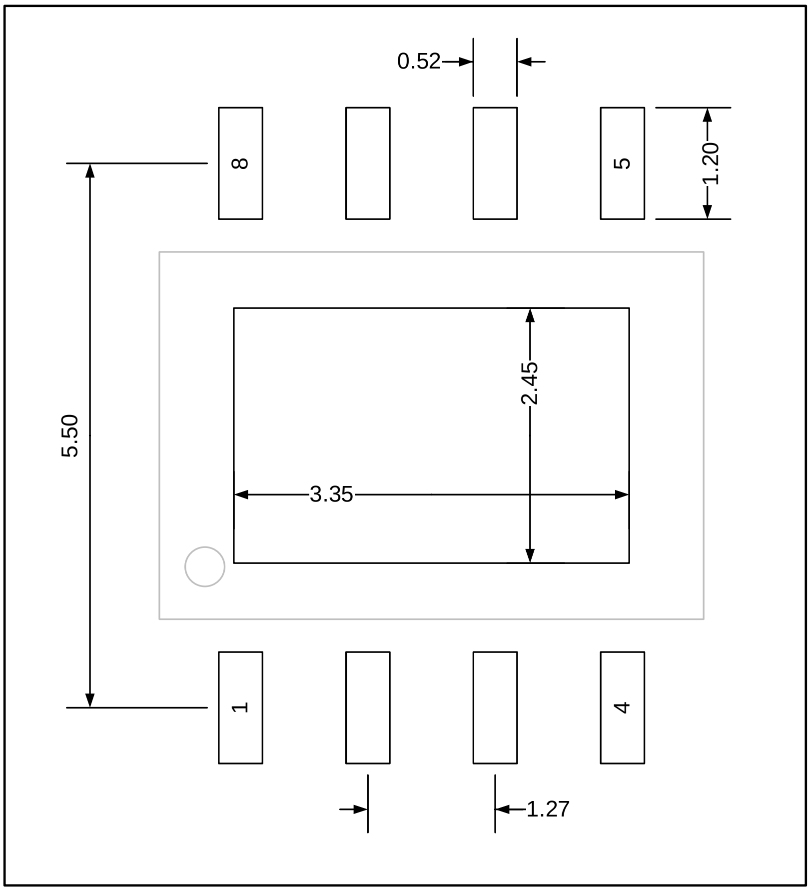


Table 9-1 SOP8-EP dimensions

Symbol	Min	Typ	Max
A	—	—	1.70
A1	0.05	—	0.10
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
D1	3.10	3.30	3.45
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
E2	2.26	2.40	2.56
e	—	1.27	—
L	0.50	0.60	0.80
L1	—	1.05	—
L2	—	0.25	—
h	0.25	—	0.50
θ	0°	—	8°

(Original dimensions are in millimeters).

Figure 9-2 SOP8-EP recommend footprint



9.2 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 9-2 Package thermal characteristics(1)

Symbol	Condition	Package	Value	Unit
Θ_{JA}	Natural convection, 2S2P PCB	SOP8	39.41	°C/W
Θ_{JB}	Cold plate, 2S2P PCB	SOP8	12.83	°C/W
Θ_{JC}	Cold plate, 2S2P PCB	SOP8	26.81	°C/W
Ψ_{JB}	Natural convection, 2S2P PCB	SOP8	12.45	°C/W
Ψ_{JT}	Natural convection, 2S2P PCB	SOP8	2.65	°C/W

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

10 Ordering information

Table 10-1 Part order code for GD30DR3000x

Ordering Code	Package	Package Type	Packing Type	MOQ	Temperature Operating Range
GD30DR3000WGTR-K	SOP8-EP	Green	Tape&Reel	3000	Industrial -40°C to +85°C

11 Revision history

Table 11-1 Revision history

Revision No.	Description	Date
1.0	Initial Release	Feb.20, 2023

Important Notice