H-bridge Drivers for Brush Motors

H-bridge Drivers (VREF Series)

BD621□Series,BD622□Series,BD623□Series

No.11007EDY01

●Description

These H-bridge drivers are full bridge drivers for brush motor applications. Each IC can operate at a wide range of power-supply voltages (from 3V to 36V), supporting output currents of up to 2A. MOS transistors in the output stage allow for PWM signal control, while the integrated VREF voltage control function of previous models offers direct replacement of deprecated motor driver ICs. These highly efficient H-bridge driver ICs facilitate low-power consumption design.

●Contents

1) Block diagrams 2
2) Control input pins 3
3) Reference voltage (VREF) input pin 3
4) Power supply and ground pin 3
5) Driver outputs 4
6) Heat sink fin 4
7) Thermal design 5
8) Thermal derating curve and transient thermal resistance 6
9) A.S.O. curve 7
10) Application circuit examples 8
11) Evaluation board 10

●Line up matrix

Rating voltage	Channels	Maximum output current		
		0.5A	1.0A	2.0A
7V	1ch	BD6210 HFP / F	BD6211 HFP / F	BD6212 HFP / FP
18V	1ch	BD6220F	BD6221F	BD6222 HFP / FP
	2ch	BD6225FP	BD6226FP	
36V	1ch	BD6230F	BD6231 HFP / F	BD6232 HFP / FP
	2ch		BD6236 FP / FM	BD6237FM

*Packages; F:SOP8, HFP:HRP7, FP:HSOP25, FM:HSOP-M28

● Block diagrams

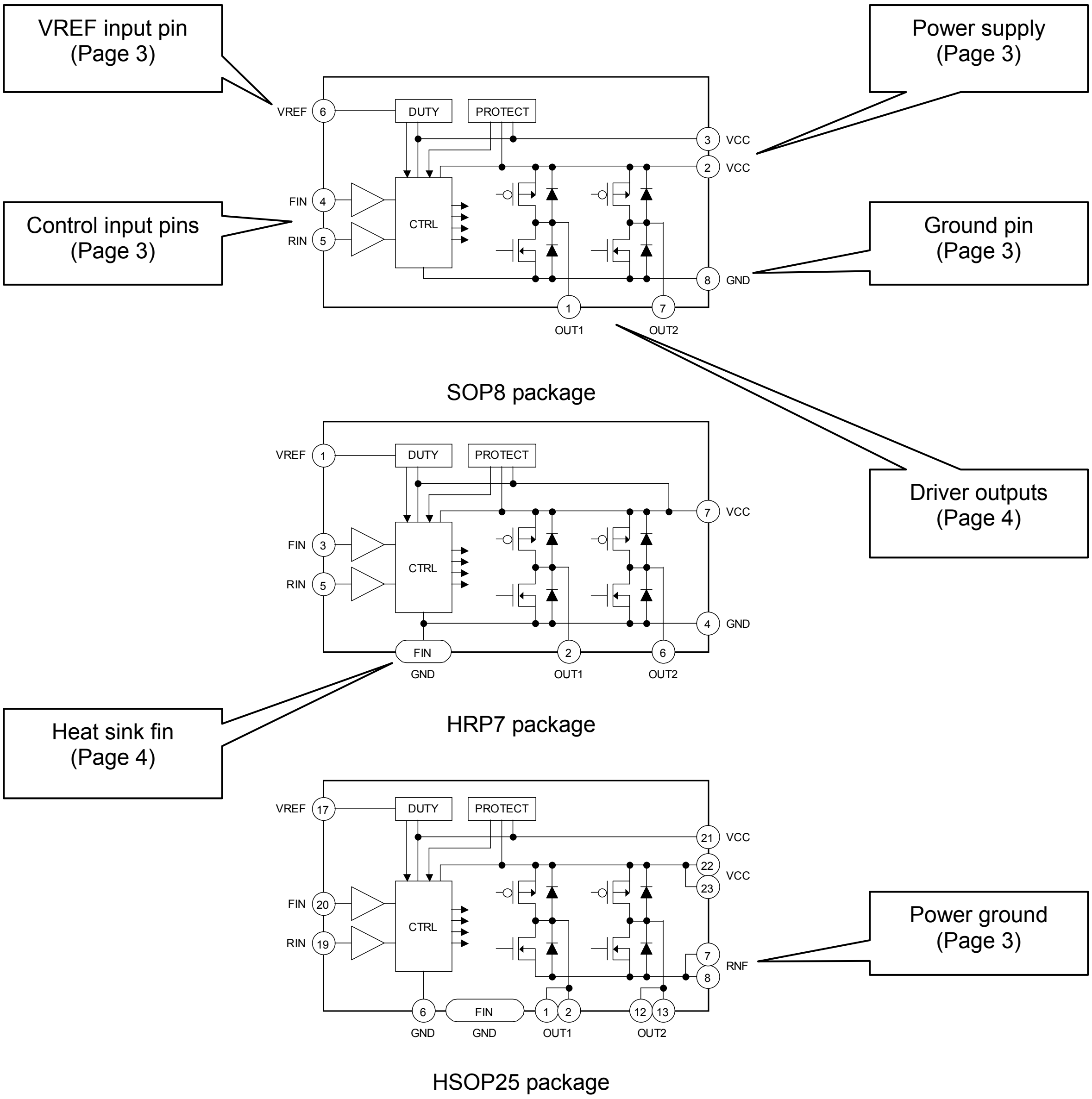


Fig. 1 H-bridge driver block diagram

Pin description table

Pin name	Function
VCC	Power supply
FIN	Control input (forward)
RIN	Control input (reverse)
VREF	Duty setting pin
OUT1	Driver output
OUT2	Driver output
RNF	Power stage ground
GND	Ground

●Control input pins

The input threshold voltage of the control pins are TTL level (H:2.0V, L:0.8V), with a hysteresis voltage of approximately 0.3V. The IC will accept input voltages up to the VCC voltage. The output bridge stage has a built-in "dead time" period of about 400ns (typ.) to protect against rush current; therefore, an "off" period when switching between modes is not necessary.

The IC can accept a PWM input signal in the range of 20kHz to 100kHz. At frequencies less than 20kHz, the IC will enter standby mode (output: Hi-Z), and at frequencies higher than 100kHz, the output switching signal becomes unable to follow the input signal. When the system switches to standby mode from any other mode (except brake), the internal control logic remains active for at least 50µs before shutting down all other circuits.

The control input pins are connected internally to pull-down resistors (100kΩ typ.). However, when operation is controlled via PWM or VREF, switching noise on the output stage may affect the input on these pins and cause undesired operation. In such cases, attaching an external pull-down resistor (10kΩ recommended) between each control pin and ground, or connecting each pin to an input voltage of 0.8V or less (preferably GND), is recommended.

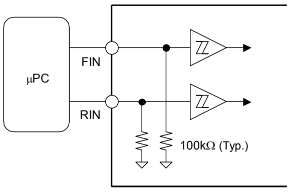


Fig.2 Equivalent circuit

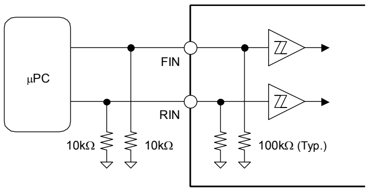


Fig.3 Equivalent circuit with noise compensation

●Reference voltage input pin (VREF) pin

The VREF voltage input pin is connected to a MOSFET gate input and therefore has very high input impedance. Leaving this pin open will cause unstable operation; therefore, connect it to VCC when not using VREF control mode.

As this pin is designed only to accept analog input signals, do not connect a PWM signal to the input. It can, however, be connected to a signal that switches between different voltages for IC control.

When used in applications where variations on the VREF input voltage may occur, insert a capacitor between VREF and GND. However, make sure that the voltage across the capacitor does not become reverse-biased (i.e. VCC < VREF) when power is switched off.

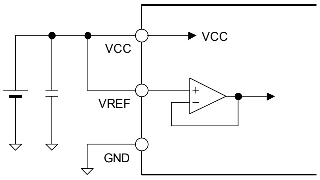


Fig.4 Application without VREF control

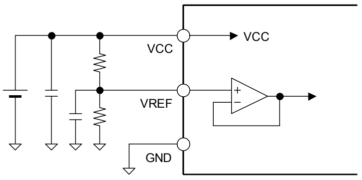
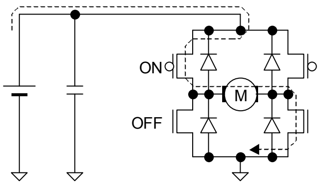


Fig.5 Application with unstable VREF input

●Power supply and ground pin

When used in applications where separate small- and large-signal power supplies are connected to the IC, the power supplies should be shorted together as close as possible to the IC's input pins. The GND connection to the RNF pin should be shorted the same way. In the two-channel version of the device, there are separate pins for the power and ground of each channel; although they are electrically connected to each other within the device, ensure that both channels' power and ground pins are connected externally to the power supply. When operating in VREF or PWM control mode, establish a current path for current recovery from the motor via a bypass capacitor between VCC and ground.



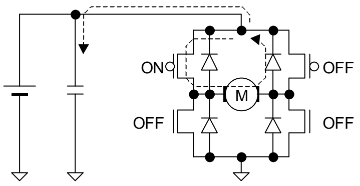


Fig.6 Current path when ON (PWM mode)

Fig.7 Current path when OFF (PWM mode)

Recommended value of the bypass capacitor is different depending on the armature resistance of the brush motor, the use power supply voltage and the output current of driver IC. It is important to conclusively confirm that the actual motor operation, referring to the following graphs.

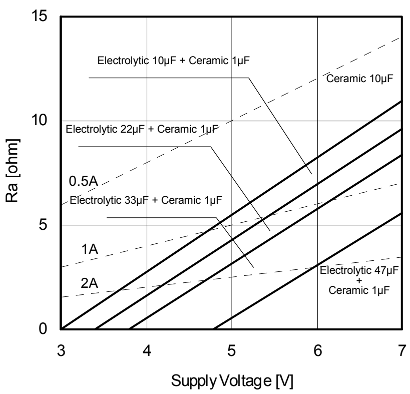


Fig.8 BD621X series
(7V rating products)

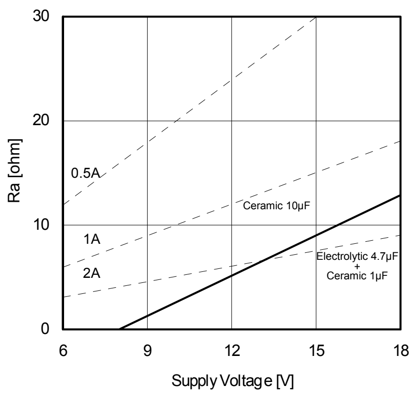


Fig.9 BD622X series
(18V rating products)

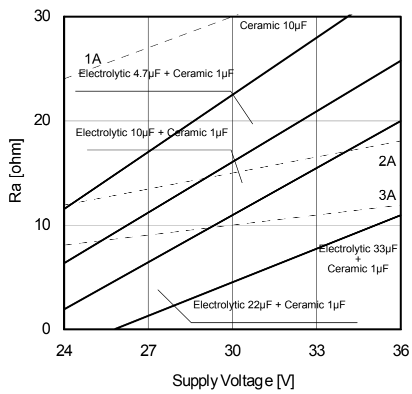


Fig.10 BD623X series
(36V rating products)

●Driver outputs

This IC features integrated over-current protection (OCP) circuitry in the output stage to protect the IC from sudden jumps in current. However, if an instantaneous amount of current with a high rise time (0.1A/µs or more) is encountered due to power supply or ground faults, for example, internal components of the IC may be damaged before the OCP engages due to the OCP activation window of 10µs (typ.). When the IC is used in applications with a low-impedance or high-output power supply, consider adding physical protection devices (such as fuses) to the input.

Do not connect an external capacitor directly to the output pin as doing so may cause a rush current to flow from the output, damaging internal components. However, if an output capacitor is necessary, for example, to reduce noise on the output, connect it in series with a resistor to avoid output rush currents. Note that doing so may increase switching power consumption in VREF or PWM control modes.

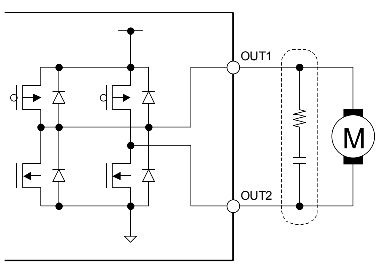


Fig.11 Snubber circuit example

●Heat sink fin

HPR7, HSOP25 and HSOPM28 packages feature heat sink fins. As the fin is connected directly to the internal die, it should be mounted directly to as large a ground pattern as possible to maximize heat radiation. The ground plane should also be connected to the system GND potential. Connecting the fin to anything other than GND may cause the IC to malfunction.

●Thermal design

The IC must be operated below the maximum junction temperature (T_j) value of 150°C as specified in the operating conditions. The junction temperature T_j is determined by the following equation:

$T_j \approx T_a + \theta_{j\text{-}a} \times P_c$ [°C] … (1)

Where, T_j: Junction temperature [°C], T_a: Ambient temperature [°C], P_c: Power consumption [W], $\theta_{j\text{-}a}$: Junction - ambient thermal resistance [°C/W]

The power consumption P_C is determined by the following equation:

$Pc\,[W] \approx (I_{OUT}^2 \times R_{ON}) \times (V_{REF} / V_{CC}) + I_{OUT} \times (V_{ON(H)} + V_{F(H)}) \times (1 - V_{REF} / V_{CC}) + V_{CC} \times I_{CC}$ … (2)

Where, I_{OUT}: Motor current [A], R_{ON}: Output on-resistance [Ω], V_{REF}: VREF voltage [V], V_{CC}: Supply voltage [V], $V_{ON(H)}$: High side output on voltage [V], $V_{F(H)}$: High side output body diode voltage [V], I_{CC}: Supply current [A]
(Refer to the technical note about output on-voltage, body diode voltage and supply current.)

For pulse output, transient thermal resistance is used to calculate junction temperature:

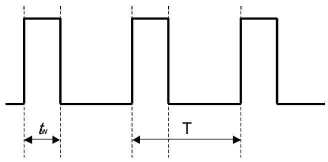
$T_j \approx T_a + r(t_w) \times \theta_{j\text{-}a} \times P_c$ [°C] … (3)

Where, t_w: Pulse on-time [s], $r(t_w)$: Transient thermal resistance normalized by $t = t_w$

If a single pulse is used, calculate the power dissipation by equation (3) above, using the corresponding transient thermal resistance taken from the graph on the next page. If a repeating pulse is used, calculate the normalized transient thermal resistance $r'(t)$ using the following equation, then substitute for $r(t_w)$ in formula (3).

$r'(t) \approx \{ \theta_{j\text{-}a} \times D + (1 - D) \times \theta_{T+tw} - \theta_T + \theta_{tw} \} / \theta_{j\text{-}a}$ [°C/W] … (4)

Where, t_w: Power input time [s], T: Pulse period [s], D: Duty cycle ($D = t_w/T$)
θ_{T+tw}, θ_T, θ_{tw}: Thermal resistance of the pulse width ($T+t_w$), (T), (t_w)



If the waveform is not rectangular in shape, its area can be approximated via the following simple waveforms:

a) Approximation of triangle wave
Approximate via a rectangular wave of 0.71 x width, 0.7 x peak level.

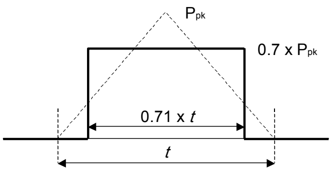


Fig.12 Approximation of triangle wave

b) Approximation of sine wave
Approximate via a rectangular wave of 0.91 x width, 0.7 x peak level.

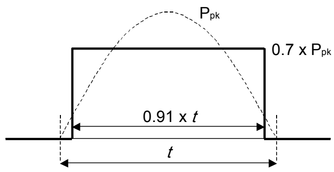


Fig.13 Approximation of sine wave

c) Complex wave 1
Approximate to a rectangular wave of similar area.

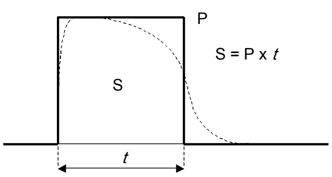


Fig.14 Complex wave 1

d) Complex wave 2
Approximate to multiple rectangular blocks of similar area.

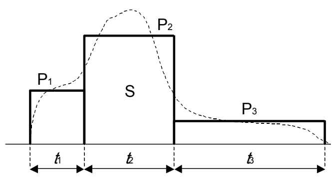


Fig.15 Complex wave 2

●Thermal derating curve and transient thermal resistance (reference data)

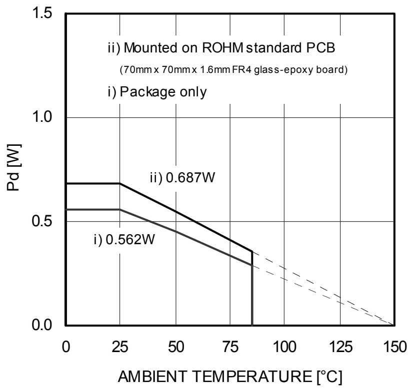


Fig.16 Derating curve (SOP8)

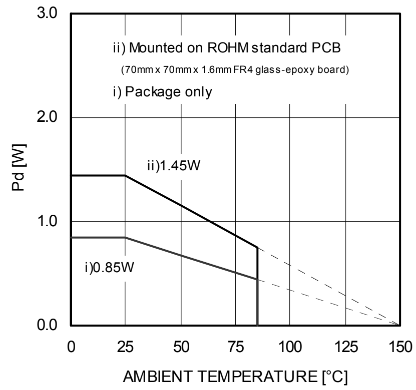


Fig.17 Derating curve (HSOP25)

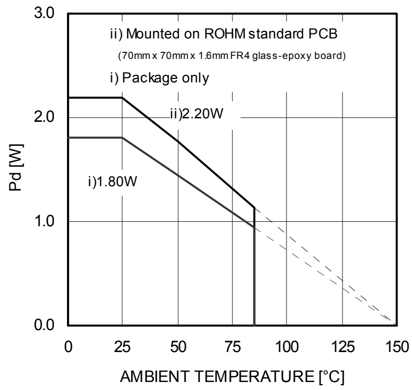


Fig.18 Derating curve (HSOP-M28)

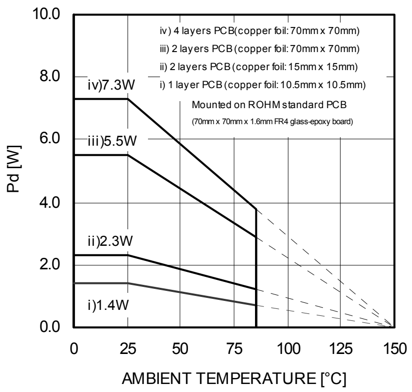


Fig.19 Derating curve (HRP7)

Table 1 Thermal resistance

Package	$\theta_{j\text{-}a}$ [°C/W]
SOP8	182
HSOP25	86.2
HSOP-M28	56.8
HRP7	89.3

Mounted on a 70mmx70mmx1.6mm FR4 glass-epoxy board with less than 3% copper foil.

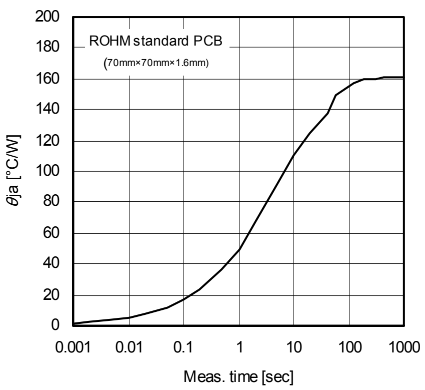


Fig.20 Transient thermal resistance (SOP8)

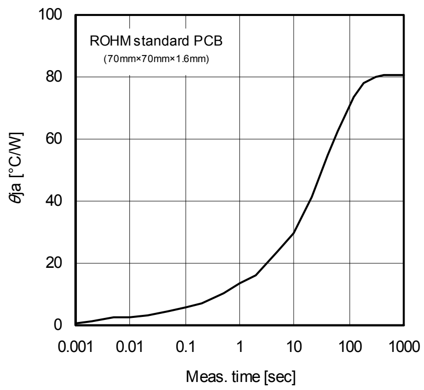


Fig.21 Transient thermal resistance (HSOP25)

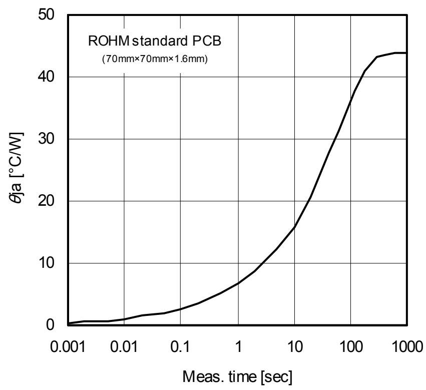


Fig.22 Transient thermal resistance (HSOP-M28)

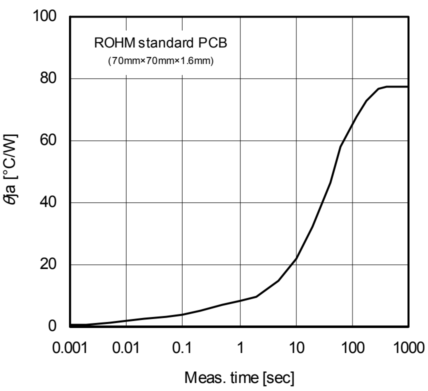


Fig.23 Transient thermal resistance (HRP7)

Transient thermal resistance is measured data only; values are not guaranteed.

●ASO curve (reference data)

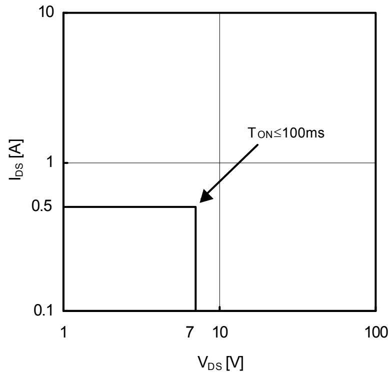


Fig.24 ASO curve (Ta=25°C)
(7V/0.5A class)

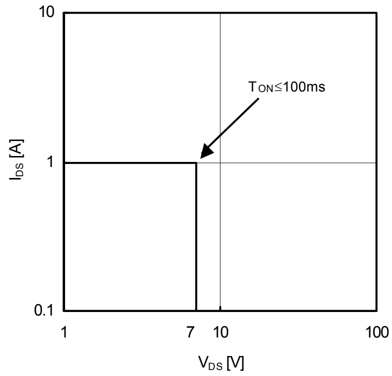


Fig.25 ASO curve (Ta=25°C)
(7V/1A class)

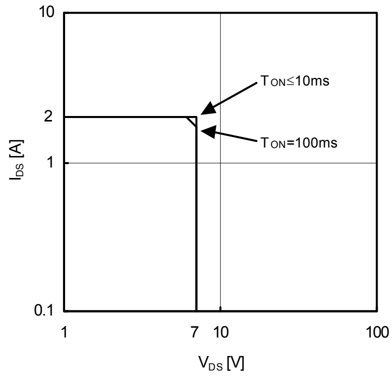


Fig.26 ASO curve (Ta=25°C)
(7V/2A class)

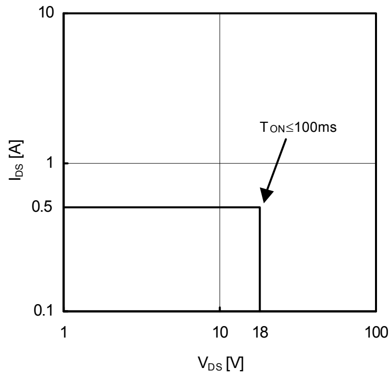


Fig.27 ASO curve (Ta=25°C)
(18V/0.5A class)

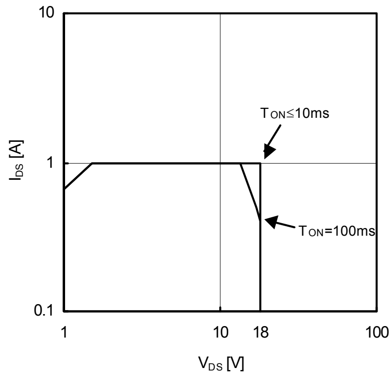


Fig.28 ASO curve (Ta=25°C)
(18V/1A class)

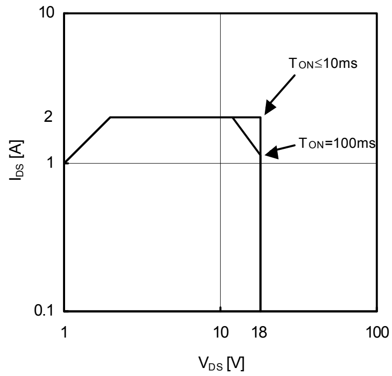


Fig.29 ASO curve (Ta=25°C)
(18V/2A class)

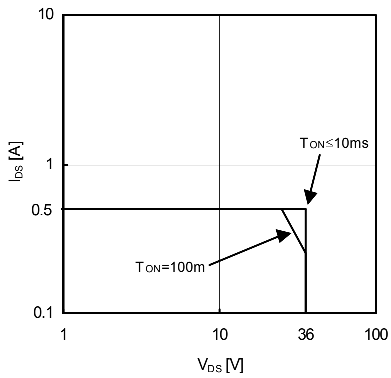


Fig.30 ASO curve (Ta=25°C)
(36V/0.5A class)

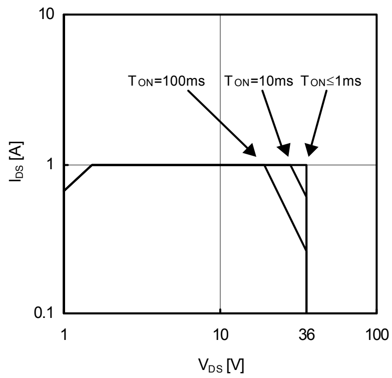


Fig.31 ASO curve (Ta=25°C)
(36V/1A class)

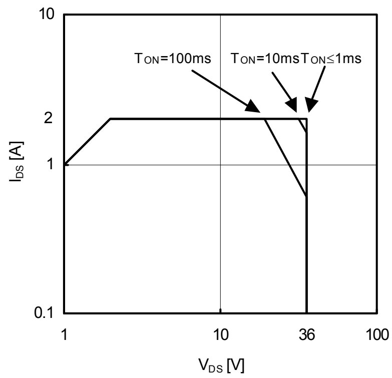
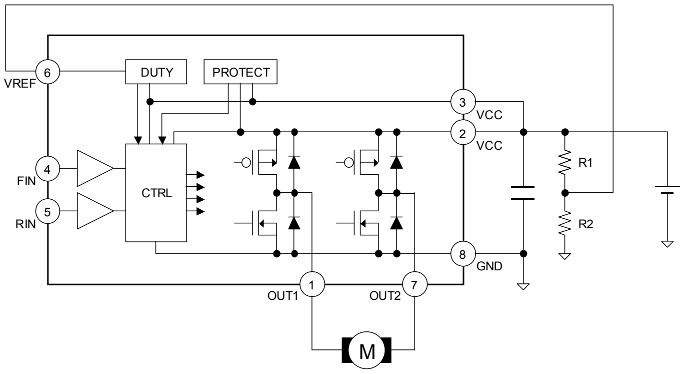


Fig.32 ASO curve (Ta=25°C)
(36V/2A class)

Note: ASO curve is measured data only, values are not guaranteed.

●Application examples

1) Regulated power supply application

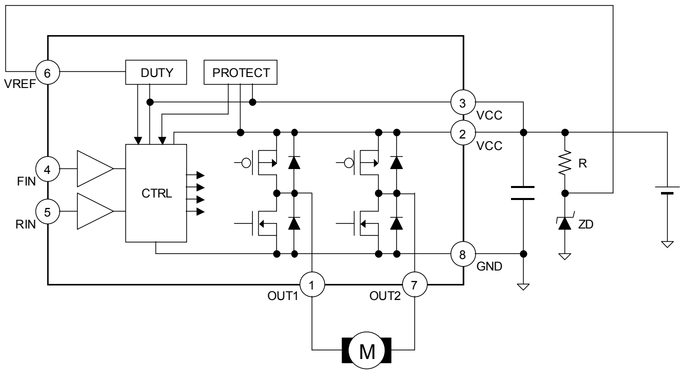


VREF set via resistive voltage divider

The voltage across the motor equals VCC x R2/(R1+R2) during operation.

Fig.33 Application example 1

2) Unstable power supply or battery-driven application

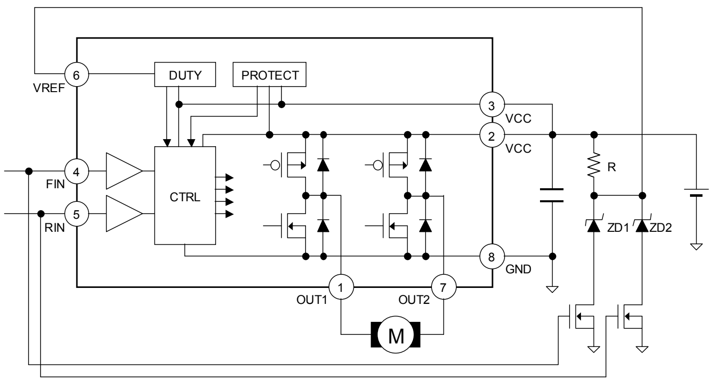


VREF set via zener diode

Voltage across the motor equals the zener diode forward voltage during operation.

Fig.34 Application example 2

3) Reversible, variable-torque application



VREF controlled via switched zener diodes

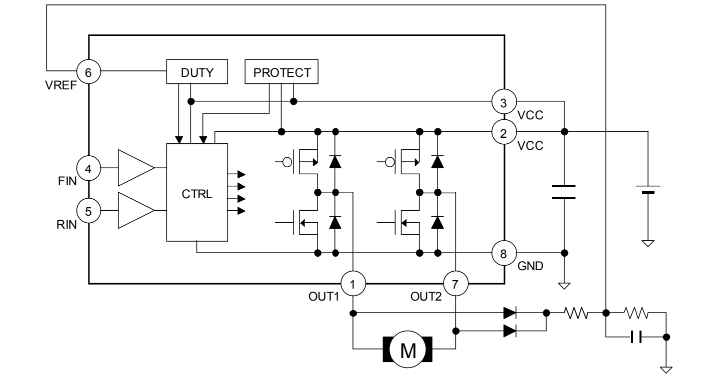
VREF synchronizes with two different zener voltages, switched on or off by FIN or RIN signals.

This application is useful when using lead-angle motors, or in applications where the load is different for forward and reverse directions.

Fig.35 Application example 3

●Application examples - continued

4) Application to avoid current rush on startup

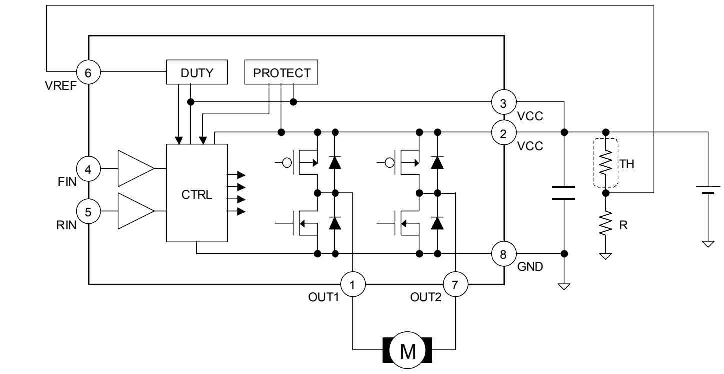


VREF controlled by RC time constant on feedback loop (soft-start)

Note, however, that motor torque on startup can be decreased if the RC time constant is too long.

Fig.36 Application example 4

5) Motor temperature-speed control

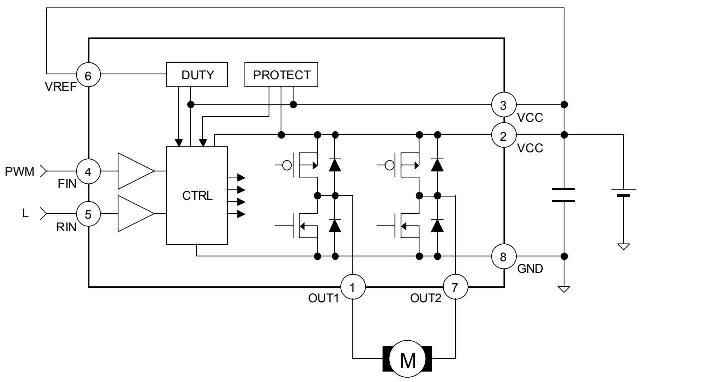


VREF set by thermistor

Useful in applications where motor speed needs to follow changes in temperature, or to protect the motor from overheating.

Fig.37 Application example 5

6) Direct PWM drive



Input PWM signal directly to control pins

Connect VREF to VCC.
Control pins can accept PWM signals From 20kHz to 100kHz.

This example allows for forward rotation.
For reverse rotation, the input signals (PWM, L) should be switched.

Fig.38 Application example 6

●Evaluation board - 1ch / SOP8 package type

1 channel type, SOP8 package, common evaluation board
Board size: 55mm x 55mm x 1.6mm (2 layers), Material: FR4, Copper foil thickness: 35μm

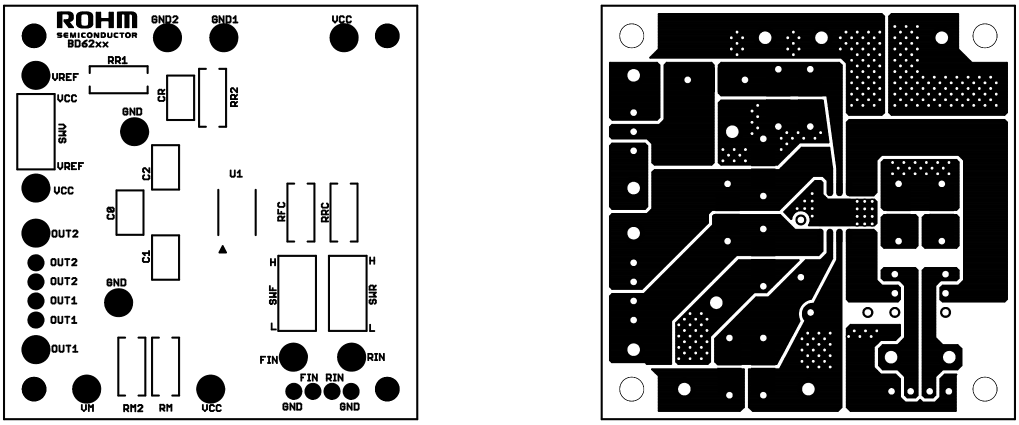


Fig.39 Silk screen / Copper foil pattern (front)

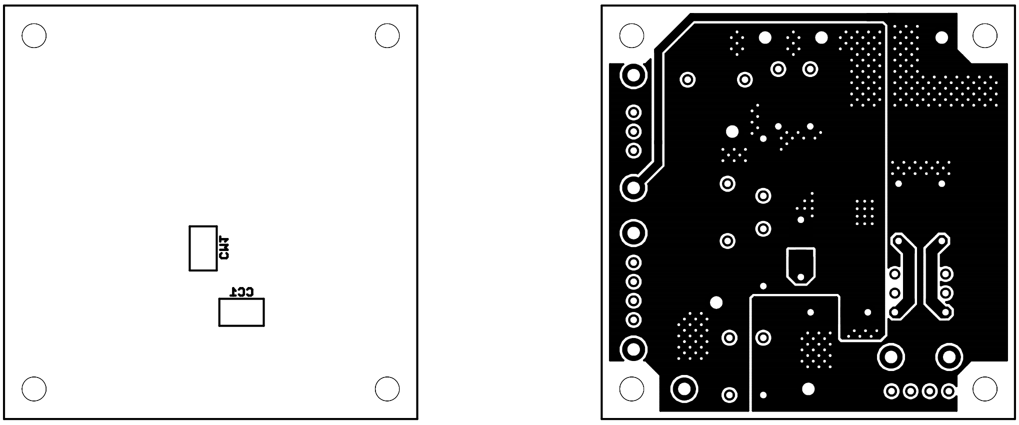


Fig.40 Silk screen / Copper foil pattern (rear)

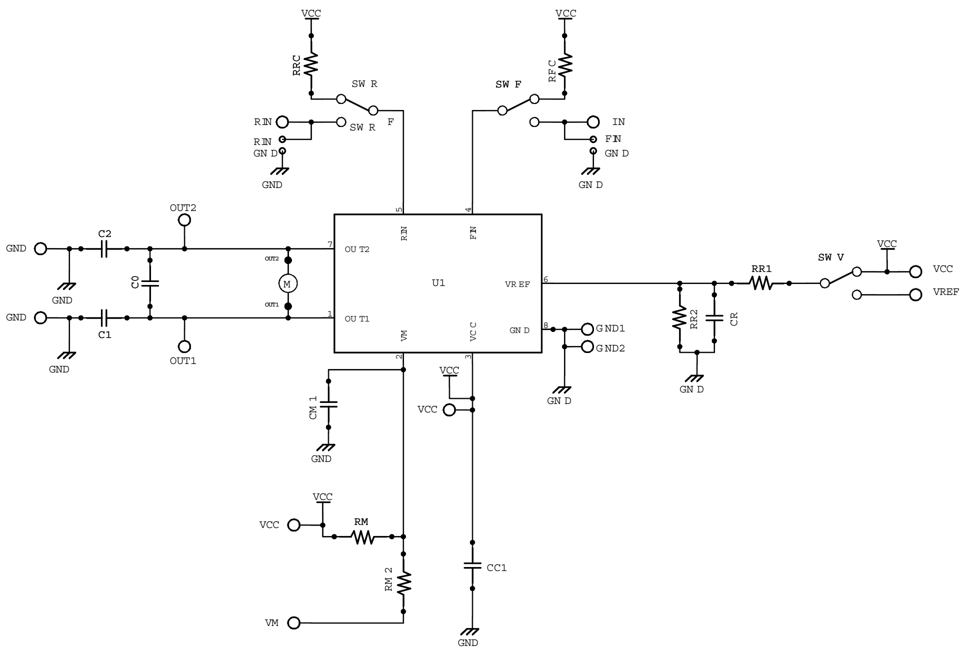


Fig.41 Evaluation board schematic

●Evaluation board - 1ch / HRP7 package type

1 channel type, HRP7 package, common evaluation board
Board size: 55mm x 55mm x 1.6mm (2 layers), Material: FR4, Copper foil thickness: 35μm

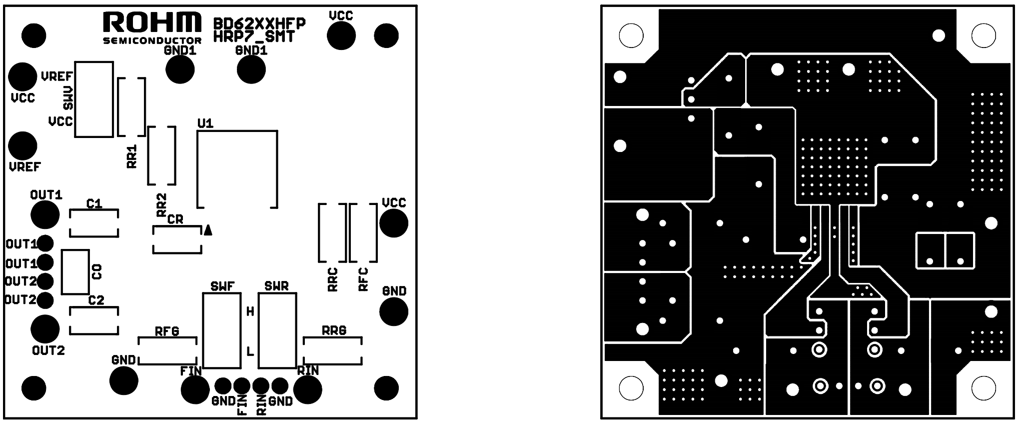


Fig.42 Silk screen / Copper foil pattern (front)

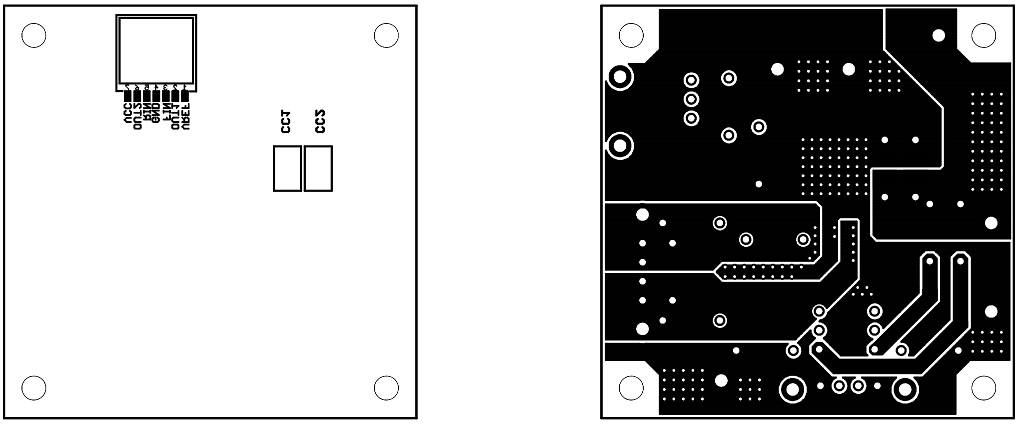


Fig.43 Silk screen / Copper foil pattern (rear)

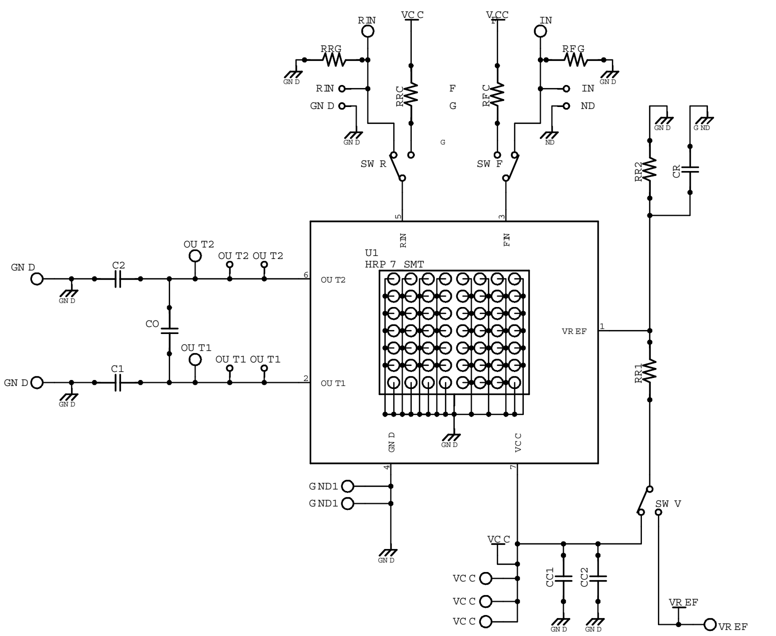


Fig.44 Evaluation board schematic

●Evaluation board - 1ch / HSOP25 package type

1 channel type, HSOP25 package, common evaluation board
Board size: 55mm x 55mm x 1.6mm (2 layers), Material: FR4, Copper foil thickness: 35μm

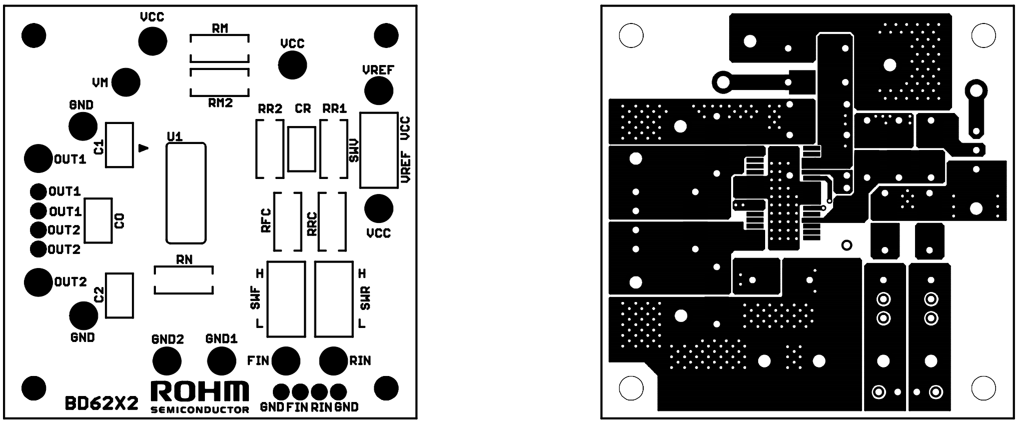


Fig.45 Silk screen / Copper foil pattern (front)

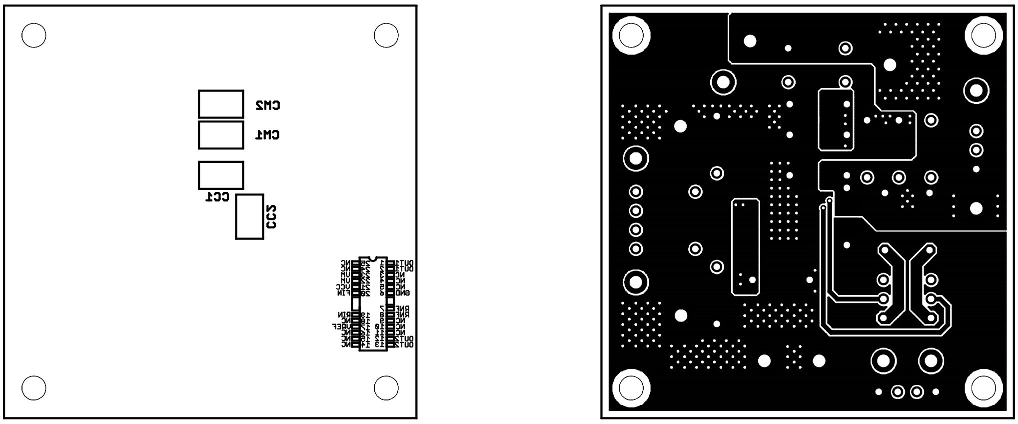


Fig.46 Silk screen / Copper foil pattern (rear)

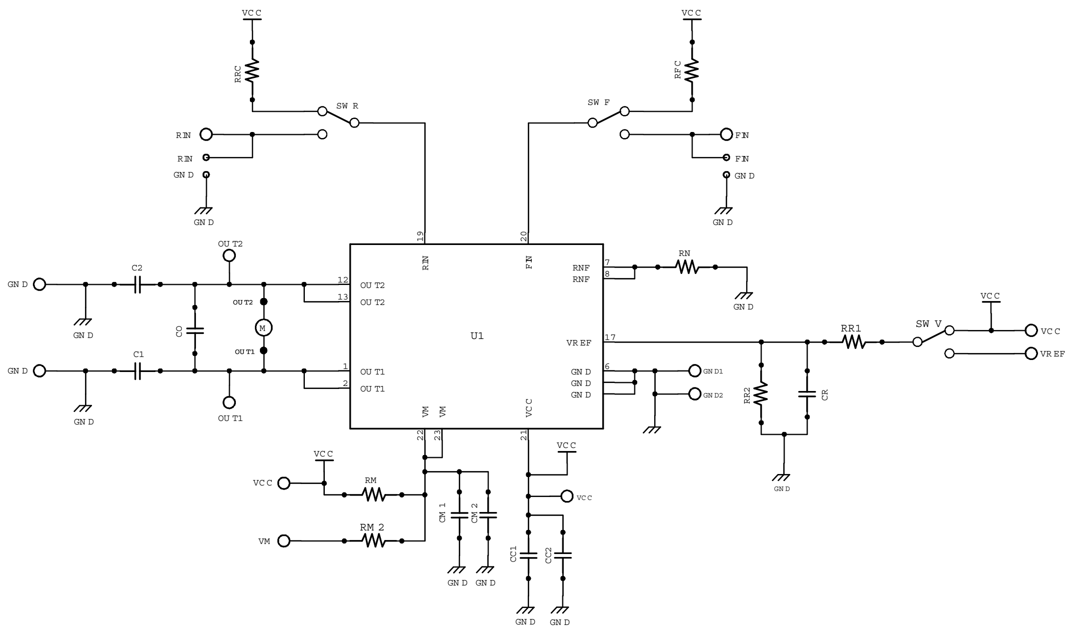


Fig.47 Evaluation board schematic

●Evaluation board - 2ch / HSOP25 package type

2 channels type, HSOP25 package, common evaluation board
Board size: 110mm x 55mm x 1.6mm (2 layers), Material: FR4, Copper foil thickness: 35μm

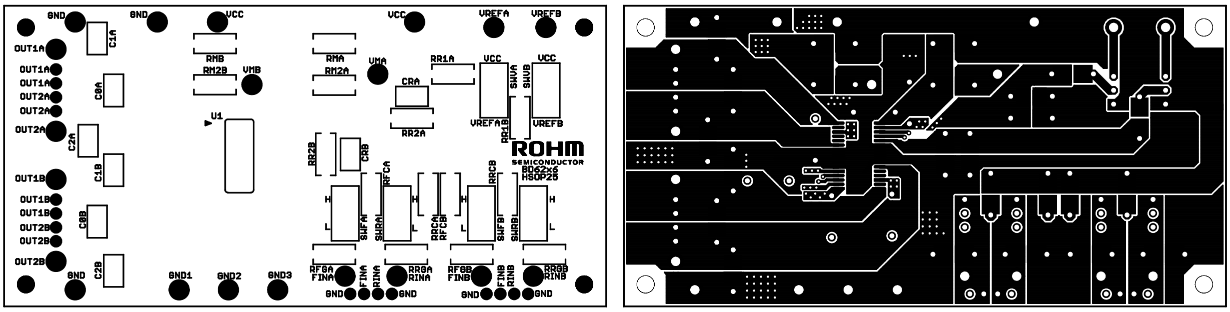


Fig.48 Silk screen / Copper foil pattern (front)

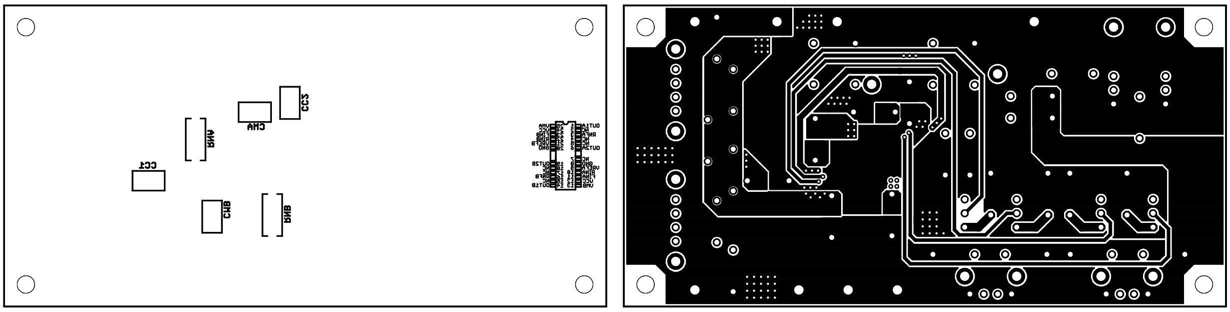


Fig.49 Silk screen / Copper foil pattern (rear)

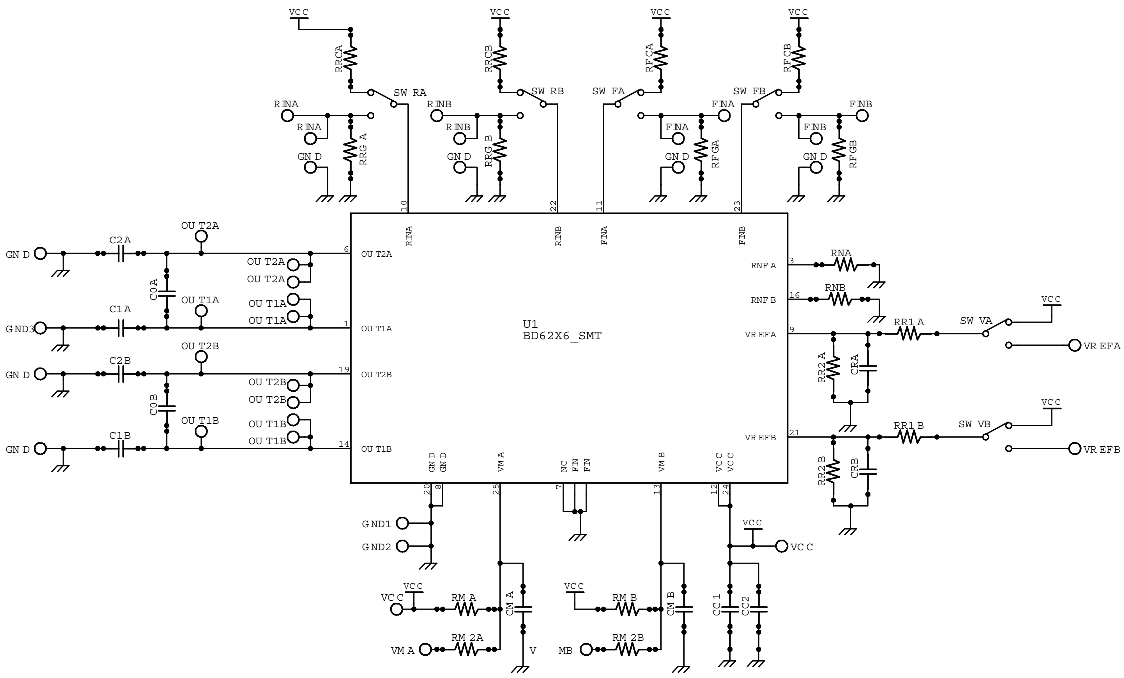


Fig.50 Evaluation board schematic

●Evaluation board - 2ch / HSOP-M28 package type

2 channels type, HSOP-M28 package, common evaluation board
Board size: 110mm x 55mm x 1.6mm (2 layers), Material: FR4, Copper foil thickness: 35µm

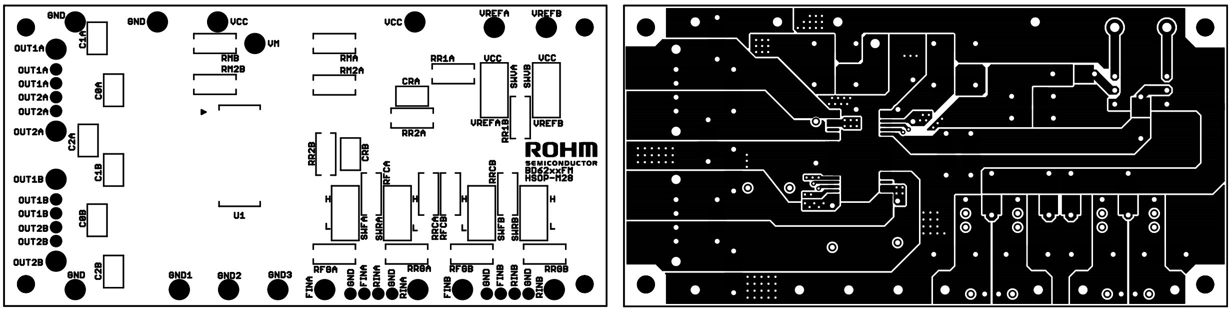


Fig.51 Silk screen / Copper foil pattern (front)

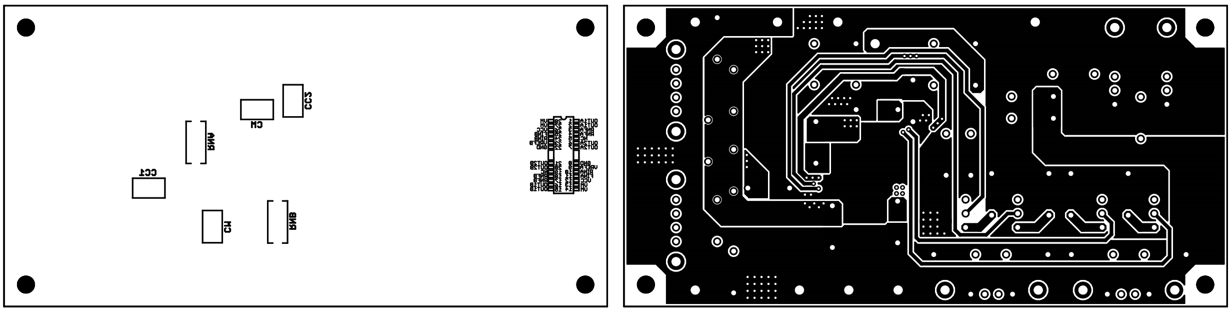


Fig.52 Silk screen / Copper foil pattern (rear)

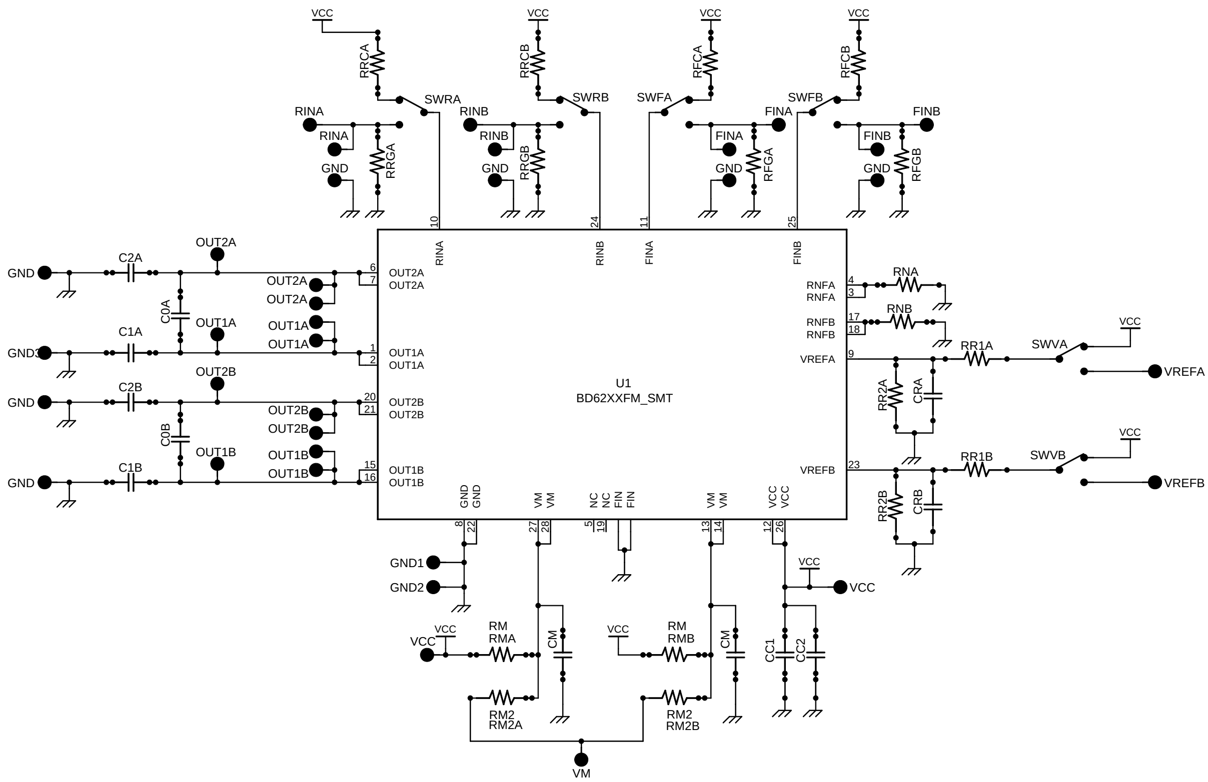


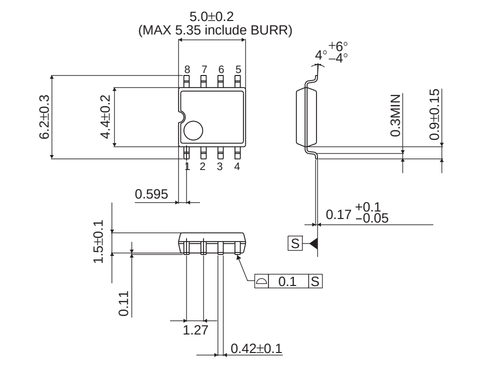
Fig.53 Evaluation board schematic

●Ordering part number

B	D		6	2	1	0		F		-	E	2

Part No.	Type	Package	Packaging and forming specification
	62XX 1X: 7V max. 2X: 18V max. 3X: 36V max. X0: 1ch/0.5A X5: 2ch/0.5A X1: 1ch/1A X6: 2ch/1A X2: 1ch/2A	F: SOP8 FP: HSOP25 FM: HSOP-M28 HFP: HRP7	E2: Embossed tape and reel (SOP8/HSOP25/HSOP-M28) TR: Embossed tape and reel (HRP7)

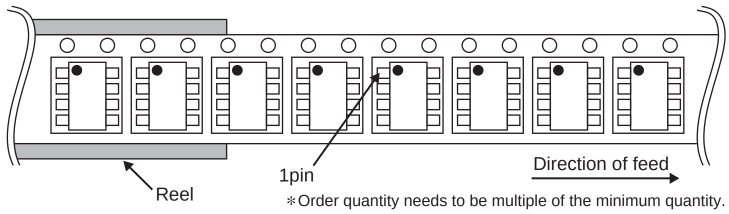
SOP8



(Unit : mm)

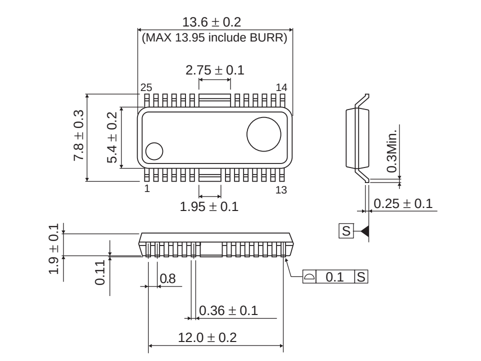
<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



*Order quantity needs to be multiple of the minimum quantity.

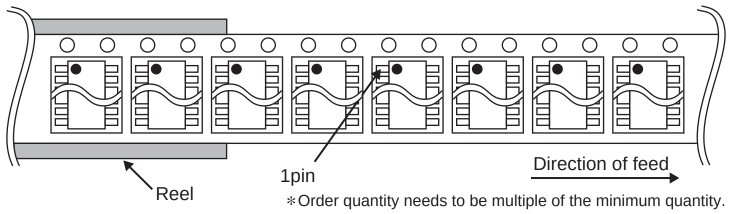
HSOP25



(Unit : mm)

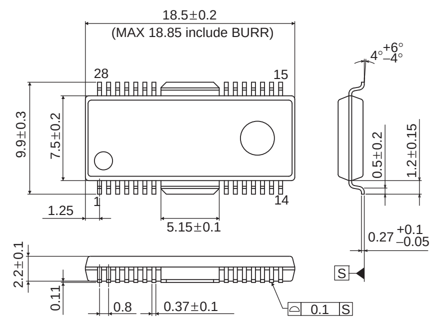
<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



*Order quantity needs to be multiple of the minimum quantity.

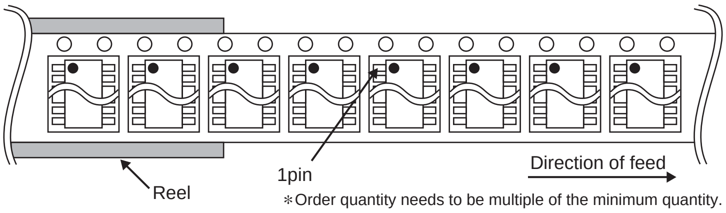
HSOP-M28



(Unit : mm)

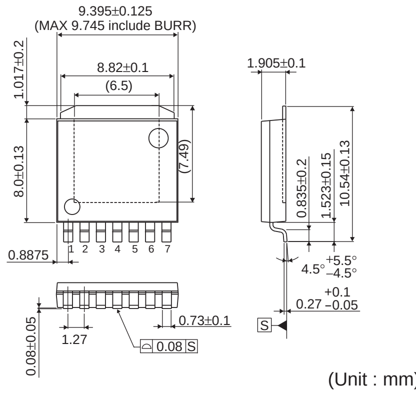
<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	1500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



*Order quantity needs to be multiple of the minimum quantity.

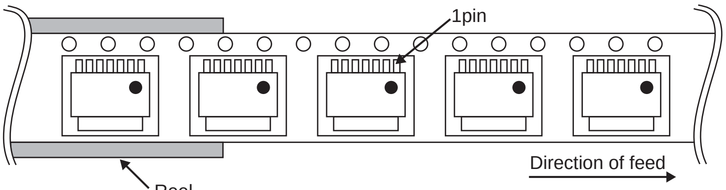
HRP7



(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2000pcs
Direction of feed	TR (The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the tape on the right hand)



*Order quantity needs to be multiple of the minimum quantity.

Notes

No copying or reproduction of this document, in part or in whole, is permitted without the consent of ROHM Co.,Ltd.

The content specified herein is subject to change for improvement without notice.

The content specified herein is for the purpose of introducing ROHM's products (hereinafter "Products"). If you wish to use any such Product, please be sure to refer to the specifications, which can be obtained from ROHM upon request.

Examples of application circuits, circuit constants and any other information contained herein illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

Great care was taken in ensuring the accuracy of the information specified in this document. However, should you incur any damage arising from any inaccuracy or misprint of such information, ROHM shall bear no responsibility for such damage.

The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM and other parties. ROHM shall bear no responsibility whatsoever for any dispute arising from the use of such technical information.

The Products specified in this document are intended to be used with general-use electronic equipment or devices (such as audio visual equipment, office-automation equipment, communication devices, electronic appliances and amusement devices).

The Products specified in this document are not designed to be radiation tolerant.

While ROHM always makes efforts to enhance the quality and reliability of its Products, a Product may fail or malfunction for a variety of reasons.

Please be sure to implement in your equipment using the Products safety measures to guard against the possibility of physical injury, fire or any other damage caused in the event of the failure of any Product, such as derating, redundancy, fire control and fail-safe designs. ROHM shall bear no responsibility whatsoever for your use of any Product outside of the prescribed scope or not in accordance with the instruction manual.

The Products are not designed or manufactured to be used with any equipment, device or system which requires an extremely high level of reliability the failure or malfunction of which may result in a direct threat to human life or create a risk of human injury (such as a medical instrument, transportation equipment, aerospace machinery, nuclear-reactor controller, fuel-controller or other safety device). ROHM shall bear no responsibility in any way for use of any of the Products for the above special purposes. If a Product is intended to be used for any such special purpose, please contact a ROHM sales representative before purchasing.

If you intend to export or ship overseas any Product or technology specified herein that may be controlled under the Foreign Exchange and the Foreign Trade Law, you will be required to obtain a license or permit under the Law.