

DC Brushless Motor Drivers for Cooling Fans

Multifunction Single-phase Full-wave Fan Motor Driver



BD6974FV

No.12010EAT17

●General description

BD6974FV is a pre-driver that controls the motor drive part composed of the power transistors. Moreover, a lot of functions are installed, and the pin is compatible with BD6973FV(rotation speed pulse signal output).

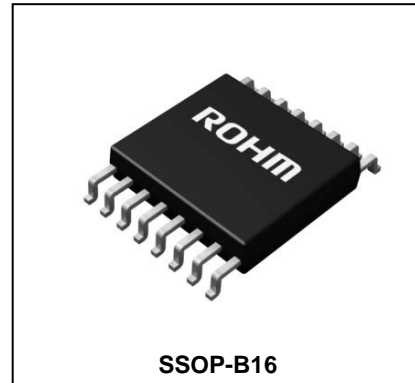
●Package

SSOP-B16

 W (Typ.) x D (Typ.) x H (Max.)
 5.00mm x 6.40mm x 1.35mm

●Features

- Pre-driver for external power transistors
- Speed controllable by DC / direct PWM input
- PWM soft switching
- Soft start
- Quick start
- Current limit
- Lock protection and automatic restart
- Lock alarm signal (AL) output



SSOP-B16

●Application

- Fan motors for general consumer equipment of desktop PC, and Server, etc.

●Absolute maximum ratings

Parameter	Symbol	Limit	Unit
Supply voltage	Vcc	20	V
Power dissipation	Pd	874.7 ^{*1}	mW
Operating temperature range	Topr	-40 to +100	°C
Storage temperature range	Tstg	-55 to +150	°C
High side output voltage	Voh	36	V
Low side output voltage	Vol	15	V
Low side output current	Iol	10	mA
Lock alarm signal (AL) output voltage	Val	20	V
Lock alarm signal (AL) output current	Ial	10	mA
Reference voltage (REF) output current	Iref	12	mA
Hall bias (HB) output current	Ihb	12	mA
Input voltage (H+, H-, TH, MIN, CS)	Vin	7	V
Junction temperature	Tj	150	°C

*1 Reduce by 7.0mW/°C over Ta=25°C. (On 70.0mm×70.0mm×1.6mm glass epoxy board)

●Recommended operating conditions

Parameter	Symbol	Limit	Unit
Operating supply voltage range	Vcc	4.3 to 17.0	V
Operating input voltage range 1 (H+, H-) (more than Vcc=9V)	Vin1	0 to 7	V
Operating input voltage range 1 (H+, H-) (less than Vcc=9V)		0 to Vcc-2	V
Operating input voltage range 2 (TH, MIN)	Vin2	0 to Vref	V

○Product structure : Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays

●Pin configuration

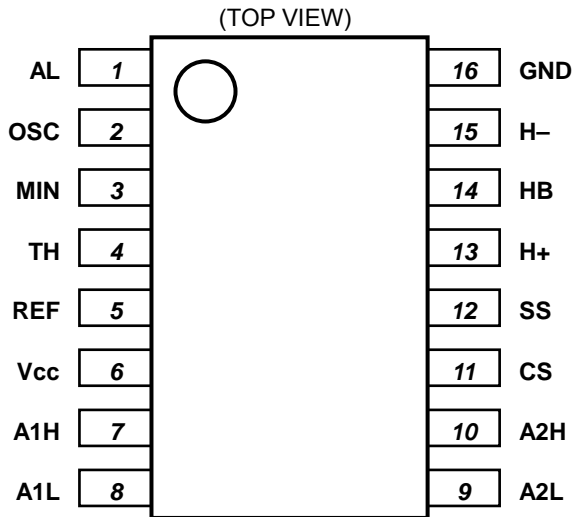


Fig.1 Pin configuration

●Pin description

P/No.	T/Name	Function
1	AL	Lock alarm signal output terminal
2	OSC	Oscillating capacitor connecting terminal
3	MIN	Minimum output duty setting terminal
4	TH	Output duty controllable input terminal
5	REF	Reference voltage output terminal
6	Vcc	Power supply terminal
7	A1H	High side output terminal 1
8	A1L	Low side output terminal 1
9	A2L	Low side output terminal 2
10	A2H	High side output terminal 2
11	CS	Output current detection terminal
12	SS	Soft start capacitor connecting terminal
13	H+	Hall + input terminal
14	HB	Hall bias terminal
15	H-	Hall - input terminal
16	GND	Ground terminal

●Block diagram

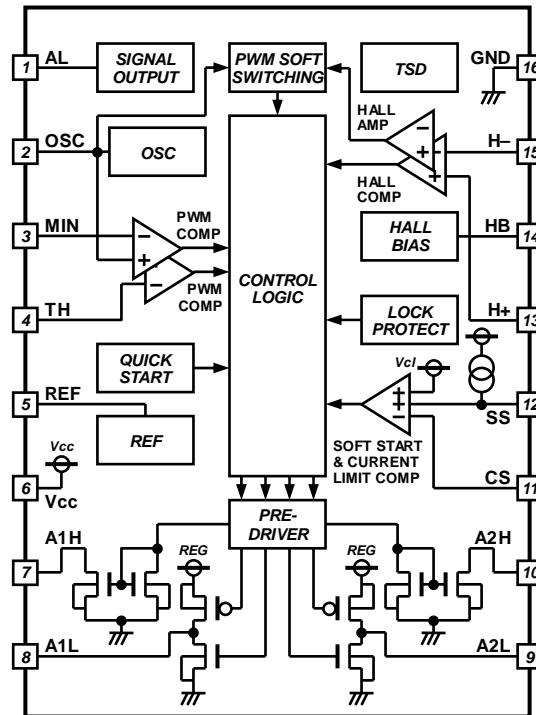


Fig.2 Block diagram

●I/O truth table

Hall input		Driver output			
H+	H-	A1H	A1L	A2H	A2L
H	L	Hi-Z	H	L	L
L	H	L	L	Hi-Z	H

H; High, L; Low, Hi-Z; High impedance

Motor state	AL
Rotating	L
Locking	Hi-Z

L; Low, Hi-Z; High impedance
AL output is open-drain type.

●Electrical characteristics(Unless otherwise specified Ta=25°C, Vcc=12V)

Parameter	Symbol	Limit			Unit	Conditions	Ref. data
		Min.	Typ.	Max.			
Circuit current	Icc	3	5	8	mA		Fig.3
Hall input hysteresis voltage	Vhys	±5	±10	±15	mV		Fig.4
High side output current	Ioh	9.0	12.0	16.5	mA	Voh=12V	Fig.5
High side output leak current	Iohl	-	-	10	μA	Voh=36V	Fig.6
Low side output high voltage	Volh	9.3	9.5	-	V	Iol=-5mA	Fig.7, 8
Low side output low voltage	Voll	-	0.5	0.7	V	Iol=5mA	Fig.9, 10
Lock detection ON time	Ton	0.20	0.30	0.45	s		Fig.11
Lock detection OFF time	Toff	4.0	6.0	9.0	s		Fig.12
AL output low voltage	Vall	-	-	0.3	V	Ial=5mA	Fig.13, 14
AL output leak current	Iall	-	-	10	μA	Val=17V	Fig.15
OSC high voltage	Vosch	2.3	2.5	2.7	V		Fig.16
OSC low voltage	Voscl	0.8	1.0	1.2	V		Fig.16
OSC charge current	Icosc	-55	-40	-25	μA		Fig.17
OSC discharge current	Idosc	25	40	55	μA		Fig.17
Output ON duty 1	Poh1	75	80	85	%	Vth=Vref x 0.26 Pull up resistance 1kΩ, OSC=470pF	-
Output ON duty 2	Poh2	45	50	55	%	Vth=Vref x 0.35 Pull up resistance 1kΩ, OSC=470pF	-
Output ON duty 3	Poh3	15	20	25	%	Vth=Vref x 0.44 Pull up resistance 1kΩ, OSC=470pF	-
Reference voltage	Vref	4.8	5.0	5.2	V	Iref=-2mA	Fig.18, 19
Hall bias voltage	Vhb	1.10	1.26	1.50	V	Ihb=-2mA	Fig.20, 21
Current limit setting voltage	Vcl	120	150	180	mV		Fig.22
SS charge current	Iss	-300	-120	-50	nA	Vss=0V	Fig.23
TH input bias current	Ith	-	-	-0.2	μA	Vth=0V	Fig.24
MIN input bias current	Imin	-	-	-0.2	μA	Vmin=0V	Fig.25
CS input bias current	Ics	-	-	-0.2	μA	Vcs=0V	Fig.26

About a current item, define the inflow current to IC as a positive notation, and the outflow current from IC as a negative notation.

● Typical performance curves(Reference data)

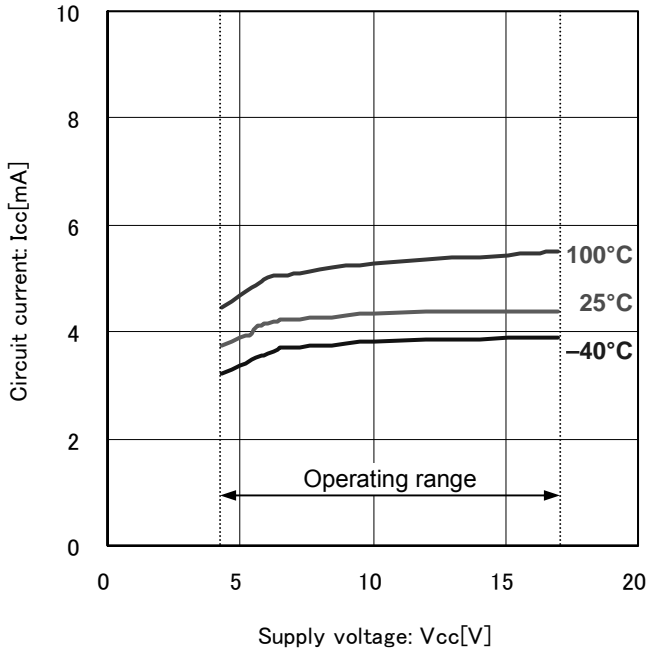


Fig.3 Circuit current

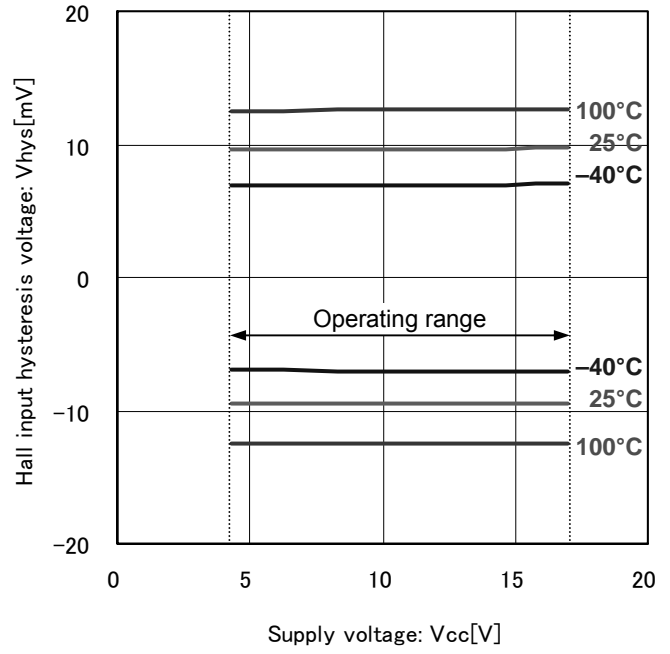


Fig.4 Hall input hysteresis

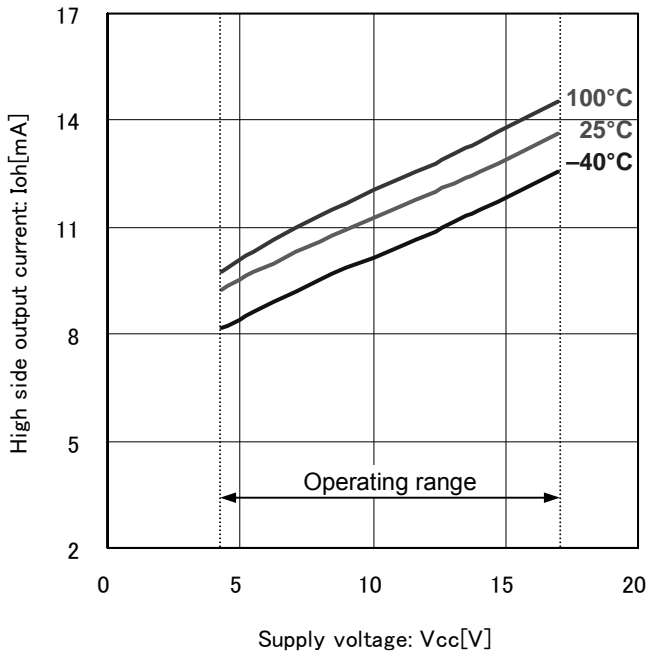


Fig.5 High side output current

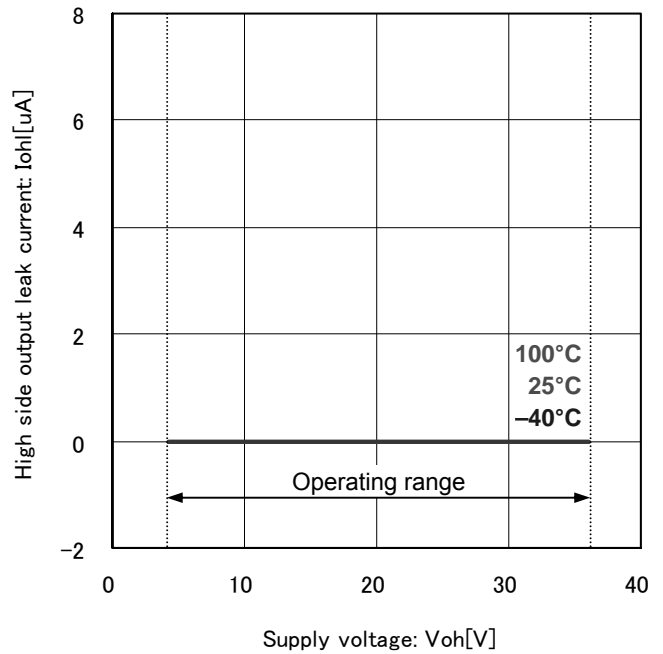


Fig.6 High side output leak current

● Typical performance curves(Reference data)

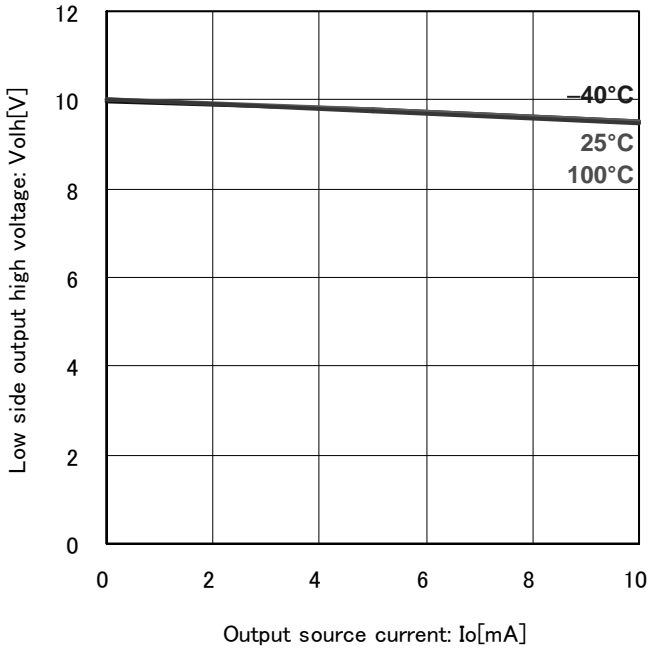


Fig.7 Low side output high voltage (V_{cc}=12V)

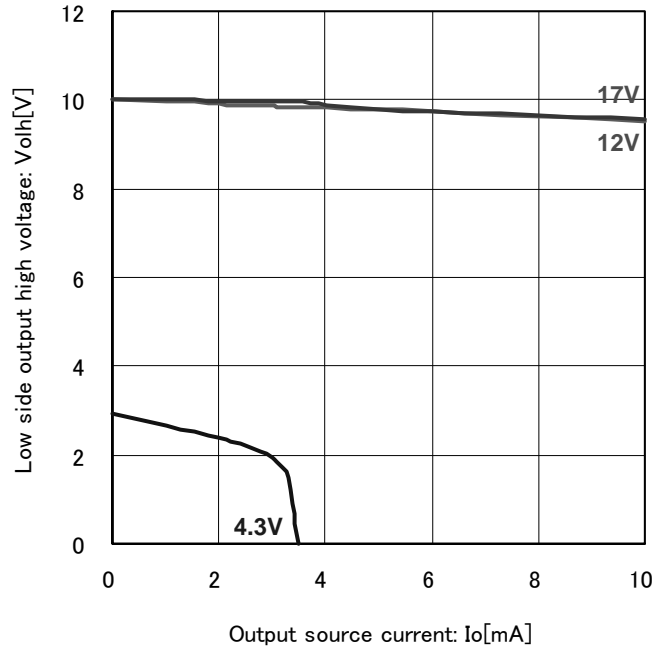


Fig.8 Low side output high voltage (T_a=25°C)

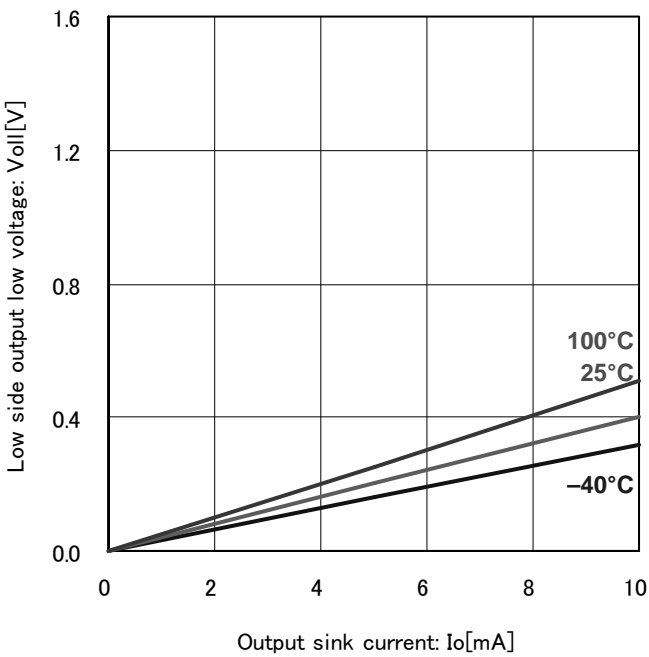


Fig.9 Low side output low voltage (V_{cc}=12V)

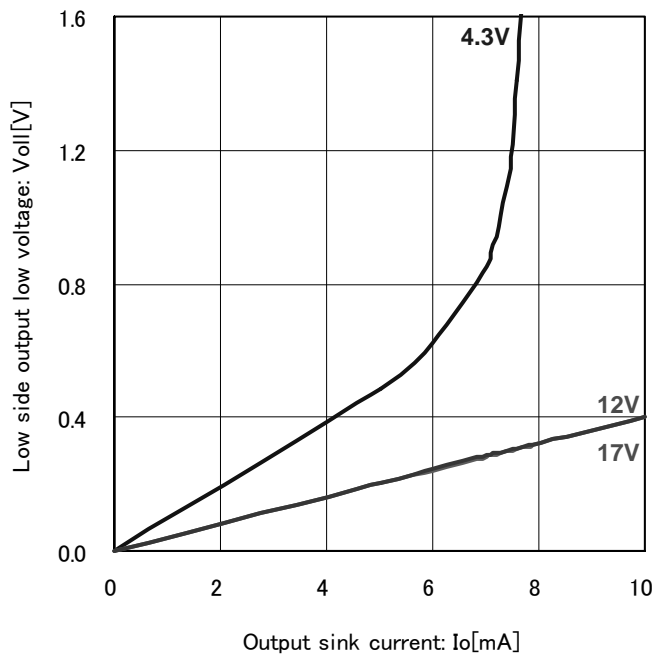


Fig.10 Low side output low voltage (T_a=25°C)

● Typical performance curves(Reference data)

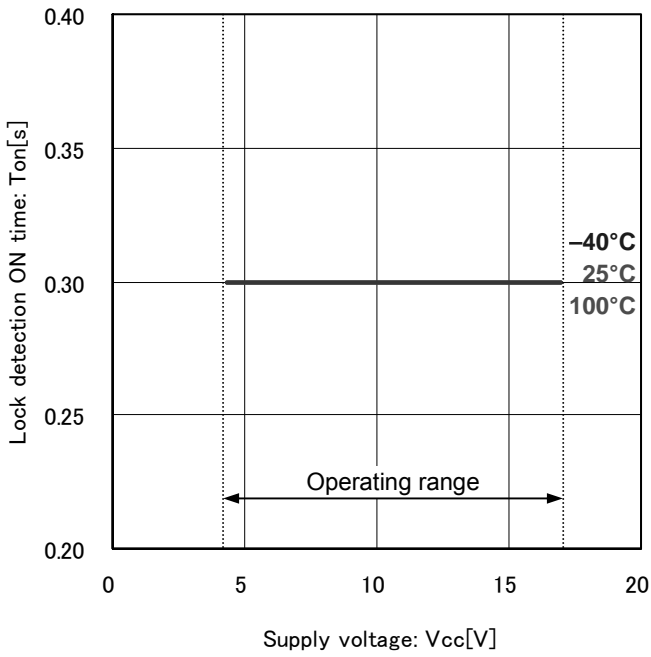


Fig.11 Lock detection ON time

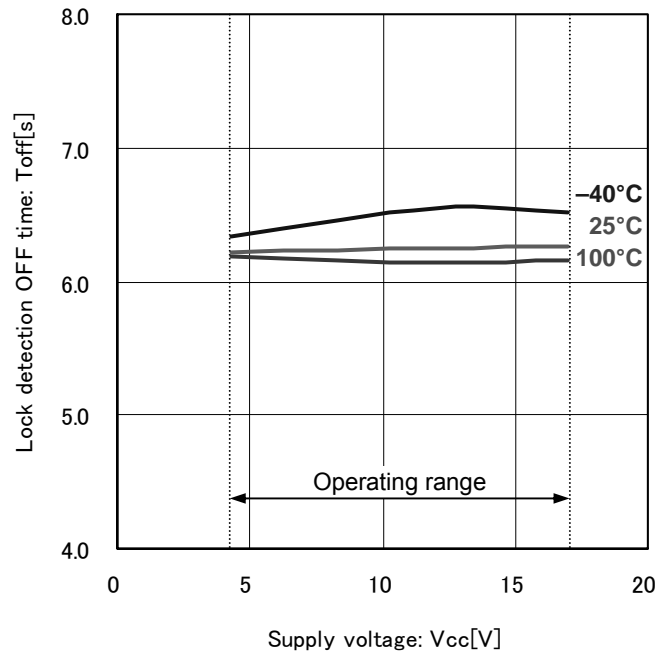


Fig.12 Lock detection OFF time

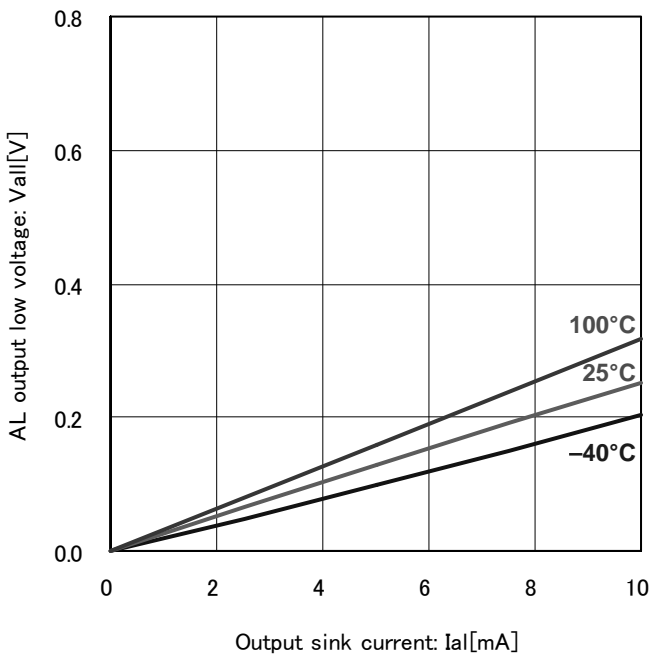


Fig.13 AL output low voltage (Vcc=12V)

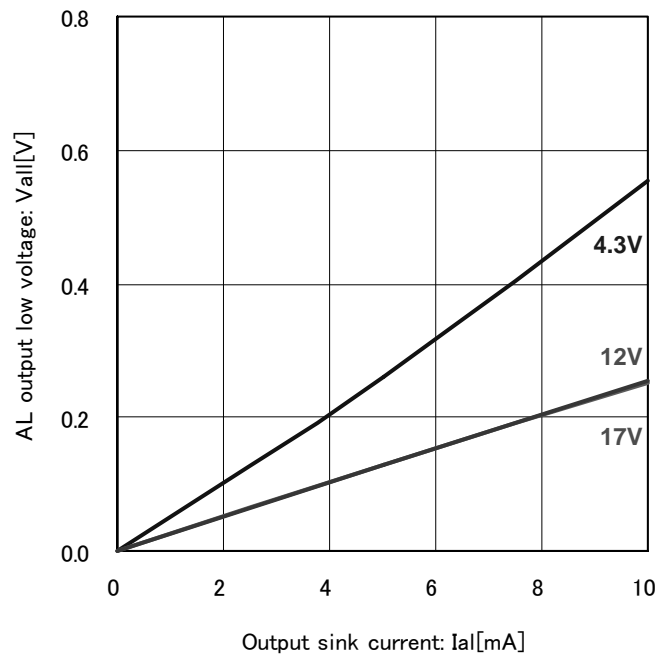


Fig.14 AL output low voltage (Ta=25°C)

● Typical performance curves(Reference data)

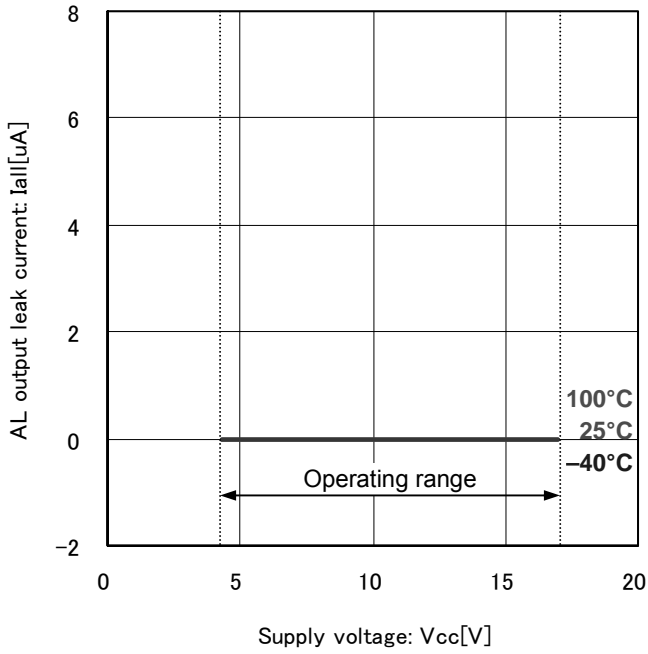


Fig.15 AL output leak current

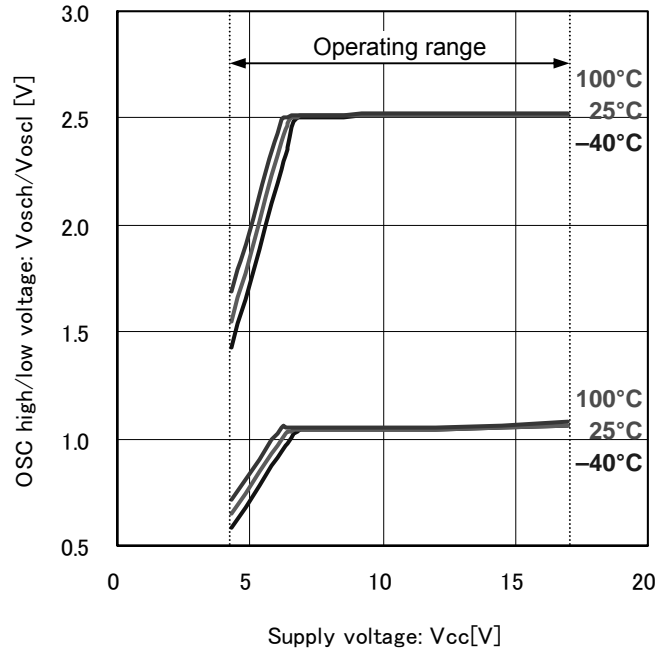


Fig.16 OSC high/low voltage

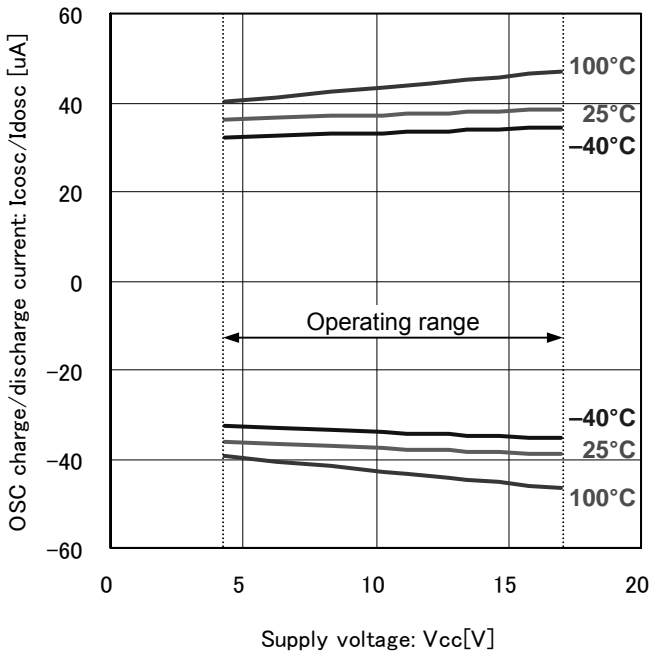


Fig.17 OSC charge/discharge current

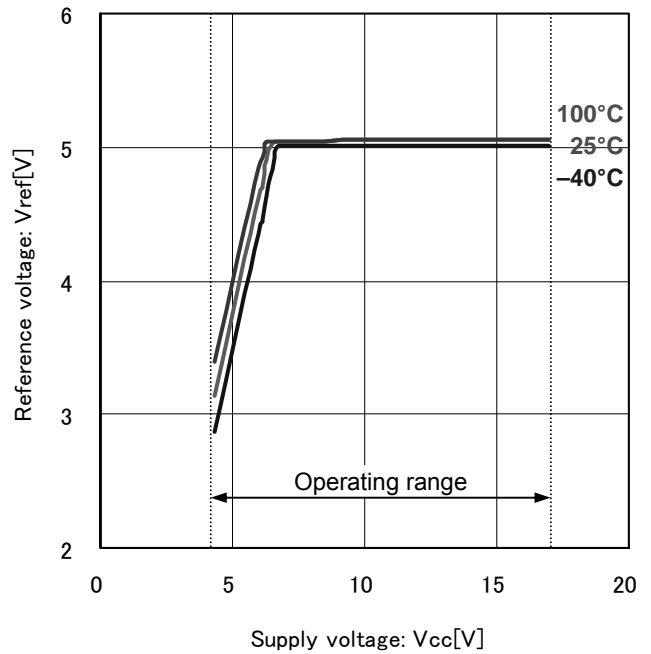


Fig.18 Reference voltage

●Typical performance curves(Reference data)

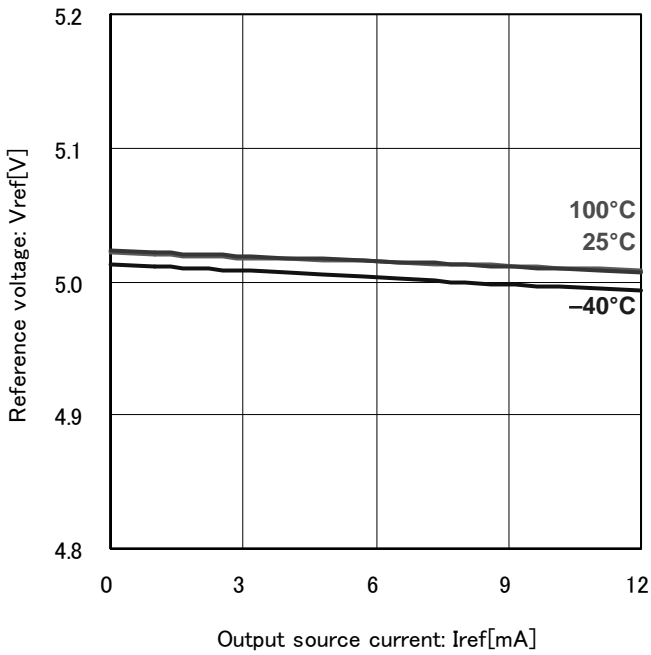


Fig.19 Reference voltage current ability ($V_{cc}=12V$)

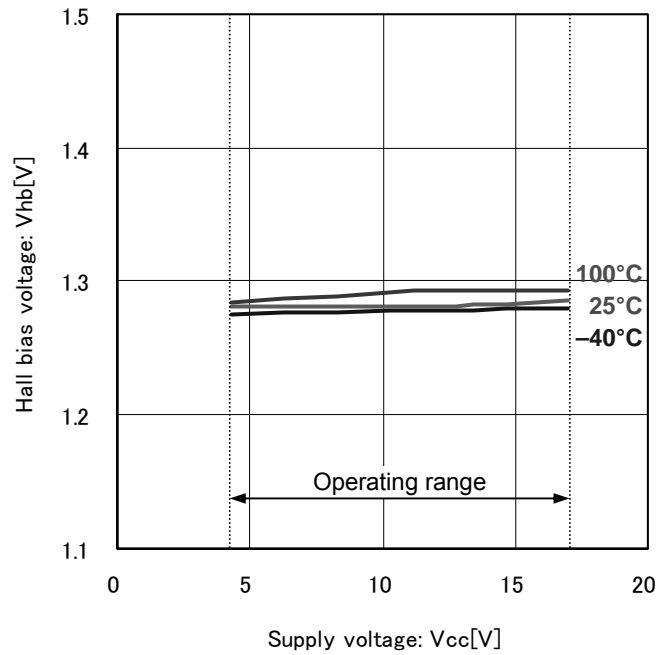


Fig.20 Hall bias voltage

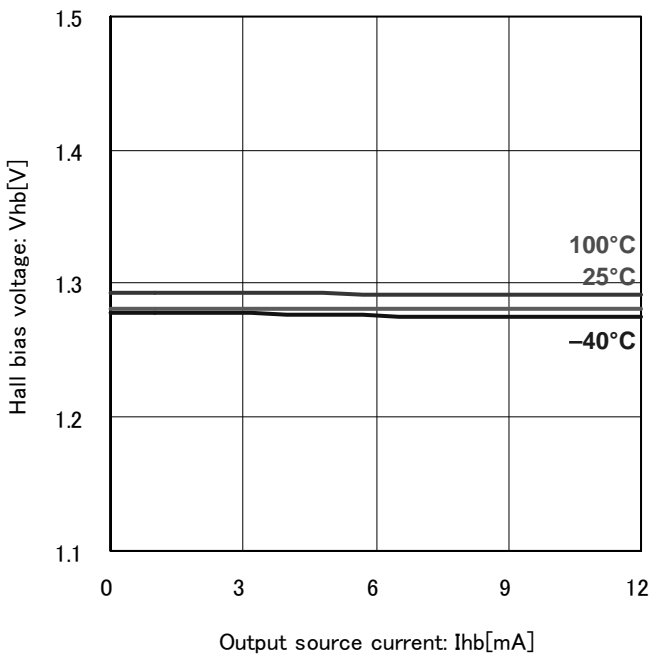


Fig.21 Hall bias voltage current ability ($V_{cc}=12V$)

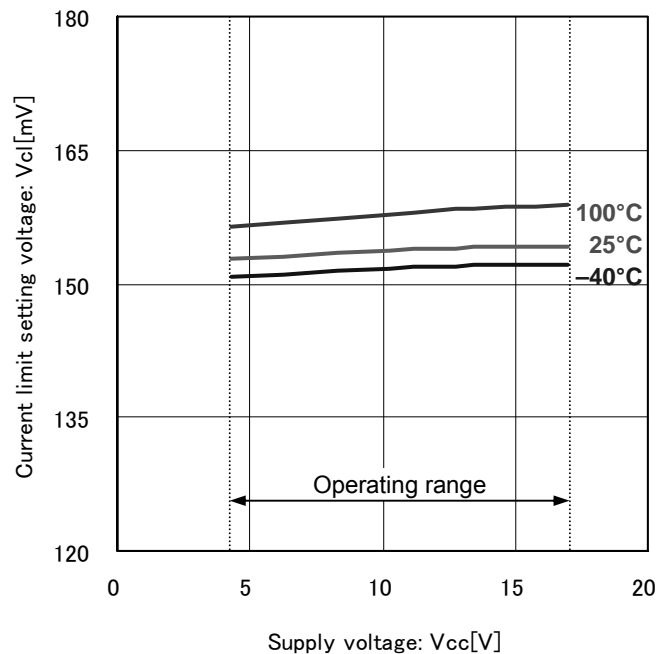


Fig.22 Current limit setting voltage

● Typical performance curves(Reference data)

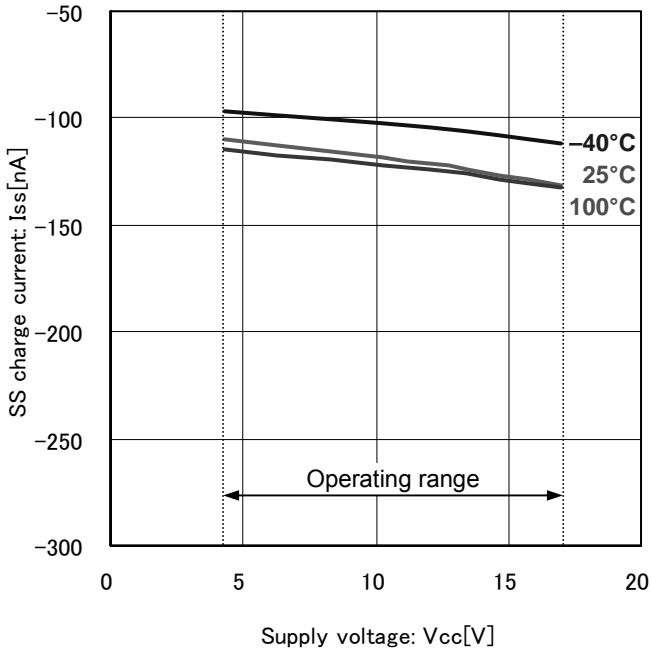


Fig.23 SS charge current

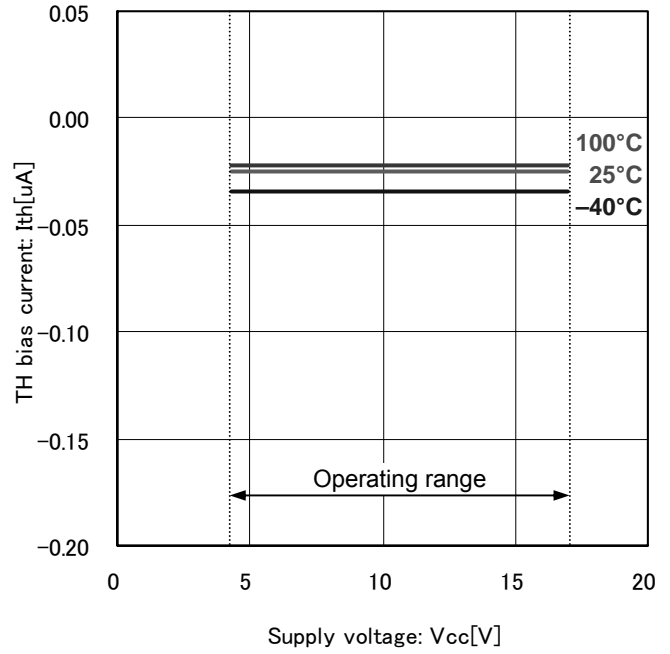


Fig.24 TH bias current

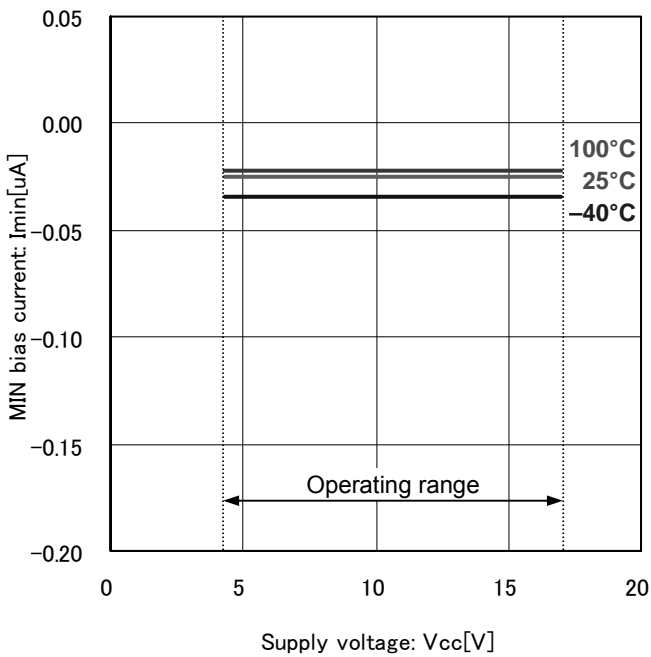


Fig.25 MIN bias current

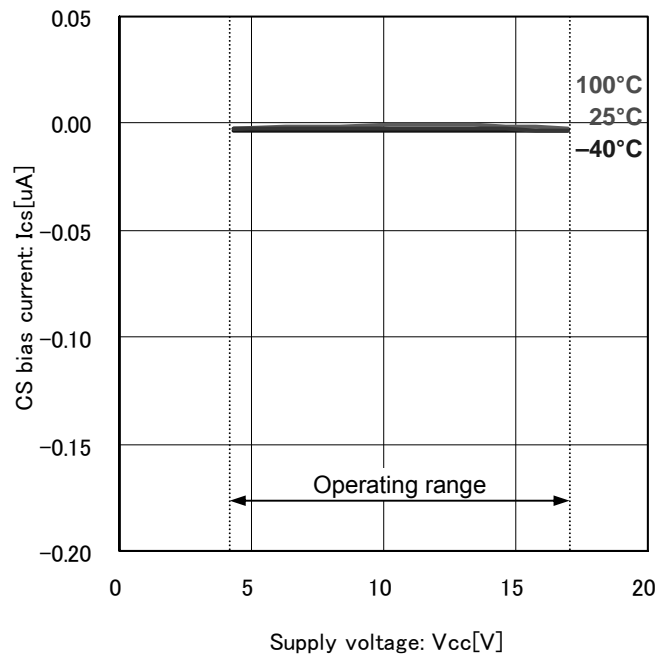


Fig.26 CS bias current

●Application circuit example(Constant values are for reference)

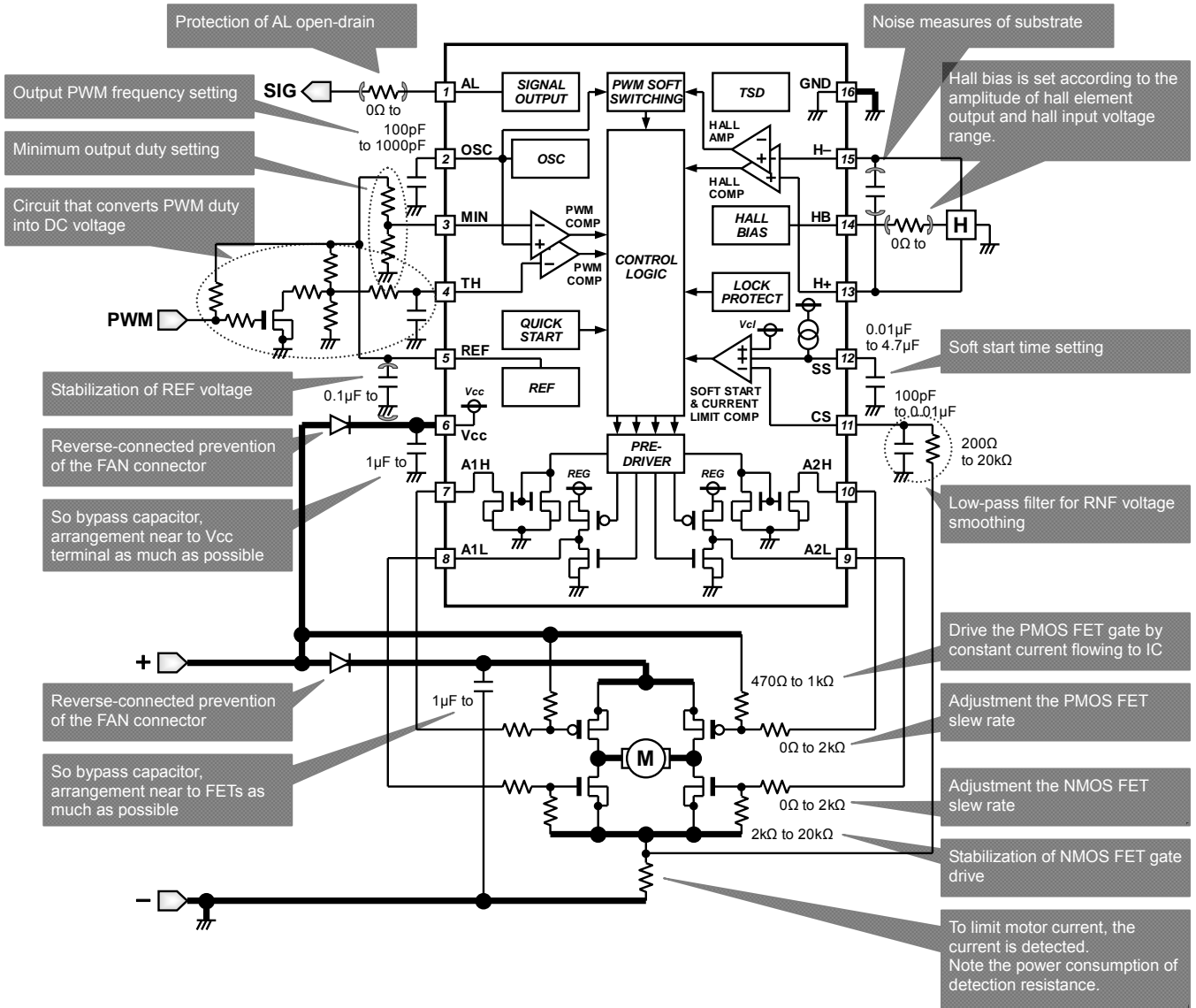


Fig.27 PWM controllable 4 wires type motor application circuit

Substrate design note

- a) Motor power and ground lines are made as fat as possible.
- b) IC power line is made as fat as possible.
- c) IC ground line is common with the application ground except motor ground (i.e. hall ground etc.), and arranged near to (-) land.
- d) The bypass capacitors (Vcc side and Vm side) are arrangement near to Vcc terminal and FETs, respectively.
- e) H+ and H- lines are arranged side by side and made from the hall element to IC as shorter as possible, because it is easy for the noise to influence the hall lines.

●Power dissipation

Power dissipation (total loss) indicates the power that can be consumed by IC at Ta=25°C (normal temperature). IC is heated when it consumes power, and the temperature of IC chip becomes higher than ambient temperature. The temperature that can be accepted by IC chip depends on circuit configuration, manufacturing process, etc., and consumable power is limited. Power dissipation is determined by the temperature allowed in IC chip (maximum junction temperature) and thermal resistance of package (heat dissipation capability). The maximum junction temperature is in general equal to the maximum value in the storage temperature range.

Heat generated by consumed power of IC is radiated from the mold resin or lead frame of package. The parameter which indicates this heat dissipation capability (hardness of heat release) is called heat resistance, represented by the symbol θ_{ja} [°C/W]. This heat resistance can estimate the temperature of IC inside the package. Fig.28 shows the model of heat resistance of the package. Heat resistance θ_{ja} , ambient temperature Ta, junction temperature Tj, and power consumption P can be calculated by the equation below:

$$\theta_{ja} = (T_j - T_a) / P \text{ [}^\circ\text{C/W]}$$

Thermal de-rating curve indicates power that can be consumed by IC with reference to ambient temperature. Power that can be consumed by IC begins to attenuate at certain ambient temperature. This gradient is determined by thermal resistance θ_{ja} . Thermal resistance θ_{ja} depends on chip size, power consumption, package ambient temperature, packaging condition, wind velocity, etc., even when the same package is used. Thermal de-rating curve indicates a reference value measured at a specified condition. Fig.29 shows a thermal de-rating curve (Value when mounting FR4 glass epoxy board 70[mm] x 70[mm] x 1.6[mm] (copper foil area below 3[%])). Thermal resistance θ_{jc} from IC chip joint part to the package surface part of mounting the above-mentioned same substrate is shown in the following as a reference value.

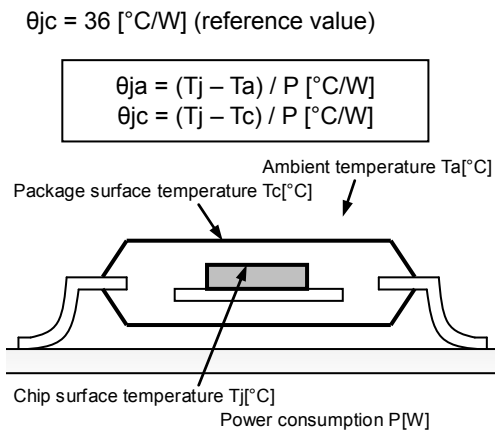


Fig.28 Thermal resistance

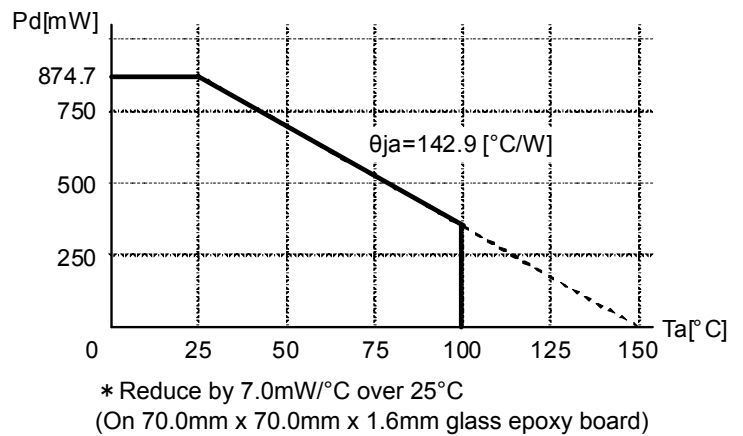
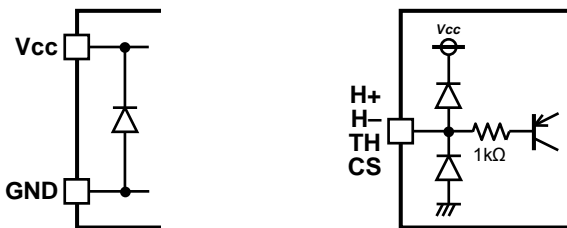


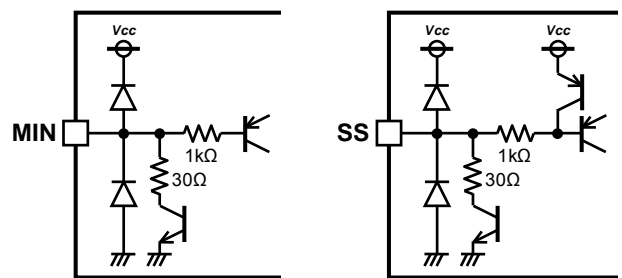
Fig.29 Thermal de-rating curve

●I/O equivalence circuit(Resistance values are typical)

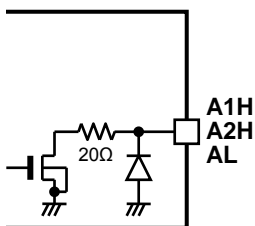
- 1) Power supply terminal, and Ground terminal
- 2) Hall input terminals, Output duty controllable input terminal, and Output current detection terminal



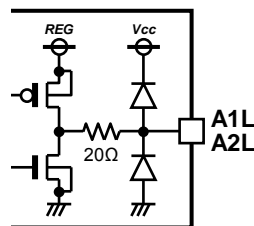
- 3) Minimum output duty setting terminal
- 4) Soft start capacitor connecting terminal



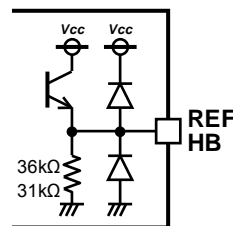
- 5) High side output 1, 2 terminals, and Lock alarm signal output terminal



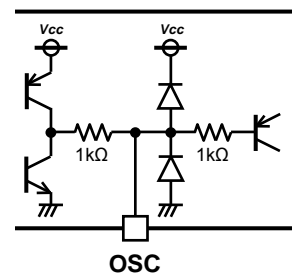
- 6) Low side output 1, 2 terminals



- 7) Reference voltage output terminal, and Hall bias terminal



- 8) Oscillating capacitor connecting terminal



●Operational Notes

- 1) Absolute maximum ratings
An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.
- 2) Connecting the power supply connector backward
Connecting of the power supply in reverse polarity can damage IC. Take precautions when connecting the power supply lines. An external direction diode can be added.
- 3) Power supply line
Back electromotive force causes regenerated current to power supply line, therefore take a measure such as placing a capacitor between power supply and GND for routing regenerated current. And fully ensure that the capacitor characteristics have no problem before determine a capacitor value. (When applying electrolytic capacitors, capacitance characteristic values are reduced at low temperatures)
- 4) GND potential
It is possible that the motor output terminal may deflect below GND terminal because of influence by back electromotive force of motor. The potential of GND terminal must be minimum potential in all operating conditions, except that the levels of the motor outputs terminals are under GND level by the back electromotive force of the motor coil. Also ensure that all terminals except GND and motor output terminals do not fall below GND voltage including transient characteristics. Malfunction may possibly occur depending on use condition, environment, and property of individual motor. Please make fully confirmation that no problem is found on operation of IC.
- 5) Thermal design
Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.
- 6) Inter-pin shorts and mounting errors
Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.
- 7) Actions in strong electromagnetic field
Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.
- 8) ASO
When using the IC, set the output transistor so that it does not exceed absolute maximum ratings or ASO.
- 9) Thermal shut down circuit
The IC incorporates a built-in thermal shutdown circuit (TSD circuit). Operation temperature is 175°C (typ.) and has a hysteresis width of 25°C (typ.). When IC chip temperature rises and TSD circuit works, the output terminal becomes an open state. TSD circuit is designed only to shut the IC off to prevent thermal runaway. It is not designed to protect the IC or guarantee its operation. Do not continue to use the IC after operation this circuit or use the IC in an environment where the operation of this circuit is assumed.
- 10) Testing on application boards
When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.
- 11) GND wiring pattern
When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the ground potential of application so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage. Be careful not to change the GND wiring pattern of any external components, either.
- 12) Capacitor between output and GND
When a large capacitor is connected between output and GND, if Vcc is shorted with 0V or GND for some cause, it is possible that the current charged in the capacitor may flow into the output resulting in destruction. Keep the capacitor between output and GND below 100μF.
- 13) IC terminal input
When Vcc voltage is not applied to IC, do not apply voltage to each input terminal. When voltage above Vcc or below GND is applied to the input terminal, parasitic element is actuated due to the structure of IC. Operation of parasitic element causes mutual interference between circuits, resulting in malfunction as well as destruction in the last. Do not use in a manner where parasitic element is actuated.
- 14) In use
We are sure that the example of application circuit is preferable, but please check the character further more in application to a part that requires high precision. In using the unit with external circuit constant changed, consider the variation of externally equipped parts and our IC including not only static character but also transient character and allow sufficient margin in determining.

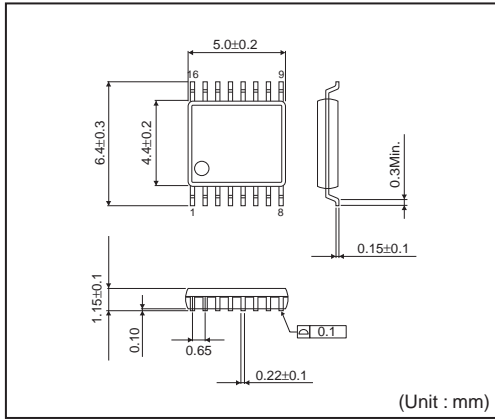
●Status of this document

The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.

If there are any differences in translation version of this document, formal version takes priority.

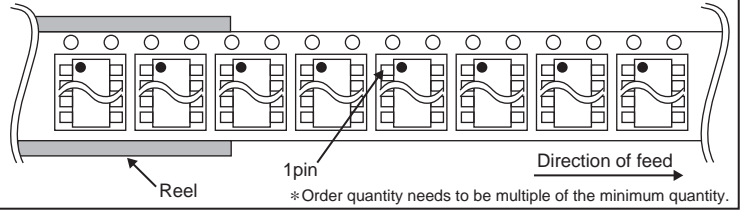
●Physical dimension tape and reel information

SSOP-B16



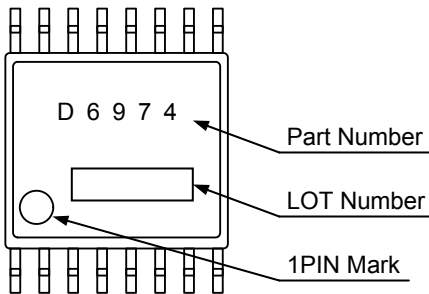
<Tape and Reel information>

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)



●Marking diagram

SSOP-B16
(TOP VIEW)



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