3Phase spindle motor driver for CD-ROM

BD6669FV

BD6669FV is a 3-phase spindle motor driver adopting 180° PWM direct driving system. Noise occurred from the motor driver when the disc is driven can be reduced. Low power consumption and low heat operation are achieved by using DMOS FET and driving directly.

●Applications

CD-ROM

●Features

1) Direct-PWM-Linear driving system.
2) Built in power save circuit.
3) Built in current limit circuit.
4) Built in FG-output.
5) Built in hall bias circuit.
6) Built in reverse protection circuit.
7) Built in short brake circuit.
8) Low consumption by MOS-FET.
9) Built in capacitor for oscillator.
10) Built in rotation detect.

●Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	7	V
Supply voltage for motor	V_M	7	V
VG pin voltage	V_G	20	V
Output current	I_{OMAX}	1000 *1	mA
Power dissipation	Pd	1020 *2	mW
Junction temperature	Tj_{MAX}	150	°C
Operating temperature range	Topr	−20 to +75	°C
Storage temperature range	Tstg	−55 to +150	°C

*1 However, do not exceed Pd, ASO and Tj=150°C.
*2 70mm×70mm×1.6mm glass epoxy board.
Reduce power by 8.16mW for each degree above 25°C.

●Recommended operating conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{CC}	4.5	–	5.5	V
Supply voltage for motor	V_M	3	–	6.5	V
VG pin voltage	V_G	7.5	–	14	V

This product described in this specification isn't judged whether it applies to cocom regulations.
Please confirm in case of export.
◎This product is not designed for protection against radioactive rays.

●**Block diagram**

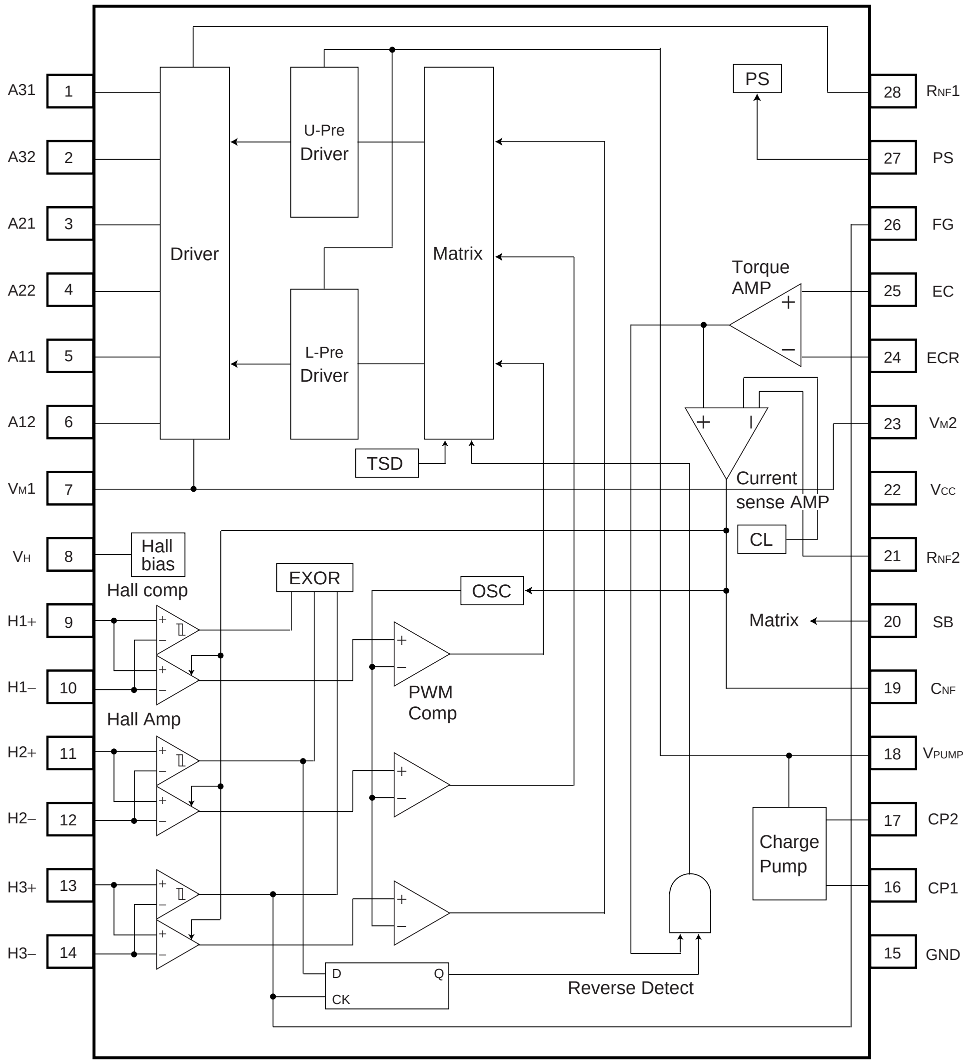


Fig.1

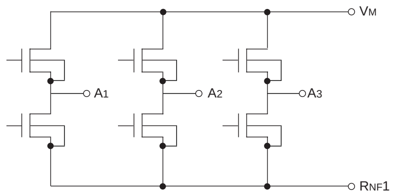
●Pin descriptions

Pin No.	Pin name	Function
1	A_{31}	Output3 for motor
2	A_{32}	Output3 for motor
3	A_{21}	Output2 for motor
4	A_{22}	Output2 for motor
5	A_{11}	Output1 for motor
6	A_{12}	Output1 for motor
7	V_{M1}	Power supply fo driver
8	V_{H}	Hall bias pin
9	H_1^+	Hall input AMP 1 positive input
10	H_1^-	Hall input AMP 1 negative input
11	H_2^+	Hall input AMP 2 positive input
12	H_2^-	Hall input AMP 2 negative input
13	H_3^+	Hall input AMP 3 positive input
14	H_3^-	Hall input AMP 3 negative input
15	GND	GND
16	CP1	Capacitor pin 1 for charge pump
17	CP2	Capacitor pin 2 for charge pump
18	V_{PUMP}	Capacitor connection pin for charge pump
19	CNF	Capacitor connection pin for phase compensation
20	SB	Short brake pin
21	R_{NF2}	Resistor connection pin for current sense
22	V_{CC}	Power supply for signal division
23	V_{M2}	Power supply for driver
24	ECR	Torque control standard voltage input terminal
25	EC	Torque control voltage input terminal
26	FG	FG output pin
27	PS	Power save pin
28	R_{NF1}	Resistor connection pin for current sense

●Input output circuits

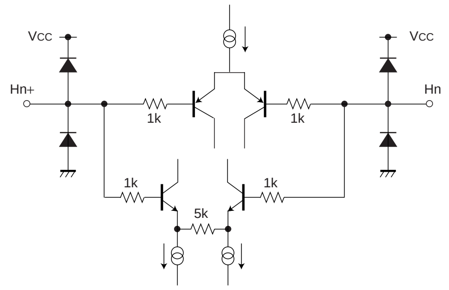
Output pins

A_1 : Pin1, 2, A_2 : Pin3, 4, A_3 : Pin5, 6



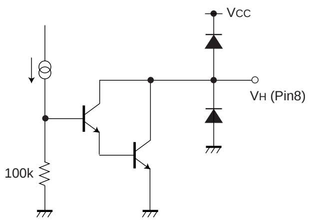
Hall input

H1+ : Pin9, H1− : Pin10, H2+ : Pin11, H2− : Pin12,
H3+ : Pin13, H3− : Pin14



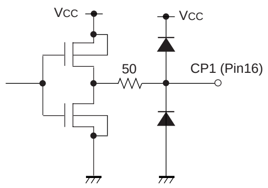
Hall bias

Pin8



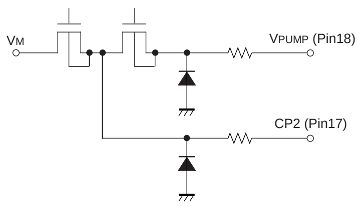
CP1 output

Pin16



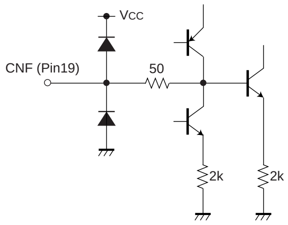
CP2 / VPUMP output

CP2 : Pin17, VPUMP : Pin18



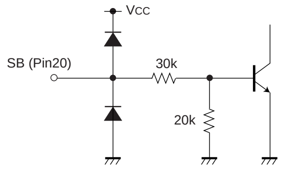
CNF

Pin19



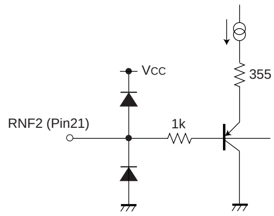
Short brake

Pin20



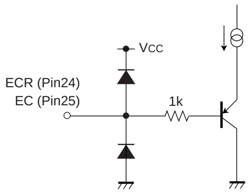
RNF2

Pin21



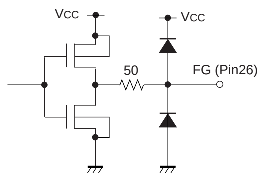
Torque amplifier

ECR : Pin24, EC : Pin25



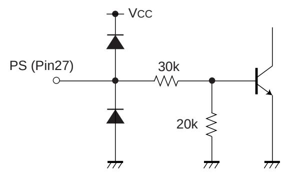
FG output

FG : Pin26



Power save

Pin27

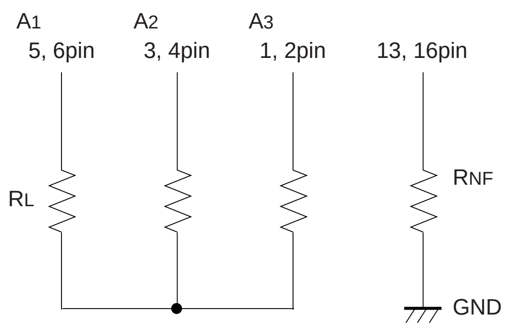


●Electrical characteristics (unless otherwise noted, Ta=25°C, V_{CC}=5V, V_M=5V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test Circuit
<Total>							
Circuit current 1	$I_{CC}1$	–	–	5	µA	Sutand by mode	Fig.2
Circuit current 2	$I_{CC}2$	5	11	17	mA		Fig.2
<Power save>							
ON voltage range	V_{PSON}	–	–	1.0	V	Sutand by mode	Fig.2
OFF voltage range	V_{PSOFF}	2.5	–	–	V		Fig.2
<Hall bias>							
Hall bias voltage	V_{HB}	0.6	1.0	1.4	V	I_{HB}=10mA	Fig.2
<Hall AMP>							
Input bias current	I_{HA}	–8.0	–2.0	–	µA		Fig.4
In-phase input voltage range	V_{HAR}	1.4	–	3.6	V		Fig.4
Minimum input level	V_{INH}	100	–	–	mV_{PP}	Hall input Amp	Fig.4
Hall hysteresis level (+)	V_{HYS^+}	5	20	40	mV		Fig.8
Hall hysteresis level (–)	V_{HYS^-}	–40	–20	–5	mV		Fig.8
<Torque control>							
Input voltage range	E_C, E_{CR}	0	–	5	V	Linear range 0.5V~3.3V	Fig.6
Offset voltage (+)	$Ecofs^+$	5	50	100	mV		Fig.6
Offset voltage (–)	$Ecofs^-$	–100	–50	–5	mV		Fig.6
Input current	E_{CIN}	–12	–2.5	–	µA	E_C=E_{CR}=1.65V	Fig.6
<Short brake SW>							
ON voltage range	V_{SBON}	2.5	–	–	V	Short brake	Fig.7
OFF voltage range	V_{SBOFF}	–	–	1.0	V		Fig.7
<Output>							
Input / Output gain	G_{EC}	0.8	1.0	1.2	A/V		Fig.6
Output ON-resistance	R_{ON}	0.3	0.5	0.7	Ω	I_O=±600mA (Upper+Lower)	Fig.5
Torque limit voltage	V_{TL}	0.16	0.2	0.24	V		Fig.3
<FG output>							
High voltage	V_{FGH}	4.6	–	–	V	I_{FG}=–100µA	Fig.6
Low voltage	V_{FGL}	–	–	0.4	V	I_{FG}=+100µA	Fig.6
<Charge pump voltage>							
Charge pump output voltage	Vpump	6	10	14	V	V_{CC}=V_M=5V	Fig.9

●Measuring circuit

1. Value of resistor (Fig.2~Fig.9)



R_L=5Ω, R_{NF}=0.33Ω

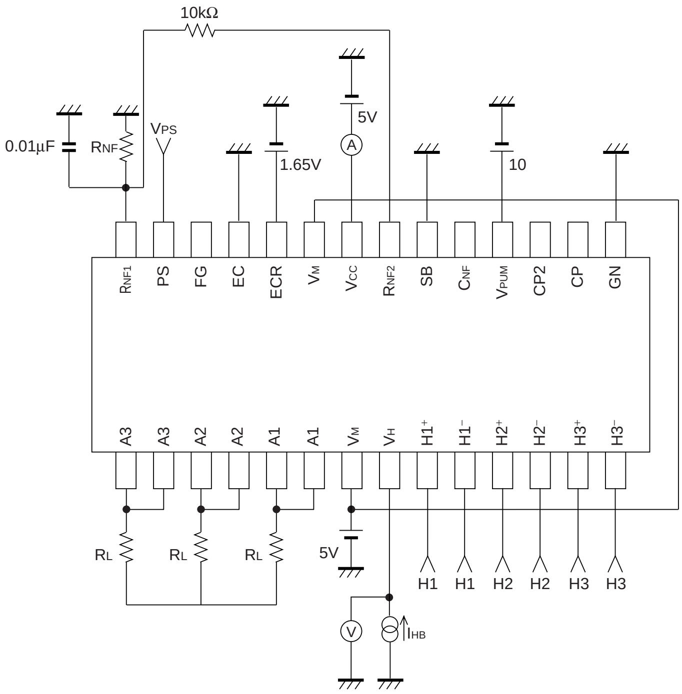
2. Input-output table

	Input condition						Output condition					
							$E_C<E_{CR}$			$E_C>E_{CR}$		
Pin No.	23	24	25	26	27	28	17.18	14.15	11.12	17.18	14.15	11.12
	H_1^+	H_1^-	H_2^+	H_2^-	H_3^+	H_3^-	A_1	A_2	A_3	A_1	A_2	A_3
Condition1	L	M	H	M	M	M	H	L	L	L	H	H
Condition2	H	M	L	M	M	M	L	H	H	H	L	L
Condition3	M	M	L	M	H	M	L	H	L	H	L	H
Condition4	M	M	H	M	L	M	H	L	H	L	H	L
Condition5	H	M	M	M	L	M	L	L	H	H	H	L
Condition6	L	M	M	M	H	M	H	H	L	L	L	H

Input voltage
- H=2.8V
- M=2.5V
- L=2.2V

Output logic
- H : Upper Tr ON
- L : Lower Tr ON

3. **Measuring circuit**



$I_{CC}1$: Value of A_1
V_{PS}=0 [V]
Hall input condition : condition1

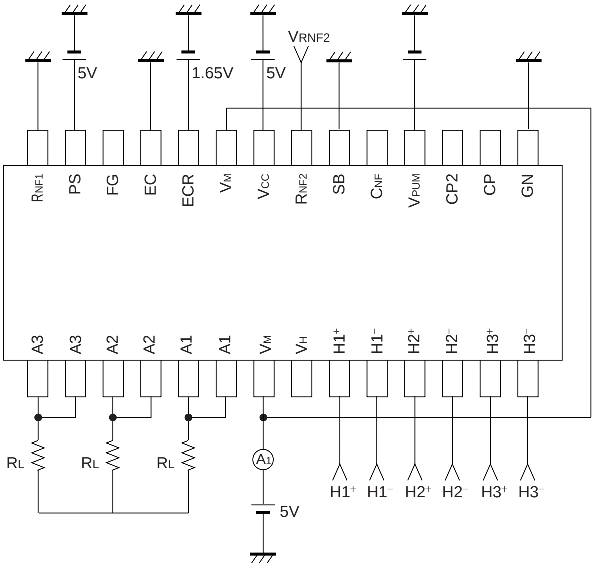
$I_{CC}2$: Value of A_1
V_{PS}=5 [V]
Hall input condition : condition1

V_{HB} : Value of V_1
V_{PS}=5 [V]
I_{HB}=10 [mA]

V_{PSON} : Range of Vps output pins become input-output table.

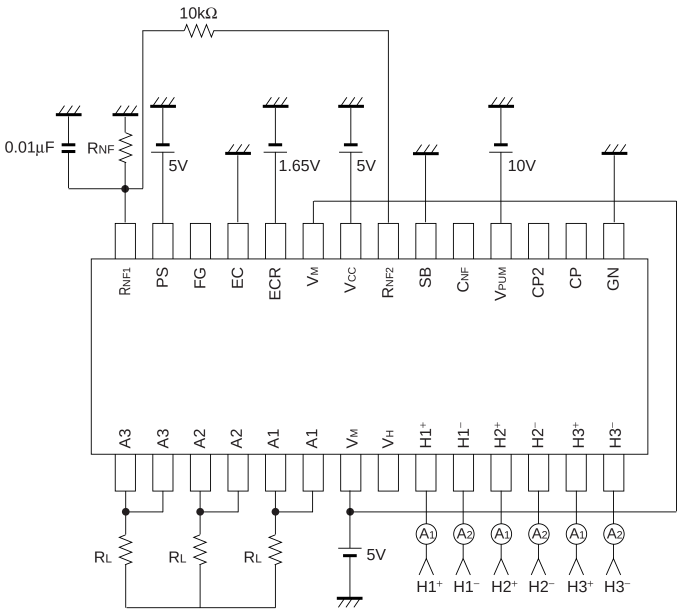
V_{PSOFF} : Range of Vps output pins become open.

Fig.2



V_{TL} : Range of V_{RNF2} that V_M current (I_M) become 0A.
V_{PS}=5 [V]

Fig.3



I_{HA} : Value of 'A1' (Hn^+=2.5V, Hn^-=2.0V)
Value of 'A2' (Hn^+=2.0V, Hn^-=2.5V)
n=1, 2, 3

V_{HAR} : HALL voltage range that output pins become input-output table.

V_{INH} : HALL input level that output pins become input-output table.

V_{INH} : $|Hn^+ - Hn^-|$
Hn^-=2.5 V

Fig.4

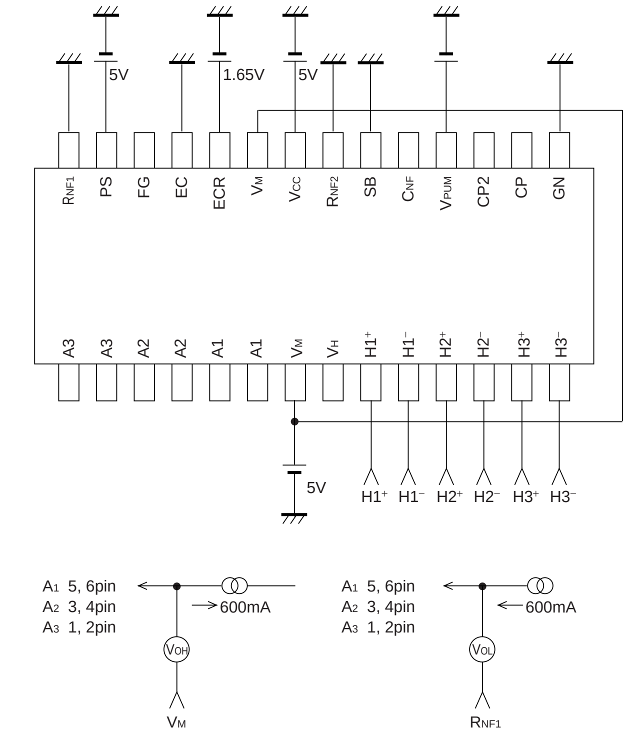


Fig.5

V_{OH} : In case output measurement pin='H' by input condition and I_O=–600mA, value of 'V_{OH}'

V_{OL} : In case output measurement pin='L' by input condition and I_O=600mA, value of 'V_{OL}'

$Ron=(V_{OH}+V_{OL})\ /\ 0.6$

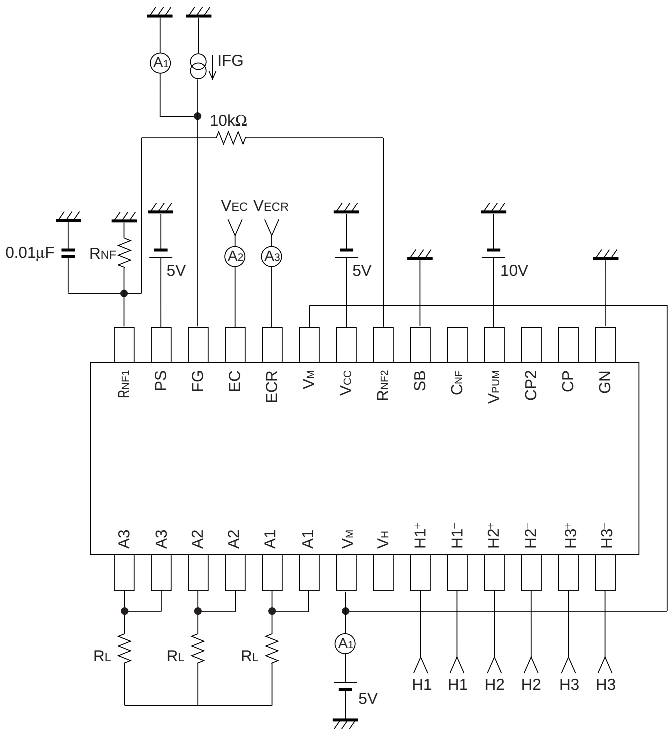


Fig.6

E_C, E_{CR} : Torque control operating range.

E_{COFS} : E_C voltage range that V_M current (I_M) is 0A.

E_{CIN} : Value of 'A2' (E_C=E_{CR}=1.65V)
Value of 'A3' (E_C=E_{CR}=1.65V)

V_{FGH} : Value of V_1 (I_{FG}=–100µA)
Hall input condition 3.

V_{FGL} : Value of V_1 (I_{FG}=+100µA)
Hall input condition 4.

G_{EC}= { (V_1–V_2) / (1.5–1.2) } / 0.5
When E_{CR}=1.65V
value of V_1 (E_C=1.2V)
value of V_2 (E_C=1.5V)

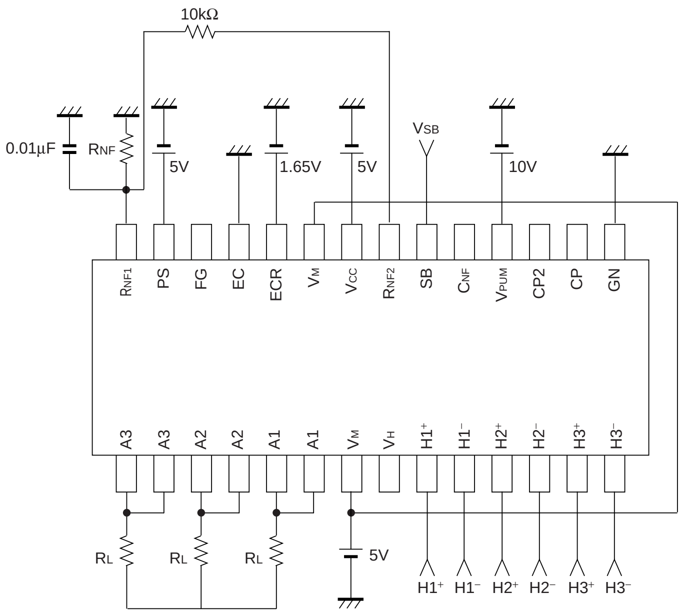


Fig.7

V_{SBON} : Volatge range of 'V_{SB}' that output pins become 'L'.

V_{SBOFF} : Range of 'V_{SB}' that output pins become input-output table.

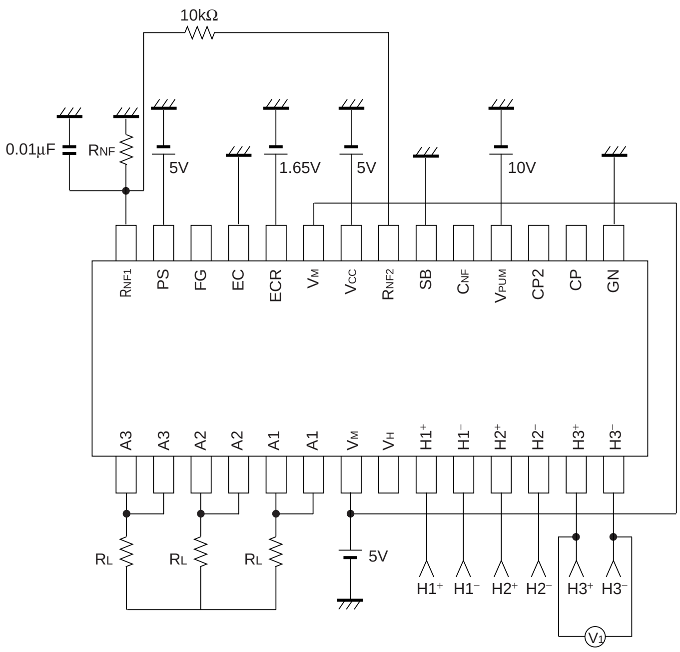
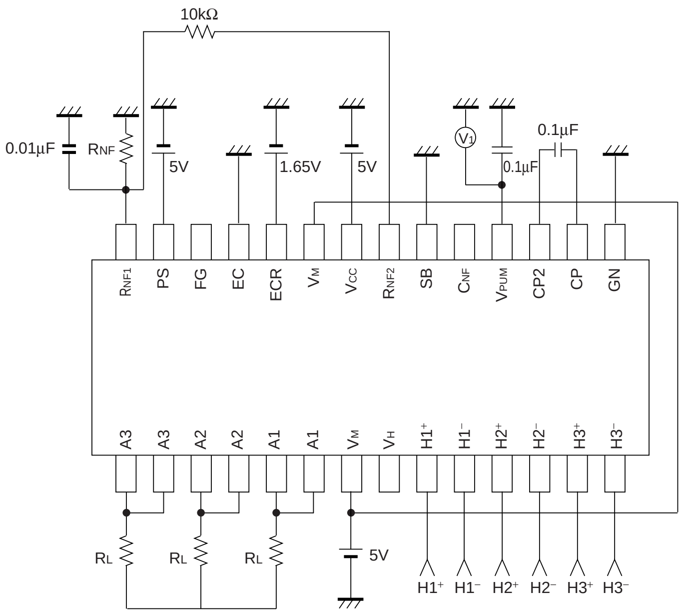


Fig.8

V_{HYS} : Voltage difference $H3^+$ to $H3^-$ that FG voltage change V1.



V_{PUMP} : Value of V1.

Fig.9

●Circuit operation

1. Application

(1) Hall input

Hall element can be used with both series and parallel connection. Determining R1 and R2, make sure to leave an adequate margin for temperature and dispertion in order to satisfy in-phase input voltage range and minimum input level.

A motor doesn't reach the regular number of rotation, if hall input level decrease under high temperature.

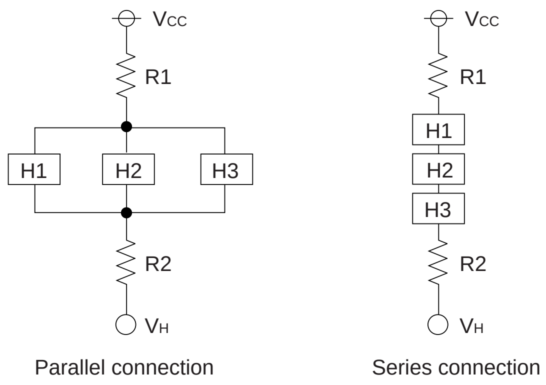


Fig.10

2.Torque voltage

By the voltage difference between EC and ECR, the current driving motor changes as shown in Fig.11 below.

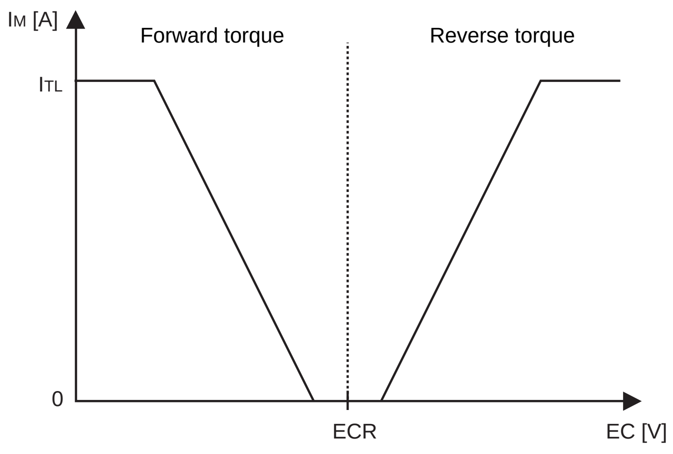


Fig.11

The gain of the current driving motor for the voltage of EC can be changed by the resistance of RNF.

(3) Current limit

The maximum value of the current driving motor can be changed by the resistance of RNF.

I_{TLL}=0.2 / RNF (A)

(4) Short brake

The short brake is switched by SB pin and its operation is shown in table below.

SB	EC < ECR	EC > ECR
L	Rotating forward	Reverse brake
H	Short brake	Short brake

Output upper (3phase) FET turn off and lower (3phase) FET turn on in short brake mode, as shown Fig.12.

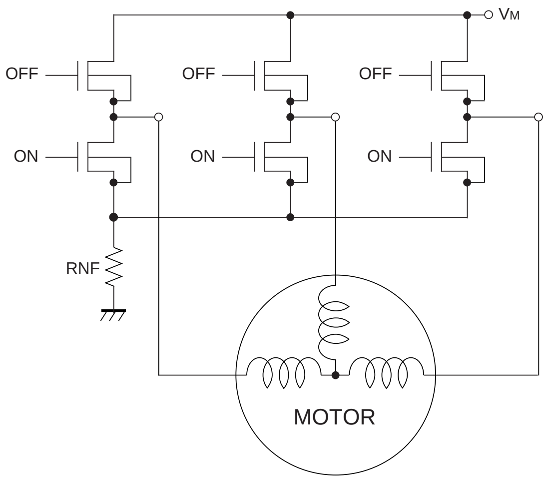


Fig.12

(5) Reverse detection

Reverse detection is constructed as shown in Fig.13. Output is opened when EC>ECR and the motor is rotating reverse.

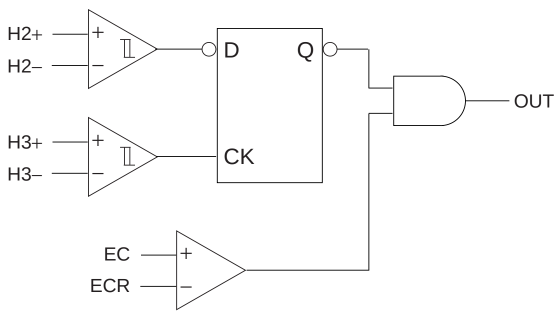
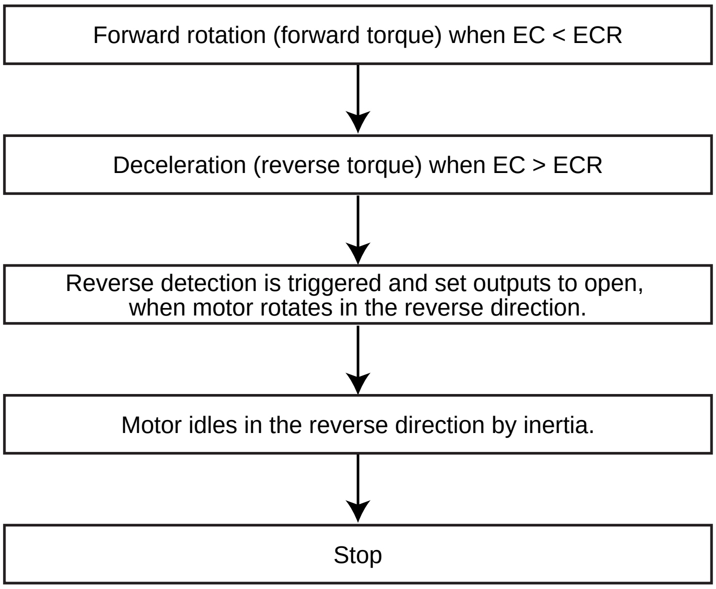


Fig.13

Motor rotation at reverse detection



(6) Timing chart

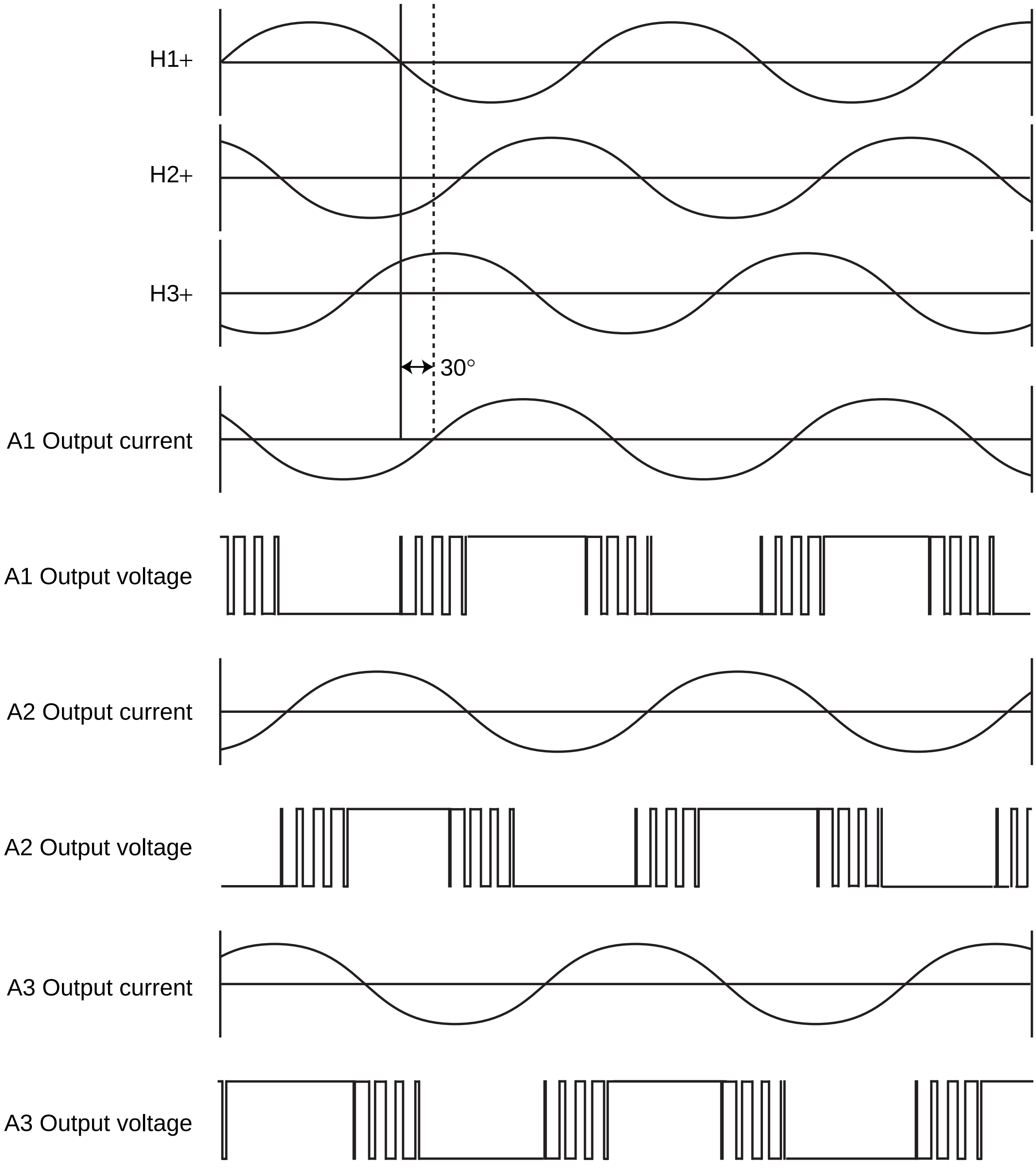


Fig.14

●**Application example**

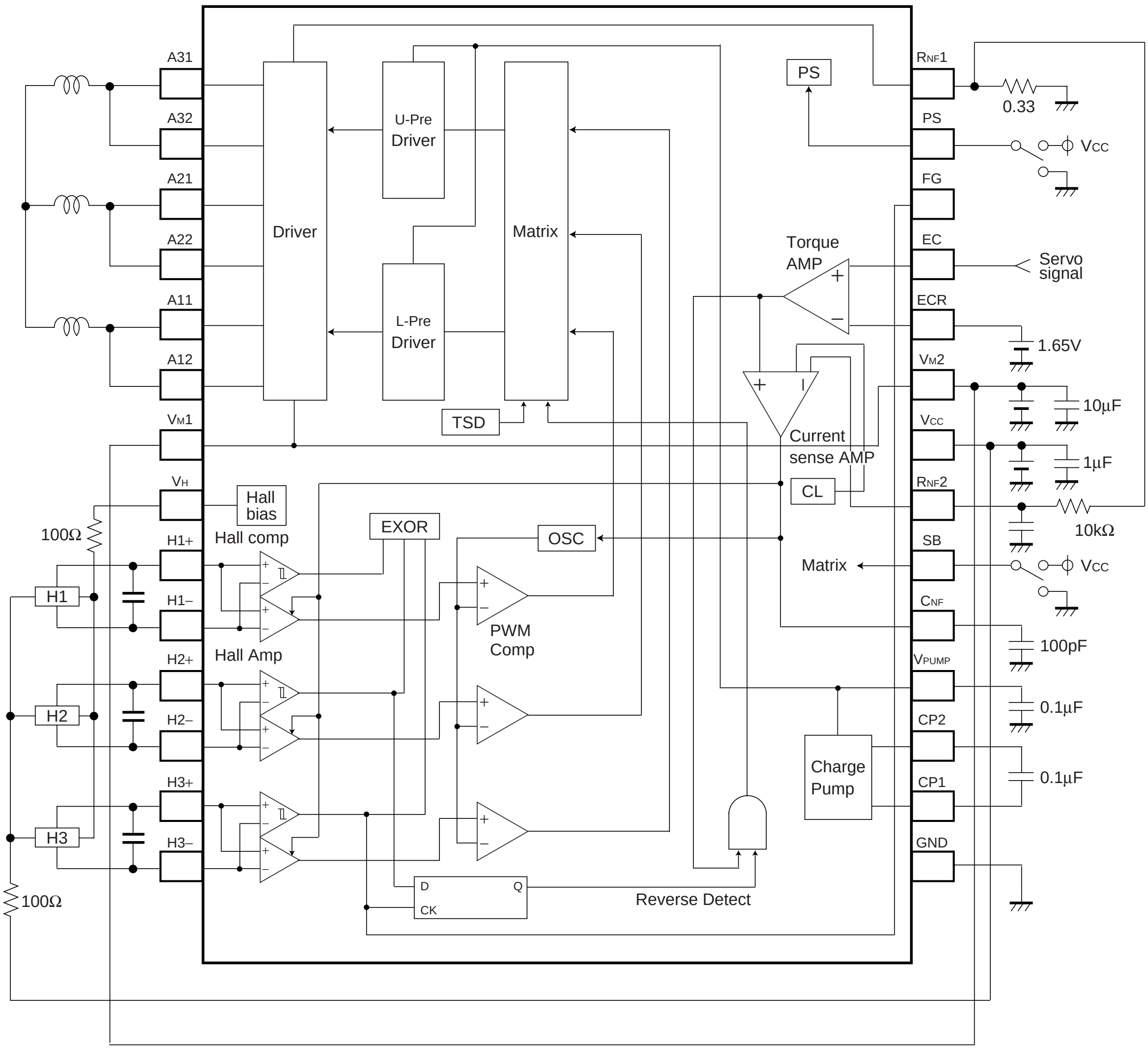


Fig.15

●**Operation notes**

1. Absolute maximum ratings
   Absolute maximum ratings are those values which, if exceeded, may cause the life of a device to become significantly shorted. Moreover, the exact failure mode cannot be defined, such as a short or an open. Physical countermeasures, such as a fuse, need to be considered when using a device beyond its maximum ratings.

2. GND potential
   The GND terminal should be the location of the lowest voltage on the chip. All other terminals should never go under this GND level, even in transition.

3. Thermal design
   The thermal design should allow enough margin for actual power dissipation.

4. Mounting failures
   Mounting failures, such as misdirection or mismounts, may destroy the device.

5. Electromagnetic fields
   A strong electromagnetic field may cause malfunctions.

6. Coil current flowing into V_M
   A coil current-flows from motor into V_M when torque control input changes from EC<ECR into EC>ECR, and V_M voltage rises if V_M voltage source doesn't have an ability of current drain.
   Make sure that surrounding circuits work correctly and aren't destroyed, when V_M voltage rises.
   Physical countermeasures, such as a diode for voltage clamp, need to be considered under these conditions.

7. CNF pin
   An appropriate capacitor (100pF (typ.)) at CNF pin make motor current smooth. Make sure the motor current doesn't oscillate, even in transition.

●Electrical characteristics curve

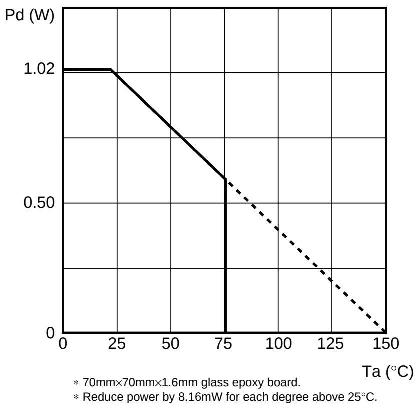
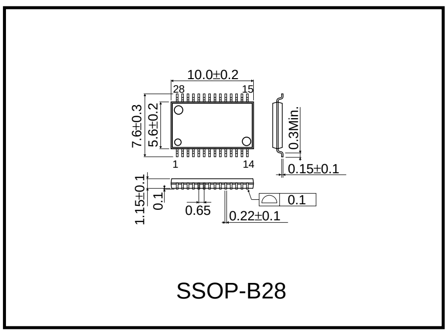


Fig.16 Power dissipation curve

●External dimensions (Units : mm)



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