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~+75	°C
Storage temperature range	Tstg	−55~+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

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●**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

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●Input output circuits

Output pins A1 : Pin1, 2, A2 : Pin3, 4, A3 : Pin5, 6	Hall input H1+ : Pin9, H1− : Pin10, H2+ : Pin11, H2− : Pin12, H3+ : Pin13, H3− : Pin14
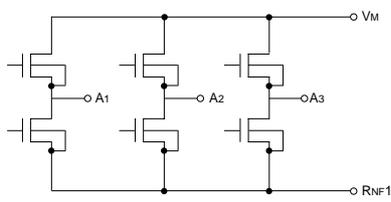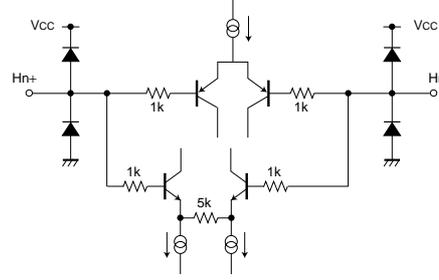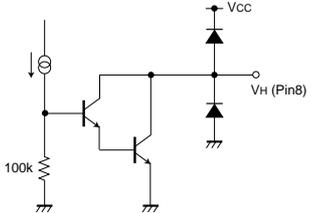
Hall bias Pin8	CP1 output Pin16	CP2 / VPUMP output CP2 : Pin17, VPUMP : Pin18
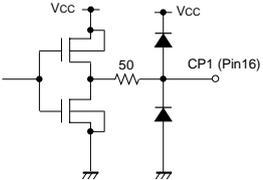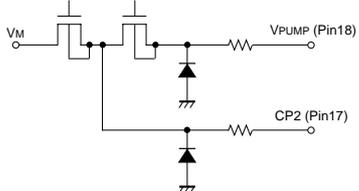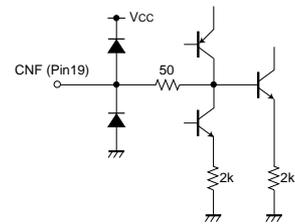
CNF Pin19	Short brake Pin20	RNF2 Pin21
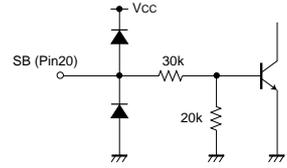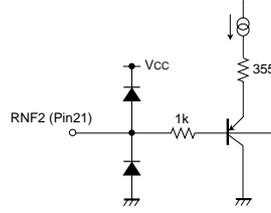
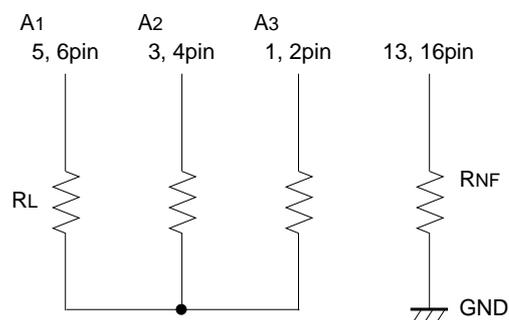| Torque amplifier ECR : Pin24, EC : Pin25	FG output FG : Pin26	Power save Pin27
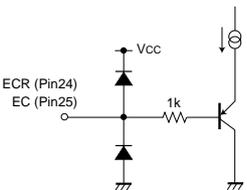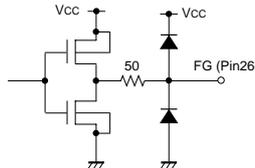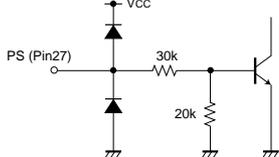
Motor driver ICs

●**Electrical characteristics** (unless otherwise noted, Ta=25°C, Vcc=5V, VM=5V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test Circuit
<Total>							
Circuit current 1	Icc1	–	–	5	μA	Sutand by mode	Fig.2
Circuit current 2	Icc2	5	11	17	mA		Fig.2
<Power save>							
ON voltage range	VPSON	–	–	1.0	V	Sutand by mode	Fig.2
OFF voltage range	VPSOFF	2.5	–	–	V		Fig.2
<Hall bias>							
Hall bias voltage	VHB	0.6	1.0	1.4	V	IHB=10mA	Fig.2
<Hall AMP>							
Input bias current	IHA	−8.0	−2.0	–	μA		Fig.4
In-phase input voltage range	VHAR	1.4	–	3.6	V		Fig.4
Minimum input level	VINH	100	–	–	mVPP	Hall input Amp	Fig.4
Hall hysteresis level (+)	VHYS+	5	20	40	mV		Fig.8
Hall hysteresis level (−)	VHYS−	−40	−20	−5	mV		Fig.8
<Torque control>							
Input voltage range	EC, ECR	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	ECIN	−12	−2.5	–	μA	EC=ECR=1.65V	Fig.6
<Short brake SW>							
ON voltage range	VSBON	2.5	–	–	V	Short brake	Fig.7
OFF voltage range	VSBOFF	–	–	1.0	V		Fig.7
<Output>							
Input / Output gain	GEC	0.8	1.0	1.2	A/V		Fig.6
Output ON-resistance	RON	0.3	0.5	0.7	Ω	Io=±600mA (Upper+Lower)	Fig.5
Torque limit voltage	VTL	0.16	0.2	0.24	V		Fig.3
<FG output>							
High voltage	VFGH	4.6	–	–	V	IFG=−100μA	Fig.6
Low voltage	VFGL	–	–	0.4	V	IFG=+100μA	Fig.6
<Charge pump voltage>							
Charge pump output voltage	Vpump	6	10	14	V	Vcc=VM=5V	Fig.9

●**Measuring circuit**

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

A1
5, 6pin

A2
3, 4pin

A3
1, 2pin

13, 16pin

RL

RNF

GND

RL=5Ω, RNF=0.33Ω

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2. Input-output table

Pin No.	Input condition						Output condition					
							$E_C < E_{CR}$			$E_C > E_{CR}$		
	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_{CC1} : Value of A_1
$V_{PS}=0$ [V]
Hall input condition : condition1

I_{CC2} : 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

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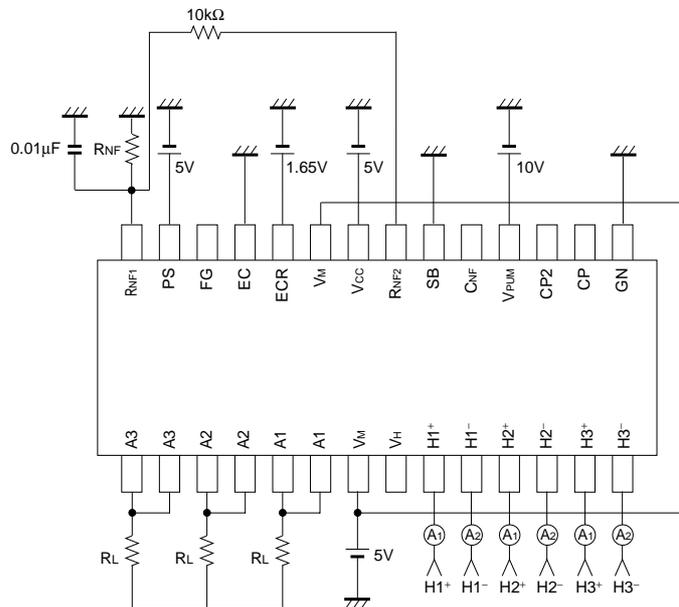
V_{TL} : Range of V_{RNF2} that V_M current (I_M)
become 0A.
V_{PS}=5 [V]

Fig.3

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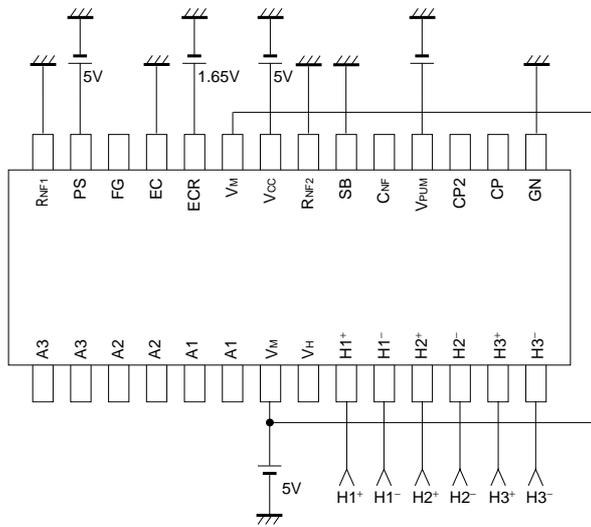Value of 'A2' (Hn$^+$=2.0V, Hn$^-$=2.5V)
n=1, 2, 3

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

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}'
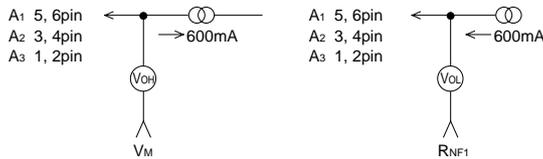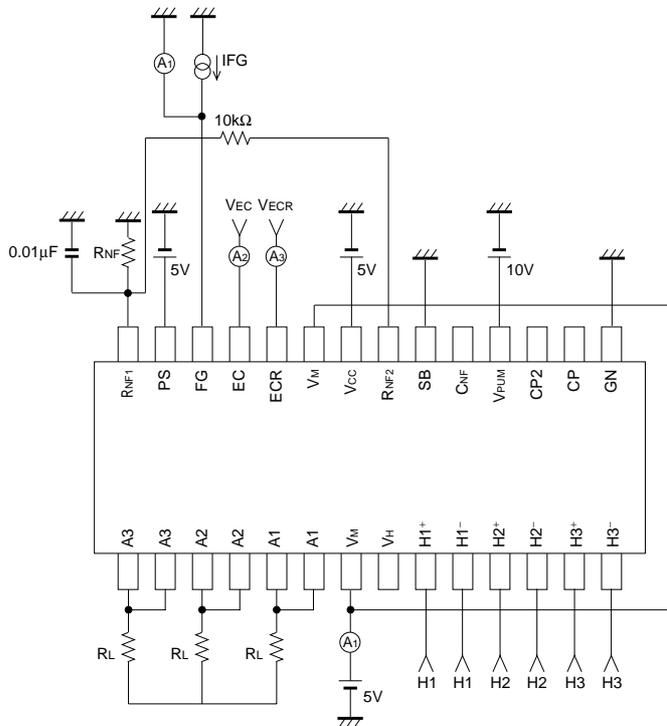
R_{on}=(V_{OH} + V_{OL}) / 0.6

Fig.5

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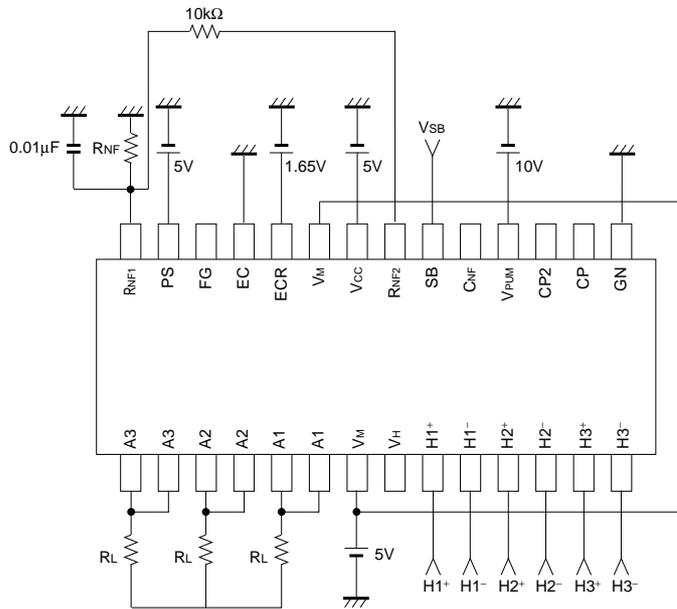Value of 'A3' (E_C=E_{CR}=1.65V)

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
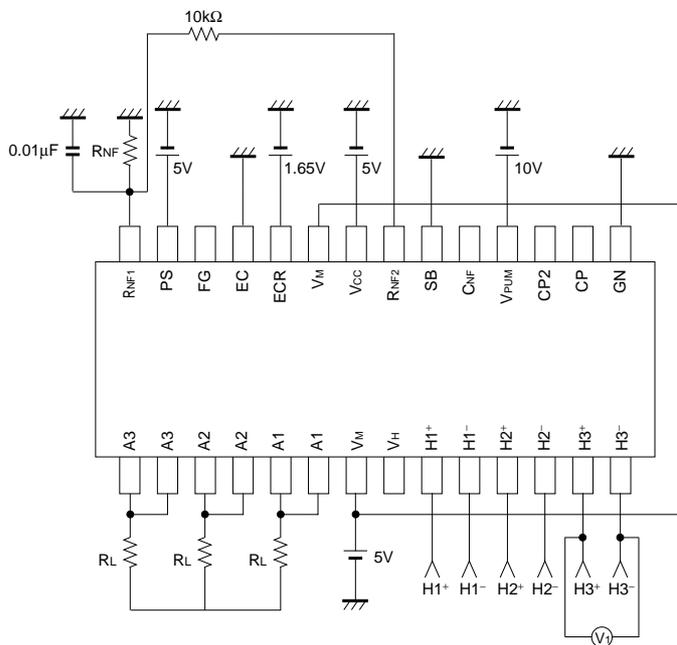value of V_1 (E_C=1.2V)
value of V_2 (E_C=1.5V)

Fig.6

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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

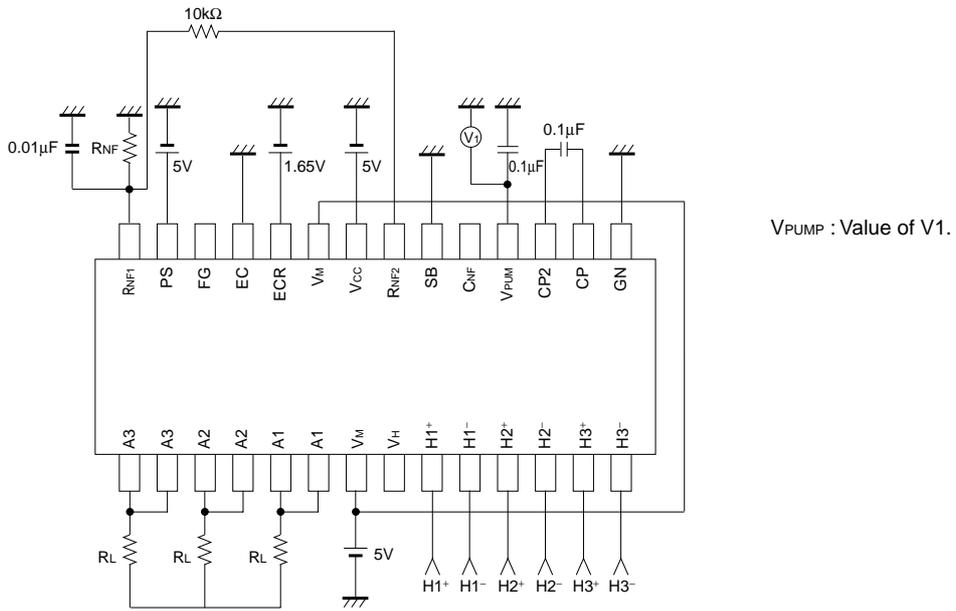V_{HYS} : Voltage difference H3+ to H3– that FG voltage change V1.

Fig.9

VPUMP : Value of V1.

● **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.
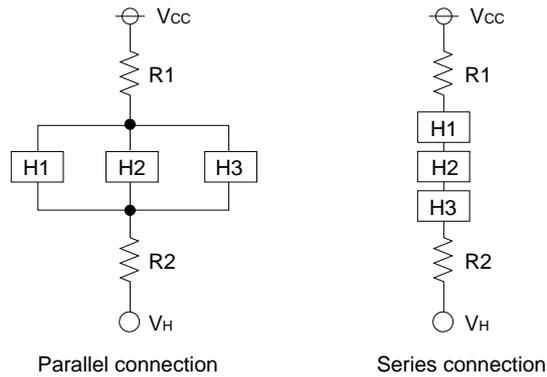
Parallel connection   Series connection

Fig.10

2. Torque voltage

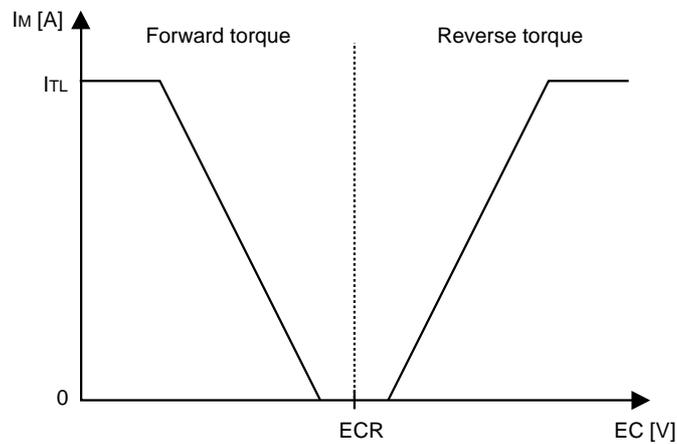By the voltage difference between EC and ECR, the current driving motor changes as shown in Fig.11 below.

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.
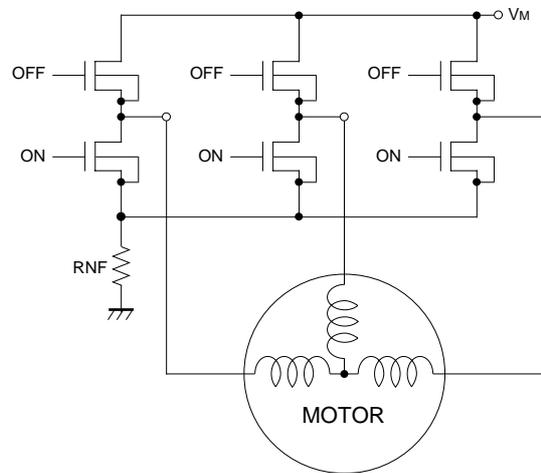

Fig.12

(5) Reverse detection

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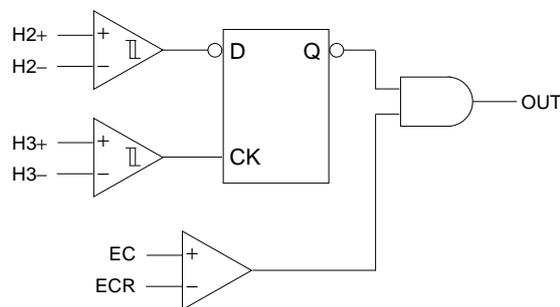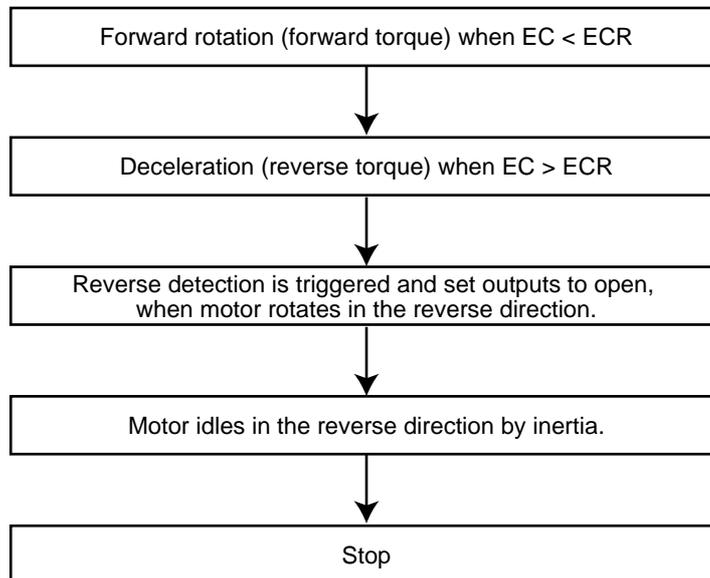

Fig.13

Motor rotation at reverse detection

```
┌─────────────────────────────────────────────────────────────┐
│      Forward rotation (forward torque) when EC < ECR          │
└─────────────────────────────────────────────────────────────┘
                              │
                              ▼
┌─────────────────────────────────────────────────────────────┐
│       Deceleration (reverse torque) when EC > ECR             │
└─────────────────────────────────────────────────────────────┘
                              │
                              ▼
┌─────────────────────────────────────────────────────────────┐
│      Reverse detection is triggered and set outputs to open,  │
│        when motor rotates in the reverse direction.           │
└─────────────────────────────────────────────────────────────┘
                              │
                              ▼
┌─────────────────────────────────────────────────────────────┐
│          Motor idles in the reverse direction by inertia.     │
└─────────────────────────────────────────────────────────────┘
                              │
                              ▼
┌─────────────────────────────────────────────────────────────┐
│                            Stop                               │
└─────────────────────────────────────────────────────────────┘
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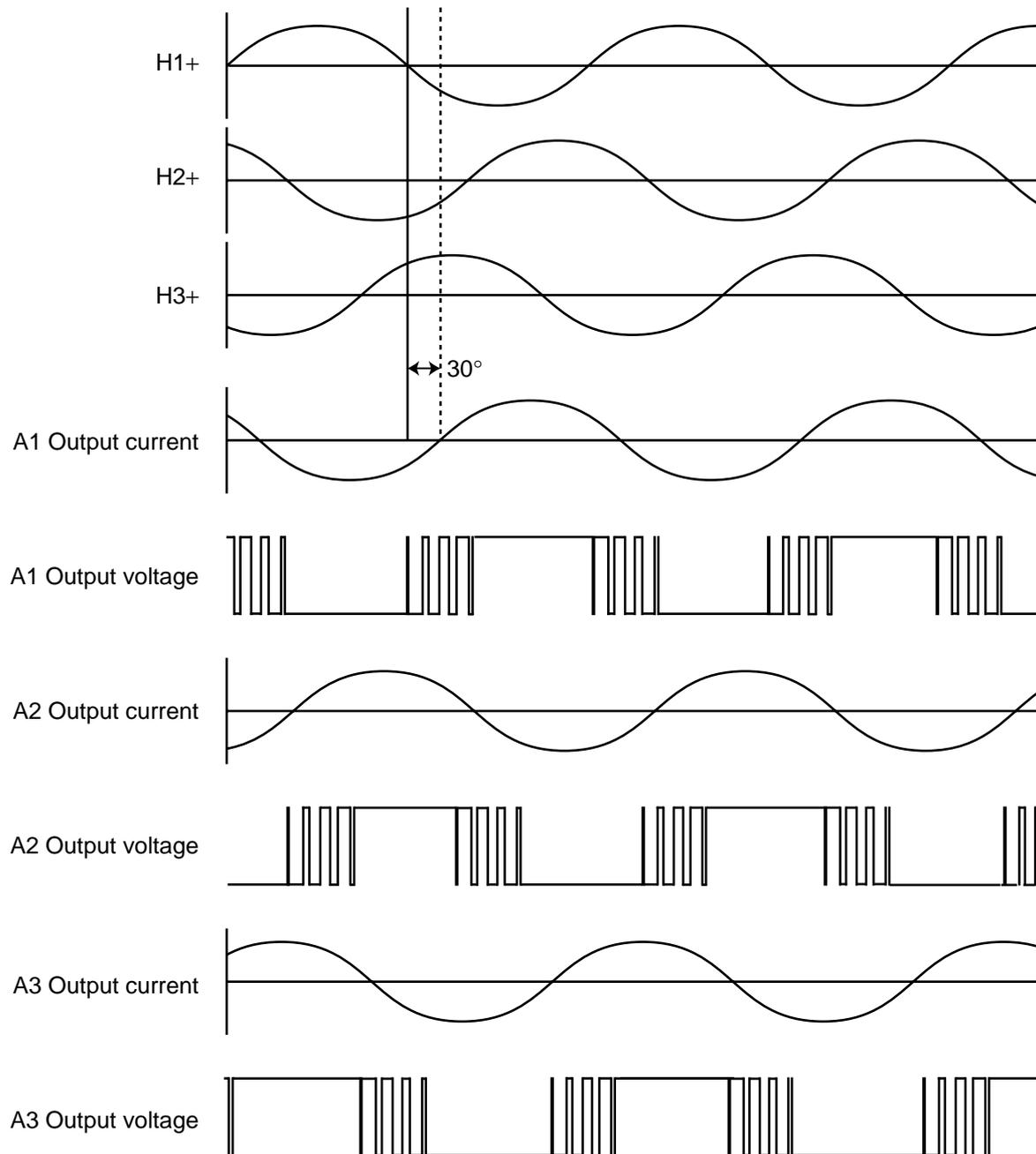
(6) Timing chart

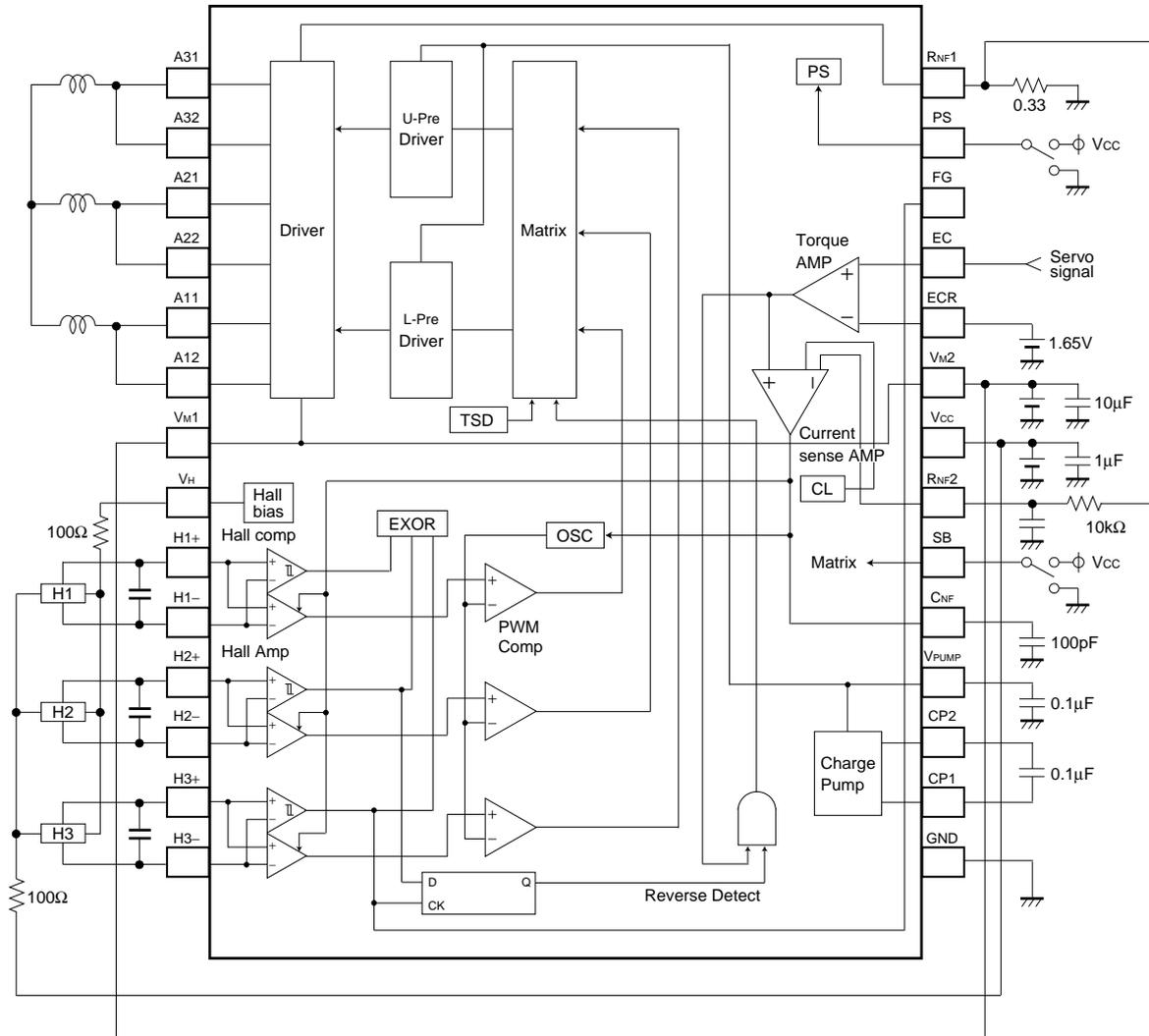
Fig.14

●**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.

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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.
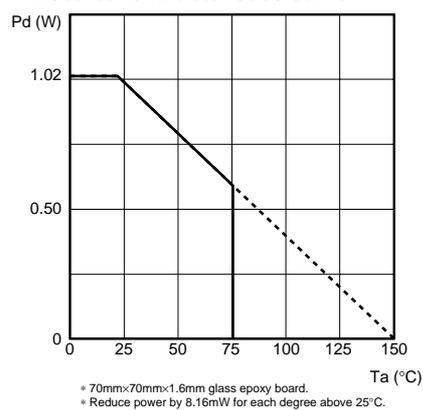
●**Electrical characteristics curve**

∗ 70mm×70mm×1.6mm glass epoxy board.
∗ Reduce power by 8.16mW for each degree above 25°C.

Fig.16 Power dissipation curve

●**External dimensions** (Units : mm)

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