Spindle and loading motor driver for PD

BA6852FP

The BA6852FP is a motor driver IC developed for use in PD, CD-ROM and DVD applications. In addition to having a conventional spindle motor driver, it includes a reversible motor driver for use with loading motors to allow easy system construction.

●Applications

PD, CD-ROM and DVD.

●Features

1) Power save circuit (three-level switch) allows FG output in power save mode.
2) FGSW allows selection between either three-phase composite output or single-phase output for the FG output.
3) The output voltage for the loading motor driver can be set using the Vref pin.

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Applid voltage	Vcc	7	V
Applid voltage	$V_{M1,2}$	15	V
Power dissipation	Pd	1700*1	mW
Operating temperature	Topr	−20～+75	℃
Storage temperature	Tstg	−55～+150	℃
Junction temperature	Tjmax	150	℃
Output current (spindle block) (loading block)	I_{OMAX}	1300*2 1000	mW

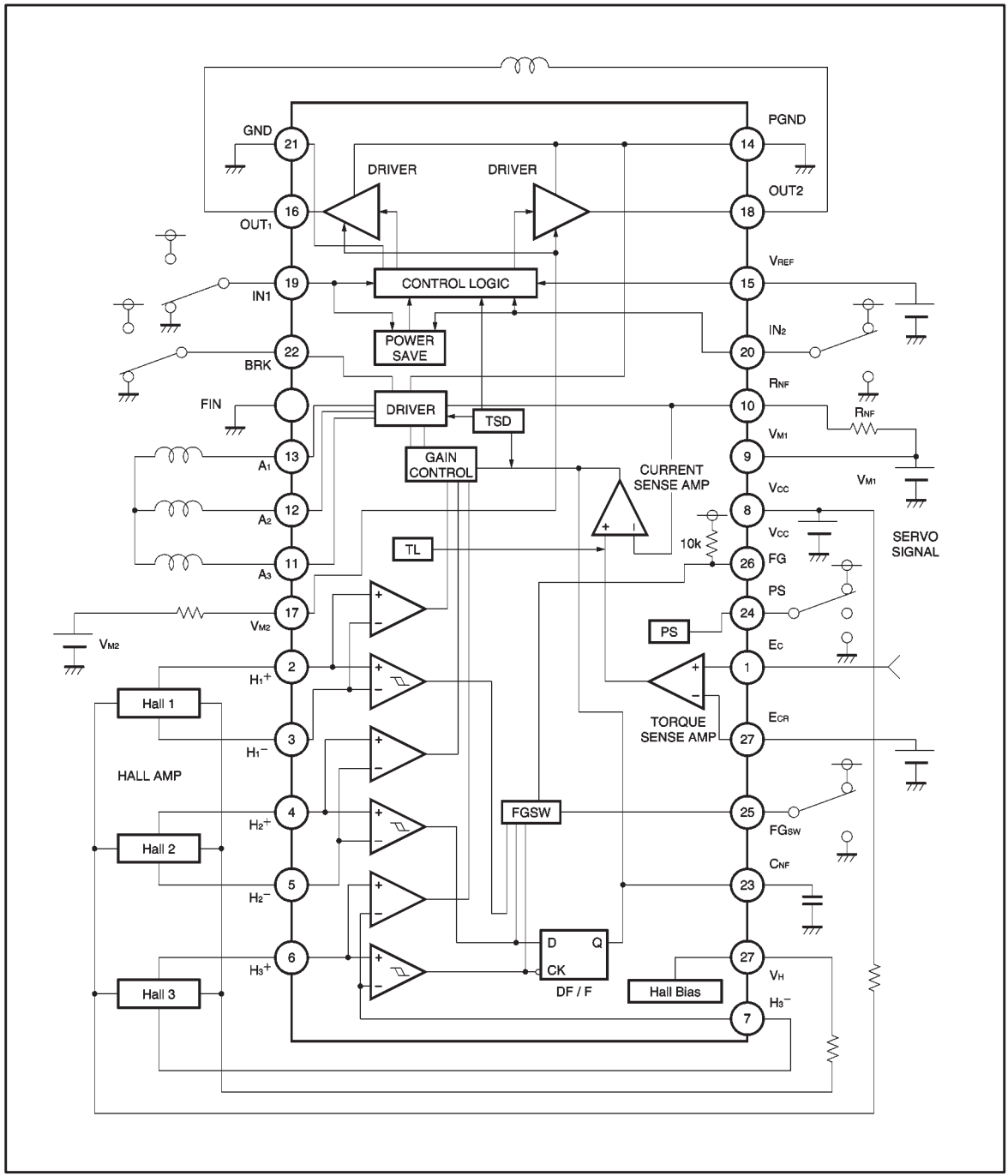
*1 When mounted on 70mm×70mm ×1.6mm glass epoxy board.
Reduced by 13.6mW for each increase in Ta of 1℃ over 25℃.

*2 Should not exceed Pd or ASO values.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage (spindle block motor power supply)	V_{CC}	4.5～5.5	V
	V_{M1}	3～14	V
(loading block motor power supply)	V_{M2}	4.5～14	V

●Block diagram



●Pin descriptions

Pin No.	Pin name	Function
1	Ec	Spindle torque control
2	H_1^+	Hall signal input pin spindle
3	H_1^-	Hall signal input pin spindle
4	H_2^+	Hall signal input pin spindle
5	H_2^-	Hall signal input pin spindle
6	H_3^+	Hall signal input pin spindle
7	H_3^-	Hall signal input pin spindle
8	V_{CC}	Signal block power supply
9	V_{M1}	Spindle motor power supply
10	R_{NF}	For connection of resistor for spindle output current detector
11	A_3	Spindle output A3
12	A_2	Spindle output A2
13	A_1	Spindle output A1
14	PGND	Driver GND
15	V_{REF}	Loading output high level voltage setting
16	OUT1	Loading motor output 1
17	V_{M2}	Loading motor power supply
18	OUT2	Loading motor output 2
19	IN1	Loading logic input
20	IN2	Loading logic input
21	GND	Signal GND
22	BRK	Spindle brake
23	CNF	For connection of capacitor for spindle phase compensation
24	PS	Spindle power save
25	FGSW	Spindle FG output switch
26	FG	Spindle FG signal output
27	V_H	Hall bias
28	E_{CR}	Spindle torque control reference
FIN	FIN	Heatsink fin

✻ The heatsink fin must be connected to GND.

●Electrical characteristics (unless otherwise noted, Ta = 25°C, V_{CC} = 5V, V_{M1} = 12V, and V_{M2} = 12V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions	Measurement circuit
[Spindle]							
Circuit current 1	I_{CC1}	—	0.4	0.6	mA	Standby mode, I_{PS}=−150 μA	Fig.3
Circuit current 2	I_{CC2}	—	2.8	4.0	mA	Only Hall bias and FG operates	Fig.3
Circuit current 3	I_{CC3}	—	5.7	8.0	mA	Operation mode, E_C=E_{CR}	Fig.3
〈Power save〉							
On current range	I_{PSON}	−350	—	−150	μA	Standby mode	Fig.4
Open current range	I_{PSOP}	−15	—	15	μA	Only Hall bias and FG operates	Fig.4
Off current range	I_{PSOFF}	150	—	350	μA	Operation mode	Fig.4
〈Hall bias〉							
Hall bias voltage	V_{HB}	—	0.9	1.5	V	I_{HB}=10mA	Fig.5
〈Hall amplifier〉							
Input bias current	I_{HA}	—	0.7	2.0	μA	—	Fig.6
Same-phase input voltage range	V_{HAR}	1.5	—	4.0	V	—	Fig.6
Minimum input level	V_{INH}	50	—	—	mV_{P-P}	—	Fig.6
Hall hysteresis	V_{HYS}	5	20	40	mV	—	Fig.12
〈Torque command〉							
Input voltage range	E_C, E_{CR}	1.0	—	4.0	V	—	Fig.7
Offset+	E_{Cof}+	20	50	80	mV	With respect to E_C=2.5V	Fig.7
Offset−	E_{Cof}−	−80	−50	−20	mV	—	Fig.7
Input bias current	E_{CIN}	−3	−0.4	3	μA	E_C=2V, E_{CR}=2.5V	Fig.7
I / O gain	G_{EC}	0.4	0.5	0.6	A / V	E_C=1.5, 2.0V	Fig.7
〈Brake〉							
On voltage range	V_{SBON}	3.5	—	—	V	Brake on mode	Fig.8
Off voltage range	V_{SBOFF}	—	—	1.5	V	Brake off mode	Fig.8
〈FG〉							
FGSW input low level voltage	V_{SWL}	—	—	1.5	V	FG1 phase output	Fig.9
FGSW input high level voltage	V_{SWH}	3.5	—	—	V	FG3 phase composition output	Fig.9
FG output high level voltage	V_{FGH}	4.5	4.9	5.0	V	I_{FG}=−10 μA	Fig.10
FG output low level voltage	V_{FGL}	0	0.2	0.35	V	I_{FG}=5.0mA	Fig.10
Duty (reference value)	Du	—	50	—	%	—	—
〈Output〉							
Output saturation high level voltage	V_{OH}	—	1.0	1.5	V	I_O=−600mA	Fig.11
Output saturation low level voltage	V_{OL}	—	0.4	0.9	V	I_O=600mA	Fig.11
V_M drive current	I_{VMD}	—	50	85	mA	E_C=0V Output open	Fig.12
Output limit current	I_{TL}	560	700	840	mA	R_{NF}=0.5Ω	Fig.5

◎Not designed for radiation resistance.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions	Measurement circuit
[Loading block]							
Circuit current 4	I_{CC4}	12	24	36	mA	Forward or reverse mode	Fig.13
Circuit current 5	I_{CC5}	29	48	67	mA	IN1="H", IN2="H"	Fig.13
Input voltage high level	V_{IH}	2.1	—	—	V	—	Fig.13
Input voltage low level	V_{IL}	—	—	0.8	V	—	Fig.13
High level input voltage	I_{IH}	45	90	135	μA	V_{IN}=2V	Fig.13
Outout saturation voltage*	V_{CE}	—	1.0	1.5	V	I_O=0.2A	Fig.14
V_{REF} pin outflow current	I_{REF}	—	2.0	5.0	μA	I_O=0.1A, V_{REF}=9V	Fig.15
V_{REF} input voltage range	V_{REF}	—	—	$(V_{M2})-1$	V	—	Fig.15

* The output saturation voltage is the sum of the upper and lower output Tr.
◎Not designed for radiation resistance.

●Measurement circuits

(1) Measurement circuit resistance

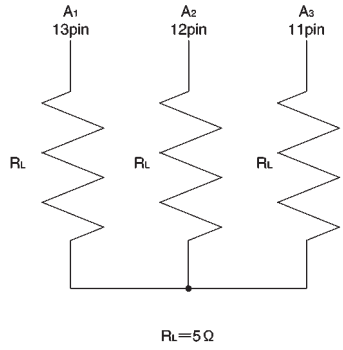


Fig.1

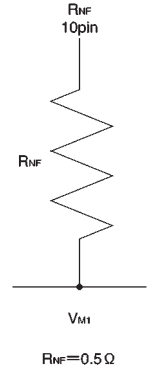


Fig.2

(2) Input/output table

	Input conditions						Output state						Measurement point
							Forward			Reverse			
Pin No.	2	3	4	5	6	7	13	12	11	13	12	11	
Pin Name	H_1^+	H_1^-	H_2^+	H_2^-	H_3^+	H_3^-	A_1	A_2	A_3	A_1	A_2	A_3	
Condition 1	L	M	H	M	M	M	H	L	L	L	H	H	13pin HIGH
Condition 2	H	M	L	M	M	M	L	H	H	H	L	L	13pin LOW
Condition 3	M	M	L	M	H	M	L	H	L	H	L	H	12pin HIGH
Condition 4	M	M	H	M	L	M	H	L	H	L	H	L	12pin LOW
Condition 5	H	M	M	M	L	M	L	L	H	H	H	L	11pin HIGH
Condition 6	L	M	M	M	H	M	H	H	L	L	L	H	11pin LOW

Note: Forward $E_C < E_{CR}$
Reverse $E_C > E_{CR}$

Input voltage H = 2.6V
M = 2.5V
L = 2.4V

(3) Measurement circuits

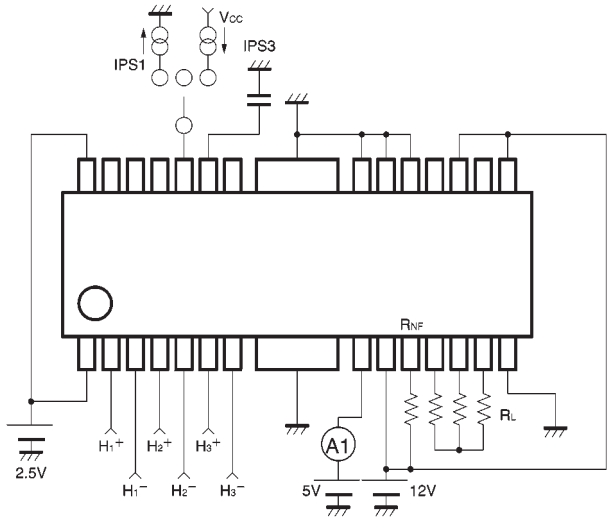


Fig.3

I_{CC1} : Ammeter A1 value
IPS1 = 150µA
H_1^-, H_2^-, H_3^- = V_{CC} / 2 (V)
H_1^+, H_2^+, H_3^+ = V_{CC} / 2 + 0.1 (V)

I_{CC2} : Ammeter A1 value
PS = OPEN
H_1^-, H_2^-, H_3^- = V_{CC} / 2 (V)
H_1^+, H_2^+, H_3^+ = V_{CC} / 2 + 0.1 (V)

I_{CC3} : Ammeter A1 value
IPS3 = 150µA
H_1^-, H_2^-, H_3^- = V_{CC} / 2 (V)
H_1^+, H_2^+, H_3^+ = V_{CC} / 2 + 0.1 (V)

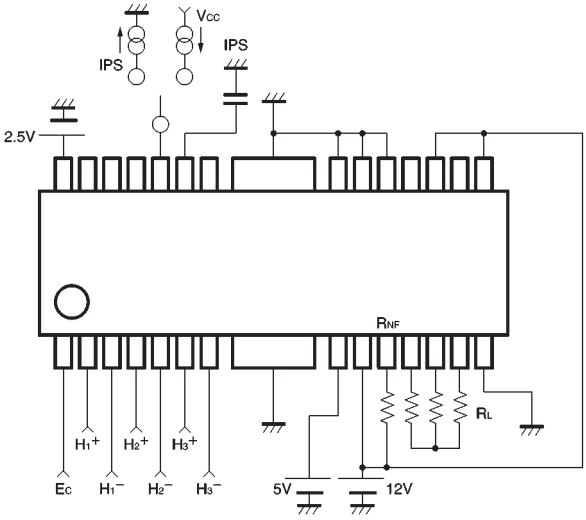


Fig.4

I_{PSON} : IPS range for which all output pins are open
(input conditions 1 to 6)

I_{PSOP} : IPS range for only FG and the hall bias operate
(input conditions 1 to 6)

I_{PSOFF} : PS range for which the output pins are as in the Input / output table
(input conditions 1 to 6)

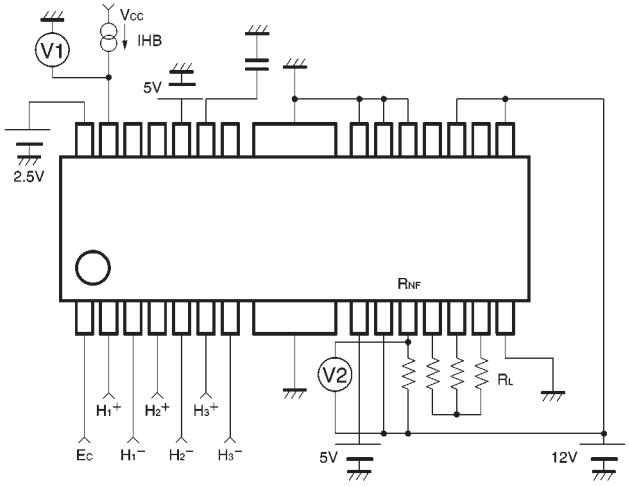


Fig.5

V_{HB} : Voltmeter V1value
VPS = 5V
IHB = 10mA

I_{TL} : (Voltmeter V2value) / 0.5
VPS = 5V
E_C = 0V
(input conditions 1 to 6)

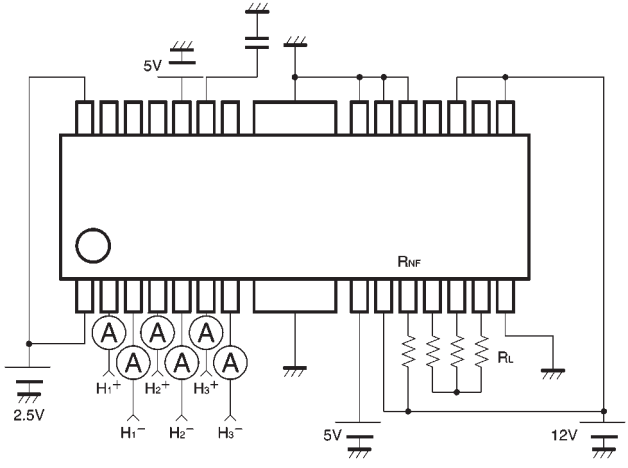


Fig.6

I_{HA} : With Hn^+ = 4.0V, Hn^- = 2.5V, the current that flows into Hn^+
With Hn^+ = 2.5V, Hn^- = 4.0V, the current that flows into Hn^-

(n = 1, 2, 3)

V_{HAR} : Hall input voltage range for which the output pin is as per the Input / output table.

V_{INH} : Hall input level for which the output pin is as per the Input / output table.
$|Hn^+ - Hn^-|$ Hin^- = 2.5V

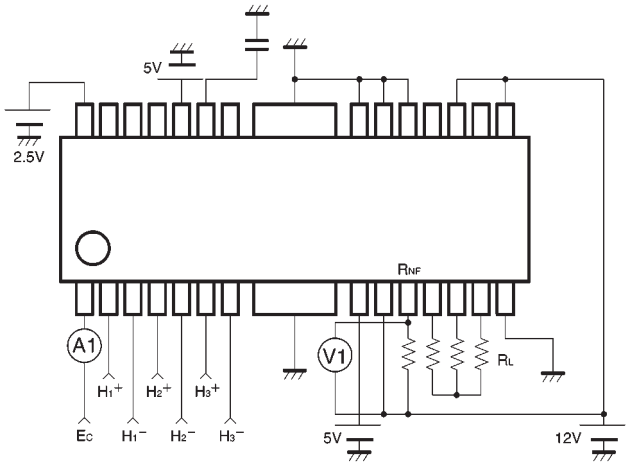


Fig.7

E_C, E_{CR} : Torque command operation voltage range

$E_{COF}\pm$: Vary E_C until E_{CR} = 2.5V, then Vary E_C voltmeter V1 < 3mV. This E_C voltage range (see operation notes (2)).

E_{CIN} : Ammeter value when E_C = 2V and E_{CR} = 2.5V

G_{EC} : If the V1 value is V2 when E_C = 1.5V, and the V1 value is V3 when E_C = 2.0V G_{EC} = {(V2 − V3) / (2.0 − 1.5)} / R_{NF} (R_{NF} = 0.5Ω)

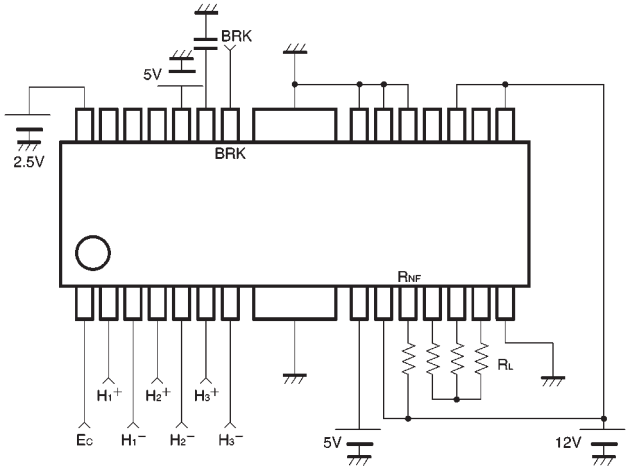


Fig.8

V_{SBON} : BRK pin voltage range when all output pins are low.

V_{SBOFF} : BRK pin voltage range when all output pins are as per the Input / output table.

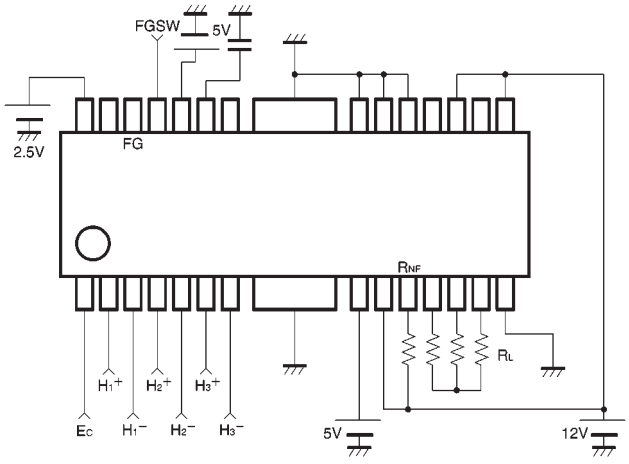


Fig.9

V_{SWL} : FGSW pin voltage range when the hall input and FG output are as per the table below.

H_1^+	H_2^+	H_3^+	FG
L	H	H	L
H	L	L	H

H=2.6V, L=2.4V Hn^-=2.5V

V_{SWH} : FGSW pin voltage range when the hall input and FG output are as per the table below.

H_1^+	H_2^+	H_3^+	FG
L	L	H	L
H	L	H	H
H	L	L	L
H	H	L	H
L	H	L	L
L	H	H	H

H=2.6V, L=2.4V Hn^-=2.5V

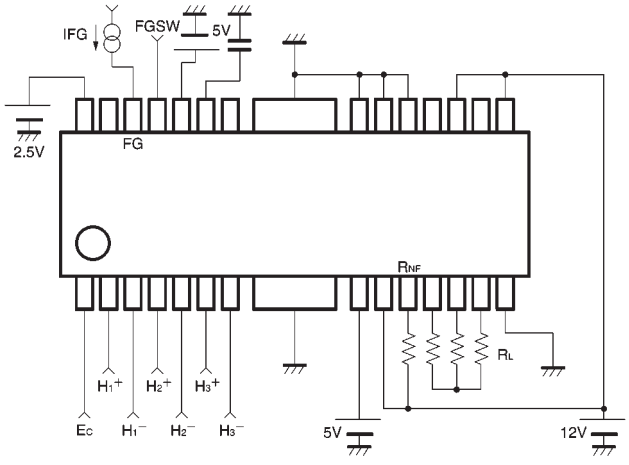


Fig.10

V_{FGH} : Voltmeter V1 value
(Input / output table, condition 2)
IFG = −10μA
FGSW = 0V

V_{FGL} : Voltmeter V1 value
(Input / output table, condition 1)
IFG = 3mA
FGSW = 0V

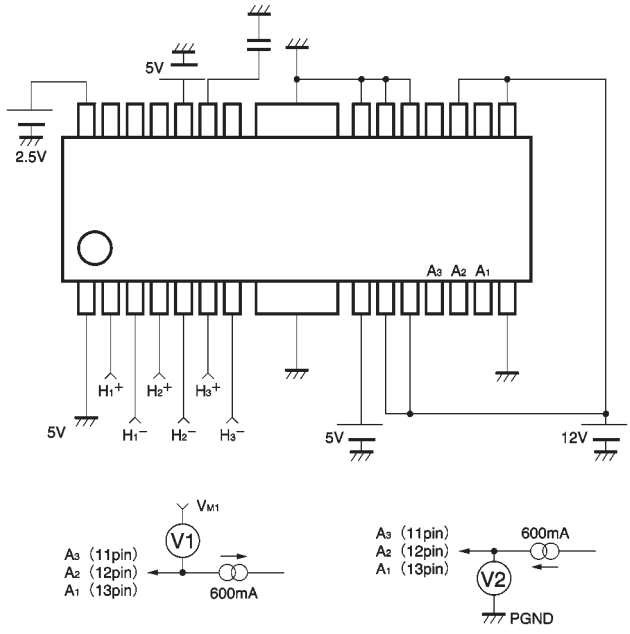


Fig.11

V_{OH} : With the output measurement pin made high level according to the input conditions, the V1 value when 600mA flows from that pin.

V_{OL} : With the output measurement pin made low level according to the input conditions, the V2 value when 600mA flows from that pin.

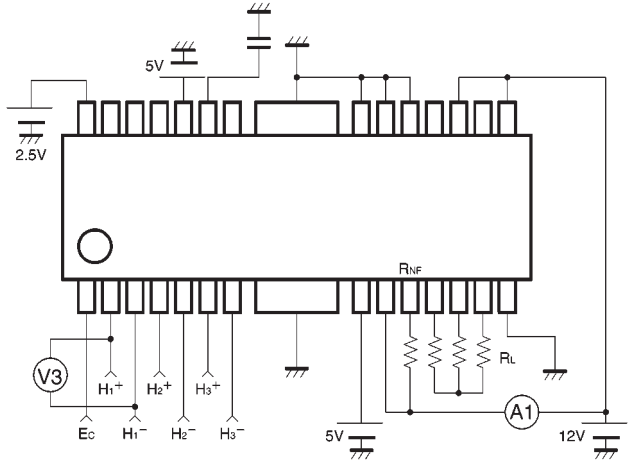


Fig.12

V_{HYS} : The voltage difference V3 between H_1^+ and H_1^- that switch the FG pin.
E_C = 2.5V
FGSW = 0V

I_{VMD} : Ammeter A1value
Output open (input conditions 1 to 6)
E_C = 0V

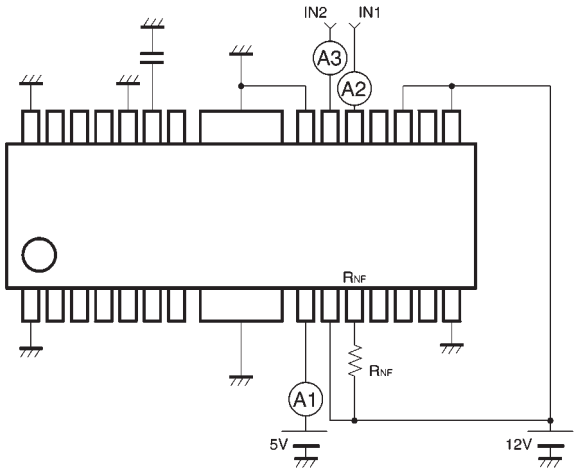


Fig.13

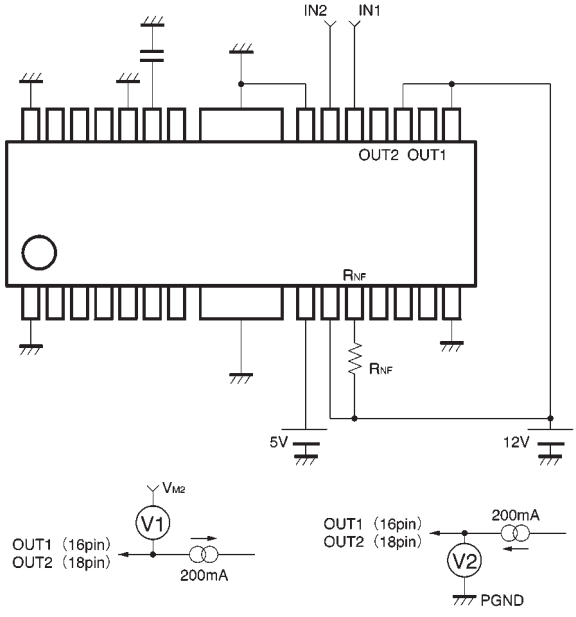


Fig.14

I_{CC4} : Ammeter A1 value
IN1 = 5V, IN2 = 0V

I_{CC5} : Ammeter A1 value
IN1 = 5V, IN2 = 5V

V_{IH} : IN1 range for which OUT1 = High, OUT2 = Low (IN2 = Low)

IN2 range for which OUT1 = Low, OUT2 = High (IN1 = Low)

V_{IL} : IN1 range for which OUT1 = Low, OUT2 = High (IN2 = High)
IN2 range for which OUT1 = High, OUT2 = Low (IN1 = High)

I_{IH} : Ammeter A2 value when IN1 = 2V
Ammeter A3 value when IN2 = 2V

V_{CE} : Sum of V1 (the value when 200mA is flowing from the output high level pin) and V2 (the value when 200mA is flowing to the output low level pin).

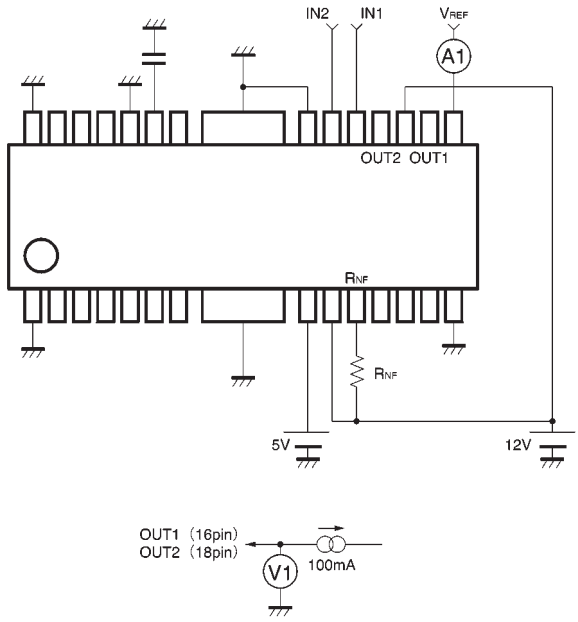


Fig.15

IREF : Ammeter A1 value
I_O = 100mA
V_{REF} = 9V

VREF : V_{REF} pin voltage range for which the output voltage can be controlled

●Operation notes

(1) Torque command

The R_{NF} pin voltage with respect to the torque command input (EC) is as follows.

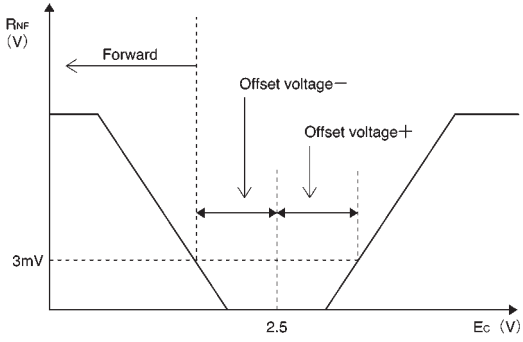


Fig.16

	Rotation direction
$E_C < E_{CR}$	Forward
$E_C > E_{CR}$	Reverse*

* Stops after reverse is detected.

The I / O gain G_{EC} from the E_C pin to the R_{NF} (output current) is determined by the R_{NF} detector resistance.

$$G_{EC} = 0.25 / R_{NF} \text{ (A / V)}$$

The torque limit current I_{TL} is given by

$$I_{TL} = 0.35 / R_{NF} \text{ (A)}.$$

(2) Power save

The power save pin logic is as follows.

Mode	PS pin
Power save mode	Outflow or pulled down to GND
FG, hall bias operation mode	Open
Spindle operation mode	Inflow or pulled up to V_{CC}

(3) Reverse rotation detector

The construction of the reverse rotation detector circuit is shown in Fig. 17.

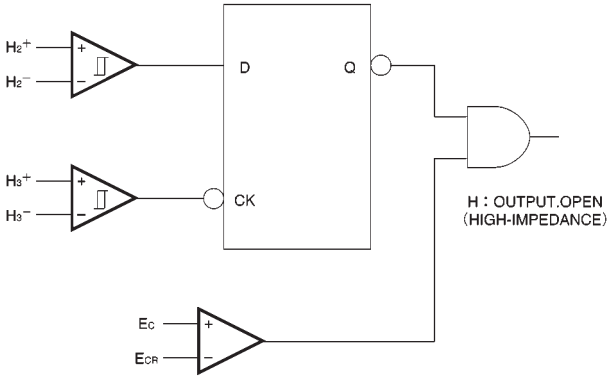


Fig.17

1) Forward ($E_C < E_{CR}$)

The phase relationship between the hall input signals H_2^+ and H_3^+ is as shown in Fig.18, and the reverse rotation detector circuit does not operate.

2) Reverse ($E_C > E_{CR}$)

The phase relationship between H_2^+ and H_3^+ is opposite to that for forward rotation, and the reverse rotation detector circuit operates to switch the output off and leave it in the open state.

Motor operation during reverse detection

When $E_C < E_{CR}$, forward rotation (right rotation)

↓

When $E_C > E_{CR}$, reverse torque is applied to reduce speed (right rotation)

↓

When the motor reverses, the reverse rotation detector operates, and the coil output is opened.

↓

Free rotation in the reverse direction by inertia.

↓

Stop

(4) Input / output timing chart (forward rotation)

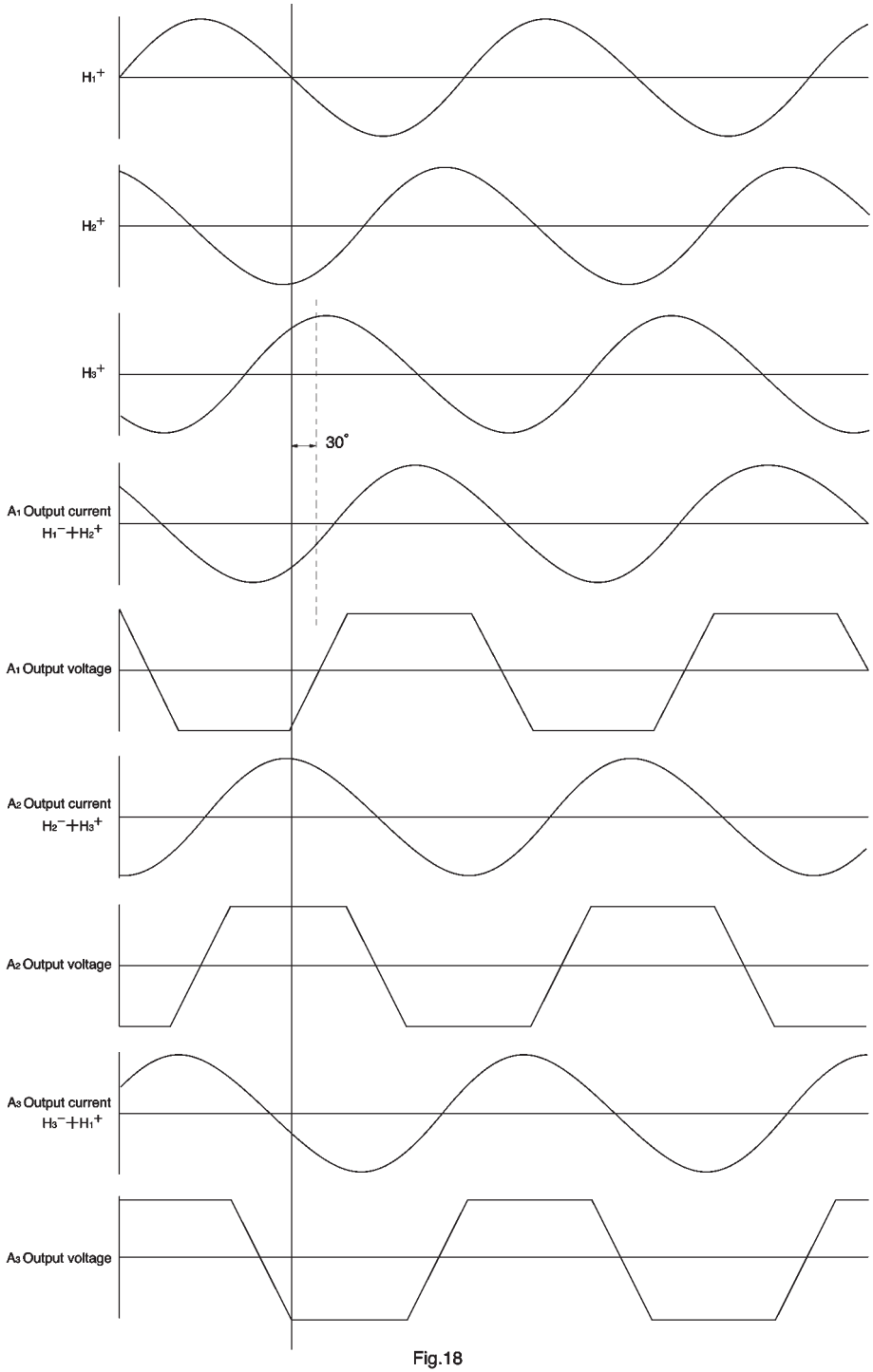


Fig.18

(5) Short brake

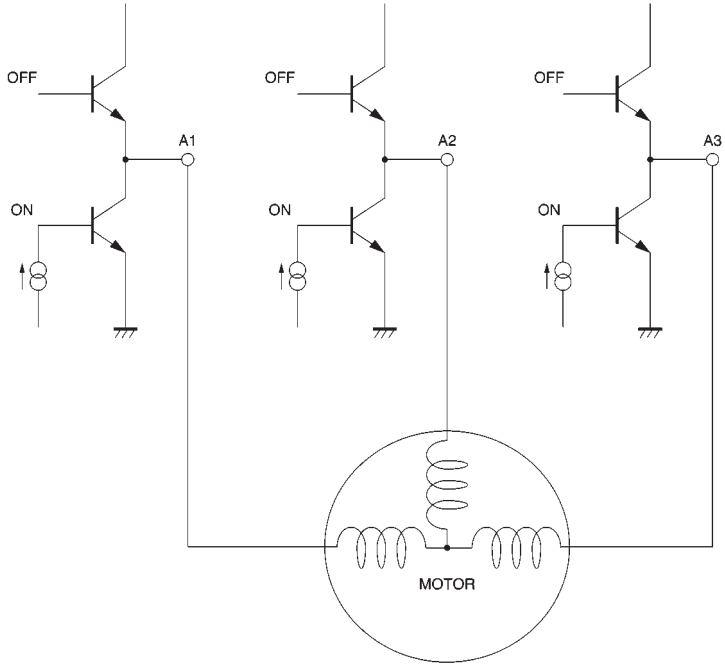


Fig.19

When the BRK pin goes to high level, the upper-side output transistors (three phase) go off, and the lower-side output transistors (three phase) go on.

(6) Hall input

The hall pins can be connected in series or parallel.

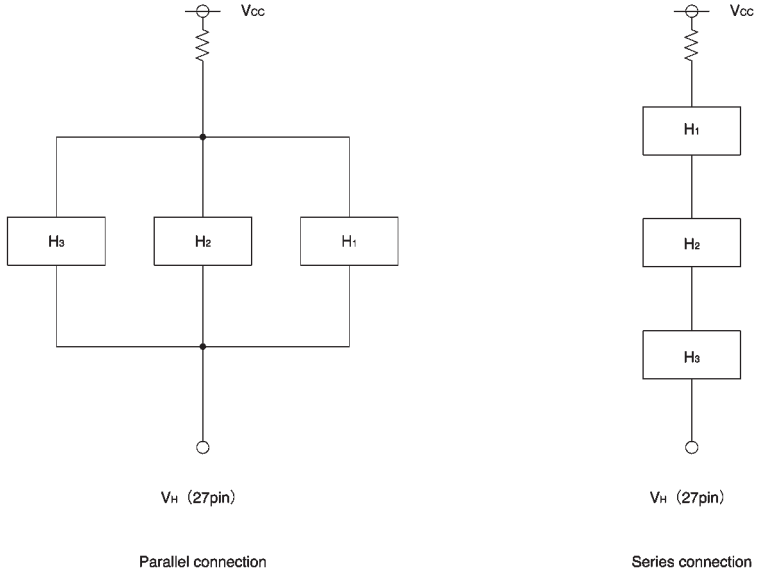


Fig.20

(7) FG output switch

The relationship between the FG output switch pin and the FG output is as follows.

	FG output mode
FGSW="H"	Three-phase composite output
FGSW="L"	Single-phase output

(8) About the input pin applied voltage

Do not apply voltage to any of the other pins when the V_{CC} voltage is not being supplied to the IC. In addition, when V_{CC} is being applied, do not apply a voltage more than V_{CC} to any of the other pins.

(9) Input pins

The loading input pin has a negative temperature characteristic, so when using it, give due consideration to the temperature characteristics.

(10) V_{REF} pin (output high level voltage setting)

The loading block output high level voltage can be set using the V_{REF} pin voltage.

The output high level voltage V_{OH} is given by the following formula.

$V_{OH} = V_{REF} + I_{REF} \times R1 + VBE\ (Q1) - VBE\ (Q3)$

The V_{REF} voltage that brings about the above formula is up to $V_{M2} - V_{CE}\ (Q2) - VBE\ (Q3)$.

Do not apply a voltage of more than V_{M2} to the V_{REF} pin.

Short the V_{REF} pin to V_{M2} if you will not use it.

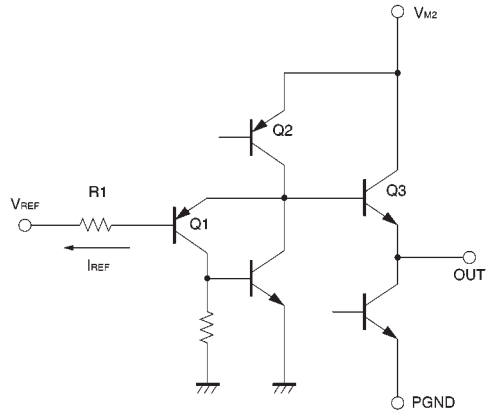


Fig.21

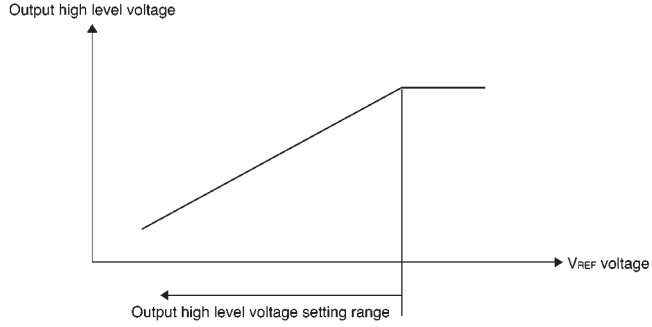


Fig.22

(11) Spindle and loading operation conditions

When IN1 or IN2 are high level, the spindle is off regardless of the PS pin input.

PS	Spindle operation mode	IN1	IN2	OUT1	OUT2
*	Refer to item (2) of the operation notes	L	L	OPEN	OPEN
**	OPEN	H	L	H	L
**	OPEN	L	H	L	H
**	OPEN	H	H	L	L

* : Refer to item of (2) the operation notes.

** : All input patterns.

(12) Driver section ground (GND)

PGND (pin 14) is the driver section GND, and is not connected to the signal section GND. This is the motor current path, so take care with the PCB track width and arrangement on the PC board.

(13) Thermal shutdown (TSD)

When the junction temperature reaches 175°C (Typ.), the motor output is opened. There is approximately 15°C (Typ.) of temperature hysteresis.

●Electrical characteristics curves

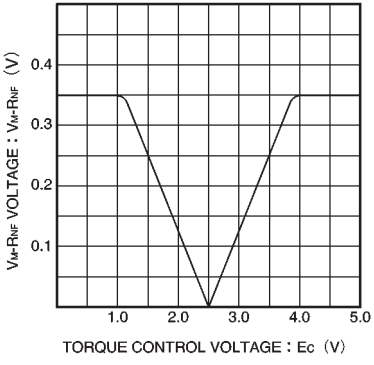


Fig.23 Torque gain / limit characteristics

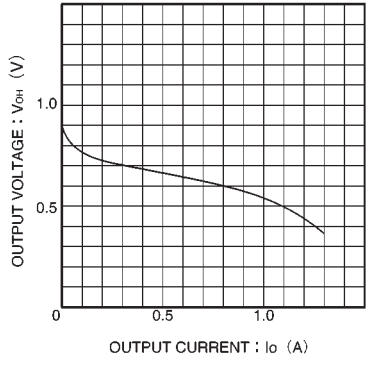


Fig.24 Spindle upper-side output saturation characteristics

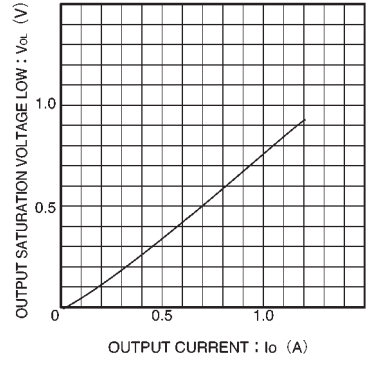


Fig.25 Spindle lower-side output saturation characteristics

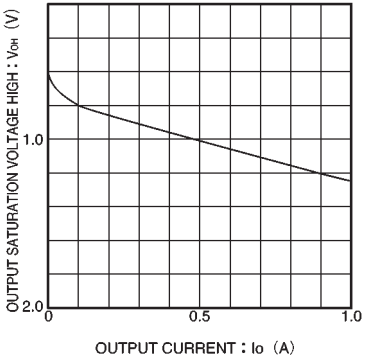


Fig.26 Loading section upper-side output saturation characteristics

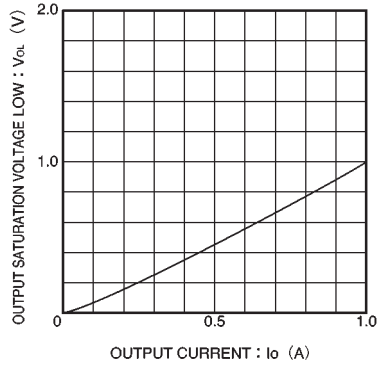


Fig.27 Loading section lower-side output saturation characteristics

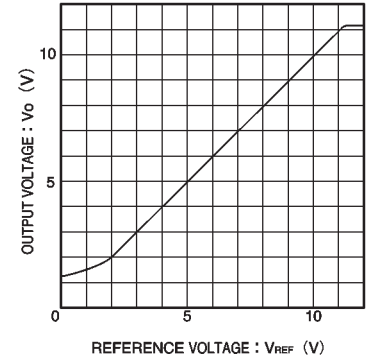


Fig.28 VREF VOUT characteristics

●External dimensions (Units: mm)