Three-phase motor driver for CD-ROMs

BA6858AFP / BA6858AFM / BA6859AFP / BA6859AFP-Y / BA6859AFM / BA6859AFS

The BA6858A and BA6859A series are ICs developed for CD-ROM spindle motor drives. In addition to the functions of the BA6849 series, (short brake, reverse-rotation prevention circuit, rotation direction dector, and FG output), the BA6858A and BA6859A series have a built-in brake mode switching pin. With torque command input, these series are compatible with the DSP3.3V. In addition, the BA6858A series has an FG composite output.

●Applications

CD-ROM, CD-R, CD-RW, DVD-ROM, and DVD-RAM

●Features

1) Three-phase, pseudo-linear drive system.
2) Built-in power save and thermal shutdown functions.
3) Built-in current limiter and Hall bias circuits.
4) Built-in FG output.
5) Built-in rotation direction detector.
6) Built-in reverse rotation prevention circuit.
7) Built-in short brake pin.
8) Built-in brake mode switching pin.
9) DSP3.3V compatible.

●Absolute maximum ratings (Ta = 25°C)

Parameter		Symbol	Limits	Unit
Applied voltage (with 5V power supply)		V_{CC}	7	V
Applied voltage (motor power supply)		V_M	15	V
Power dissipation	BA6858AFM BA6859AFM	Pd	2200*3	mW
	BA6858AFP BA6859AFP		1700*1	mW
	BA6859AFP-Y		1450*2	mW
	BA6859AFS		1000*4	mW
Operating temperature		Topr	−20～+75	˚C
Storage temperature		Tstg	−55～+150*5	˚C
Output current		I_{OUT}	1300*6	mA

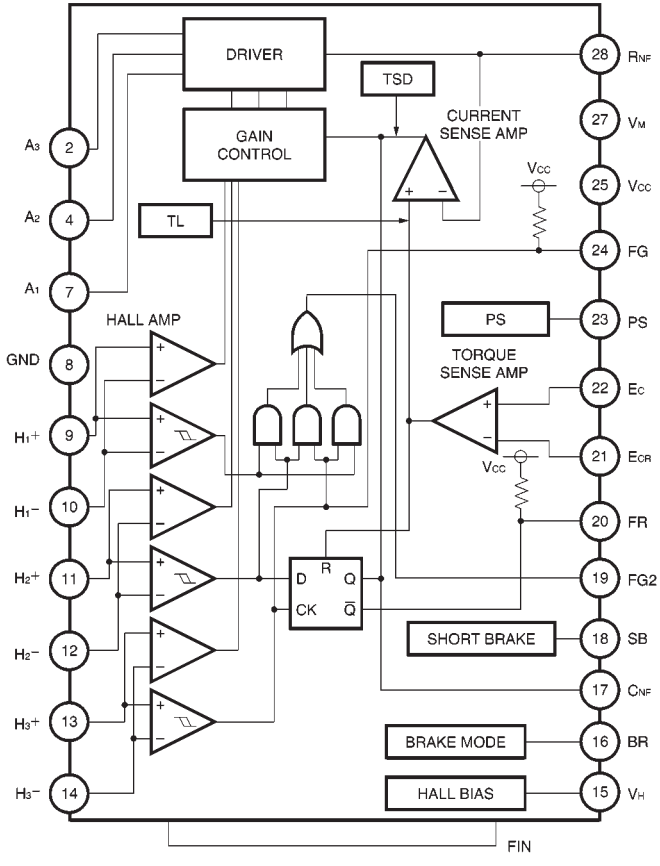
* When mounted on a 70mm × 70mm × 1.6mm glass epoxy board.
*1 Reduced by 13.6mW for each increase in Ta of 1℃ over 25℃.
*2 Reduced by 11.6mW for each increase in Ta of 1℃ over 25℃.
*3 Reduced by 17.6mW for each increase in Ta of 1℃ over 25℃.
*4 Reduced by 8.0mW for each increase in Ta of 1℃ over 25℃.
*5 Tj should not exceed 150℃.
*6 Should not exceed Pd or ASO values.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	4.5～5.5	V
	V_M	3.0～14	V

●Block diagram

BA6858AFP / BA6858AFM



Note: The diagram shows the BA6858AFP / BA6858AFM.

●Pin descriptions

BA6858AFP / BA6858AFM

Pin No.	Pin name	Function
2	A_3	Output
4	A_2	Output
7	A_1	Output
8	GND	GND
9	H_1^+	Hall signal input
10	H_1^-	Hall signal input
11	H_2^+	Hall signal input
12	H_2^-	Hall signal input
13	H_3^+	Hall signal input
14	H_3^-	Hall signal input
15	V_H	Hall bias
16	BR	Brake mode switch
17	C_{NF}	For connection of phase compensation capacitor
18	SB	Short brake
19	FG_2	Three-phase composite FG signal output
20	FR	Rotation direction detection
21	E_{CR}	Torque control reference
22	E_C	Torque control
23	PS	Power save
24	FG	FG signal output
25	V_{CC}	Power supply
27	V_M	Motor power supply
28	R_{NF}	For connection of output current detection resistor
FIN	—	SUB GND

* Missing pin numbers are N.C.

BA6859AFP / BA6859AFM

Pin No.	Pin name	Function
2	A_3	Output
4	A_2	Output
7	A_1	Output
8	GND	GND
9	H_1^+	Hall signal input
10	H_1^-	Hall signal input
11	H_2^+	Hall signal input
12	H_2^-	Hall signal input
13	H_3^+	Hall signal input
14	H_3^-	Hall signal input
15	V_H	Hall bias
16	BR	Brake mode switch
17	C_{NF}	For connection of phase compensation capacitor
18	SB	Short brake
20	FR	Rotation direction detection
21	E_{CR}	Torque control reference
22	E_C	Torque control
23	PS	Power save
24	FG	FG signal output
25	V_{CC}	Power supply
27	V_M	Motor power supply
28	R_{NF}	For connection of output current detection resistor
FIN	—	SUB GND

∗ Missing pin numbers are N.C.

BA6859AFP-Y

Pin No.	Pin name	Function
4	A_3	Output
5	A_2	Output
6	A_1	Output
7	GND	GND
8	H_1^+	Hall signal input
9	H_1^-	Hall signal input
10	H_2^+	Hall signal input
11	H_2^-	Hall signal input
12	H_3^+	Hall signal input
13	H_3^-	Hall signal input
14	V_H	Hall bias
15	BR	Brake mode switch
16	C_{NF}	For connection of phase compensation capacitor
17	SB	Short brake
18	FR	Rotation direction detection
19	E_{CR}	Torque control reference
20	E_C	Torque control
21	PS	Power save
22	FG	FG signal output
23	V_{CC}	Power supply
24	V_M	Motor power supply
25	R_{NF}	For connection of output current detection resistor
FIN	—	SUB GND

∗ Missing pin numbers are N.C.

BA6859AFS

Pin No.	Pin name	Function
1	—	SUB GND
2	A_3	Output
3	A_2	Output
5	A_1	Output
6	GND	GND
7	H_1^+	Hall signal input
8	H_1^-	Hall signal input
9	H_2^+	Hall signal input
10	H_2^-	Hall signal input
11	H_3^+	Hall signal input
12	H_3^-	Hall signal input
13	V_H	Hall bias
14	BR	Brake mode switch
15	C_{NF}	For connection of phase compensation capacitor
16	SB	Short brake
17	FR	Rotation direction detection
18	E_{CR}	Torque control reference
19	E_C	Torque control
20	PS	Power save
21	FG	FG signal output
22	V_{CC}	Power supply
23	V_M	Motor power supply
24	R_{NF}	For connection of output current detection resistor

∗ Missing pin numbers are N.C.

●Input / output circuits

(1) Power save

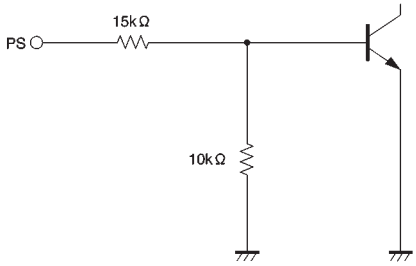


Fig.1

(2) Torque command input

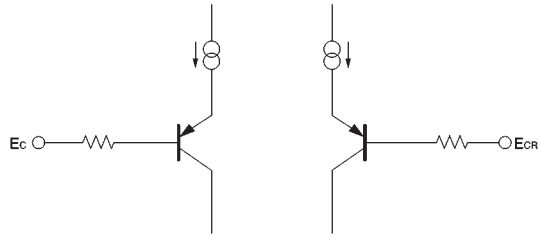


Fig.2

(3) Torque output (A_1, A_2, and A_3)

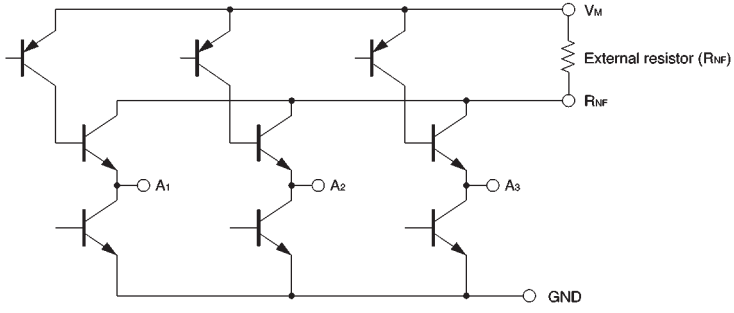


Fig.3

(4) Hall input (H_1^+, H_1^-, H_2^+, H_2^-, H_3^+, H_3^-)

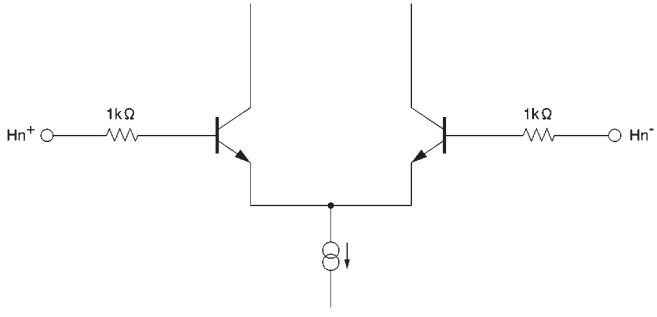


Fig.4

(5) Hall bias

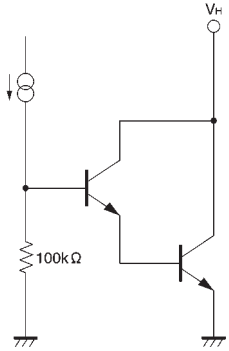


Fig.5

(6) FG output

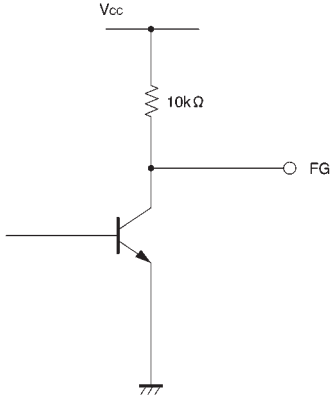


Fig.6

(7) FG_2 Output

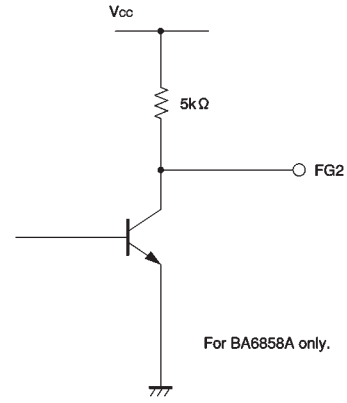


Fig.7

(8) FR output

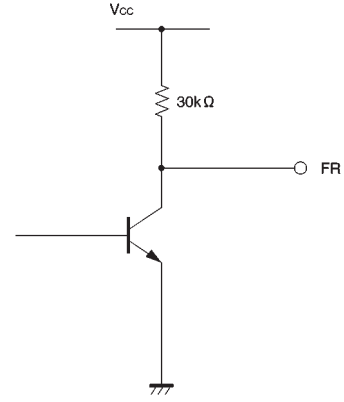


Fig.8

(9) Short brake

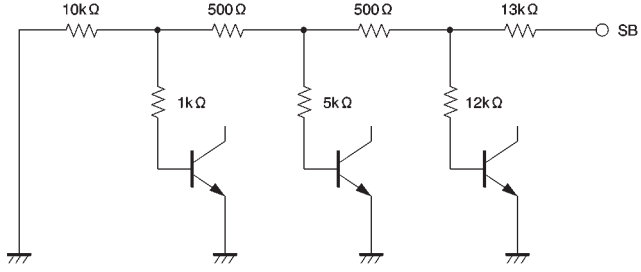


Fig.9

(10) Brake mode

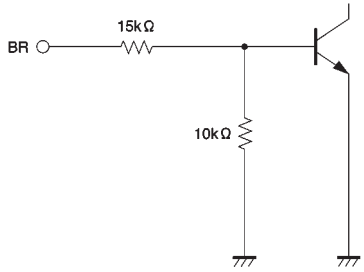


Fig.10

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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Total device〉						
Circuit current 1	I_{CC1}	—	0	0.2	mA	In the power save ON state
Circuit current 2	I_{CC2}	—	5.8 5.0	8.5 (58A) 7.5 (59A)	mA	In the power save OFF state
〈Power save〉						
ON voltage range	V_{PSON}	—	—	1.0	V	—
OFF voltage range	V_{PSOFF}	2.5	—	—	V	—
〈Hall bias〉						
Hall bias voltage	V_{HB}	0.5	0.9	1.5	V	I_{HB}=10mA
〈Hall amplifier〉						
Input bias current	I_{HA}	—	0.7	3.0	μA	—
Same phase input voltage range	V_{HAR}	1.0	—	4.0	V	—
Minimum input level	V_{INH}	50	—	—	mV_{P-P}	—
H3 hysteresis level	V_{HYS}	5	20	40	mV	—
〈Torque command〉						
Input voltage range	E_C, E_{CR}	0.5	—	3.3	V	Can operate from 0 to V_{CC}.
"—" offset voltage	E_{COFF}^-	−80	−50	−20	mV	E_{CR}=1.9V
"+" offset voltage	E_{COFF}^+	20	50	80	mV	E_{CR}=1.9V
Input bias current	E_{CIN}	−3	—	3	μA	E_C=E_{CR}
I / O gain	G_{EC}	0.56	0.7	0.84	A / V	E_C=1.2V, 1.7V
〈FG〉						
FG output "H" voltage	V_{FGH}	4.5	4.8	—	V	I_{FG}=−20 μA
FG output "L" voltage	V_{FGL}	—	0.25	0.4	V	I_{FG}=3mA
〈FG2〉 (BA6858A only)						
FG2 output high level voltage	V_{FG2H}	4.6	4.9	—	V	I_{FG2}=−20 μA
FG2 output low level voltage	V_{FG2L}	—	0.25	0.4	V	I_{FG2}=3mA
DUTY (reference value)	DU	—	50	—	%	—

◎Not designed for radiation resistance.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Rotation detection〉						
FR output high level voltage	V_{FRH}	4.1	4.4	—	V	I_{FR}=−20 μA
FR output low level voltage	V_{FRL}	—	0.25	0.4	V	I_{FR}=3mA
〈Output〉						
Output saturation high level voltage	V_{OH}	—	1.0	1.4	V	I_O=−600mA
Output saturation low level voltage	V_{OL}	—	0.4	0.7	V	I_O=600mA
Pre-drive current	I_{VML}	—	35	70	mA	E_C=0V output open
Output limit current	I_{TL}	560	700	840	mA	—
〈Short brake〉						
ON voltage range	V_{SBON}	2.5	—	—	V	BR=0V
OFF voltage range	V_{SBOFF}	—	—	1.0	V	BR=0V
〈Brake mode〉						
ON voltage range	V_{BRON}	2.5	—	—	V	$E_C > E_{CR}$ SB open
OFF voltage range	V_{BROFF}	—	—	1.0	V	$E_C > E_{CR}$ SB open

◎Not designed for radiation resistance.

●Circuit operation

(1) Hall input to coil output

The phase relationship between the Hall input signals and the output current and voltage is shown in Fig.11. The motor position data input via the Hall pins is amplified by the Hall amplifier, and formed into waveforms by the matrix block. These signals are input to the output driver that supplies the drive current to the motor coils.

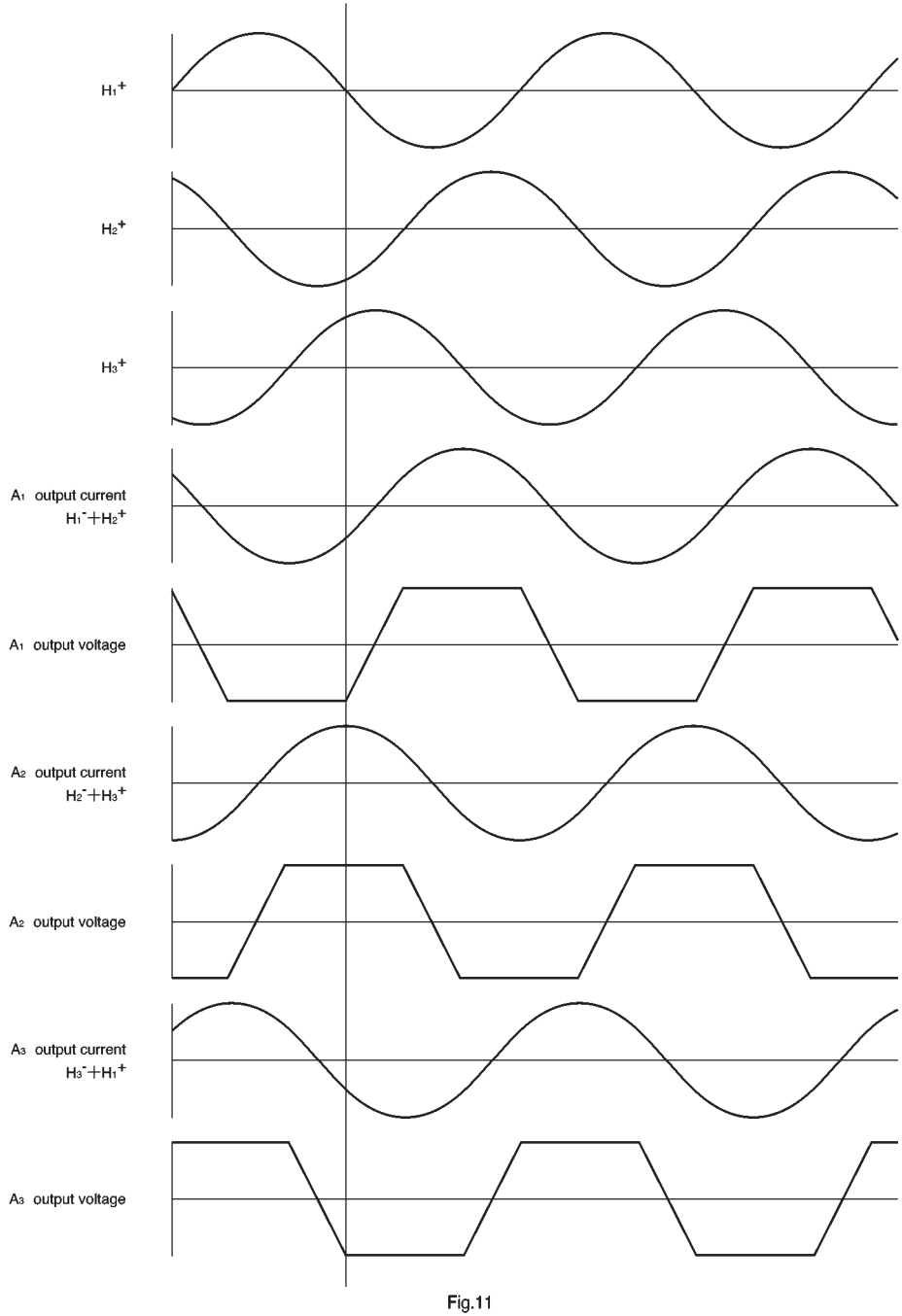


Fig.11

(2) Torque command

The R_{NF} pin voltage with respect to the torque command (E_C) is as follows:

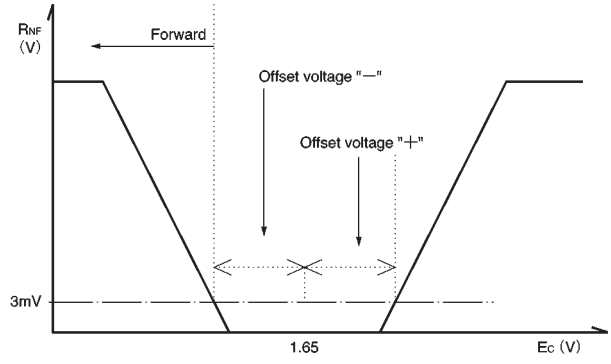


Fig.12

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

* Stops after detecting reverse.

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

$$G_{EC} = 0.35 / R_{NF} \text{ (A / V)}$$

The torque limit current ITL is given by:

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

(3) Reverse rotation detection function

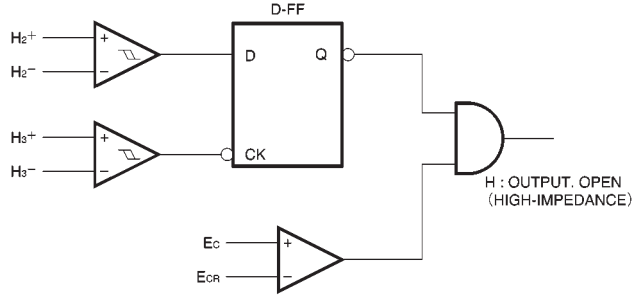


Fig.13

The reverse detection circuit construction is shown in Fig.13.

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

The phase relationship between the Hall input signals H_2^+ and H_3^+ becomes as shown in Fig.11, and the reverse rotation detection circuit does not operate.

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

The phase relationship between the signals H_2^+ and H_3^+ is opposite that for forward operation, and the reverse rotation detection circuit operates. The output goes OFF, and becomes open circuit.

	FR signal output pin
Forward	L
Reverse	H

(4) Short brake

When 2.5V or more is applied to the short brake pin, the top-side output transistors of all phases go off, and the bottom-side output transistors go on. This applies braking to the motor. Short braking operates regardless of the torque command signal.

(5) Brake mode switching

When 2.5V or more is applied to the BR pin, the brake mode for when $E_C > E_{CR}$ can be changed.

		$E_C < E_{CR}$	$E_C > E_{CR}$
BR	1.0 or less	Forward	Reverse brake
	2.5 or more	Forward	Short brake

(6) Power save

When 2.5V or more is applied to the power save pin, all circuits are on. When 1.0V or less is applied, the IC enters power save mode, and functions only for surpressing power consumption.

●Application example

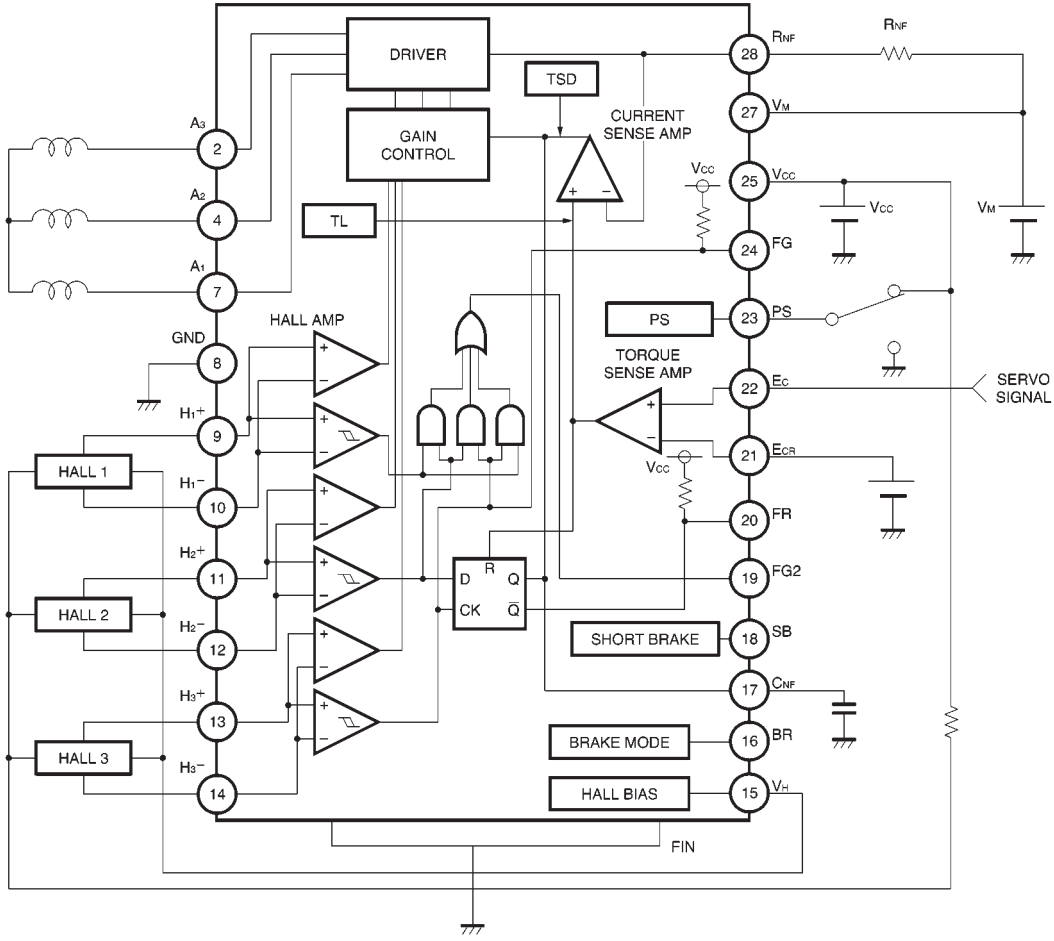


Fig.14

●Operation notes

(1) Torque command

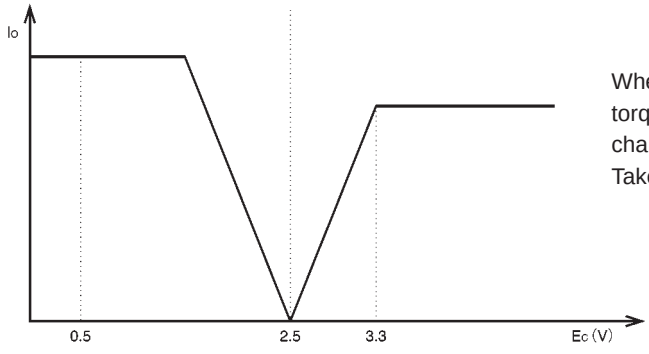


Fig.15

When operating with E_{CR} = 2.5V, the voltage range for the torque command input is 0.5V to 3.3V, and therefore, the characteristic will be unbalanced as shown in Fig.15. Take due care.

(2) Switches

The switches have a temperature characteristic of approximately –5mV / °C. Take care with regard to the input voltage range.

(3) Hall input

The input circuit shown in Fig.4 is used for the Hall inputs.
The Hall elements can be connected either in series or in parallel.

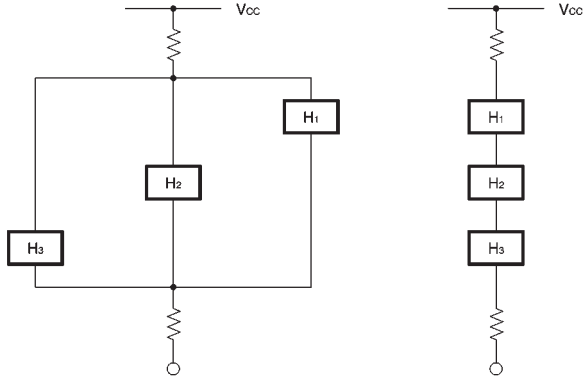


Fig.16

Set the Hall input voltage in the range 1.0V to 4.0V.
Set the resistance values between V_H and V_{CC} pins and the Hall elements after calculating the current to flow in Hall elements.
If there will not be a resistor connected between the Hall elements and the V_H pin, we recommend that I_{VH} = 5mA or more.

(4) Thermal shutdown (TSD)

When the junction temperature reaches 175°C (Typ.), the A_1, A_2, and A_3 coil outputs go open circuit.
The thermal shutdown has approximately 15°C (Typ.) of hysteresis.

●Electrical characteristics curves

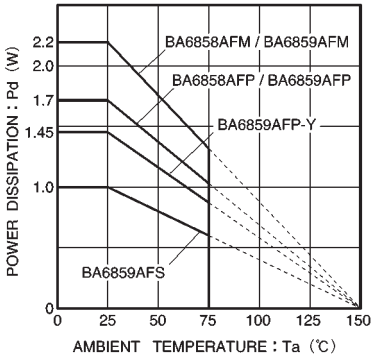


Fig.17 Package derating curves

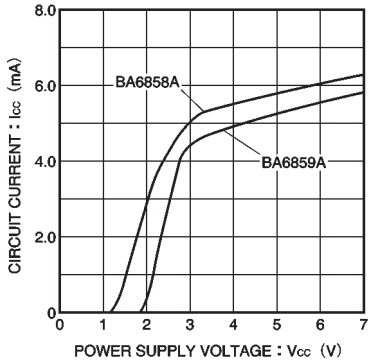


Fig.18 Power supply current vs. power supply voltage

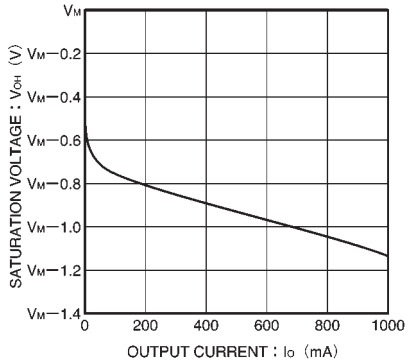


Fig.19 Upper-side output saturation voltage vs. output current

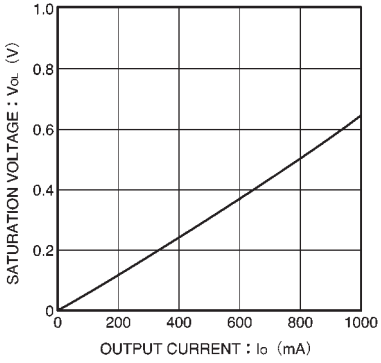
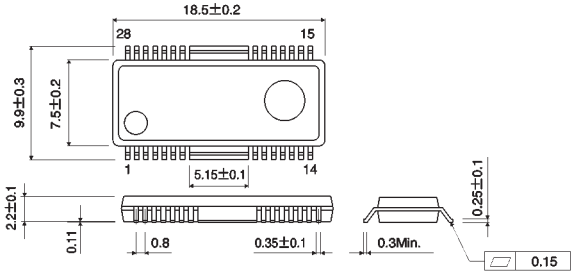


Fig.20 Lower-side output saturation voltage vs. output current

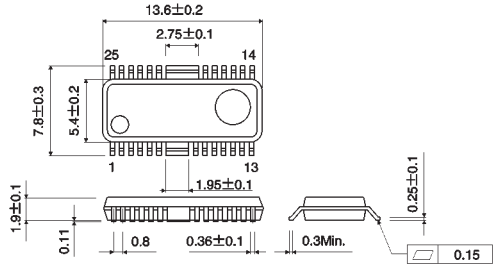
●External dimensions (Units: mm)

BA6858AFP / BA6859AFP



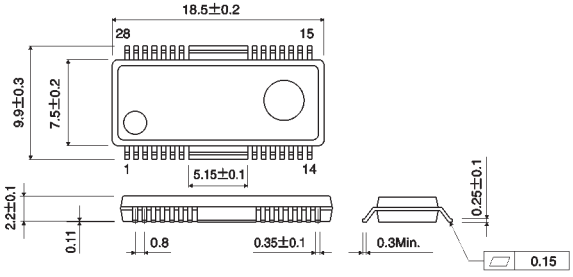
HSOP28

BA6859AFP-Y



HSOP25

BA6858AFM / BA6859AFM



HSOP-M28

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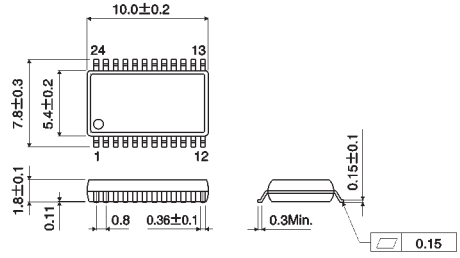

SSOP-A24