# 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<br>BA6859AFM | Pd | 2200*3 | mW |
| | BA6858AFP<br>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 |

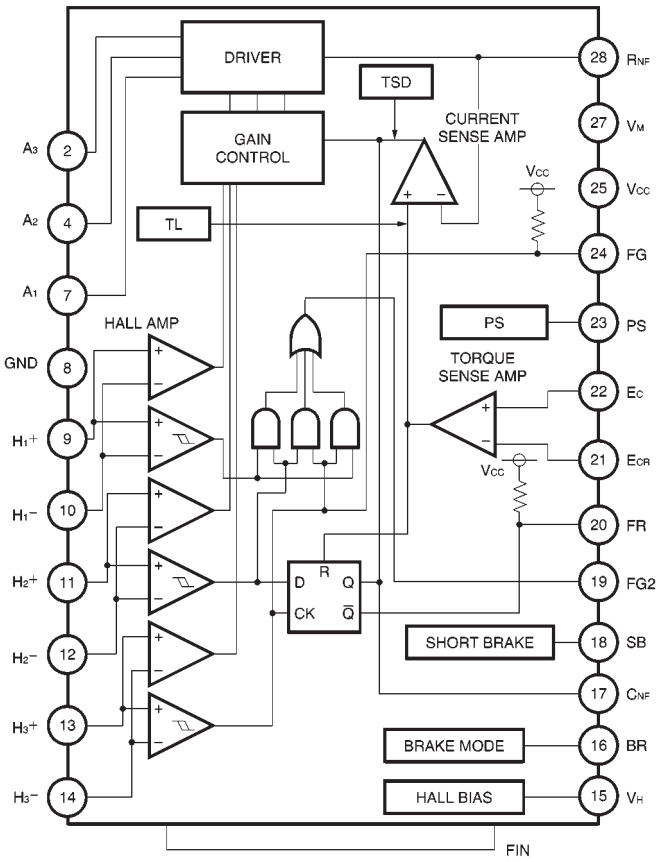
* When mounted on a 70mm × 70mm × 1.6mm glass epoxy board.
*1 Reduced by 13.6mW for each increase in Ta of 1℃ over 25℃.
*2 Reduced by 11.6mW for each increase in Ta of 1℃ over 25℃.
*3 Reduced by 17.6mW for each increase in Ta of 1℃ over 25℃.
*4 Reduced by 8.0mW for each increase in Ta of 1℃ over 25℃.
*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

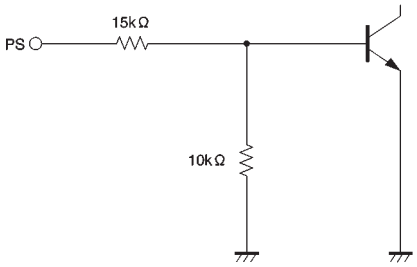



Fig.1

(2) Torque command input

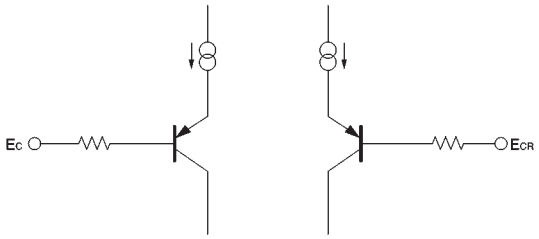



Fig.2

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

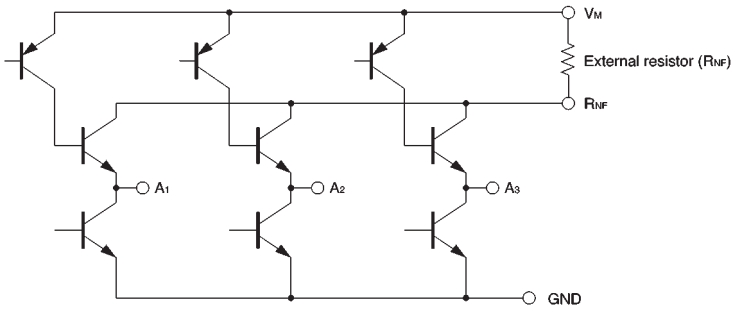



Fig.3

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

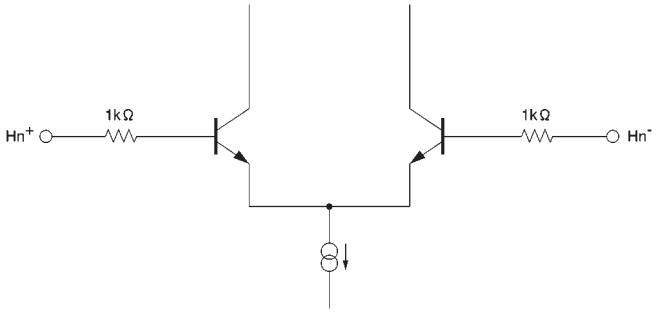



Fig.4

(5) Hall bias

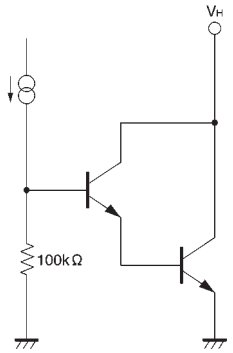



Fig.5

(6) FG output

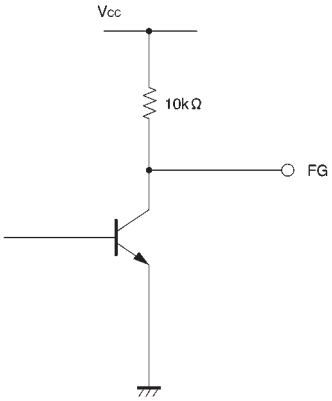



Fig.6

(7) $FG_2$ Output

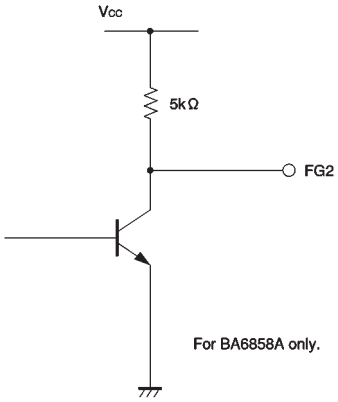



Fig.7

(8) FR output

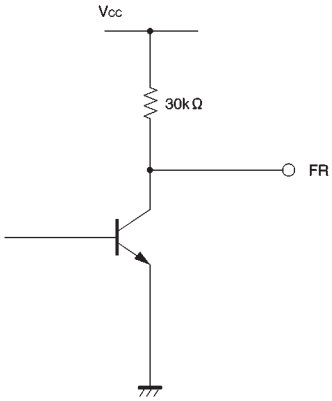



Fig.8

(9) Short brake

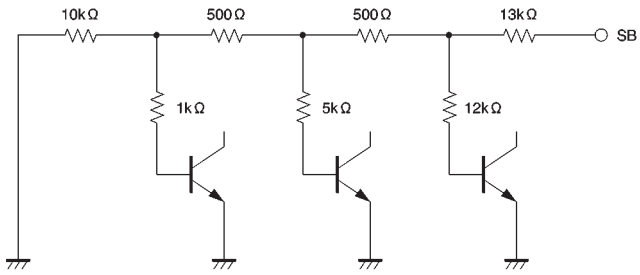



Fig.9

(10) Brake mode

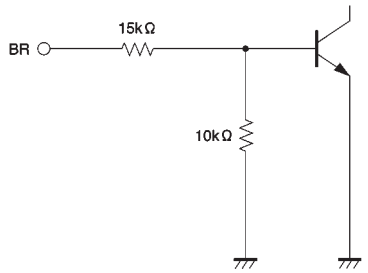



Fig.10

●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<br>5.0 | 8.5 (58A)<br>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.

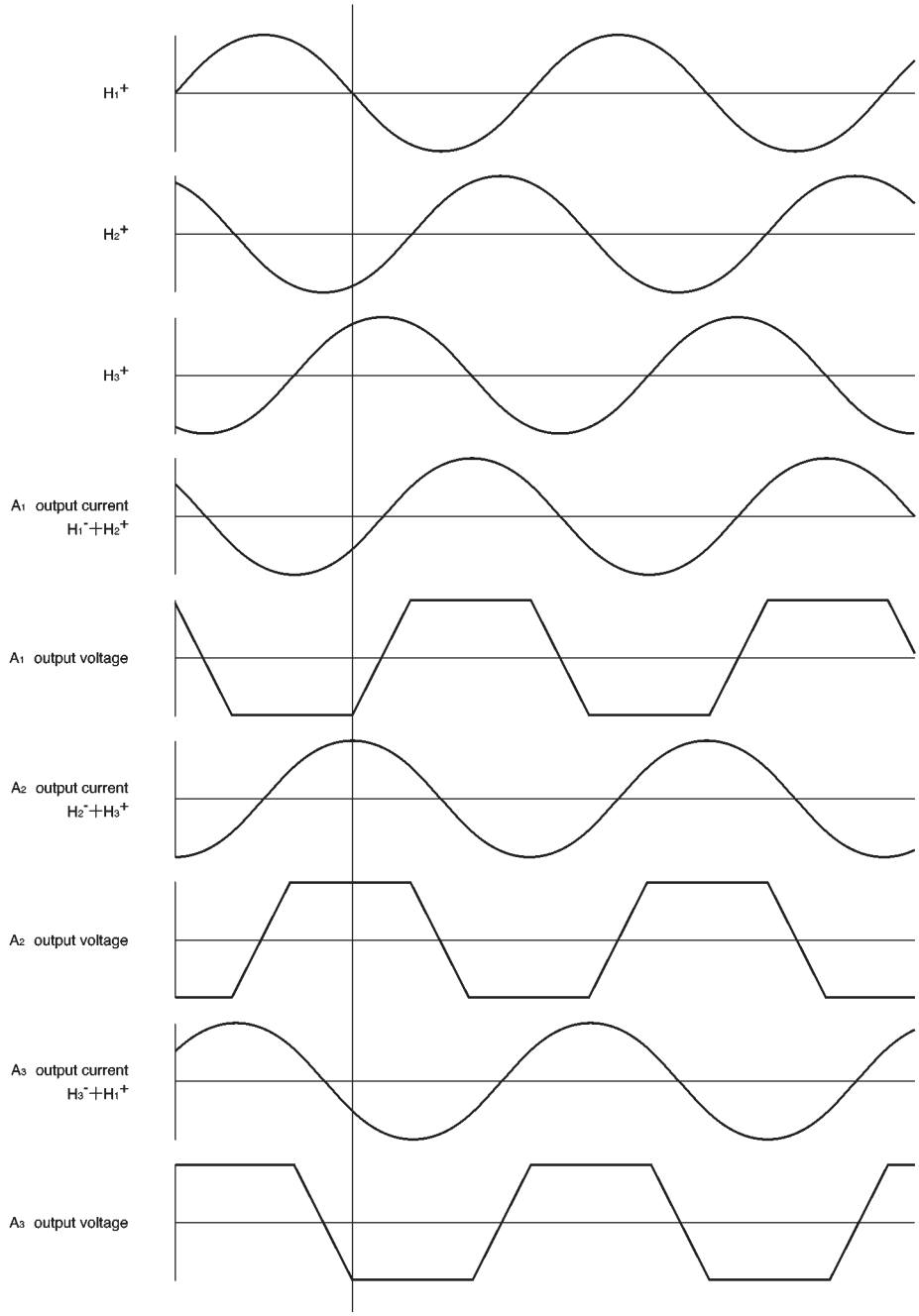



Fig.11

(2) Torque command

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

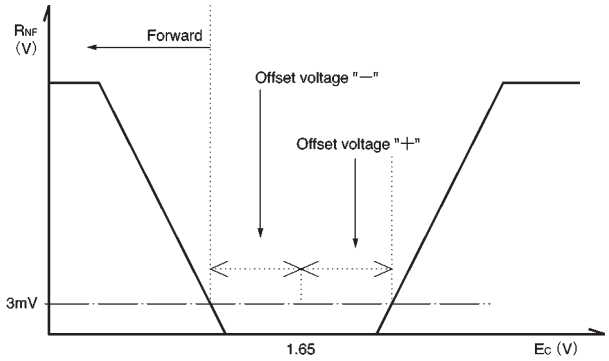



Fig.12

| | 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

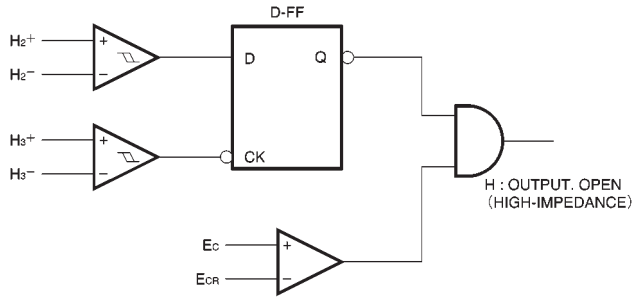



Fig.13

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

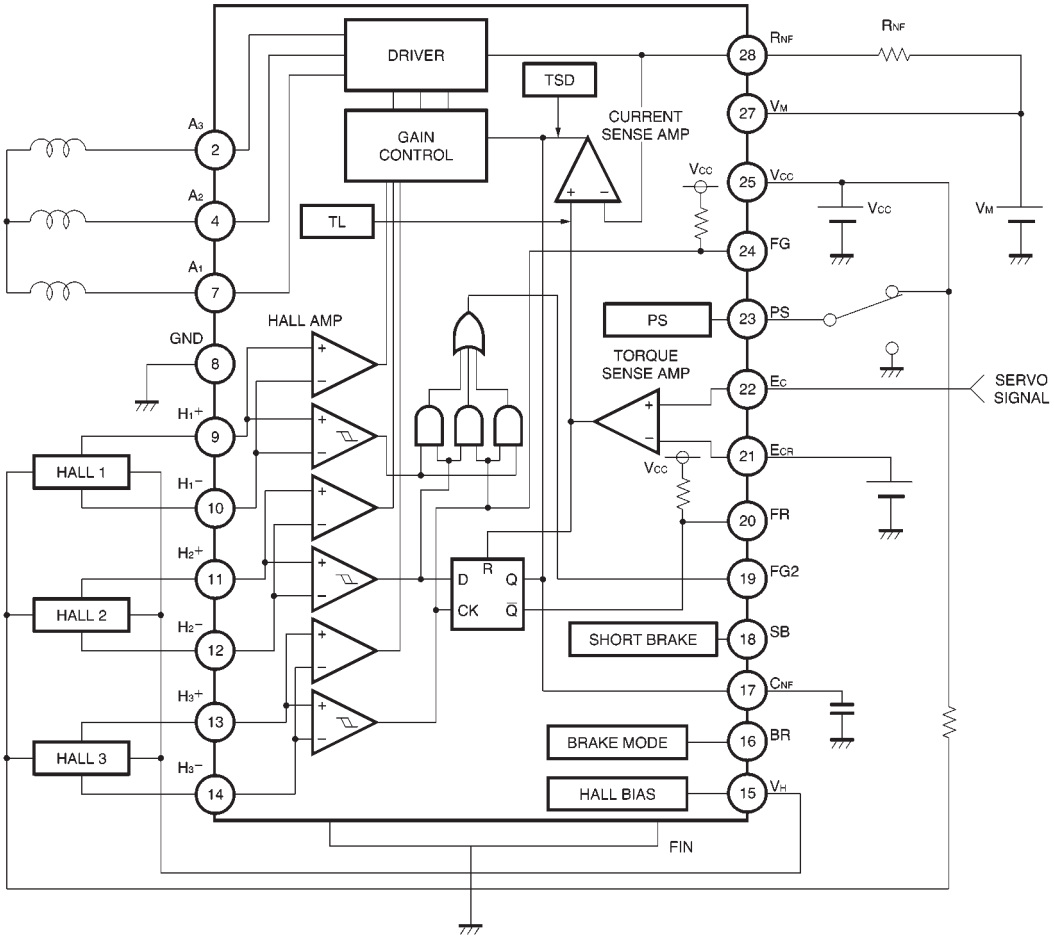



Fig.14

●Operation notes

(1) Torque command

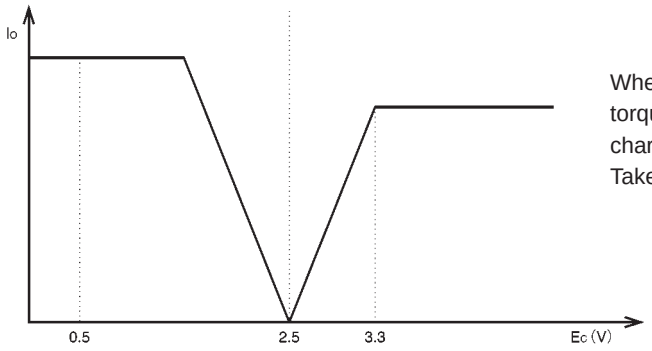



Fig.15

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.

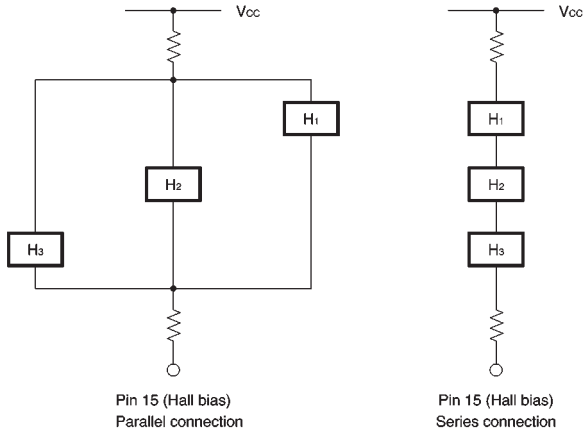



Fig.16

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

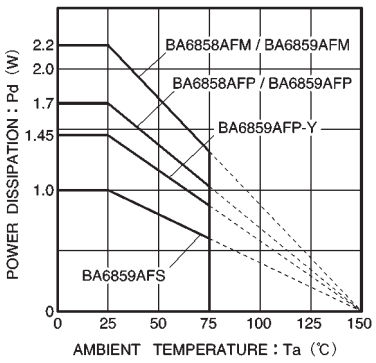



Fig.17 Package derating curves

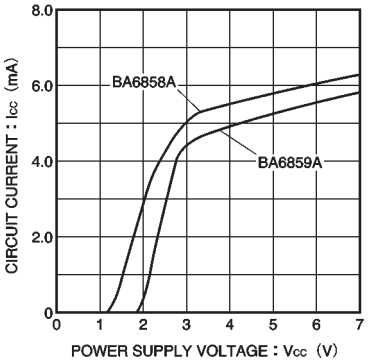



Fig.18 Power supply current vs. power supply voltage

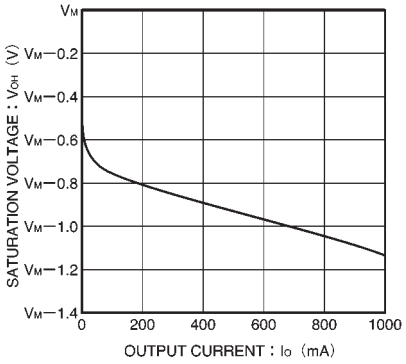



Fig.19 Upper-side output saturation voltage vs. output current

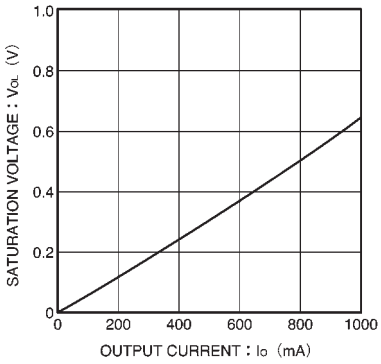
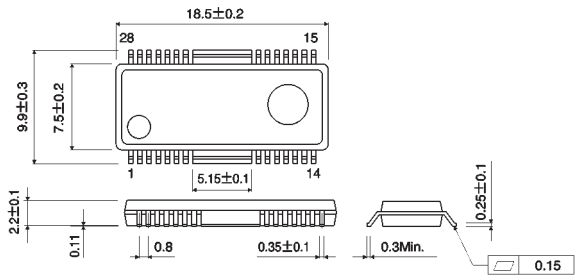



Fig.20 Lower-side output saturation voltage vs. output current

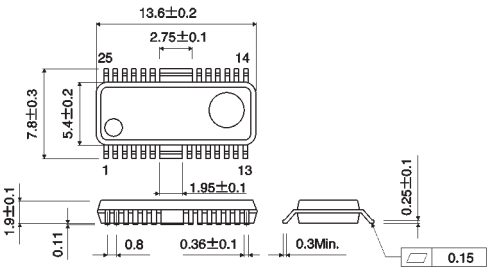
●External dimensions (Units: mm)

BA6858AFP / BA6859AFP



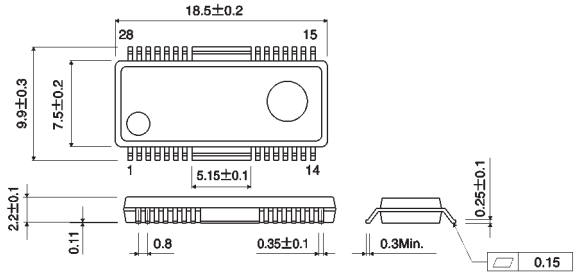

HSOP28

BA6859AFP-Y



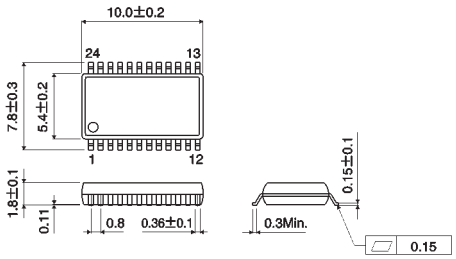

HSOP25

BA6858AFM / BA6859AFM




HSOP-M28

BA6859AFS




SSOP-A24