Reversible motor driver
BA6950FS

The BA6950FS is a reversible-motor driver suited for brush motors. Two logic inputs allow four output modes : forward, reverse, stop (standby), and brake. The rotational speed of motor can be set arbitrarily by changing the voltage applied to the motor with control pins. The IC can also drive a motor at a constant speed by using a built-in current feedback amplifier.

●Applications
VCRs, audio equipment

●Features
1) Two logic inputs allow four output modes : forward, reverse, stop (standby), and brake.
2) Motor speed variable with voltage control signals.
3) Built-in current feedback amplifier allows constant motor speed.
4) Control gain can be set arbitrarily by using external resistors.
5) Built-in thermal shutdown circuit.

●Absolute maximum ratings (Ta=25℃)

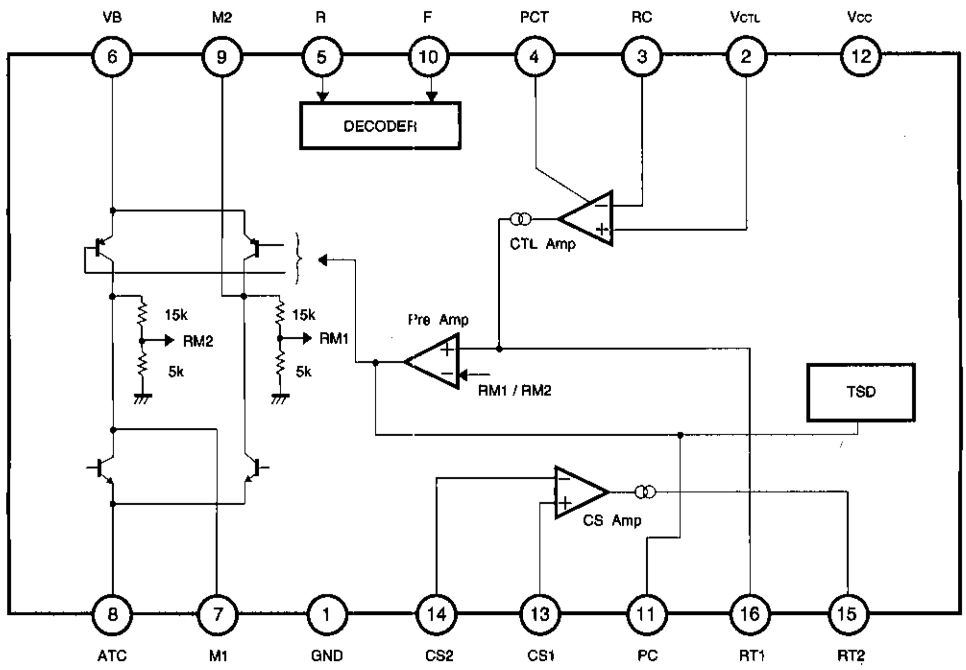
Parameter	Symbol	Limits	Unit
Applied voltage	V_{CC}	8	V
Applied voltage	VB	18	V
Power dissipation	Pd	800*1	mW
Operating temperature	Topr	−20~75	℃
Storage temperature	Tstg	−55~150	℃
Output current	I_{OUT}	400*2	mA

*1 Mounted on a glass epoxy PCB (90 X 50 X 1.6 mm).
Reduce power by 6.4 mW for each degree above 25℃.
*2 Should not exceed Pd- or ASO-value.

●Recommended operating conditions (Ta=25℃)

Parameter	Symbol	Range	Unit
Recommended power supply voltage	V_{CC}	3~6	V
	VB	3~16	V
	V_{CTL}	0~ (V_{CC}−1.8V)	V

●Block diagram



(Resistances are typical values)

●Pin description

Pin No.	Pin name	Function
1	GND	GND
2	V_{CTL}	Control signal input pin
3	RC	Resistor connection pin for control gain setting
4	PCT	Capacitor connection pin for control phase compensation
5	R_{IN}	Logic input pin
6	VB	Driver power supply pin
7	M1	Motor output pin
8	ATC	Resistor connection pin for output current detection
9	M2	Motor output pin
10	F_{IN}	Logic input pin
11	PC	Capacitor connection pin for current feedback phase compensation
12	V_{CC}	Signal power supply pin
13	CS1	Resistor connection pin for CSAMP gain setting
14	CS2	Resistor connection pin for CSAMP gain setting
15	RT2	Resistor connection pin for control gain setting
16	RT1	Resistor connection pin for control gain setting

●Input/output equivalent circuit (resistances, in Ω, are typical values)

(1) R and F inputs (pins 5 and 10)

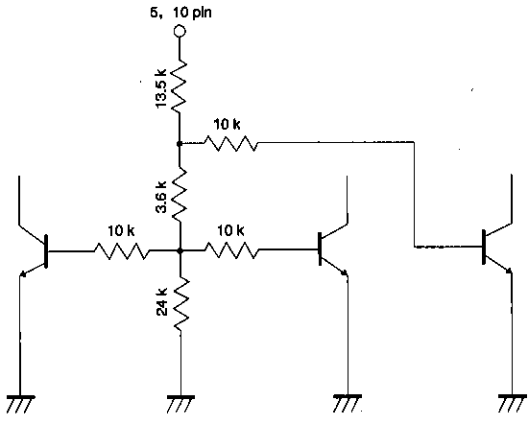


Fig.1

(3) Motor output (pins 6, 7, 8, and 9)

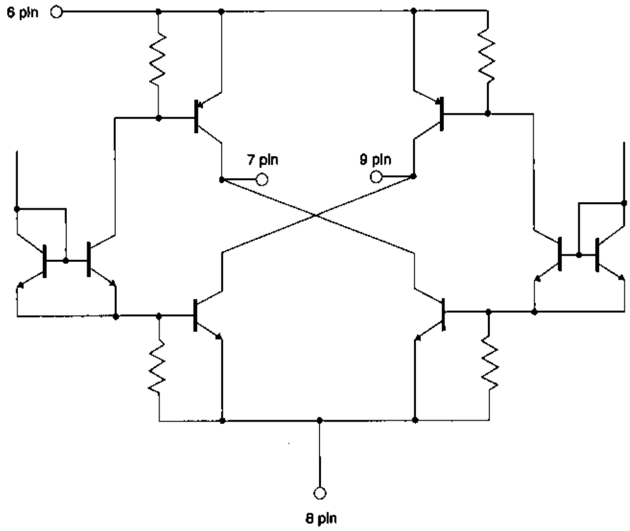


Fig.3

(2) CTL amplifier (pins 2 and 3)

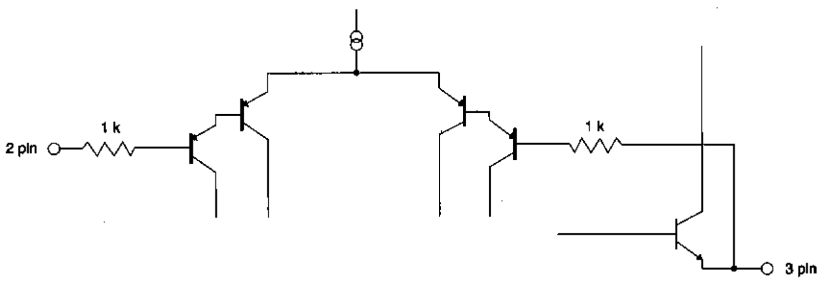


Fig.2

●Electrical characteristics (unless otherwise noted, Ta=25℃, V_{CC}=4.8V, VB=4.8V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Circuit current 1	I_{CC1}	−	4.0	6.0	mA	(R_{IN}, F_{IN})=(L, H) or (H, L), V_{CTL}=0V
Circuit current 2	I_{CC2}	−	0.7	1.5	mA	(R_{IN}, F_{IN})=(L, L), V_{CTL}=0V
Circuit current 3	I_{Boff}	−	0	1.0	μA	IB when V_{CC}= 0 V
HIGH level R/F voltage	$V_{R/F H}$	2.0	−	−	V	
LOW level R/F voltage	$V_{R/F L}$	−	−	0.8	V	
HIGH level input current	$I_{R/F H}$	−	80	135	μA	R_{IN}=2V, F_{IN}=2V
CTL amplifier offset	$V_{CTL ofs}$	−5.0	−	+5.0	mV	(V_{CTL}- RC) when V_{CTL} = 0 V, 1 V
CTL amplifier gain	$V_{CTL Ga}$	40	46	52	μA / V	ΔI_{RT1} /1 when V_{CTL} = 2 V, 1 V
CTL output mirror ratio 1	I_{CTLR1}	0.85	1	1.15	ratio	I_{RT1}/I_{RC} when I_{RC} = 20 μA
CTL output mirror ratio 2	I_{CTLR2}	0.90	1	1.10	ratio	I_{RT1}/I_{RC} when I_{RC} = 200 μA
CS amplifier offset	CS ofs	−5.0	−	+5.0	mV	(CS1 - CS2) when CS1 = 0 V, 0.1 V
CS output mirror ratio 1	I_{CSR1}	0.85	1	1.15	ratio	I_{RT2}/I_{CS2} when I_{CS2}= 20 μA
CS output mirror ratio 2	I_{CSR2}	0.90	1	1.10	ratio	I_{RT2}/I_{CS2} when I_{CS2}= 200 μA
HIGH level output voltage	V_H	2.0	4.6	−	V	M1, M2 voltage when V_{CTL} = 0.2 V
Low-side output saturation voltage	V_{OL}	−	0.07	0.2	V	RT1 = V_{CC} when I_O = 50mA
High-side output saturation voltage	V_{OH}	−	0.09	0.3	V	RT1 = V_{CC} when I_O = 50mA

◎ Not designed for radiation resistance

●Circuit operation

(1) Input section (F_{IN}, R_{IN})

Control signals are input from these pins. Current flows from M2 to M1 (forward mode) when F_{IN} is HIGH and R_{IN} is LOW, and from M1 to M2 (reverse mode) when R_{IN} is HIGH and F_{IN} is LOW. Putting F_{IN} and R_{IN} both HIGH results in the brake mode in which the high-side output transistor is turned off to shut down the motor driving current and the low-side output transistor is turned ON to absorb the counter-electromotive force of the motor, so that a brake is put on the motor. When F_{IN} and R_{IN} are both LOW, both M1 and M2 are left open and the motor stops.

Input/output truth table

F_{IN}	R_{IN}	M1	M2	Mode
H	L	L	H	Forward
L	H	H	L	Reverse
H	H	L	L	Brake
L	L	OPEN		Standby

(2) Output section (M1, M2)

Two logic inputs control the motor by changing the status of bridge-configured transistors.

(3) HIGH level output voltage

Values of current, voltage, and HIGH level output voltage can be set as follows by using external resistors (refer to the application circuit of Fig. 4).

- I16 pin (I_{RT1})
  I16 pin (I_{RT1})=V2 pin/R1 · · · ①
- I15 pin (I_{RT2})
  I15 pin (I_{RT2})=I8 pin×R5/R4 · · · ②
- V16 pin (V_{RT1})
  V16 pin=R3×(I16 pin+I15 pin)+R2×I16 pin · · · ③
- V7, 9 pin (M1, M2 voltage; high-side voltage)
  V7, 9 pin=4 × V16 pin (Typ.) · · · ④

(4) Current feedback amplifier

The pin-8 current is increased when the motor rotational speed is reduced by loading, and the current feedback amplifier increases the pin-15 current according to equation ②. Because the pin-16 voltage then increases according to equation ③, the HIGH level output voltage also increases according to equation ④. In this way, the rotational speed is kept constant by increasing the voltage applied to the motor.

●Application example

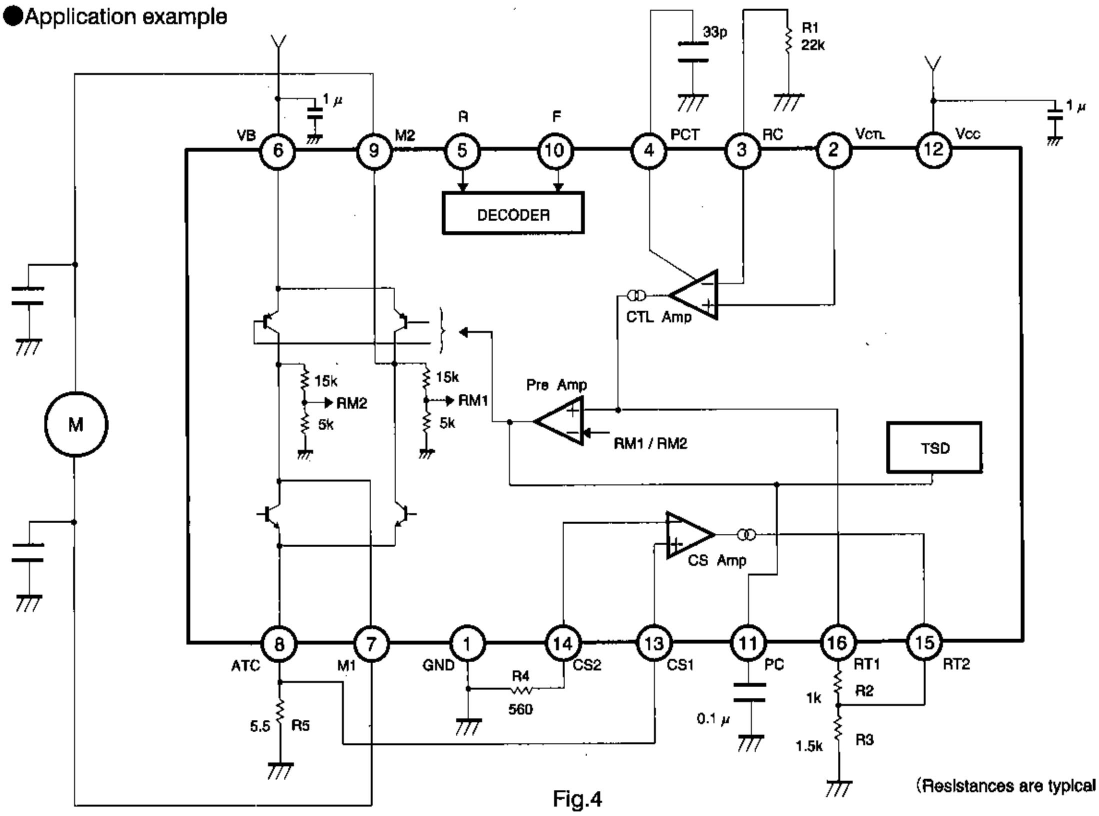


Fig.4

(Resistances are typical values)

●Operation notes

(1) Thermal shutdown circuit

The thermal shutdown (TSD) circuit turns off all driver outputs when the IC junction temperature rises above 175℃. The temperature difference between the activation and deactivation settings is about 20℃.

・Temperature setting of TSD

	Min.	Typ.	Max.	Unit
TSD activation temperature	150	175	200	℃
Hysteresis width	—	20	—	℃

(2) Control logic and control signal input pins

Voltage should never be applied to the control logic input pins (pins 5 and 10) or the control signal input pin (pin 2) when the Vcc voltage is not applied to the IC. Similarly, the voltage on each input pin should not exceed any applied Vcc voltage.

(3) PCB arrangement

When changing the rotational direction of a motor, a large current of up to a few hundred milliamperes can flow between the motor power supply (pin 6) and RNF (pin 8). Depending on the application, this large output current may flow back to input pins, resulting in output oscillation or other malfunctions. Make sure that your design does not allow a common impedance between the large current output lines and the input section. Suppress the power supply impedance to low levels, otherwise output oscillation may occur.

(4) Package power

The power dissipated by the IC varies widely with the supply voltage and the output current. Give full consideration to the package power dissipation rating when setting the supply voltage and the output current.

(5) The input pins (pins 5 and 10) have temperature-dependent characteristics. Take the temperature effect into consideration when using the IC.

(6) To eliminate motor noise, connect a capacitor between M1 (pin 7) and GND and between M2 (pin 9) and GND.

●Electrical characteristic curves

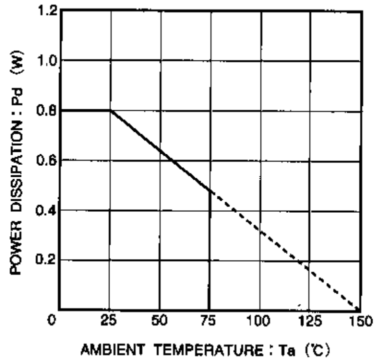


Fig.5 Temperature dependence of power dissipation

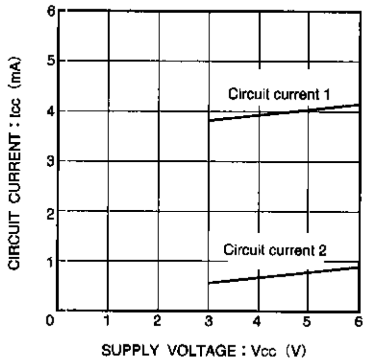


Fig.6 Circuit current vs. supply voltage

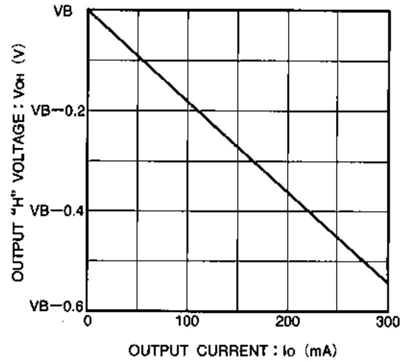


Fig.7 HIGH level output voltage vs. output current

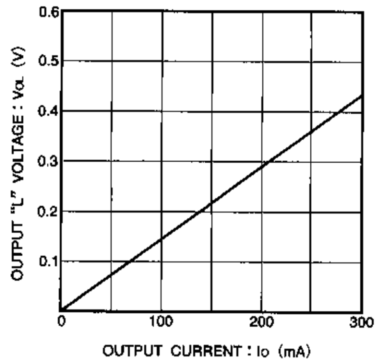
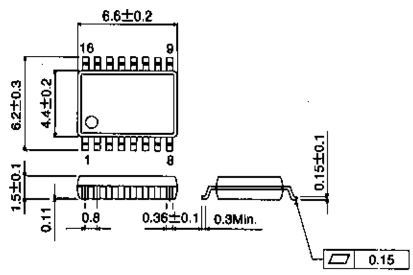


Fig.8 LOW level output voltage vs. output current

●External dimensions (Units: mm)



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