2-phase motor driver for VCR cylinder motors
BA6970FS

The BA6970FS is a direct-drive motor driver suitable for 2-phase, full-wave linear motors. The IC consists of a Hall amplifier control circuit, driver circuits, FG / PG signal amplifiers, and hysteresis amplifiers.

●Applications
VCR cylinder motors

●Features
1) Linear drive system provides low switching noise.
2) Output current can be controlled by either current or voltage input.
3) Two amplifiers and two hysteresis amplifiers.

4) Constant supply voltage pin for hall devices.
5) High ratio of output current and control current. (4000 typically)
6) Available in a compact surface-mount package.

●Block diagram

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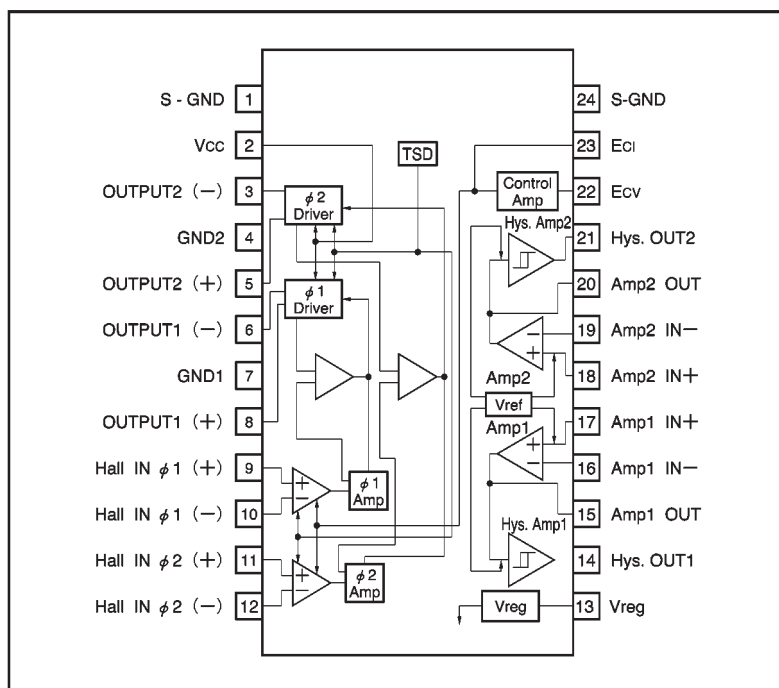
●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Applied voltage	V_{CC}	18	V
Power dissipation	Pd	1000*1	mW
Operating temperature	Topr	$-25\sim+75$	℃
Storage temperature	Tstg	$-55\sim+150$	℃
Output current	$I_{OMax.}$	1200*2	mA
Input current	$I_{ECIMax.}$	5	mA

*1 When mounted on a glass epoxy board (90× 50×1.6 mm).
   Reduced by 8 mW for each increase in Ta of 1℃ over 25℃.
*2 Should not exceed Pd or ASO values (for the current of one phase).

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Operating power supply voltage	V_{CC}	8.0~16.0	V

●Electrical characteristics (unless otherwise noted, Ta = 25°C, Vcc = 12V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Supply current	I_{CC}	—	5.8	13.0	mA	—
Constant output voltage	V_{reg}	4.6	5.0	5.4	V	—
⟨MDA⟩						
Hall element minimum input voltage	V_{INH}	50	—	—	mV$_{P-P}$	—
Hall input bias current	I_{BH}	—	0.25	2.0	μA	I_{cont}=100μA
Output saturation high level voltage	V_{OH}	10.45	10.79	—	V	I_{OUT}=800mA
Output saturation low level voltage	V_{OL}	—	1.33	2.16	V	I_{OUT}=800mA
⟨ECV (voltage control)⟩						
Allowable torque command input voltage	E_{CV}	0	—	V_{reg}	V	—
Torque control voltage offset	E_{CVOFS}	−150	0	150	mV	For 0.48 X V_{reg}
Torque control input current	I_{ECVIN}	—	1.0	6	μA	E_{CV}=2.5V
Output standby current	$I_{ECVidle}$	—	0	5	mA	E_{CV}=2.5V
I/O gain	G_{ECV}	0.38	0.55	0.64	A / V	Measured at E_{CV} = 2.8 V, 3.3 V; ΔV_{IN} = 100 mV
⟨E$_{CI}$ (current control)⟩						
Ratio of pin-23 current and output current	I_{OUT} / I_{cont}	3300	4000	4700	—	ΔV_{IN} = 100 mV; measured at I_{cont} = 30 μA, 50 μA
Output current differential	ΔI_{OUT}	−30	0	30	mA	I_{cont}=30μA
⟨Amp1, Amp2⟩						
Input sink current	I_{INA}	—	0.2	2.0	μA	V_{IN}=2.5V
Open loop gain	G_A	65	70	—	dB	f_{IN}=500Hz
DC bias voltage variation	ΔV_{BA}	−10	0	10	%	Variation from V_{reg}
Output high level voltage	$V_{OH A}$	V_{reg} −1.48	V_{reg} −0.72	—	V	$I_{OH A}$=0.5mA
Output low level voltage	$V_{OL A}$	—	0.85	1.45	V	$I_{OL A}$=0.5mA
Input voltage of Amplifiers 1 and 2	V_{AB}	1.2	—	4.0	V	—
⟨Hys. Amp1, 2⟩						
Hysteresis width	V_{hys}	±142	±180	±218	mV	—
Output low level voltage	V_{OLhys}	—	0.12	0.32	V	I_{OLhys}A=2mA
Out put pull-up resistance	V_{Bhys}	7.0	10.0	13.0	kΩ	—

◎Not designed for radiation resistance.

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●Pin descriptions

Pin No.	Pin name	Function
1	S—GND	Signal ground
2	V$_{CC}$	Output current control
3	OUTPUT2 （—）	Output
4	GND2	OUTPUT2 GND
5	OUTPUT2 （＋）	Output
6	OUTPUT1 （—）	Output
7	GND1	OUTPUT1 GND
8	OUTPUT1 （＋）	Output
9	Hall IN ϕ 1 （＋）	Hall signal input
10	Hall IN ϕ 1 （—）	Hall signal input
11	Hall IN ϕ 2 （＋）	Hall signal input
12	Hall IN ϕ 2 （—）	Hall signal input
13	Vreg	Constant voltage output
14	Hys.OUT1	Hysteresis amplifier 1 output
15	Amp1OUT	Amplifier 1 output ; hysteresis amplifier 1 input
16	Amp1IN—	Amplifier 1 input , inverted
17	Amp1IN＋	Amplifier 1 input , non-inverted
18	Amp2IN＋	Amplifier 2 input , non-inverted
19	Amp2IN—	Amplifier 2 input , inverted
20	Amp2OUT	Amplifier 2 output ; hysteresis amplifier 2 input
21	Hys.OUT2	Hysteresis amplifier 2 output
22	ECV	Output current control (voltage control)
23	ECI	Output current control (current control)
24	S—GND	Signal ground

●Input / output circuits

(1)　Ecv (22 pin)
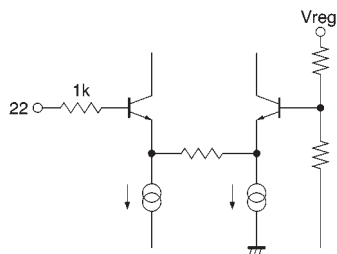
(All resistances, in Ω, are typical values)

Fig.1

(2)　Coil output (8, 6, 5, 3 pin)
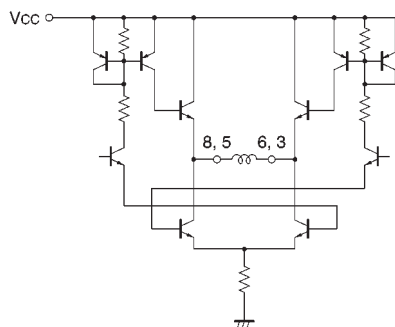
(All resistances, in Ω, are typical values)

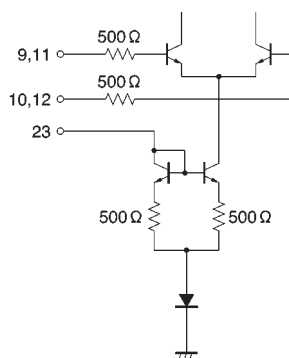Fig.2

(3)　Hall inputs (9, 10, 11, 12 pin), Ecι input

(All resistances, in Ω, are typical values)
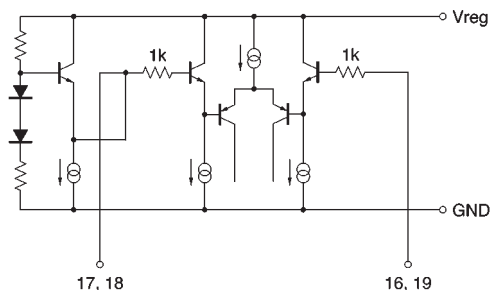
Fig.3

(4)　I / O of amplifiers 1 and 2

(All resistances, in Ω, are typical values)
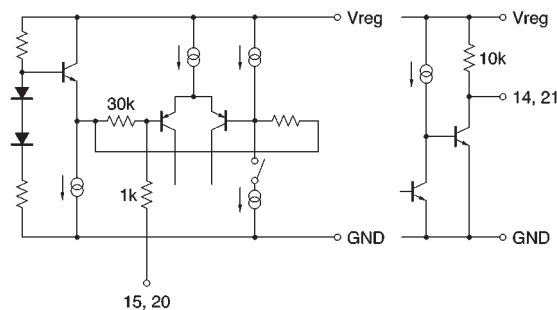
Fig.4

(5)　I / O of hysteresis amplifiers

(All resistances, in Ω, are typical values)

Fig.5

＊Note that the resistance values can vary ±30%

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●Circuit operation

(1)   The signal from the Hall device is amplified by the Hall amplifier and then supplied to the driver circuit. The driver gain, which is constant, is regulated by changing the Hall amplifier gain with the E_{CI} input current or the E_{CV} input voltage (E_{CI} and E_{CV} are output current control pins). The motor rotational speed is sensed by the FG, and the output from which is F / I-converted and supplied to the E_{CI} pin or F / V-converted and supplied to the E_{CV} pin as a feedback signal, so that a constant rotational speed is maintained as follows (Fig. 6) :

1) The motor speed decreases.
2) The speed control IC outputs a feedback signal
3) The Hall amplifier gain increases.
4) The output current increases.
5) The motor speed increases.

(2)   When the voltage on Hall $IN_{\phi 1}$ (+) is higher than the voltage on Hall $IN_{\phi 1}$ (−), an output current flows from OUT1 (+) to OUT1 (−) according to the voltage differential. When the voltage on Hall $IN_{\phi 1}$ (−) is higher, on the other hand, an output current flows from OUT1 (−) to OUT1 (+).

Similarly, when the voltage on Hall $IN_{\phi 2}$ (+) is higher than the voltage on Hall $IN_{\phi 2}$ (−), an output current flows from OUT2 (+) to OUT2 (−) according to the voltage differential. When the voltage on Hall $IN_{\phi 2}$ (−) is higher, on the other hand, an output current flows from OUT2 (−) to OUT2 (+).
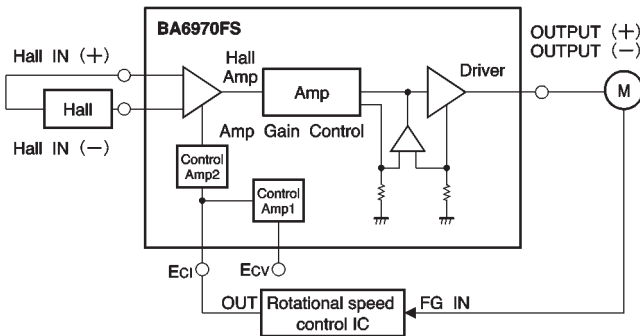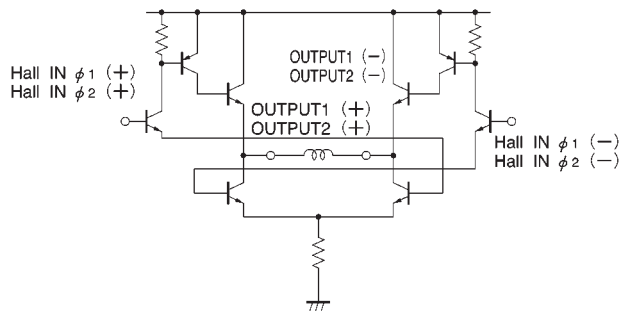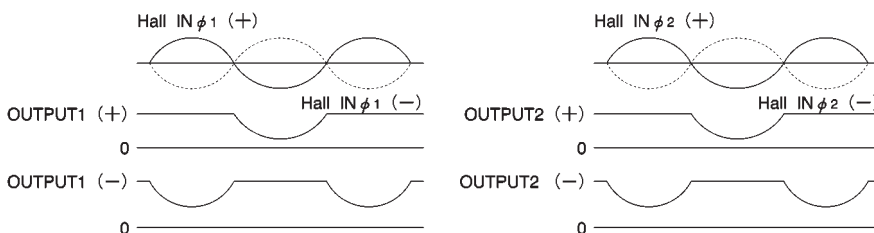

Fig.6

Fig.7

Fig.8

(3)　Output waveforms are shown in Fig. 9. Because of the amplifier offset, the output is left OPEN when the output signal switches from positive to negative. The output waveform is determined by the external circuit because the IC impedance increases during this transition period. Since inductive loads are usually provided, a capacitor should be connected to suppress backlash voltages.

Fig.9

●Operation notes

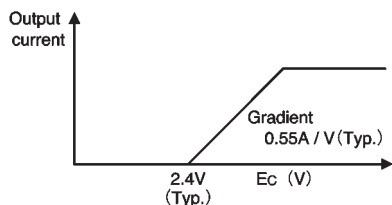(1)　Ecv input (pin 22)

The Ecv input is plotted against the output current in Fig. 10.

Fig.10

(2)　Hall input

Hall input signals of 50mV (peak to peak) or greater should be applied between pins 9 and 10 and between pins 11 and 12. The DC input range is 2V to (Vreg − 1.5V). There will be no problem if the input is centered around Vreg / 2.

Because the Hall input impedance is 1MΩ or grater, any type of Hall device can be connected. No current flows when the transistor is off because pins 9 and 10 as well as pins 11 and 12 are differential inputs.

Because the IC is a linear driver, any DC offset in the Hall device will be amplified and appear in the output. Use Hall devices having a minimum offset. Hall devices can be connected in either series or parallel.
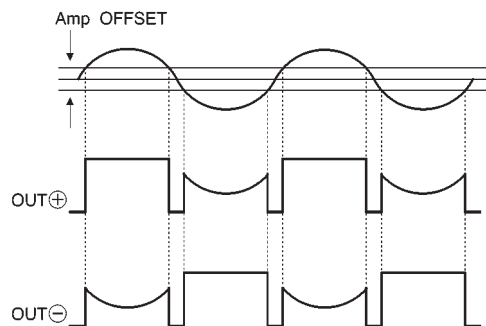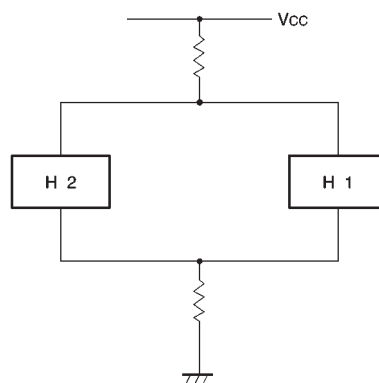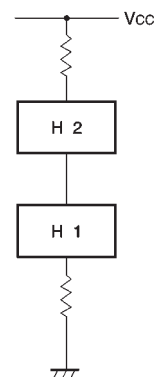

Parallel connection

Series connection

Fig.11

(3) E$_{CI}$ input

The E$_{CI}$ input circuit has 2V$_F$ and a 500Ω resistor connected in series. Current is limited only by the 500Ω resistor.

(4) Amplifiers 1 and 2

An input range of 0.6V to (V$_{CC}$ − 1.2V) is recommended. Unpredictable outputs may occur when the input is outside this range.

(5) Hysteresis amplifier

An input range of 0.6V to (V$_{CC}$ − 1.2V) is recommended. Unpredictable outputs may occur when the input is outside this range.

(6) Thermal shutdown circuit

The thermal shutdown circuit puts the driver outputs (8, 6, 5, 3 pin) to the open state at the temperature of 175°C (typical). The circuit is deactivated when the temperature drops to about 155°C.

(7) Signal ground pin

Pins 1 and 24 are signal ground pins. Be noted that unpredictable outputs may occur if your application causes a large current between pins 1 and 24 via the bonding wire IC chip.
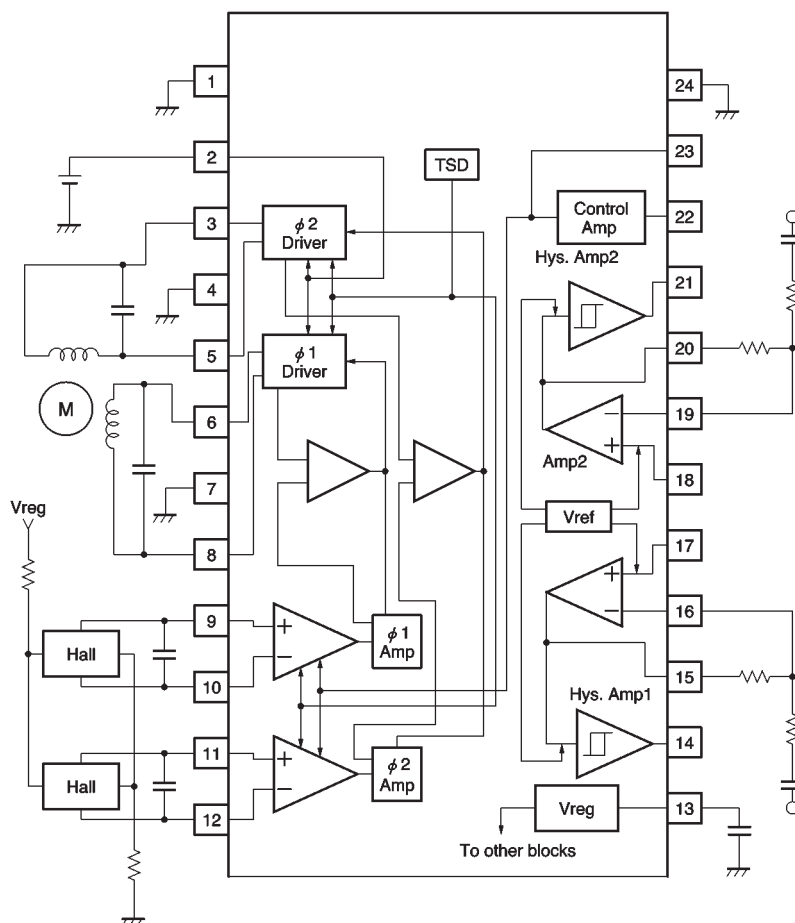
●Application example

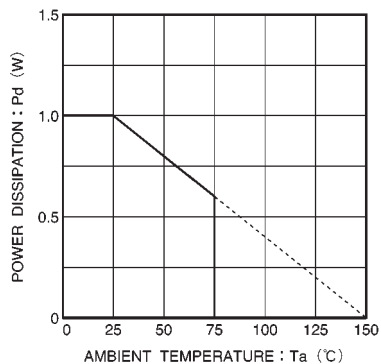Fig.12

●Electrical characteristic curves
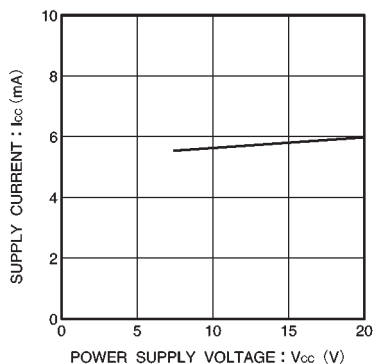

Fig.13   Thermal derating curve

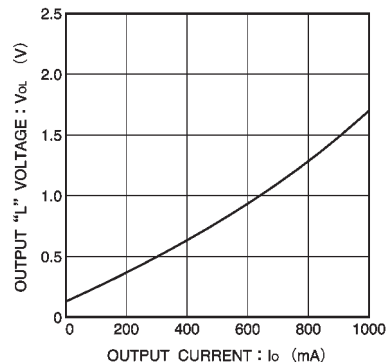Fig.14   Supply current vs. power supply voltage

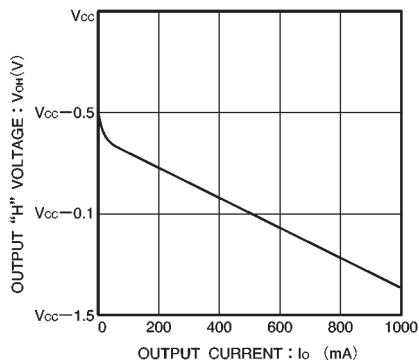Fig.15   Output low level voltage vs. output current

Fig.16   Output high level voltage vs. output current

●External dimensions (Units: mm)

SSOP-A24

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