BA6485AFP-Y

3-phase, full-wave, pseudo-linear motor driver

The BA6485AFP-Y is an IC that can be used to control and drive floppy disk drive spindle motors. This IC uses a 3-phase, full-wave pseudo-linear drive system.

With a built-in digital servo and power saving function, this device has a high performance and can reduce the number of components required in the floppy drive.

The gain of the FG amplifier can be changed by external component, making it suitable for use in the thin-type motors.

Features

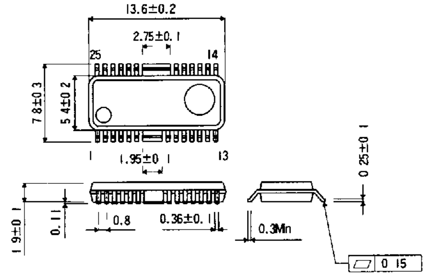
- available in HSOP25 package
- oscillator frequency is 1000.8 kHz
- switchable between 300 and 360 rpm
- low output saturation voltage with very small variations between phases
- built-in high performance digital servo circuit
- built-in Hall-effect elements power switch
- built-in current limiter and thermal shutdown

Applications

- floppy disk drive

Dimensions (Units : mm)

BA6485AFP-Y (HSOP25)



Block diagram

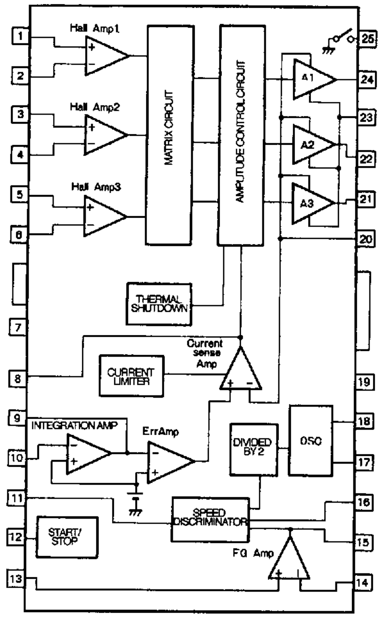


Table 1 Pin description (Sheet 1 of 2)

Pin no.	Pin name	Function
1	H1+	Hall input amplifier 1+ input
2	H1-	Hall input amplifier 1– input
3	H2+	Hall input amplifier 2+ input
4	H2-	Hall input amplifier 2– input
5	H3+	Hall input amplifier 3+ input
6	H3-	Hall input amplifier 3– input
7	S-GND	Signal ground
8	C_{NF}	Connection point for error amplifier output phase compensation capacitor
9	Err in	Error amplifier input (integration amplifier output)
10	F in	Integration amplifier inverted input
11	SD out	Speed discriminator output
12	ST / SP	Start/stop pin
13	FGin+	FG amplifier positive input

Table 1 Pin description (Sheet 2 of 2)

Pin no.	Pin name	Function
14	FGin-	FG amplifier inverted input
15	FGout	FG amplifier output
16	SC	Speed control input
17	OCS1	Oscillator output
18	OSC2	Oscillator input
19	V_{CC}	Power supply
20	R_{NF}	Driver voltage supply (current sense pin)
21	A3	Motor output 3
22	A2	Motor output 2
23	P-GND	Driver ground
24	A1	Motor output 1
25	H-GND	Hall bias switch (ground)

Absolute maximum ratings (T_a = 25°C)

Parameter	Symbol	Limits	Unit	Conditions
Power supply voltage	V_{CC}	7	V	
Power dissipation	P_d	1450	mW	Mounted on 90 mm×50 mm × 1.6 mm glass-epoxy PCB. Reduce power by 11.6 mW/°C for each degree above 25°C.
Output current	I_{Omax}	1000	mA	
Operating temperature	T_{opr}	−25 ~ +75	°C	
Storage temperature	T_{stg}	−55 ~ +150	°C	

Recommended operating conditions (T_a = 25°C)

Parameter	Symbol	Min	Typical	Max	Unit
Operating voltage	V_{CC}	4.2		6.5	V

Electrical characteristics (unless otherwise noted, T_a = 25°C, V_{CC} = 5 V)

Parameter	Symbol	Min	Typical	Max	Unit	Conditions
Supply current	I_{CC}	13	20	28	mA	
Stand-by current	I_{st}			3.0	μA	Pin 12 = 0 V
Hall in-phase input voltage	V_{HB}	1.5		4.5	V	
Hall amplifier input sensitivity	V_{Hin}	60			mV_{pk-pk}	Minimum differential input
Output saturation voltage	V_{sat}		0.95	1.20	V	V_{SAT} at I_{OUT} = 350 mA total, sum of high and low ends
Speed discriminator HIGH output level	V_{DH}	4.7	4.9		V	I = 500 μA (source)
Speed discriminator LOW output level	V_{DL}		0.1	0.25	V	I = 500 μA (sink)
Integration amp output H	V_{EinH}	2.8	3.0	3.2	V	Pin 10 = 2.0 V
Integration amp output L	V_{EinL}	1.3	1.5	1.7	V	Pin 10 = 3.0 V
FG amp open loop gain	G_{FG}	65	70		dB	f = 300 Hz
Speed discriminator minimum input	V_{FGmin}	250			mV_{pk-pk}	FG amplifier output
Speed discriminator noise margin	V_{FGnm}			60	mV_{pk-pk}	FG amplifier output
Error amplifier reference potential	V_{Err}	2.47	2.57	2.67	V	Pin 9 potential
Control input gain	G_{Err}	−14	−11	−7.5	dB	V_{RNF} with respect to $V_{pin\ 9}$, R_{NF} = 0.56 Ω
Oscillator frequency	f_{osc}		1000.8	1100	kHz	
Oscillation frequency accuracy	Δf_{osc}	−0.2		+0.2	%	f_{osc} = 1000.8 kHz
Current limiter voltage	V_{cl}	175	205	235	mV	Measured from pin 20 to V_{CC}. R_{NF} = 0.56 Ω
Pin 12 HIGH	V_{12H}	3.0		5.0	V	Operating state
Pin 12 LOW	V_{12L}	0.0		0.5	V	Standby state
Pin 16 HIGH	V_{16H}	1.5		5.0	V	f_{FG} = 360 Hz (phase locked)
Pin 16 LOW	V_{16L}	0.0		1.0	V	f_{FG} = 300 Hz (phase locked)
Pin 25 saturation voltage	V_{25}		0.8	1.0	V	Pin 25 current = 10 mA (sink)

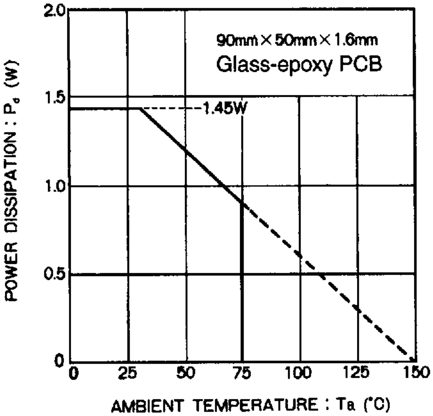


Figure 1

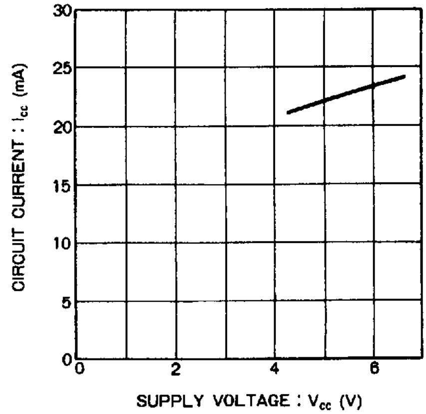


Figure 2

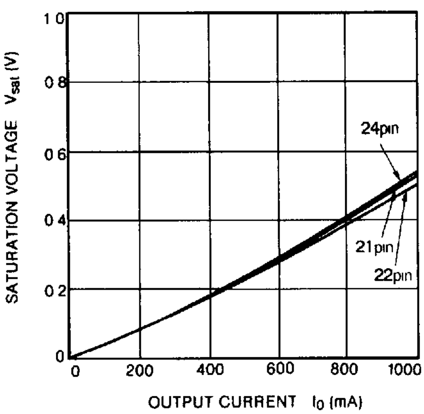


Figure 3

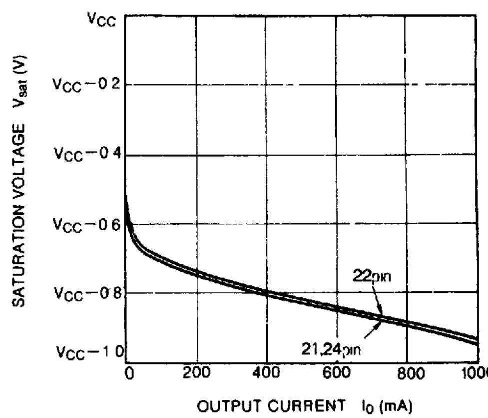


Figure 4

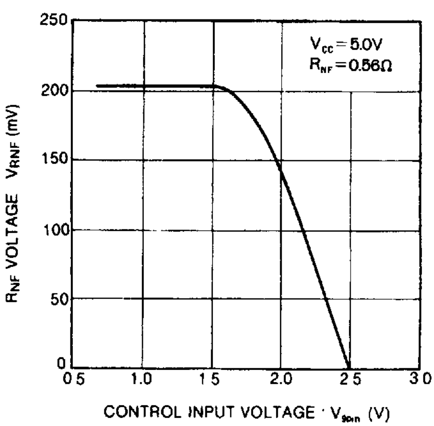


Figure 5

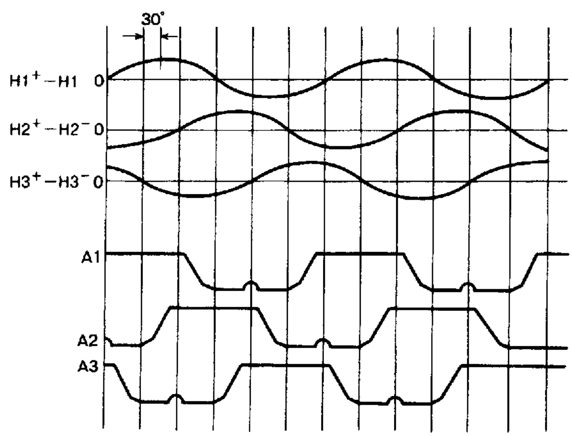
Operation

[Refer to Figure 17]

Hall inputs to driver outputs

Three Hall signals (for the three phases of the motor) are amplified in Hall amplifiers 1, 2, and 3, and applied to a matrix section, where they are further amplified and combined. After voltage-to-current conversion in the amplitude control circuit, the signals are fed to output drivers, which supply drive currents to the motor windings. Figure 6 shows the phase relationships between the Hall signal inputs and the current and voltage waveforms at the outputs of the drivers.

Figure 6 Hall input phase relationships



Error amplifier (pin 9) - current feedback amplifier (pins 8 and 20)

A control voltage from the integrator circuit is applied to the input of the error amplifier (pin 9). The output of the error amplifier is fed through a current feedback amplifier to the input of the amplitude control circuit, where it acts to control the output current. Pin 20 is the inverting input of the current feedback amplifier.

The external resistor (R_{NF}) is connected between pin 20 and V_{CC} to sense the current flowing in the motor windings. The voltage (across R_{NF}) is provided as feedback. The output current is limited by a current limiter circuit. The output current limit (I_{max}) is determined by the small resistance (R_{NF}) connected between pin 20 and V_{CC} as follows:

$$I_{max}(\text{typical}) = \frac{205\ \text{mV(typical)}}{R_{NF}}$$

Pin 8 is the current feedback amplifier output. To prevent amplifier oscillation, connect the capacitor C_{NF} between this pin and V_{CC}.

Start/stop (pin 12)

The ST/SP pin controls switching between the run and standby states. In the run state, motor power is supplied. In the standby mode, all transistors are off and no motor drive current is supplied, and I_{CC} is zero.

Oscillator (pins 17 and 18)

The oscillator generates the master clock for the logic circuits. You can either connect a ceramic resonator and capacitors, as shown in Figure 17, or provide an external clock signal, inputting it directly to pin 18. The maximum operating frequency is 1100 kHz.

Speed selection (Pin 16)

The voltage level at pin 16 determines the modulus of an internal clock divider, which controls the motor speed. The selectable motor speeds are 300 and 360 rpm.

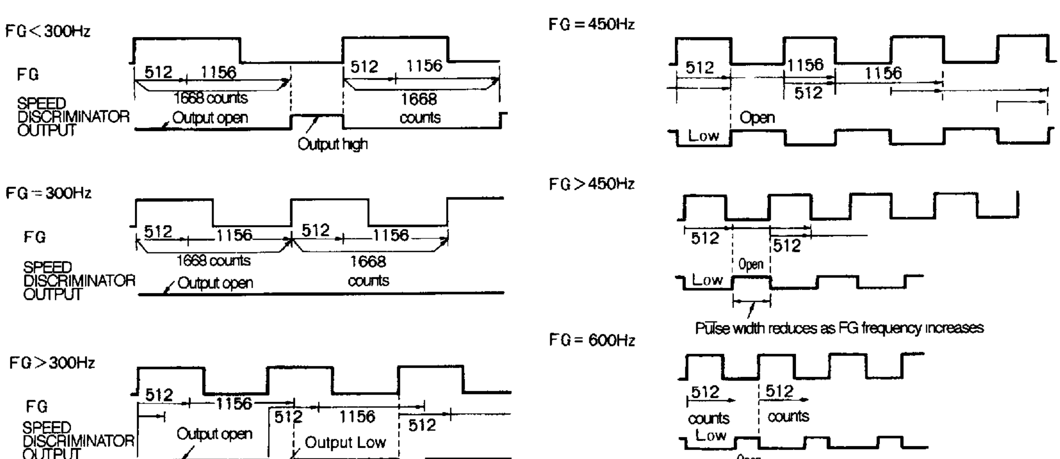
FG amplifier (pins 13, 14 and 15)

The FG amplifier amplifies the FG signal from the motor. The gain can be set by external components. Following amplification, the FG signal is passed through a Schmitt (hysteresis) circuit and applied as an input to the motor speed logic.

Speed discriminator (pin 11)

The speed discriminator compares the frequency of the FG signal to that of a reference signal derived by dividing the clock. It then outputs, at pin 11, a PWM signal corresponding to the difference between the FG and the reference signals. (See Figure 7.)

Figure 7



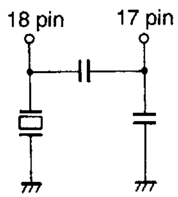
Precautions for use

Ceramic resonator external circuit constants

The proper values for externally-connected circuit constants depend on the ceramic resonator used. The circuit constants should be decided only after you have determined which manufacturer's resonator you will be using, and have studied the resonator.

The circuit is shown in Figure 8. The decision as to which capacitors to use should be largely based on the precision and temperature characteristics of the capacitors.

Figure 8 Ceramic resonator external circuit



External clock oscillator

An external clock can be directly coupled to the OSC2 pin (pin 18). When you use an external clock, ensure that nothing is connected to pin 17 and that the voltage peaks at the OSC2 pin do not exceed the voltage on V_{CC} or fall below ground potential.

Oscillator frequency vs. motor speed

The speed of rotation of the motor (FG amp output, at pin 15) may vary due to variances in integrator circuit constants and the performance characteristics of the motor. You can correct the motor speed to compensate for these variances by adjusting the oscillator frequency. The frequency can be finely adjusted by changing the values of the external capacitors. For detailed information on how to do this, consult the ceramic resonator manufacturer.

Thermal shutdown (TSD)

At a temperature of typically 170°C, the TSD circuit opens the A1, A2, and A3 outputs and the motor shuts down. The TSD circuit resets when the temperature falls below 145°C (typically).

Hall element connection methods

Hall elements can be connected in series or parallel. If the elements are connected in series, however, care must be taken not to allow the Hall element output to exceed the Hall in-phase input range (V_{HB}), as listed in the “Electrical characteristics” table.

Hall element input levels

Excessively large signals on the Hall inputs can cause switching noise. The differential input amplitude should be kept to about 100 mV_{pk-pk} to minimize this effect.

Driver section ground pin (pin 23)

Pin 23, the motor current ground, is not connected to the signal ground on pin 7. This pin is in the motor current path, and the conductor trace must be wide enough to carry the motor current.

Cooling fin and pin 7

The cooling fin must be connected to the IC substrate. Pin 7 is the signal ground. Both the cooling fin and pin 7 must be connected to the ground trace of the PCB.

Input and output equivalent circuits

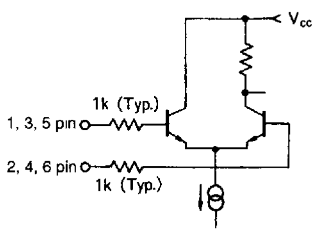


Figure 9 Hall inputs (pins 1 ~ 6)

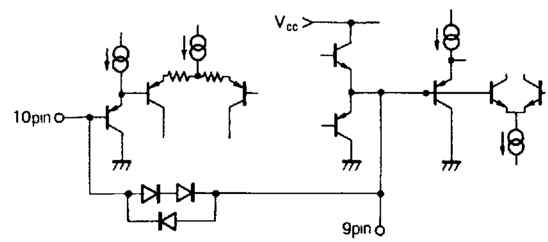


Figure 10 Integration amplifier (pins 9, 10)

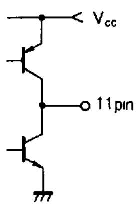


Figure 11 Speed discriminator (pin 11)

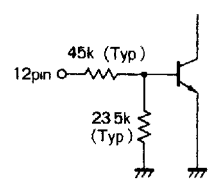


Figure 12 Start/stop circuit (pin 12)

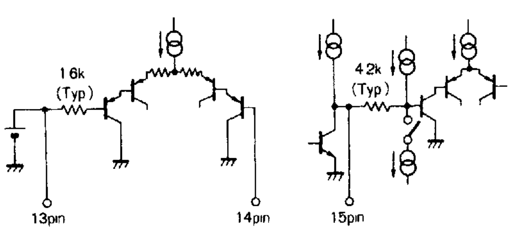


Figure 13 FG control amplifier (pins 13 ~ 15)

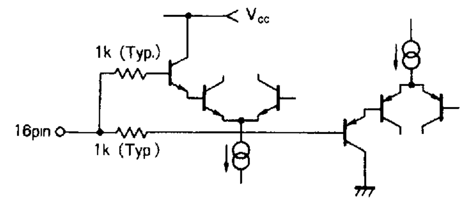


Figure 14 Speed controller (pin 16)

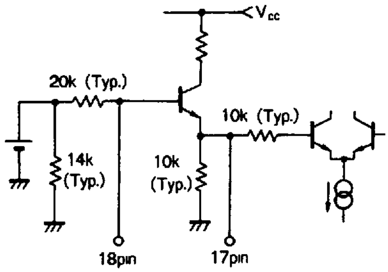


Figure 15 Oscillator (pins 17 and 18)

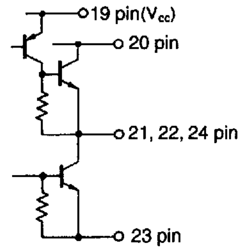


Figure 16 Motor output (pins 19 ~ 24)

Figure 17 Application example

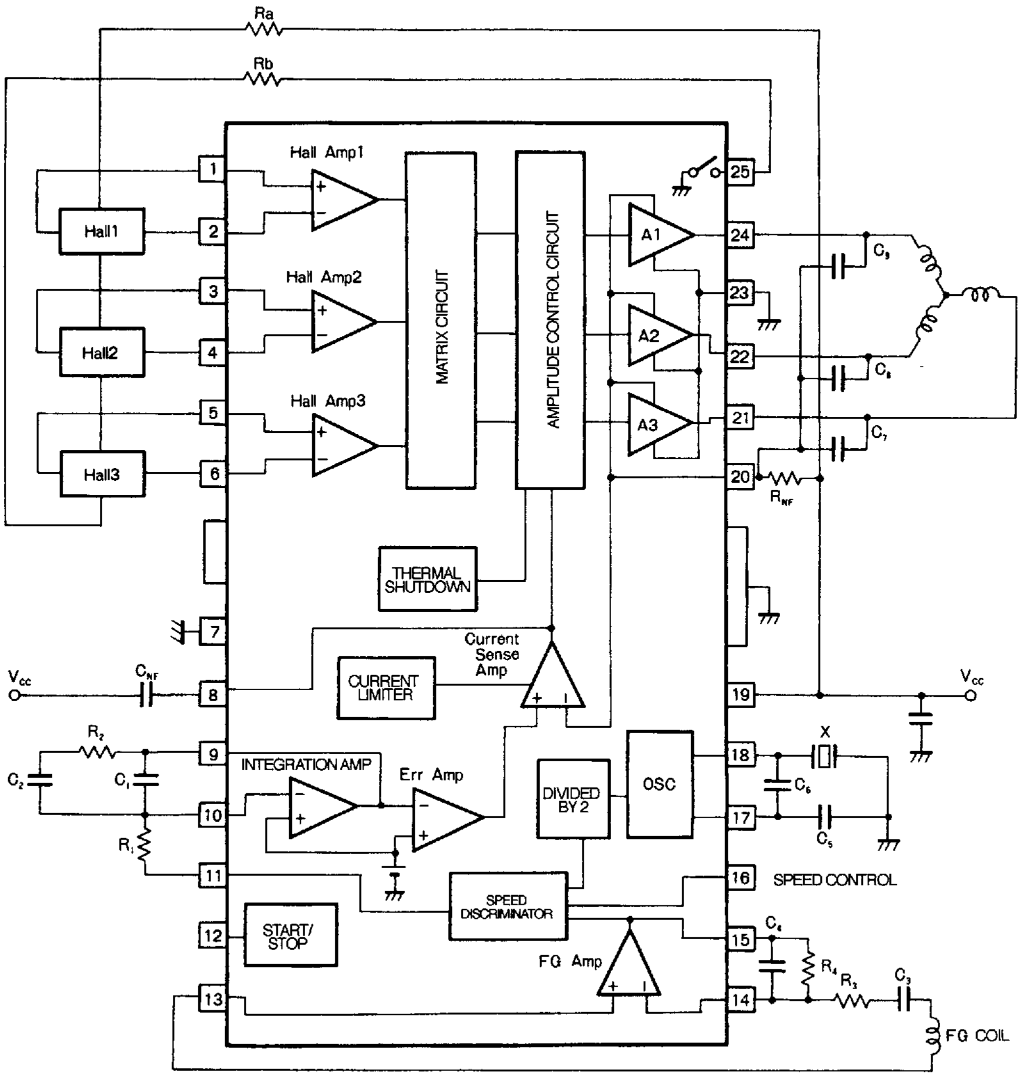


Table 2 External component function

Component	Function
R_a, R_b	Determine Hall element current, output bias
C_{NF}	Output current phase compensation capacitors
C_1	Integration circuit constant
R_1	Integration circuit constant
C_2	Integration circuit constant
R_2	Integration circuit constant
C_3	FG amplifier input coupling capacitor
R_3, R_4	FG amplifier gain
C_4	FG amplifier high frequency cut-off constant
C_5, C_6	Oscillator capacitors
C_7, C_8, C_9	For output waveform stabilization