

# HA13456A/AMP

## Three-Phase Brushless DC Motor Driver

### Description

The HA13456/AMP three-phase brushless DC motor driver can provide an output current of 1.0 A per phase. It is intended for use as a floppy disk drive spindle motor driver.

### Features

- Single-chip motor driver
- Digital control eliminates need for calibration
- Low current consumption

### Functions

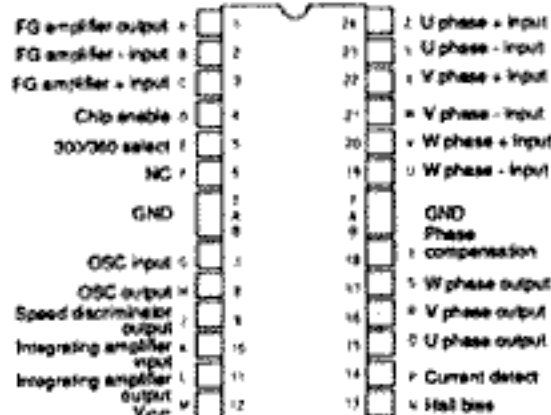
- 1.0-A three-phase output circuit
- Hall amplifier matrix
- Control amplifier (current control)
- FG amplifier, zero-cross detector
- Oscillator circuit
- High-speed discriminator
- 300 or 360 rpm
- Integrating amplifier
- Current limiter
- Overtemperature shutdown (OTSD)
- Chip enable

### Product Line-up

Name	Package
HA13456A	DP-24TS
HA13456AMP	MP-28T

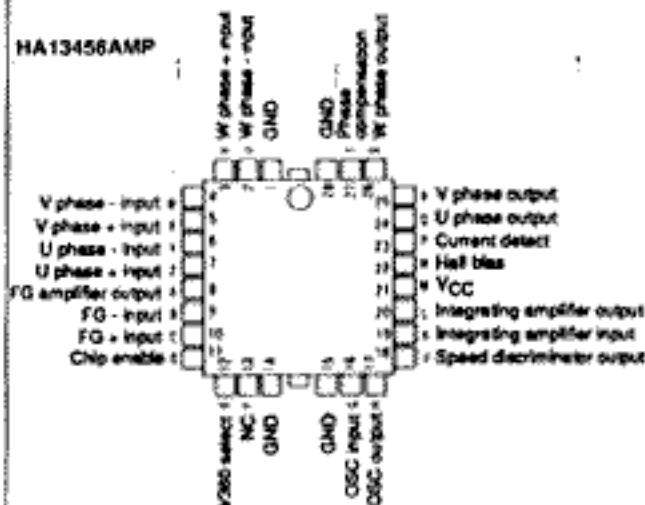
### Pin Arrangement

HA13456A



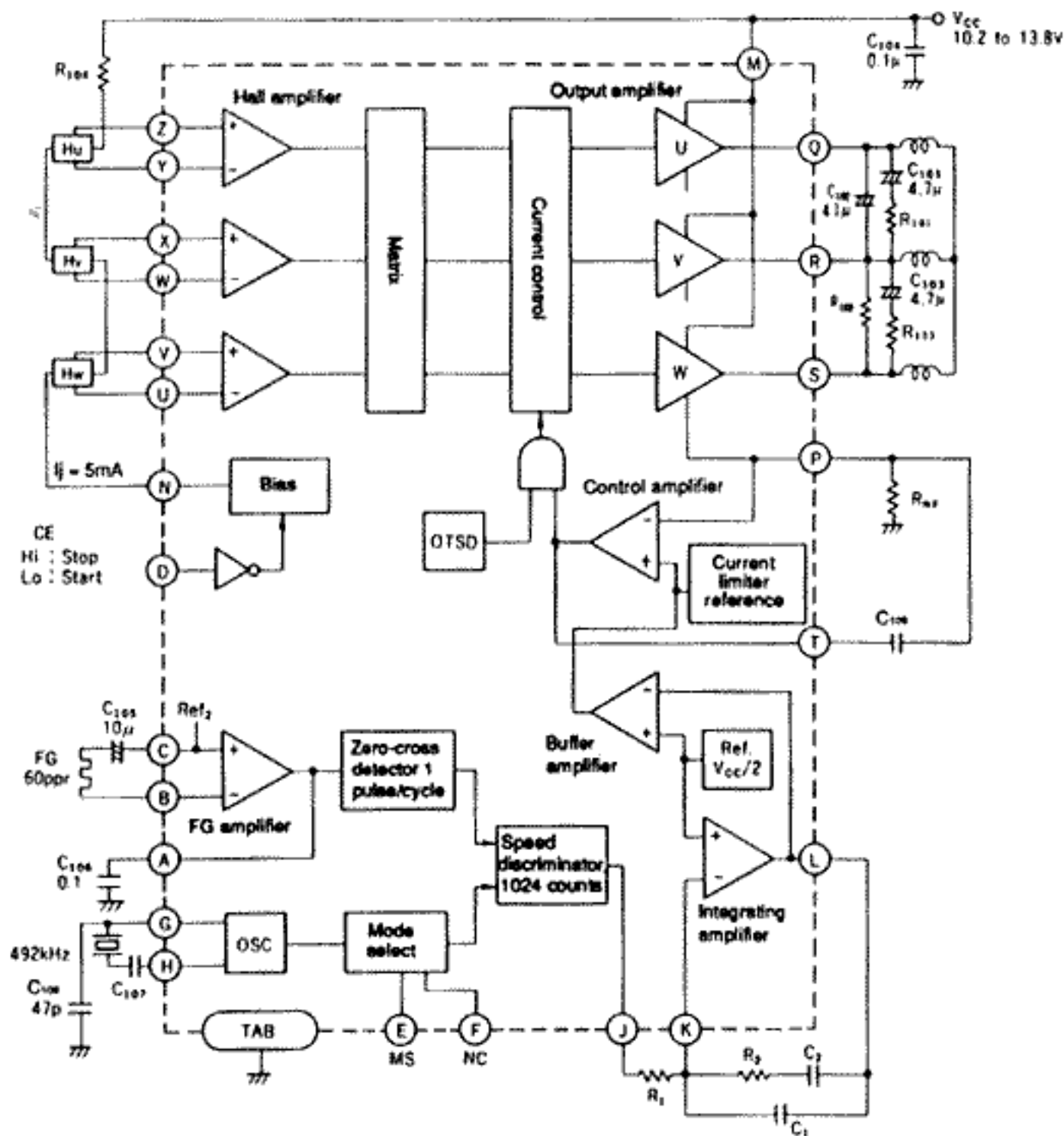
(Top View)

HA13456AMP



(Top View)

## Block Diagram



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## Truth Table

Chip Enable CE	Hall amplifier input						Output		
	U+	U-	V+	V-	W+	W-	U	V	W
L	H	L	L	H	H	L	H	L	Open
	H	L	L	H	L	H	H	Open	L
	H	L	H	L	L	H	Open	H	L
	L	H	H	L	L	H	L	H	Open
	L	H	H	L	H	L	L	Open	H
	L	H	L	H	H	L	Open	L	H
H	X	X	X	X	X	X	Open	Open	Open

## Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating	Unit	Notes
Power supply voltage	V <sub>CC</sub>	+15	V	1
Peak output current	I <sub>op</sub>	1.0	A	2
Normal output current	I <sub>o</sub>	0.7	A	
Input voltage	V <sub>in</sub>	-0.5 to V <sub>CC</sub>	V	3
Power dissipation	P <sub>f</sub>	2	W	4
Junction temperature	T <sub>j</sub>	150	°C	5
Storage temperature	T <sub>stg</sub>	-55 to +125	°C	

## Notes:

1. The operating voltage range (V<sub>CC</sub>) is 10.2 to 13.8 V.
2. t ≤ 0.5 seconds
3. Applies to chip enable CE and mode select MS pins.
4. For T<sub>c</sub>=100°C. Thermal resistance is as follows.  
θ<sub>j-c</sub> ≤ 20°C/W  
θ<sub>j-a</sub> ≤ 60°C/W (when using glass epoxy baseplate)
5. Operating junction temperature (T<sub>jopr</sub>) range is 0 to 125°C.

Electrical Characteristics ( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 12\text{V}$ )

Item	Symbol	Min	Typ	Max	Unit	Test Conditions	Pins		Notes	
							DP-24TS	MP-28T		
Quiescent current	$I_{Q1}$	—	0.45	1.0	mA	$CE = 2\text{V}$	12	21	1	
	$I_{Q2}$	—	15	23	mA	$CE = 0.8\text{V}$ , $R_L = \text{OPEN}$				
Input low voltage	$V_{IL}$	—	—	0.8	V		4, 5	11, 12		
Input high voltage	$V_{IH}$	2.0	—	$V_{CC}$	V					
Input low current	$I_{IL}$	—	—	$\pm 20$	$\mu\text{A}$	$V_{IL} = 0\text{V}$				
Input high current	$I_{IH}$	50	—	200	$\mu\text{A}$	$V_{IH} = 2\text{V}$	4	11		
		—	—	$\pm 10$	$\mu\text{A}$		5	12		
Hall amplifier	Input current	$I_{HB}$	—	—	$\pm 10$	$\mu\text{A}$	$V_H = 2\text{V}$	19–24	2–7	
	Input common mode voltage range	$V_H$	1.5	—	$V_{CC}$	V				
				—1.0						
	Differential input voltage range	$U_H$	75	—	—	mVpp				
Hall bias	Output voltage	$V_{HB}$	1.2	1.6	2.0	V	$CE = 0.8\text{V}$ , $I_D = 5\text{mA}$	13	22	
	Leakage current	$I_{H\text{ off}}$	—	—	$\pm 10$	$\mu\text{A}$	$CE = 2\text{V}$ , $V_{CE} = 15\text{V}$			
Output amplifier	Leakage current	$I_{CER}$	—	—	$\pm 1$	mA	$CE = 2\text{V}$ , $V_{CE} = 15\text{V}$	15,	24,	
	Saturation voltage	$V_{sat}$	—	1.5	2.2	V	$I_D = 0.7\text{A}$	16,	25,	2
—			1.2	1.6	V	$I_D = 0.35\text{A}$	17,	26		
Current limiter reference voltage	$V_{ref1}$	370	410	450	V		14	23		
Control amplifier	Voltage gain	$G_{CTL}$	-2	0	+2	V		14	23	
	Phase deviation	$\Delta G_{CTL}$	—	—	$\pm 1.0$	dB				
Integrating amplifier	Reference voltage	$V_{ref2}$	—	6.3	—	dB		10	19	
	Input current	$I_{B1}$	—	—	$\pm 50$	nA				
	Output voltage amplitude	$A+$	—	0.7	—	V	$I_g = -0.5\text{mA}$	11	20	3
			—	-1.3	—	V	$I_g = 0.5\text{mA}$			
Gain bandwidth	$BW_D$	—	300	—	kHz	$G_V = 0\text{dB}$				
Speed discriminator	Output high voltage	$V_{DOH}$	$V_{CC}$	—	—	V	$I_{10} = 0.5\text{mA}$	9	18	
			-0.3							
	Output low voltage	$V_{DOL}$	—	—	0.3	V	$I_{10} = -0.5\text{mA}$			
	Output cutoff current	$I_{D\text{ off}}$	—	—	$\pm 50$	nA	$V = 2.5\text{V}$			
	Operating frequency	$f_D$	—	—	1000	kHz				
	Number of counts	$N_D$	—	1024	—	—				
OSC	Frequency range	$f_{OSC}$	—	—	1000	kHz		8	17	
	Frequency error	$\Delta f_{OSC}$	—	—	$\pm 0.2$	%	492 kHz			
FG amplifier	Voltage gain	$G_{FG}$	38	40	42	dB	$f = 300\text{Hz}$	1	8	
	Undistorted maximum output voltage	$V_O$	0.4	—	—	Vrms				
	Input voltage	$V_I$	2	—	—	mVpp		2, 3	9, 10	
OTSD	Operating temperature	$T_{ad}$	12.5	—	—	$^\circ\text{C}$				4

## Notes.

1. Not including Hall bias current.
2. Sum of upper and lower saturation voltages.
3. Based on  $V_{ref2}$ .
4. For reference only; not tested before delivery.

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## External Components

Part No.	Reference Value	Purpose	Notes
	12 V, 5.25" FDD		
R <sub>101</sub> , R <sub>102</sub> , R <sub>103</sub>	4.7 Ω	Stability	
R <sub>104</sub>	1.8 kΩ	Hall amplifier bias	
R <sub>1</sub>	56 kΩ	Integration constant	
R <sub>2</sub>	56 kΩ	Integration constant	
R <sub>NF</sub>	0.39 Ω	Current detect	1
C <sub>101</sub> , C <sub>102</sub> , C <sub>103</sub>	4.7 μF	Stability	2
C <sub>104</sub>	0.1 μF	Power supply bypass	3
C <sub>105</sub>	10 μF	AC connection to FG amplifier	
C <sub>106</sub>	0.1 μF	Bandwidth setting for FG amplifier	
C <sub>107</sub>	47 pF	AC connection to oscillator	
C <sub>108</sub>	47 pF	Stability	
C <sub>109</sub>	0.1 μF	Control amplifier phase compensation	
C <sub>1</sub>	0.04 μF	Integration constant	4
C <sub>2</sub>	0.47 μF	Integration constant	4
X <sub>tal</sub>	492 kHz	Oscillator	5

### Notes:

1. The current limiter operates according to the following equation.

$$I_{O \max} = \frac{V_{ref} 1}{R_{NF}}$$

2. Use non-polar capacitors.
3. Place as close as possible to the IC.
4. Use non-polar capacitor with low leakage current.
5. The relationship between the oscillator frequency  $f_{osc}(\text{Hz})$  and the FG frequency  $f_{FG}(\text{Hz})$  is as follows.
  - a. When MS = high:

$$f_{osc} = \frac{8 \times 1024 \times f_{FG}}{8}$$

- b. When MS = low:

$$8 \times 1024 \times f_{FG}$$