HA13440

Three-Phase Brushless DC Motor Driver

Description

The HA13440MP three-phase brushless DC motor drive (output current: 1.0 A/phase) is designed to drive FDD (Floppy Disk Drive) spindle motor.

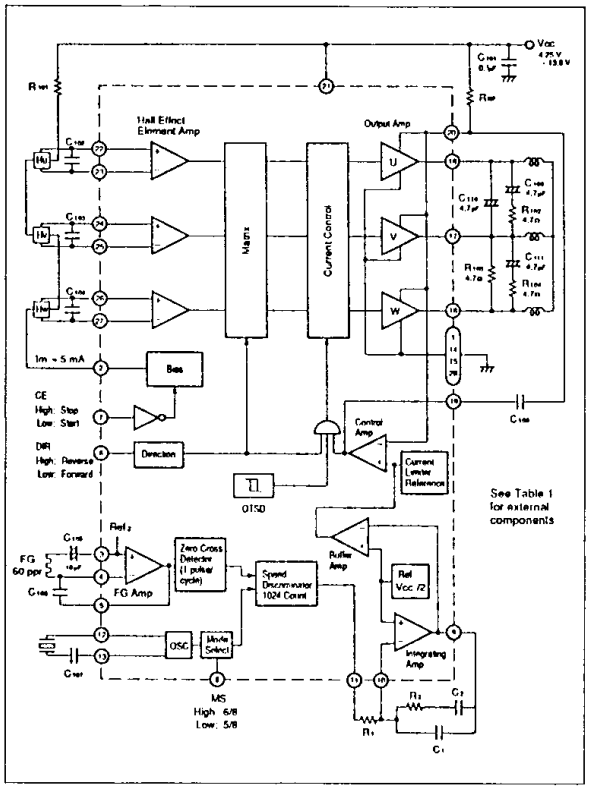
Functions

- 1.0 A three-phase output circuit
- Hall-effect element amp matrix
- Control amp (current control)
- Direction control
- FG amp, zero cross detector
- Oscillation circuit
- Speed discriminator
- 300/360 rpm select
- Integrating amp
- Current limiter
- Over Temperature Shut Down (OTSD)
- Chip enable

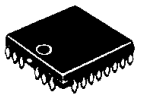
Features

- Servo system on a single chip
- Digital control requires no adjustment
- +5 V operation (operating voltage range: 4.25 to 13.8 V)
- Low power dissipation
- Small, low thermal resistance surface-mount package

Block Diagram

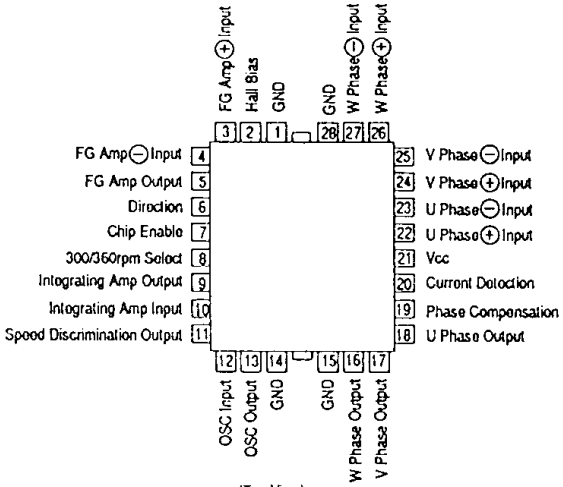


HA13440MP/HA13440NMP



(MP-28T)

Pin Arrangement



Ordering Information

Type No.	Package
HA13440	MP-28T
HA13440MS	MS-28
HA13440NMP	MP-28T

Table 1 Truth Table

Chip Enable CE	Direction DIR	Hall-Effect Element Amp Input						Output		
		U+	U–	V+	V–	W+	W–	U	V	W
L	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	H	L	L	H	H	L	L	H	Open
		H	L	L	H	L	H	L	Open	H
		H	L	H	L	L	H	Open	L	H
		L	H	H	L	L	H	H	L	Open
		L	H	H	L	H	L	H	Open	L
		L	H	L	H	H	L	Open	H	L
H	X	X	X	X	X	X	X	Open	Open	Open

Table 2 External Components

Part No.	Recommended Value		Purpose	Note
	5 V/3.5" FDD	12 V/5.25" FDD		
R_{101}, R_{102}, R_{103}	4.7 Ω	4.7 Ω	Stability	
R_{104}	330 Ω	1.8 kΩ	Hall-effect element bias	
R_1	56 kΩ	56 kΩ	Integral constant	
R_2	150 kΩ	56 kΩ	Integral constant	
R_{NF}	0.62 Ω	0.39 Ω	Current detection	1
C_{101}, C_{102}, C_{103}	4.7 µF	4.7 µF	Stability	2

External Components (cont)

C_{104}	0.1 µF	0.1 µF	Supply bypass	3
C_{105}	10 µF	10 µF	FG amp AC coupling	
C_{106}	4700 pF	4700 pF	FG amp band setting	
C_{107}	47 pF	47 pF	Oscillation AC coupling	
C_{108}	0.1 µF	0.1 µF	Control amp phase compensation	
C_{109}, C_{110}, C_{111}	0.01 µF	0.01 µF	Stability	
C_1	0.022 µF	0.047 µF	Integral constant	5
C_2	0.22 µF	0.47 µF	Integral constant	5
X'tal	492 kHz	492 kHz		4

Notes: 1. Current limiter operates by the following equation:

$$Iomax = \frac{V_{ref1}}{R_{NF}}$$

2. Use non-polar type.
3. Place as near the IC as possible.
4. Oscillation frequency (fosc) is determined by the following equation:
   (1) When 300/360 selection is high level,

$$fosc = \frac{8192}{6} f_{FG} \quad (Hz)$$

   (2) When 300/360 selection is low level,

$$fosc = \frac{8192}{5} f_{FG} \quad (Hz)$$

5. Use small leak current.

Table 3 Absolute Maximum Ratings (Ta= 25 °C)

Item	Symbol	Rating	Unit	Note
Supply voltage	Vcc	+15	V	1
Instantaneous output current	Iop	1.0	A	2
Continuous output current	Io	0.7	A	
Input voltage	V_{IN}	+7	V	3
Power dissipation	P_T	2	W	4

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

Junction temperature	Tj	150	°C	5
Storage temperature range	Tstg	–55 to +125	°C	

The absolute maximum ratings are limiting values, to be applied individually, beyond which the device may be permanently damaged. Functional operation under any of these conditions is not guaranteed. Exposing a circuit to its absolute maximum rating for extended periods of time may affect the device's reliability.

Notes:
1. Operating voltage range is:
   Vcc = 4.25 to 13.8 V
2. t ≤ 0.5 second
3. Chip enable CE, direction DIR, and mode select MS terminals
4. Pin, 1, 14, 15, and 28=100 °C. Thermal resistance is:
   θj-pin ≤ 25 °C/W
   θj-a ≤ 55 °C/W(metal base substrate)
   θj-a ≤ 80 °C/W(glass-epoxy board)
5. Operating junction temperature is:
   Tjopr=0 to +125 °C

Table 4 Electrical Characteristics (Ta=25 °C, Vcc=4.25 to 13.8 V)

Item		Symbol	Min	Typ	Max	Unit	Test condition	Applicable Terminal	Note
Quiescent current		I_{Q1}	—	0.15	0.5	mA	CE=2 V	20, 21	1
		I_{Q2}	—	15	23	mA	CE=0.8 V, R_L=Open	20, 21	1
Input low voltage		V_{IL}	—	—	0.8	V		6, 7, 8	
Input high voltage		V_{IH}	2.0	—	Vcc	V			
Input low current		I_{IL}	—	—	±10	μA	V_{IL}=0 V		
Input high current		I_{IH}	—	—	±10	μA	V_{IH}=2 V		
Hall-effect element amp	Input current	I_{HB}	—	—	±10	μA	V_H=2 V	22 to 27	
	Common mode input voltage	V_H	1.5	—	Vcc–1.0	V			
	Differential input voltage range	U_H	70	—	200	mVpp			
Hall-effect elemnent bias	Output voltage	V_{HB}	1.2	1.6	2.0	V	CE=0.8 V, Ij=5 mA	2	
	Leak current	I_H off	—	—	±10	μA	CE=2 V, V_{CE}=15 V		

Electrical Characteristics (cont)

Output amp	Leak current	I_{CER}	—	—	100	μA	C_E=2 V, V_{CE}=15 V	16, 17, 18	
	Saturation voltage	Vsat	—	1.3	1.8	V	Io=0.7 A		2
			—	1.0	1.2	V	Io=0.35 A		2
Current limiter reference voltage		V_{ref1}	0.225	0.25	0.275	V		20	3
Control amp	Reference voltage	V_{ref2}	0.9 Vcc/2	Vcc/2	1.1 Vcc/2	V		10	4
	Voltage gain	G_{CTL}	−12	−10	−8	dB		16, 17, 18	
	Voltage gain difference	ΔG_{CTL}	—	—	±1.0	dB			
Integrating amp	Input current	I_{B1}	—	—	±50	nA		10	
	Output voltage amplitude	A+	0.62	0.72	0.82	V	I⑨=0.5 mA	9	5
		A−	−1.64	−1.44	−1.22	V	I⑨=−0.5 mA		5
	Gain band width	BW_D	100	300	1000	kHz	Gv=0 dB		
Speed discriminator	Output high voltage	V_{DOH}	Vcc−0.3	—	—	V	Io=0.5 mA	11	
	Output low voltage	V_{DOL}	—	—	0.3	V	Io=−0.5 mA		
	Cut-off current	I_D off	—	—	±50	nA	V=2.5 V		
	Operating frequency	f_D	—	—	1000	kHz			
	Count number	N_D	—	1024	—				
OSC	Oscillation frequency range	fosc	—	—	1000	kHz		13	
	Oscillation frequency error	Δfosc	—	—	±0.2	%	492 kHz (ceramic oscillation)		

Electrical Characteristics (cont)

FG amp	Voltage gain	G_{FG}	39	41	43	dB	f=300 Hz	5	
	Gain band width	BW_2	5	10	20	kHz	C_{108}=0, G_{FG}=−3 dB		
	Input resistance	Ri	120	180	240	Ω		3	
	Distortionless output voltage	Vo	1.0	—	—	Vrms	f=300 Hz	5	
Zero cross detection	Hysteresis	Vhys	35	50	65	mV		5	
	Offset voltage	Vos	—	—	±10	mV			
OTSD	Operating temperature	Tsd	125	—	—	°C			
	Hysteresis	Thys	—	25	—	°C			

Notes:
1. Sum of pins ⑳, ㉑ current
2. Sum of upper and lower transistor saturation voltage
3. Measure from V_{CC} pin
4. If V_{CC}>11.2 V, the value is 5.6 V ±10 %
5. Measure from V_{ref2}