

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.

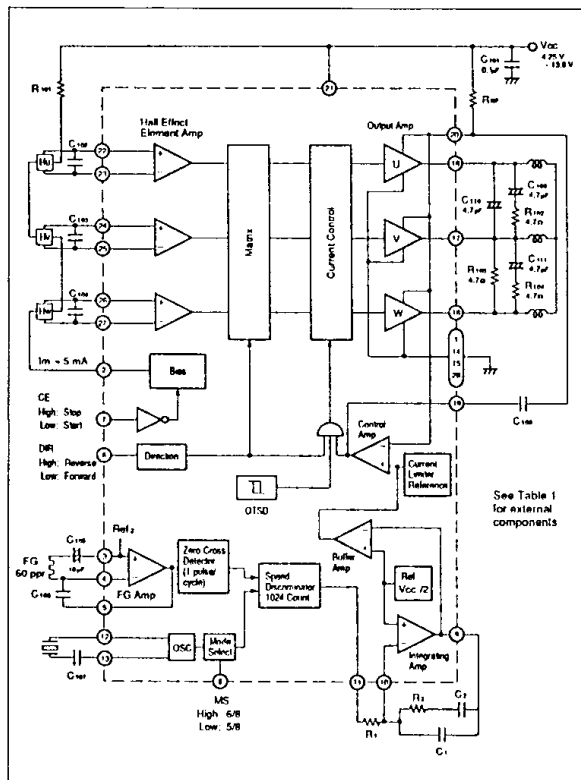
Functions

- 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

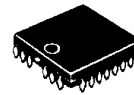
Features

- 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

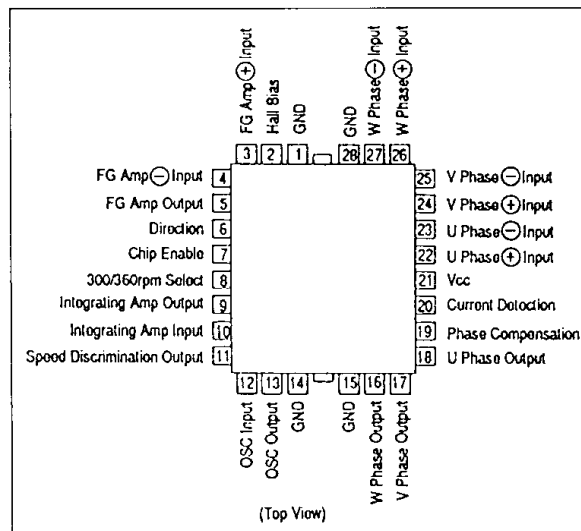


HA13440MP/HA13440NMP



(MP-28T)

Pin Arrangement



Ordering Information

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



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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		
R101, R102, R103	4.7 Ω	4.7 Ω	Stability	
R104	330 Ω	1.8 k Ω	Hall-effect element bias	
R1	56 k Ω	56 k Ω	Integral constant	
R2	150 k Ω	56 k Ω	Integral constant	
RNF	0.62 Ω	0.39 Ω	Current detection	1
C101, C102, C103	4.7 μ F	4.7 μ F	Stability	2



External Components (cont)

C ₁₀₄	0.1 μ F	0.1 μ F	Supply bypass	3
C ₁₀₅	10 μ F	10 μ F	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 μ F	0.1 μ F	Control amp phase compensation	
C ₁₀₉ , C ₁₁₀ , C ₁₁₁	0.01 μ F	0.01 μ F	Stability	
C ₁	0.022 μ F	0.047 μ F	Integral constant	5
C ₂	0.22 μ F	0.47 μ F	Integral constant	5
X'tal	492 kHz	492 kHz		4

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

$$I_{\text{omax}} = \frac{V_{\text{ref1}}}{R_{\text{NF}}}$$

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,

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

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

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

5. Use small leak current.

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

Item	Symbol	Rating	Unit	Note
Supply voltage	V _{CC}	+15	V	1
Instantaneous output current	I _{op}	1.0	A	2
Continuous output current	I _o	0.7	A	
Input voltage	V _{IN}	+7	V	3
Power dissipation	P _T	2	W	4



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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. $t \leq 0.5$ second
3. Chip enable CE, direction DIR, and mode select MS terminals
4. Pin, 1, 14, 15, and 28=100 °C. Thermal resistance is:
 $\theta_{j-pin} \leq 25$ °C/W
 $\theta_{j-a} \leq 55$ °C/W(metal base substrate)
 $\theta_{j-a} \leq 80$ °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	Iq1	—	0.15	0.5	mA	CE=2 V	20, 21	1
	Iq2	—	15	23	mA	CE=0.8 V, RL=Open	20, 21	1
Input low voltage	VIL	—	—	0.8	V		6, 7, 8	
Input high voltage	VIH	2.0	—	Vcc	V			
Input low current	IL	—	—	±10	μA	VIL=0 V		
Input high current	IH	—	—	±10	μA	VIH=2 V		
Hall-effect element amp	Input current	IHB	—	±10	μA	VH=2 V	22 to 27	
	Common mode input voltage	VH	1.5	—	Vcc−1.0	V		
	Differential input voltage range	UH	70	—	200	mVpp		
Hall-effect element bias	Output voltage	VHB	1.2	1.6	2.0	V	CE=0.8 V, Ij=5 mA	2
	Leak current	IH off	—	±10	μA	CE=2 V, VCE=15 V		



Electrical Characteristics (cont)

Output amp	Leak current	I _{CER}	—	—	100	μA	CE=2 V, V _{CE} =15 V	16, 17, 18	
	Saturation voltage	V _{sat}	—	1.3	1.8	V	I _o =0.7 A		2
			—	1.0	1.2	V	I _o =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 V _{CC} /2	V _{CC} /2	1.1 V _{CC} /2V			10	4
	Voltage gain	G _{CTL}	−12	−10	−8	dB		16, 17, 18	
	Voltage gain difference	ΔG _{CTL}	—	—	±1.0	dB			
Integrat- ing amp	Input current	I _{B1}	—	—	±50	nA		10	
	Output voltage amplitude	A+	0.62	0.72	0.82	V	I _Ⓢ =0.5 mA	9	5
		A−	−1.64	−1.44	−1.22	V	I _Ⓢ =−0.5 mA		5
	Gain band width	BW _D	100	300	1000	kHz	G _v =0 dB		
Speed discrimi- nator	Output high voltage	V _{DOH}	V _{CC} −0.3	—	—	V	I _o =0.5 mA	11	
	Output low voltage	V _{DOL}	—	—	0.3	V	I _o =−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	f _{osc}	—	—	1000	kHz		13	
	Oscillation frequency error	Δf _{osc}	—	—	±0.2	%	492 kHz (ceramic oscillation)		

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Electrical Characteristics (cont)

FG amp	Voltage gain	GFG	39	41	43	dB	f=300 Hz	5
	Gain band width	BW ₂	5	10	20	kHz	C ₁₀₈ =0, GFG=-3 dB	
	Input resistance	R _i	120	180	240	Ω		3
	Distortionless output voltage	V _o	1.0	—	—	V _{rms}	f=300 Hz	5
Zero cross detection	Hysteresis	V _{hys}	35	50	65	mV		5
	Offset voltage	V _{os}	—	—	±10	mV		
OTSD	Operating temperature	T _{sd}	125	—	—	°C		
	Hysteresis	Thys	—	25	—	°C		

- Notes:
1. Sum of pins ②①, ②② 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}

