HA13471, HA13472

Three-Phase Brushless Motor Driver

Description

The HA13471 and HA13472 are three-phase brushless motor drivers intended for use as spindle motor drivers in hard disk drives.

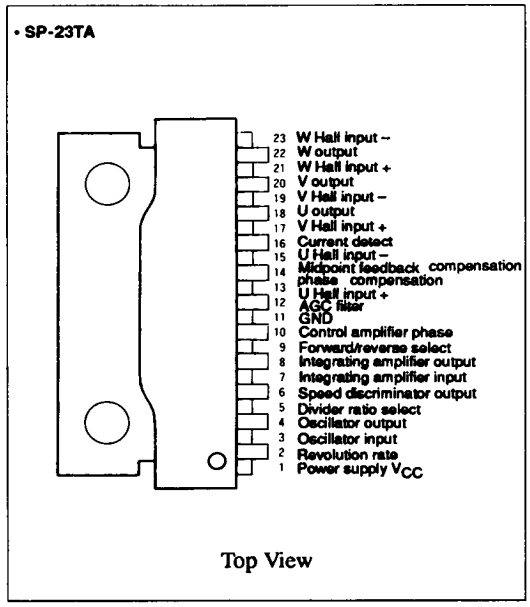
Features

- Soft switching (no voltage spike occurs during phase switching)
- Output stage snubber circuit not needed
- High output current
  —2.0 A/phase (HA13471)
  —4.0 A/phase (HA13472)
- High-efficiency, low-noise operation

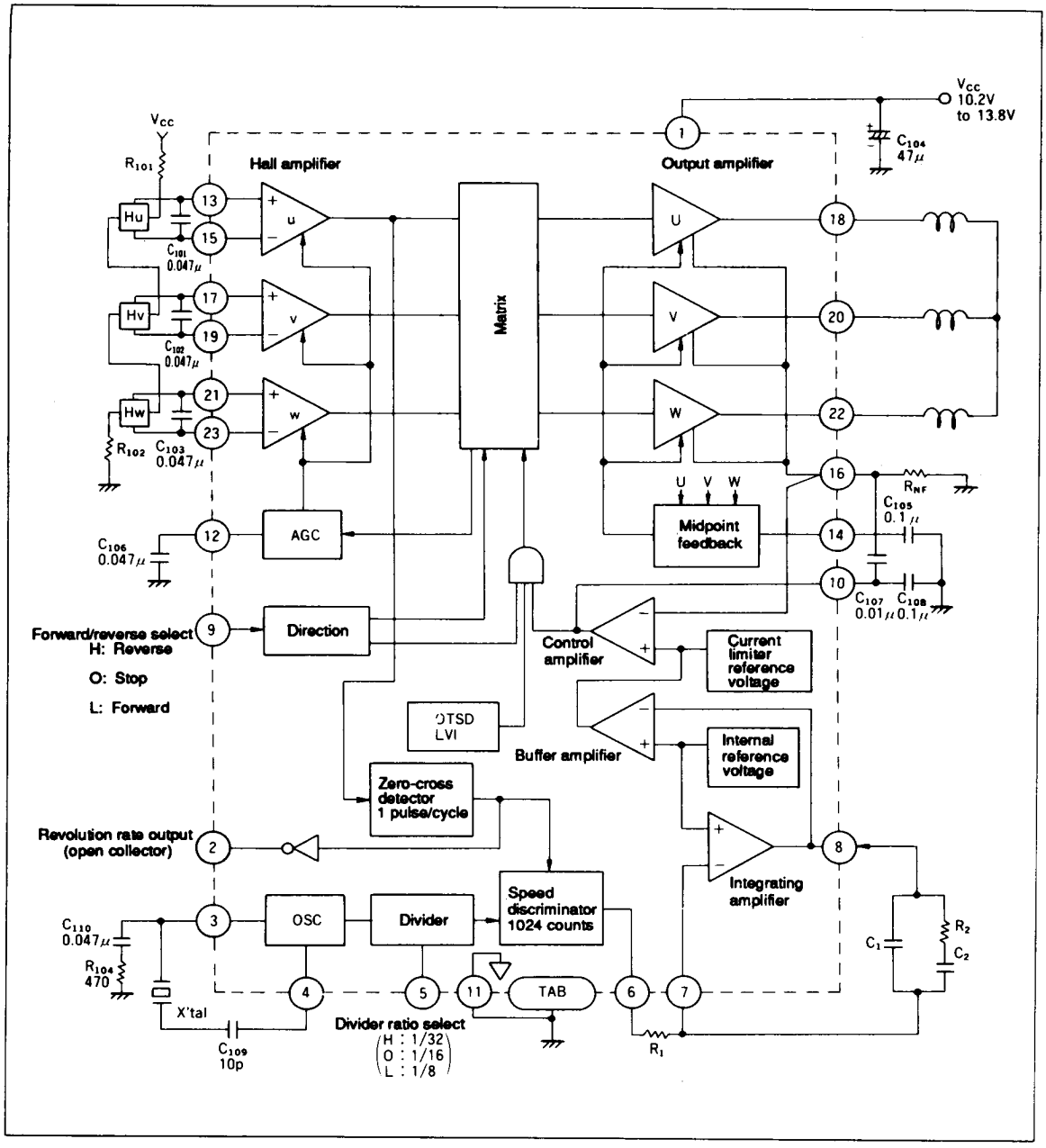
Functions

- Three-phase driver
- Hall amplifier with AGC and matrix
- Midpoint feedback
- Forward/reverse select
- Output disable
- Oscillator
- Divider ratio selector (1/32, 1/16, 1/8)
- Speed discriminator
- Integrating amplifier
- Control amplifier
- Current limiter
- Low voltage inhibiter (LVI)
- Overtemperature shutdown (OTSD)

Pin Assignment



Block Diagram



Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Rating HA13471	Rating HA13472	Unit	Notes
Power supply voltage	V_{CC}	+15	+15	V	1
Input voltage	V_{in}	V_{CC}	V_{CC}	V	2
Output voltage	I_O	2	4	A	3
Power dissipation	P_T	25	25	W	4
Junction temperature	T_j	150	150	°C	5
Storage temperature	T_{stg}	−55 to +125	−55 to +125	°C	

Notes:

1. Operating power supply voltage range is 12 V ±15% (10.2 V to 13.8 V).
2. Applies to Hall amplifier, forward/reverse select, and divider select inputs.
3. The operating locus for all output transistors should not exceed the ranges shown in figure 1 or figure 2.

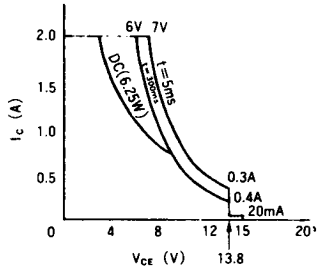


Figure 1 HA13471

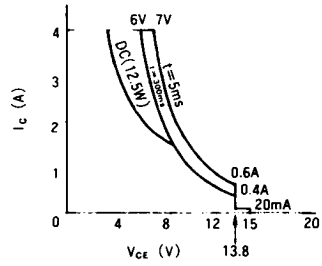


Figure 2 HA13472

4. For Tc = 75°C. Thermal resistance is as follows:
   θj − c ≤ 3°C/W
   θj − a ≤ 40°C/W
5. The operating junction temperature range is as follows:
   T_{jop} = 0°C to +125°C

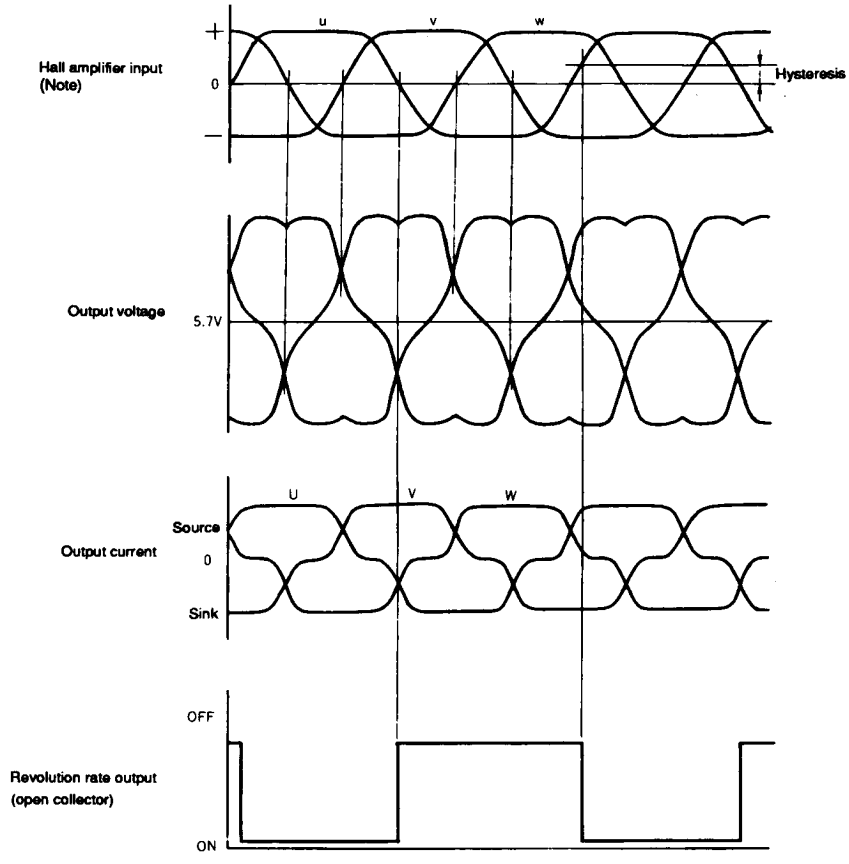
Electrical Characteristics (Ta = 25°C, V_{CC} = 12V)

Parameter		Symbol	Min	Typ	Max	Unit	Test Conditions	Pins	Notes
Current consumption		I_{CC}	—	22	33	mA		1	
Hall amplifier	Input resistance	R_{hi}	7	10	13	kΩ		13, 15	
	In-phase input voltage	V_H	2.5	—	V_{CC} −2.5	V		17, 19 21, 23	
	Differential input voltage	V_h	75	—	300	mV			
Output amplifier	Leakage current	I_{CER}	—	—	2	mA	V_{CE} = 15 V	18, 20, 22	
	Saturation voltage	V_{sat1}	—	2.8	3.2	V	I_O = 3.0 A (1.5 A)		1
		V_{sat2}	—	—	1.8	V	I_O = 0.6 A (0.3 A)		1
Current limiter	Internal reference voltage	V_{ref1}	0.225	0.25	0.275	V		16	
Buffer amplifier	Internal reference voltage	V_{ref2}	$V_{CC}/2$ −10%	$V_{CC}/2$	$V_{CC}/2$ +10%	V		7	
	Voltage gain	G_{CTL}	−2	0	+2	dB	Pins 8–16	16	
Integrating amplifier	Input current	I_B (ER)	—	—	±60	nA		7	
	Output voltage amplitude	A^+	0.55	0.7	0.85	V	I_O = 0.5 mA	8	2
		A^-	−0.55	−0.7	−0.85	V	I_O = −0.5 mA		2
	Bandwidth	BW	—	1.4	—	MHz	G_V = 0 dB		3
Speed discriminator	Output high voltage	V_{OH}	V_{CC} − 0.3	—	—	V	I_O = 0.5 mA	6	
	Output low voltage	V_{OL}	—	—	0.2	V	I_O = −0.5 mA		
	Leakage current	I_{off}	—	—	±60	nA			
	Number of counts		—	2048	—				
Oscillator	Frequency error	f_{err}	—	—	±0.1	%	Using crystal oscillator	4	
	Frequency range	f_{osc}	—	—	8	MHz	Using crystal oscillator		
Forward/reverset select	Input high voltage	V_{IH}	3.6	—	—	V	Reverse	9	
	Input middle voltage	V_{IM}	2.2	—	2.8	V	Stop		
	Input low voltage	V_{IL}	—	—	1.4	V	Forward		
	Input high current	I_{IH}	—	0.54	0.8	mA	V_{IH} = 5.5 V		
	Input low current	I_{IL}	—	−0.44	−0.8	mA	V_{IL} = 0.0 V		
Divider	Input high voltage	V_{IH2}	3.6	—	—	V	Divider ratio 1/32	5	
	Input middle voltage	V_{IM2}	2.2	—	2.8	V	Divider ratio 1/16		
	Input low voltage	V_{IL2}	—	—	1.4	V	Divider ratio 1/8		
	Input high current	I_{IH2}	—	0.54	0.8	mA	V_{IH2} = 5.5 V		
	Input low current	I_{IL2}	—	−0.44	−0.8	mA	V_{IL2} = 0.0 V		
Revolution rate output	Output leakage current	I_{CER2}	—	—	100	µA	V_{CE} = 15 V	2	
	Output low voltage	V_{OL2}	—	—	0.4	V	I_O = 1 mA		
LVI operating voltage			—	—	8.0	V			
OTSD operating temperature		T_{sd}	125	150	—	°C			3

Notes:

1. Sum of upper and lower saturation voltages. Values for the HA13471 are in parentheses.
2. Measured based on V_{ref2}.
3. This is a design target, and will not be factory tested.

Timing Chart



External Components

Symbol	Recommended Value		Purpose	Notes
	HA13471	HA13472		
	3.5" × 2 disks	5.25" × 6 disks		
R_{101},R_{102}	560 Ω	560 Ω	Hall element bias	1
R_{104}	470 Ω	470 Ω	Oscillation stability	2
R_1	240 kΩ	33 kΩ	Integration constant	3
R_2	560 kΩ	560 kΩ		
R_{NF}	0.33 Ω × 2 (parallel)	0.33 Ω × 4 (parallel)	Current detect	4
C_{101},C_{102},C_{103}	0.0 47 µF	0.047 µF	Stability	
C_{104}	≥ 47 µF	≥ 47 µF	Power supply filter	
C_{105}	0.1 µF	0.1 µF	Midpoint feedback phase compensation	
C_{106}	0.047 µF	0.047 µF	AGC filter	
C_{107}	0.01 µF	0.01 µF	Control amplifier phase compensation	
C_{108}	0.1 µF	0.1 µF		
C_{109}	10 pF	10 pF	DC filter	
C_{110}	0.047 µF	0.047 µF	Stable oscillation	2
C_1	0.022 µF	0.022 µF	Integration constant	3
C_2	0.22 µF	0.22 µF		
X'tal	3.932 MHz	3.932 MHz	Oscillation generator	

Notes:

1. Choose R_{101} and R_{102} such that the Hall amplifier output voltage falls between 75 and 300 mV_{p-p}.
2. Not required if oscillation frequency is under 4 MHz.
3. The optimal value differs depending on motor constants (moment of inertia, torque constant, and revolution rate).
4. Output current is limited as follows:

   $I_{omax} = V_{ref}/R_{NF}$