HA13441, HA13442

Three-Phase Brushless DC Motor Driver

Description

The HA13441 and HA13442 are three-phase brushless DC motor drive ICs of 2 A/phase or 4 A/phase.

Functions

- 2 A/phase (4 A/phase) three phase output circuit
- Hall-effect element amp, matrix
- Chip enable
- Buffer amp
- Control amp
- Speed discriminator
- Oscillation circuit
- Zero-cross detector
- Integrator
- Current limiter
- Ready circuit
- Low supply voltage inhibit
- Over-temperature shut down

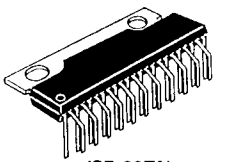
Features

- Servo system on a single chip
- Digital servo system requires no adjustment
- Large output current (2 A/phase, 4 A/phase)
- Low output voltage noise
- Small speed error
- Low thermal resistance package

Ordering Information

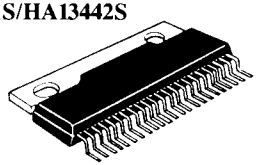
Type No.	Package
HA13441	SP-23TA
HA13441S	SP-23TD
HA13441V	SP-23TB
HA13442	SP-23TA
HA13442S	SP-23TD
HA13442V	SP-23TB

HA13440MP/HA13441/HA13442



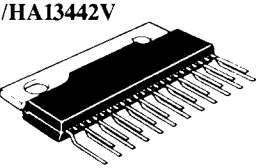
(SP-23TA)

HA13441S/HA13442S



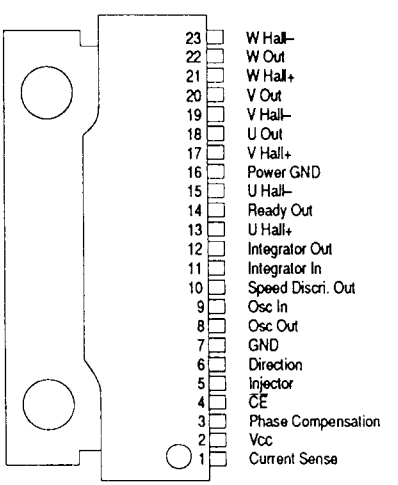
(SP-23TD)

HA13441V/HA13442V



(SP-23TB)

Pin Arrangement



(Top View)

Block Diagram

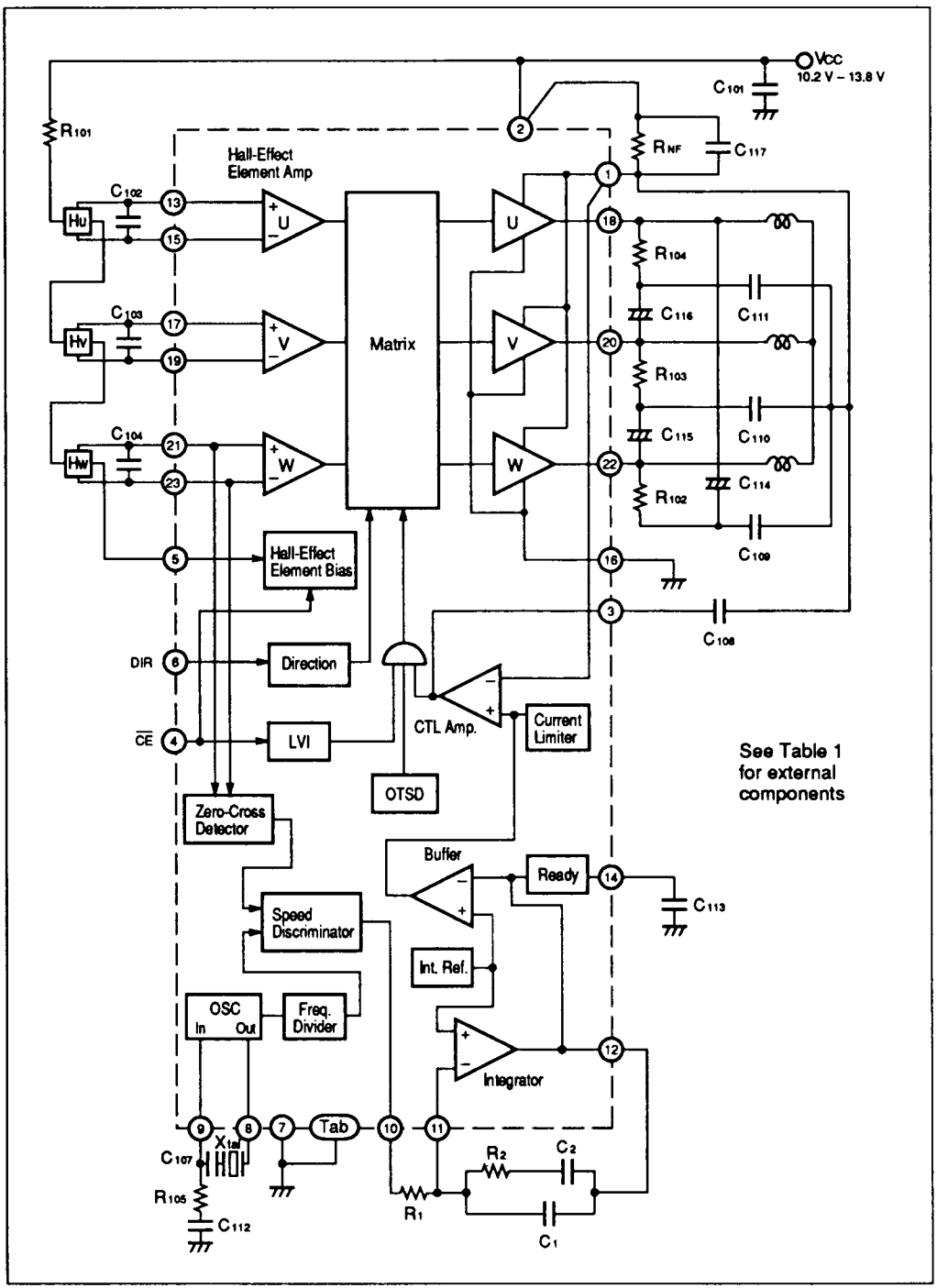


Table 1 External Components

Part No.	Reference Value		Purpose	Note
	HA13441 3.5"x2-disk HDD	HA13442 5.25"x6-disk HDD		
R_{101}	1 kΩ	1 kΩ	Hall-effect element bias	
R_{102}	470 Ω	470 Ω	Oscillation stability	1
R_{103}	330 Ω	330 Ω	Stability	2
R_{104}, R_{105}, R_{106}	2.2 Ω	2.2 Ω	Stability	2
R_1	22 kΩ	22 kΩ	Integration constant	3
R_2	330 kΩ	330 kΩ	Integration constant	3
R_{NF}	0.47 Ω	0.22 Ω	Current sense	4
C_{101}	0.1 µF	0.1 µF	Power supply bypass	2
C_{102}	10 pF	10 pF	AC coupling OSC	
C_{103}	0.047 µF	0.047 µF	Oscillation stability	1
C_{104}	0.1 µF	0.1 µF	Ready output filter	
C_{105}, C_{106}, C_{107}	3300 pF	3300 pF	Stability	2
C_{108}	0.068 µF	0.068 µF	Control amp phase compensation	2
C_{109}, C_{110}, C_{111}	0.1 µF	0.1 µF	Stability	2, 5
C_{112}, C_{113}, C_{114}	2.2 to 10 µF	2.2 to 10 µF	EMI reduction	6
C_{115}	0.1 µF	0.1 µF	Stability	5
C_1	0.022 µF	0.1 µF	Integration constant	3
C_2	0.47 µF	1.0 µF	Integration constant	3
X'tal	3.932 MHz	3.932 MHz	Resonator	7

Notes:
1. Unnecessary at some output frequencies. Contact the resonator manufacturer.
2. Put them as near the IC as possible. When attached at a distance, these parts lose effect.
3. The optimum value depends on the motor specification (moment of inertia including load, torque constant, standard rotation number).

4. Output current is limited as shown below. Use non-inductive type for R_{NF}.

$$Iomax = \frac{Vref_1}{R_{NF}}$$

5. Use capacitors which have good frequency characteristics and cause no second resonance.
6. Use non-polar type.
7. Use crystal oscillator.

Table 2 Truth Table

Chip Enable (CE)	Hall-Effect Amp Input			Output		
	U	V	W	U	V	W
L	H	L	H	H(L)	L(H)	Open(Open)
	H	L	L	H(L)	Open(Open)	L(H)
	H	H	L	Open(Open)	H(L)	L(H)
	L	H	L	L(H)	H(L)	Open(Open)
	L	H	H	L(H)	Open(Open)	H(L)
	L	L	H	Open(Open)	L(H)	H(L)
H	X	X	X	Open		

Open: High Impedance
X: Don't care

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

Item	Symbol	HA13441	HA13442	Unit	Note
Supply voltage	Vcc	+15	+15	V	1
Input voltage	V_{IN}	Vcc	Vcc	V	2
Output current	Io	2	4	A	
Power dissipation	P_T	25	25	W	3
Junction temperature	Tj	150	150	°C	4
Storage temperature hange	Tstg	–55 to +125	–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. The recommended operating supply voltage range is 12 V ±15% (10.2 V to 13.8 V).
2. Hall-effect element amp input, Direction input, Chip Enable input.

3. T_C=75 °C. Thermal resistance is:
   $\theta_{j-c} \leq 3$ °C
   $\theta_{j-a} \leq 40$ °C
4. The operating junction temperature range is T_{jop}=0 °C to +125 °C.

Table 4 Electrical Characteristics (T_a=25 °C, V_{CC}=12 V)

Item		Symbol	Min	Typ	Max	Unit	Test Condition	Applicable Terminal	Note
Quiescent current		I_{CC1}	—	1.0	2	mA	CE=2 V	1, 2	1
		I_{CC2}	—	24.0	36.0	mA	CE=0.8 V		1
Hall-effect element amp to bias	Input current	I_{HB}	—	2	10	μA	V_H=6.0 V		
	Input common mode voltage range	V_H	1.3	—	9.5	V			
	Bias voltage	V_{HB}	1.3	—	1.8	V	I_H=5 mA	5	
Output amp	Leak current	I_{CER}	—	—	2	mA	V_{CE}=15 V	18, 20, 22	
	Saturation voltage	V_{sat1}	—	2.8	3.2	V	Io=3.0 A(1.5 A)		2
		V_{sat2}	—	1.8	2.4	V	Io=0.6 A(0.3 A)		2
Reference voltage internal current limiter		V_{ref1}	0.48	0.56	0.63	V		1	2
Buffer amp	Internal reference voltage	V_{ref2}	2.95	3.15	3.35	V		11	
	Voltage gain	Gv	–8 (–5)	–6 (–3)	–4 (–1)	dB		1	3
	Difference of gain	ΔGv	—	—	±1.0	dB			
Integrator	Input current	I_B(ER)	—	—	±60	nA		11	
	Output voltage swing	A+	1.10	1.40	1.60	V	Io=0.5 mA	12	
		A–	–0.05	–0.7	–0.85	V	Io=–0.5 mA		
	Gain bandwidth	BW	100	—	—	kHz	G=0 dB		

Electrical Characteristics (Ta=25 °C, Vcc=12 V) (cont)

Speed discriminator	Output high voltage	V_{OH}	5.8	6.1	—	V	Io=0.5 mA	10	4
	Output low voltage	V_{OL}	—	—	0.2	V	Io=–0.5 mA		4
	Cut off current	Ioff	—	—	±60	nA			
	Count number		—	2048	—				
Chip enable	Input high voltage	V_{IH}	2.0	—	—	V		4	
	Input low voltage	V_{IL}	—	—	0.8	V			
	Input high current	I_{IH}	—	—	±10	μA	V_{IH}=5.5 V		
	Input low current	I_{IL}	—	—	±10	μA	V_{IL}=0 V		
OSC	Frequency error	fosc	—	—	0.1	%		8	
	Operating frequnecy	fosc	—	—	8	MHz			
Zero-cross detection sensitivity		Vz	—	—	30	mVpp		21, 23	5
Ready circuit	Output high voltage	V_{OH}	4.8	5.0	—	V	Isource=0.1 mA	14	
	Output low voltage	V_{OL}	—	0.2	0.3	V	Isink=0.1 mA		
	Output current	Isink	0.1	0.2	0.3	mA	V=2.5 V		
		Ifo	0.1	0.2	0.3	mA	V=2.5 V		
LVI operating voltage			—	—	9.0	V			
OTSD operating temperature		Tsd	125	—	—	°C			
Direction	Input high voltage	V_{IH}	4.0	—	—	V		6	
	Input low voltage	V_{IL}	—	—	0.8	V			
	Input high current	I_{IH}	—	—	±10	μA	V_{IH}=5.5 V		
	Input low current	I_{IL}	—	—	±10	μA	V_{IL}=0 V		

Notes:
1. Sum of ①, ② input pins
2. Sum of upper and lower transistor saturation voltages.
3. Measure from V_{CC} pin.
4. Measure from V_{ref2}.
5. Minimum input voltage necessary for producing trigger pulse.