

# 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

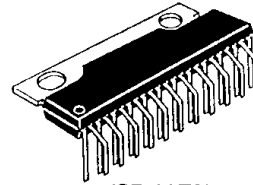
### Features

- 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

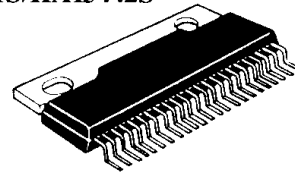
Type No.	Package
HA13441	SP-23TA
HA13441S	SP-23TD
HA13441V	SP-23TB
HA13442	SP-23TA
HA13442S	SP-23TD
HA13442V	SP-23TB

HA13440MP/HA13441/HA13442



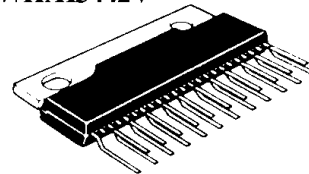
(SP-23TA)

HA13441S/HA13442S



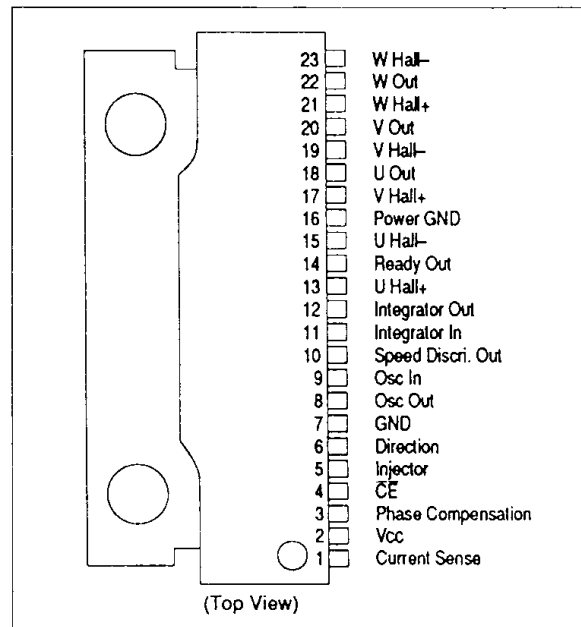
(SP-23TD)

HA13441V/HA13442V



(SP-23TB)

### Pin Arrangement



Block Diagram

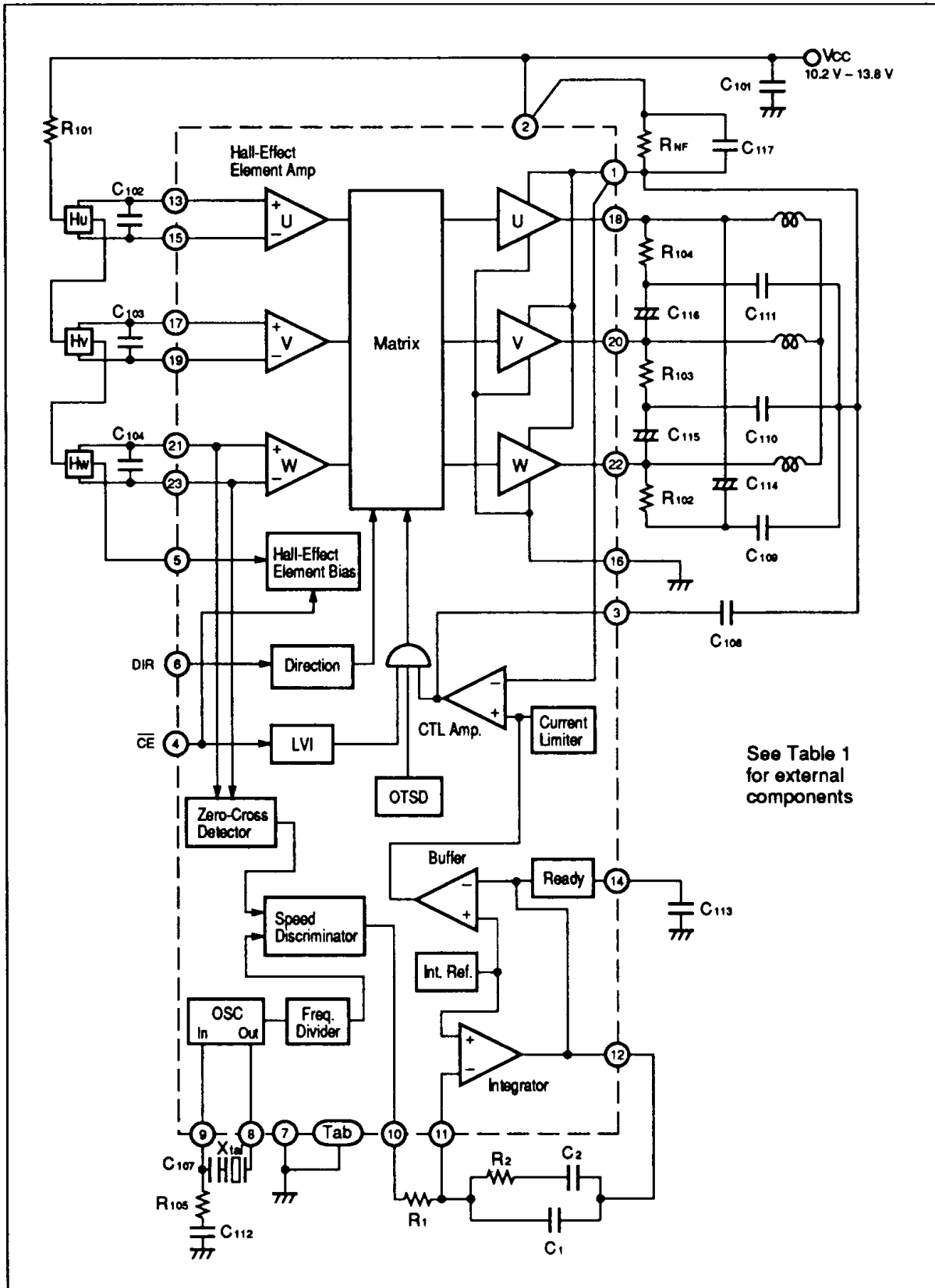


Table 1 External Components

Part No.	Reference Value		Purpose	Note
	HA13441 3.5"x2-disk HDD	HA13442 5.25"x6-disk HDD		
R101	1 k $\Omega$	1 k $\Omega$	Hall-effect element bias	
R102	470 $\Omega$	470 $\Omega$	Oscillation stability	1
R103	330 $\Omega$	330 $\Omega$	Stability	2
R104, R105, R106	2.2 $\Omega$	2.2 $\Omega$	Stability	2
R1	22 k $\Omega$	22 k $\Omega$	Integration constant	3
R2	330 k $\Omega$	330 k $\Omega$	Integration constant	3
RNF	0.47 $\Omega$	0.22 $\Omega$	Current sense	4
C101	0.1 $\mu$ F	0.1 $\mu$ F	Power supply bypass	2
C102	10 pF	10 pF	AC coupling OSC	
C103	0.047 $\mu$ F	0.047 $\mu$ F	Oscillation stability	1
C104	0.1 $\mu$ F	0.1 $\mu$ F	Ready output filter	
C105, C106, C107	3300 pF	3300 pF	Stability	2
C108	0.068 $\mu$ F	0.068 $\mu$ F	Control amp phase compensation	2
C109, C110, C111	0.1 $\mu$ F	0.1 $\mu$ F	Stability	2, 5
C112, C113, C114	2.2 to 10 $\mu$ F	2.2 to 10 $\mu$ F	EMI reduction	6
C115	0.1 $\mu$ F	0.1 $\mu$ F	Stability	5
C1	0.022 $\mu$ F	0.1 $\mu$ F	Integration constant	3
C2	0.47 $\mu$ F	1.0 $\mu$ F	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).

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4. Output current is limited as shown below. Use non-inductive type for RNF.

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

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	VIN	Vcc	Vcc	V	2
Output current	Io	2	4	A	
Power dissipation	Pr	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.  $T_c=75\text{ }^\circ\text{C}$ . Thermal resistance is:  
 $\theta_{j-c}\leq 3\text{ }^\circ\text{C}$   
 $\theta_{j-a}\leq 40\text{ }^\circ\text{C}$
4. The operating junction temperature range is  $T_{jop}=0\text{ }^\circ\text{C}$  to  $+125\text{ }^\circ\text{C}$ .

**Table 4 Electrical Characteristics ( $T_a=25\text{ }^\circ\text{C}$ ,  $V_{cc}=12\text{ V}$ )**

Item	Symbol	Min	Typ	Max	Unit	Test Condition	Applicable Terminal	Note	
Quiescent current	$I_{CC1}$	—	1.0	2	mA	$V_{CE}=2\text{ V}$	1, 2	1	
	$I_{CC2}$	—	24.0	36.0	mA	$V_{CE}=0.8\text{ V}$		1	
Hall-effect element amp to bias	Input current	$I_{HB}$	—	2	10	$\mu\text{A}$	$V_H=6.0\text{ V}$		
	Input common mode voltage range	$V_H$	1.3	—	9.5	V			
	Bias voltage	$V_{HB}$	1.3	—	1.8	V	$I_H=5\text{ mA}$	5	
Output amp	Leak current	$I_{CER}$	—	—	2	mA	$V_{CE}=15\text{ V}$	18, 20, 22	
	Saturation voltage	$V_{sat1}$	—	2.8	3.2	V	$I_o=3.0\text{ A}(1.5\text{ A})$		2
		$V_{sat2}$	—	1.8	2.4	V	$I_o=0.6\text{ A}(0.3\text{ A})$		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	$G_v$	-8 (-5)	-6 (-3)	-4 (-1)	dB		1	3
	Difference of gain	$\Delta G_v$	—	—	$\pm 1.0$	dB			
Integrator	Input current	$I_b(ER)$	—	—	$\pm 60$	nA		11	
	Output voltage swing	A+	1.10	1.40	1.60	V	$I_o=0.5\text{ mA}$	12	
		A-	-0.05	-0.7	-0.85	V	$I_o=-0.5\text{ mA}$		
	Gain bandwidth	BW	100	—	—	kHz	$G=0\text{ dB}$		

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

Speed discriminator	Output high voltage	V <sub>OH</sub>	5.8	6.1	—	V	I <sub>O</sub> =0.5 mA	10	4
	Output low voltage	V <sub>OL</sub>	—	—	0.2	V	I <sub>O</sub> =-0.5 mA		4
	Cut off current	I <sub>OFF</sub>	—	—	±60	nA			
	Count number		—	2048	—				
Chip enable	Input high voltage	V <sub>IH</sub>	2.0	—	—	V		4	
	Input low voltage	V <sub>IL</sub>	—	—	0.8	V			
	Input high current	I <sub>IH</sub>	—	—	±10	μA	V <sub>IH</sub> =5.5 V		
	Input low current	I <sub>IL</sub>	—	—	±10	μA	V <sub>IL</sub> =0 V		
OSC	Frequency error	f <sub>OSC</sub>	—	—	0.1	%		8	
	Operating frequency	f <sub>OSC</sub>	—	—	8	MHz			
Zero-cross detection sensitivity	V <sub>Z</sub>	—	—	30	mVpp			21, 23	5
Ready circuit	Output high voltage	V <sub>OH</sub>	4.8	5.0	—	V	I <sub>SOURCE</sub> =0.1 mA	14	
	Output low voltage	V <sub>OL</sub>	—	0.2	0.3	V	I <sub>SINK</sub> =0.1 mA		
	Output current	I <sub>SINK</sub>	0.1	0.2	0.3	mA	V=2.5 V		
		I <sub>FO</sub>	0.1	0.2	0.3	mA	V=2.5 V		
LVI operating voltage		—	—	9.0	V				
OTSD operating temperature	T <sub>SD</sub>	125	—	—	°C				
Direction	Input high voltage	V <sub>IH</sub>	4.0	—	—	V		6	
	Input low voltage	V <sub>IL</sub>	—	—	0.8	V			
	Input high current	I <sub>IH</sub>	—	—	±10	μA	V <sub>IH</sub> =5.5 V		
	Input low current	I <sub>IL</sub>	—	—	±10	μA	V <sub>IL</sub> =0 V		

- Notes:
1. Sum of ①, ② input pins
  2. Sum of upper and lower transistor saturation voltages.
  3. Measure from V<sub>CC</sub> pin.
  4. Measure from V<sub>REF2</sub>.
  5. Minimum input voltage necessary for producing trigger pulse.

