

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

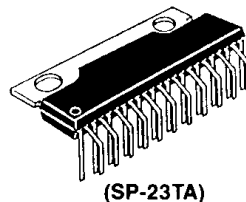
Features

- 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

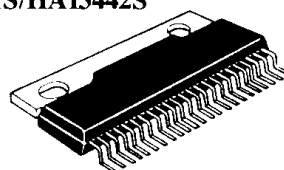
Type No.	Package
HA13441	SP-23TA
HA13441S	SP-23TD
HA13441V	SP-23TB
HA13442	SP-23TA
HA13442S	SP-23TD
HA13442V	SP-23TB

HA13440MP/HA13441/HA13442



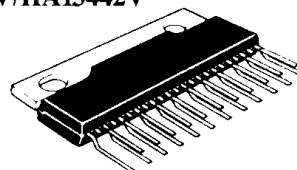
(SP-23TA)

HA13441S/HA13442S



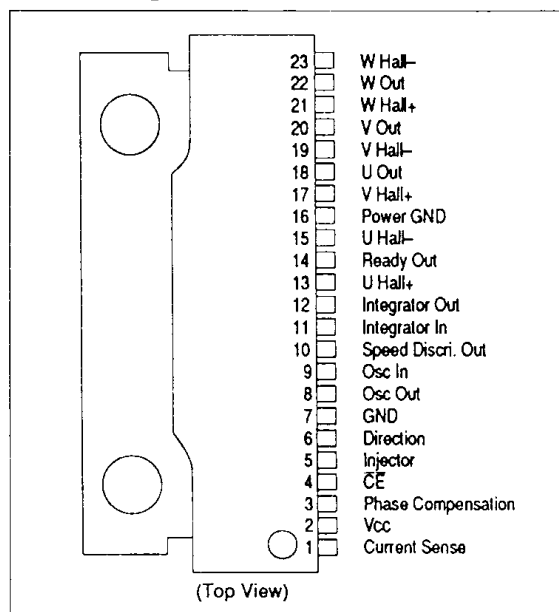
(SP-23TD)

HA13441V/HA13442V



(SP-23TB)

Pin Arrangement



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Block Diagram

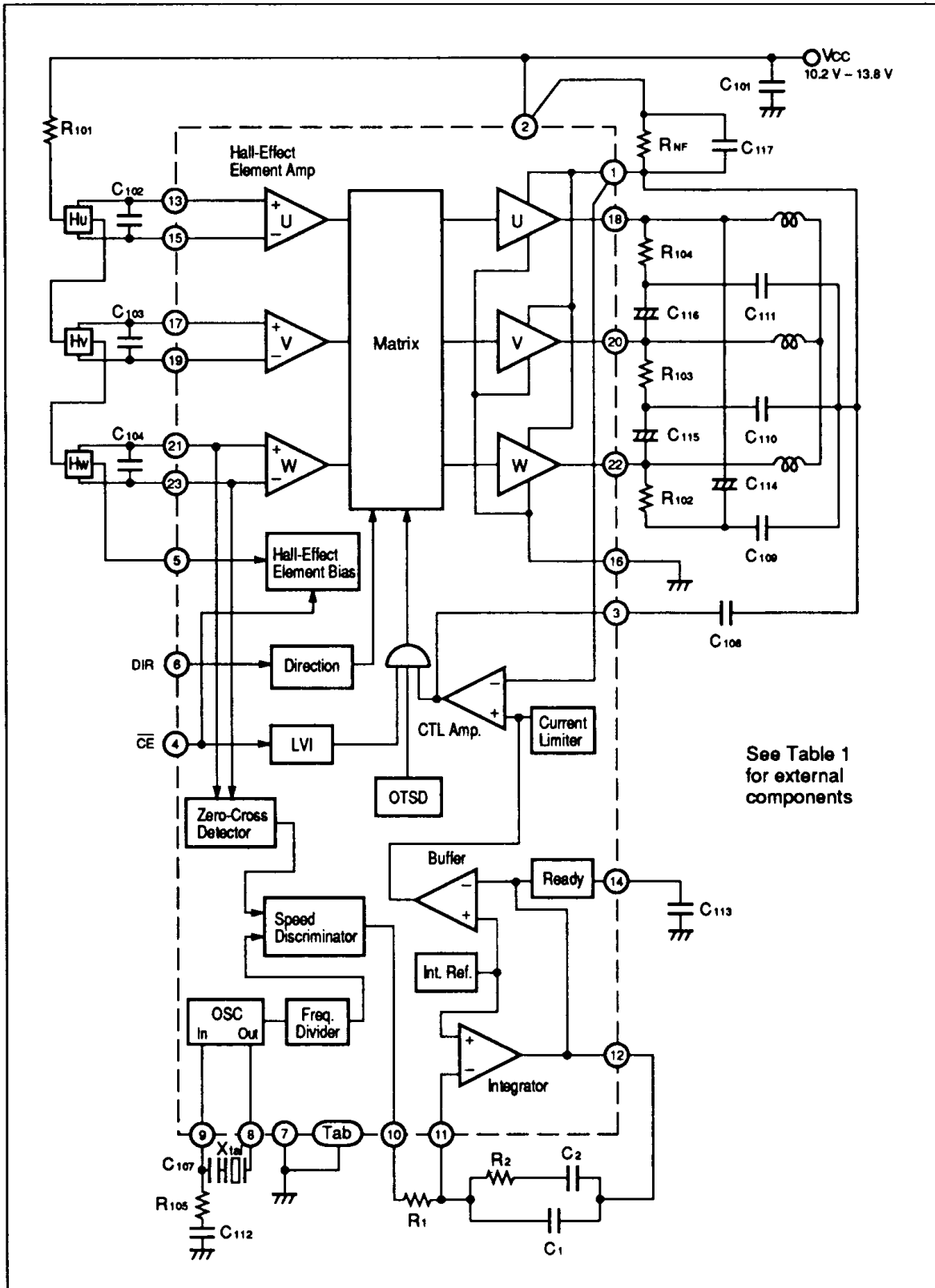


Table 1 External Components

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

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

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 (T_a=25°C)

Item	Symbol	HA13441	HA13442	Unit	Note
Supply voltage	V _{cc}	+15	+15	V	1
Input voltage	V _{IN}	V _{cc}	V _{cc}	V	2
Output current	I _o	2	4	A	
Power dissipation	P _T	25	25	W	3
Junction temperature	T _j	150	150	°C	4
Storage temperature range	T _{stg}	-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	μA	$V_H=6.0\text{ V}$		
	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	ΔG_v	—	—	± 1.0	dB			
Integrator	Input current	$I_{B(ER)}$	—	—	± 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 _{OH}	5.8	6.1	—	V	I _o =0.5 mA	10	4
	Output low voltage	V _{OL}	—	—	0.2	V	I _o =-0.5 mA		4
	Cut off current	I _{off}	—	—	±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	f _{osc}	—	—	0.1	%		8	
	Operating frequency	f _{osc}	—	—	8	MHz			
Zero-cross detection sensitivity	V _Z	—	—	30	mVpp			21, 23	5
Ready circuit	Output high voltage	V _{OH}	4.8	5.0	—	V	I _{source} =0.1 mA	14	
	Output low voltage	V _{OL}	—	0.2	0.3	V	I _{sink} =0.1 mA		
	Output current	I _{sink}	0.1	0.2	0.3	mA	V=2.5 V		
		I _{fo}	0.1	0.2	0.3	mA	V=2.5 V		
LVI operating voltage		—	—	9.0	V				
OTSD operating temperature	T _{sd}	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.

