HA13524/S/FP

Voice Coil Motor Driver

The HA13524/S/FP are VCM driver for HDD and have following functions and features.

Functions

- Input amp
- 4 A BTL output amp(HA13524/S)
- 2 A BTL output amp(HA13524FP)
- Retract circuit
- Independent OP amp
- OTSD & LVI

Features

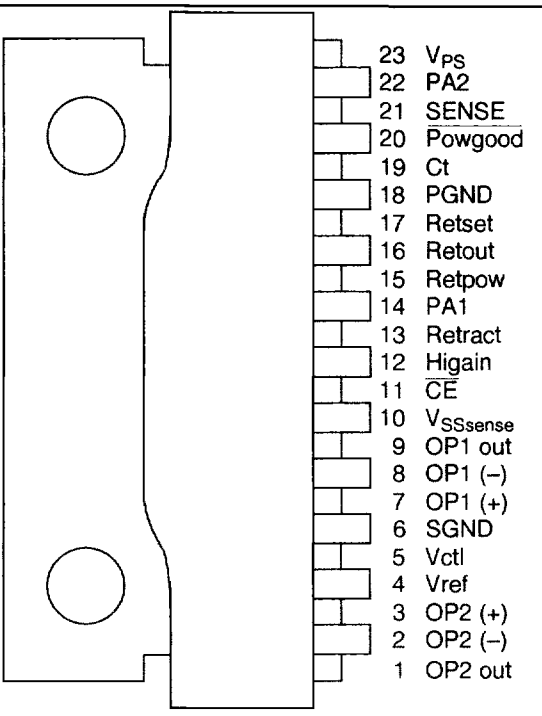
- Low saturation voltage
- No cross-over distortion
- Few external components
- Wide gain bandwidth

Ordering Information

Type No	Package
HA13524	SP-23TA
HA13524S	SP-23TD
HA13524FP	FP-26DT

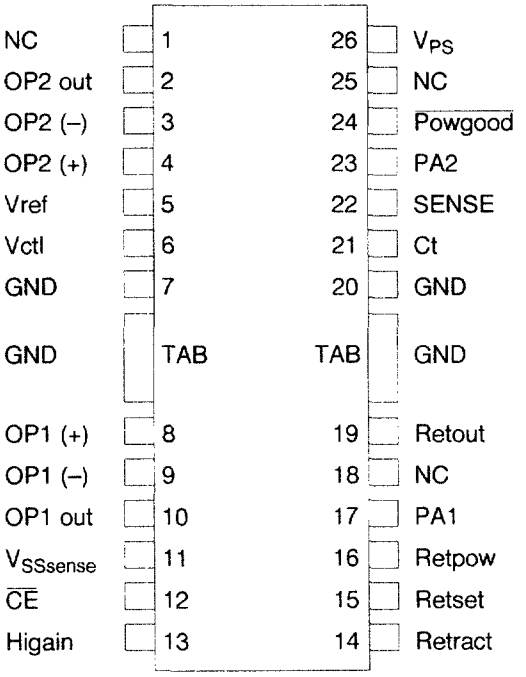
Pin Arrangement

•HA13524/S



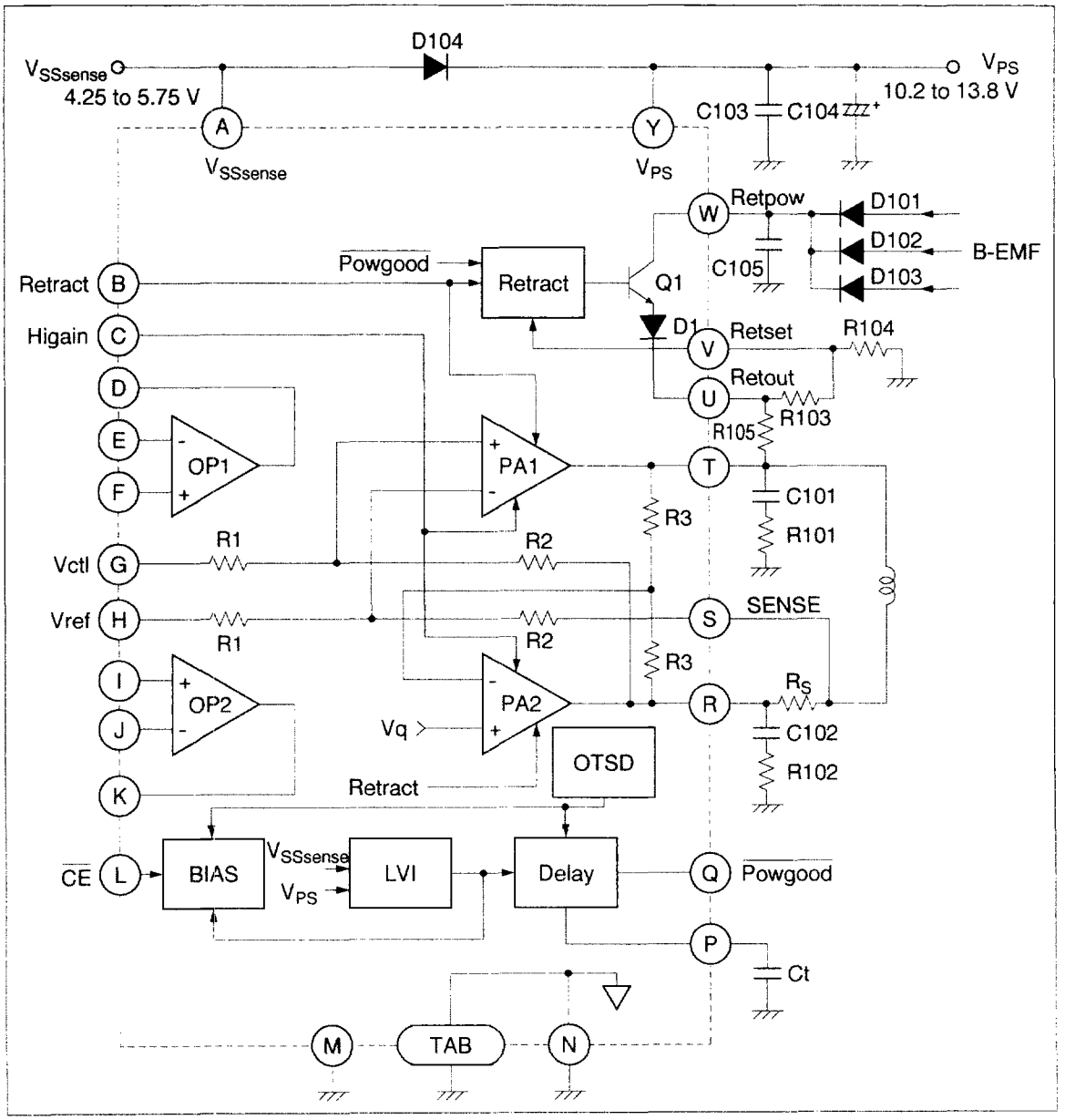
(Top view)

•HA13524FP



(Top view)

Block Diagram



Truth Table

Input					Output			
V_{PS}	$V_{SSsense}$	Retract	$\overline{CE}$	Higain	PA1	PA2	Retout	$\overline{Powgood}$
0 to 7 V	X*1	X	X	X	Disable	L	Vret*2	Z
≤Vsd*3	≤Vsd*3	X	X	X	Disable	L	Vret	Z
≤Vsd	> Vsd							
> Vsd	≤ Vsd							
> Vsd	> Vsd	H	X	X	Disable	L	Vret	Z
		L	H	X	Disable	Disable	Z	Z
			L	H	High gain	High gain	Z	L
				L	Low gain	Low gain	Z	L
			(Tj > Tsd)		Disable	L	Vret	Z

Notes: 1. X = Irrelevant
H = High voltage level
L = Low voltage level
Z = High impedance

2. See external components
3. See electrical characteristics

External Component

Parts No.	Recommended value	Purpose	Notes
R101, R102	2.2 Ω	For power amplifire output stabilization	
R103, R104	—	For retract voltage setting	1
R105	—	For retract current setting	1
R_S	≥ 0.1 Ω	Power amplifire output current detection	2
C101, C102	0.1 μF	For power amplifire output stabilization	
C103	≥ 0.1 μF	Power supply stabilization	
C104	≥ 4.7 μF	Power supply stabilization	
C105	≥ 0.1 μF	For power amplifire output stabilization	
Ct	≤ 0.1 μF	$\overline{\text{Powgood}}$ delay time setting	3
D101, D102, D103	$V_F < 0.8$ V (@ $I_F = 1$ A)	For retract	
D104	$V_F < 0.75$ V (@ $I_F = 0.5$ A)	$V_{SSsense}$ pin protection	4

Notes: 1. The retract voltage Vretout and current Iret are determined as follows.

$$\text{Vretout} = \text{Vretset}\left(1 + \frac{\text{R103}}{\text{R104}}\right)$$

$$\text{Iret} = \frac{\text{Vretout} - \text{VsatL}}{R_L + R_S + \text{R105}}$$

Where,
R_L = Load resistance
Vretset = Reference voltage for retract (See electrical characteristics)
Vsat_L = Lo side saturation voltage of PA2 (See electrical characteristics)

2. The relationship between output current I_O and input voltage Vctl is determined as follows.

$$I_O = \frac{(\text{Vctl} - \text{Vref})\ \text{Gctl}}{R_S} = \frac{(\text{Vctl} - \text{Vref})\text{gm}\cdot R'_S}{R_S}$$

Where,
Gctl = gm•R'$_S$ (See electrical characteristics)
Vref = Reference voltage for PA1

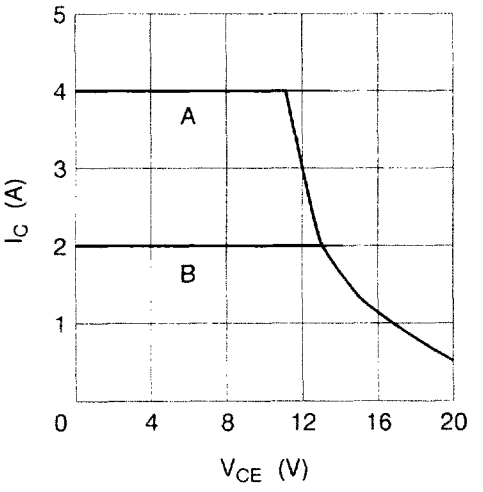
3. The $\overline{\text{Powgood}}$ delay time tpor is determined as follows.
tporhl = Ct•Vth/Icha
tporlh ≤ Ct(V_{PS} − Vth)/Idis
Where,
Icha & Idis = Charge & discharge current for pin Ct (See electrical characteristics)
Vth = Threshold voltage of pin Ct (See electrical characteristics)
4. D104 is unnecessary when $V_{SSsense}$ Terminal is not used. In this case, connect Vps.
5. Unused input terminals of OP1 and OP2 connect to GND.

Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	HA13524	HA13524S	HA13524FP	Unit	Notes
Power supply voltage	Vps	15	15	15	V	1
Output current	I_{Opeak}	4	4	2	A	2
	I_O	2.8	2.8	1.5		
Retract current	Iret	1.2	1.2	0.7	A	
Retract voltage	Vret	5	5	5	V	
Input voltage	Vin	Vps	Vps	Vps	V	3
Power dissipation	P_T	10 (Tc = 120°C)	10 (Tc = 120°C)	5 (Tc = 115°C)	W	4
Junction temperature	Tj	150	150	150	°C	5
Storage temperature range	Tstg	–55 to +125	–55 to +125	–55 to +125	°C	

Notes: 1. Operating voltage ranges is as follows.
Vps = 10.2 to 13.8 V

2. ASO of each output transistor is shown below. Operating locus must be with in the ASO.



(t_{on} = 5 ms)

A: HA13524
HA13524S

B: HA13524FP

When I_{Opeak} $t \leq 0.1$ s

3. As for pin Retract and Retset, Maximum input voltage are Vretpow
4. Thermal resistance is shown below.
   - HA13524
     θj – c ≤ 3°C/W, θj – a ≤ 40°C/W (When a glass epoxy printed circuit board is used with a wiring density of 20 %)
   - HA13524S
     θj – c ≤ 3°C/W, θj – a ≤ 40°C/W (When a glass epoxy printed circuit board is used with a wiring density of 20 %)
   - HA13524FP
     θj – c ≤ 7°C/W, θj – a ≤ 62°C/W (When a glass epoxy printed circuit board is used with a wiring density of 20 %)
5. Operating junction temperature range is 0 to +125°C.

Electrical Characteristics (Ta = 25°C, Vps = 12 V, $V_{SSsense}$ = 5 V)

Item		Symbol	Min	Typ	Max	Units	Test conditions		Applicable terminal	Note
Quiescent current		I_{PS0}	—	3	5	mA	$\overline{CE}$ = H, Retract = L		Y	
		I_{PS1}	—	45	75	mA	$\overline{CE}$ = L, Retract = L			
		I_{PS2}	—	15	25	mA	$\overline{CE}$ = L, Retract = H Retpow = 5 V		W	
$\overline{CE}$, Higain & Retract Input	Input current	Iin	—	—	±10	μA	Vin = 0 to V_{PS}		B, C, L	
		Iin(ret)	—	—	±15	μA	Vretpow = V_{PS}			
	Input high voltage	V_{IH}	2.0	—	—	V				
	Input low voltage	V_{IL}	—	—	0.8	V				
PA1 & PA2	Input resistance	Rin(H)	23	33	43	kΩ	Higain = H		G, H	
		Rin(L)	35	50	65	kΩ	Higain = L			
	Input common mode voltage range	Vcm(H)	0	—	V_{PS} −2.0	V	Higain = H			
		Vcm(L)	0	—	V_{PS} −5.0	V	Higain = L			
	Output quiescent voltage	Vq	5.45	5.75	6.05	V	Vctl = Vref = 5.75 V R_L = 2.5 Ω, R_S = 0.1 Ω		R, T	
	Total output saturation voltage	Vsat1	—	2.6	3.1	V	I_O = 3.0 A	HA13524/S		1
		Vsat2	—	1.5	1.9	V	I_O = 1.0 A			
	Total output saturation voltage	Vsat3	—	1.8	2.4	V	I_O = 1.5 A	HA13524FP		1
		Vsat4	—	1.4	1.7	V	I_O = 0.5 A			
	Output leak current	I_{CER}	—	—	±100	μA				2
	Output offset voltage (PA2-Sense)	Vofs(H)	—	—	±10	mV	Higain = H, R_S = 0.1 Ω Vctl = Vref = 5.75 V			
		Vofs(L)	—	—	±5	mV	Higain = L, R_S = 0.1 Ω Vctl = Vref = 5.75 V			
	Transfer gain	gm(H)	—	0.8	±20%	A/V	Higain = H	R'_S = 1 Ω		
		gm(L)	—	0.2	±20%	A/V	Higain = L			
	Gain bandwidth	B(H)	—	50	—	kHz	Higain = H	R_L = 2.5 Ω R_S = 0.1 Ω		
		B(L)	—	80	—	kHz	Higain = L			

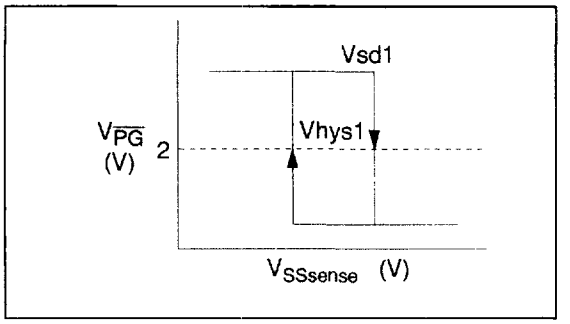
Electrical Characteristics (Ta = 25°C, Vps = 12 V, $V_{SSsense}$ = 5 V) (cont)

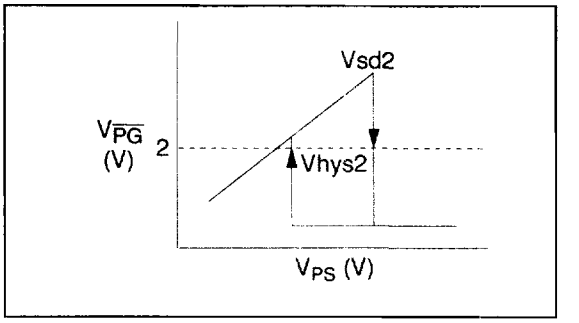
Item		Symbol	Min	Typ	Max	Units	Test conditions	Applicable terminal	Note
Retract	Retpow voltage	Vretpow	3.5	—	—	V	Iret = 0.2 A	W	
	Retset reference voltage	Vretset	1.30	1.38	1.46	V		V	
	Retset input current	Iretset	—	—	±2	μA	Vretset = 1.38 V		
	Retout saturation voltage	Vretsat1	—	2.7	3.2	V	Iret = 1.0 A, HA13524/S	U	
		Vretsat2	—	2.2	2.6	V	Iret = 0.5 A, HA13524FP		
	PA2 lowside saturation voltage	VsatL	—	0.15	0.4	V	Iret = 0.2 A Vretpow = 3.5 V	R	
OP1 & OP2	Input current	Iinop	—	—	±500	nA		E, F, I, J	
	Input offset voltage	Vosop	—	—	±10	mV			
	Input common mode voltage range	Vcmop	0	—	V_{PS} −1.8	V			
	Output high voltage	V_{OHOP}	V_{PS} −1.3	—	—	V	Iout = 1.0 mA	D, K	
	Output low voltage	V_{OLOP}	—	—	1.1	V	Iout = 1.0 mA		
	Open loop gain	Gop	—	54	—	dB	f = 10 kHz		2
	Gain bandwidth	Bop	—	6	—	MHz	Gop = 0 dB		2
$V_{SSsense}$	Input resistance	Rin1	36	52	68	kΩ		A	
LVI	Operating voltage	Vsd1	3.75	4.0	4.25	V	$V_{SSsense}$	A	3
		Vsd2	9.0	9.6	10.2	V	Vps	Y	
	Hysteresis	Vhys1	—	0.2	—	V	$V_{SSsense}$	A	3
		Vhys2	—	0.6	—	V	Vps	Y	
Delay	Threshold voltage	Vth	—	2.5	—	V		P	
	Ct charge current	Icha	—	20	—	μA			
	Ct discharge current	Idis	3	—	—	mA			
Powgood	Output high current	I_{OH}	—	—	±10	μA	V_{OH} = 15 V	Q	
	Output low voltage	V_{OL}	—	—	0.4	V	I_{OL} = 1.0 mA		

Electrical Characteristics (Ta = 25°C, Vps = 12 V, $V_{SSsense}$ = 5 V) (cont)

Item		Symbol	Min	Typ	Max	Units	Test conditions	Applicable terminal	Note
OTSD	Operating temperature	Tsd	125	150	—	°C			2
	Hysteresis	Thys	—	25	—	°C			

Note: 1. Total output voltage is as total as High side saturation voltage and Low side saturation voltage.
2. Value for guide only. At the delivery of this characteristic is not tested.
3. LVI Operating voltage is shown below.





Total output saturation voltage Vsat and Low side saturation voltage VsatL are shown below.
(Value for guide only)