HA13499MP/AMP

Three-Phase Motor Driver IC with Speed Discriminator

The HA13499MP/AMP is a 3-phase brushless DC motor driver IC with digital speed control. It was developed for use with 5 V FDD spindle motors, and has the following functions and features.

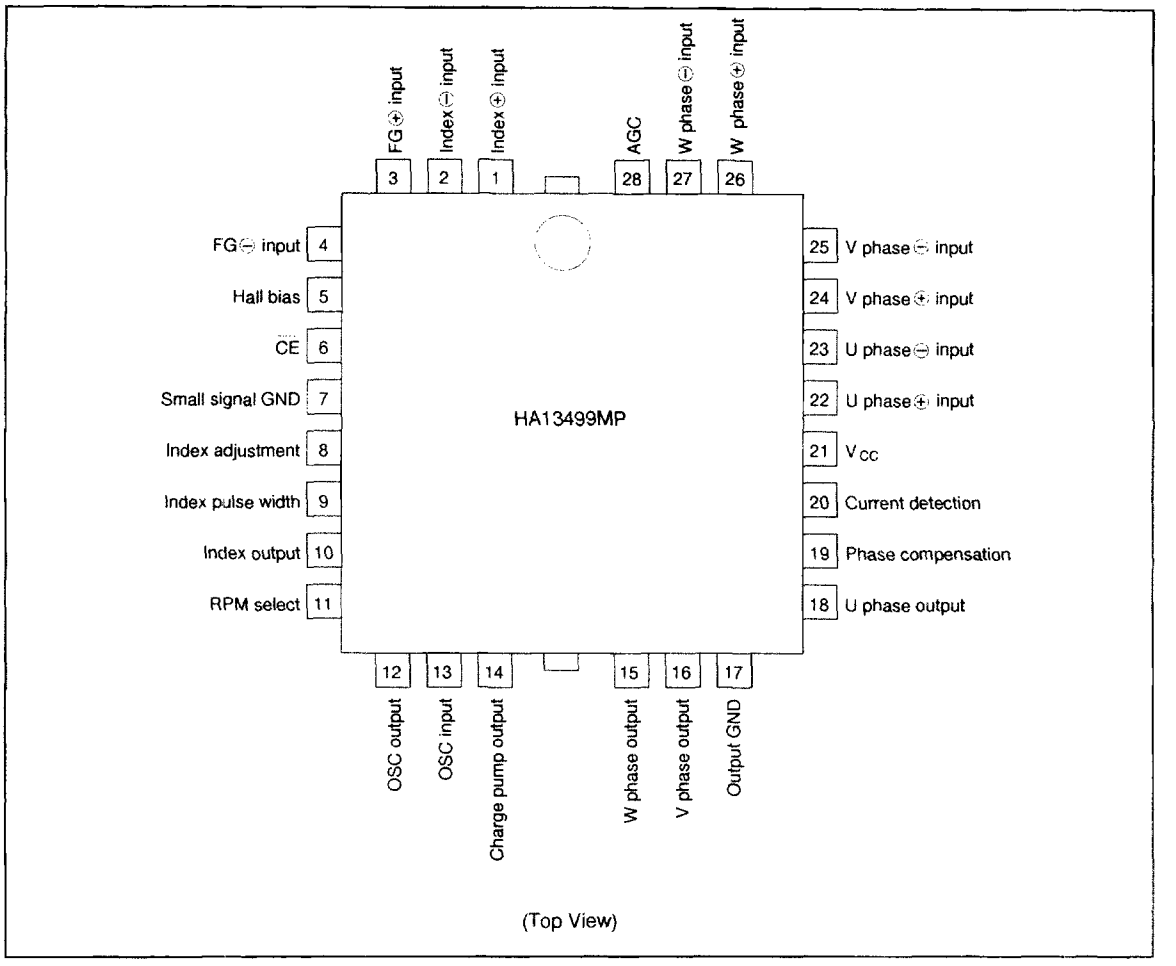
Functions

- 1.0 A per phase, 3-phase drive circuit (current driver)
- Digital speed control circuit
- Index circuit
- Circuit for switching between 300 and 360 rpm speeds
- $\overline{CE}$ circuit
- Current limiter circuit
- Thermal protection circuit (OTSD)

Features

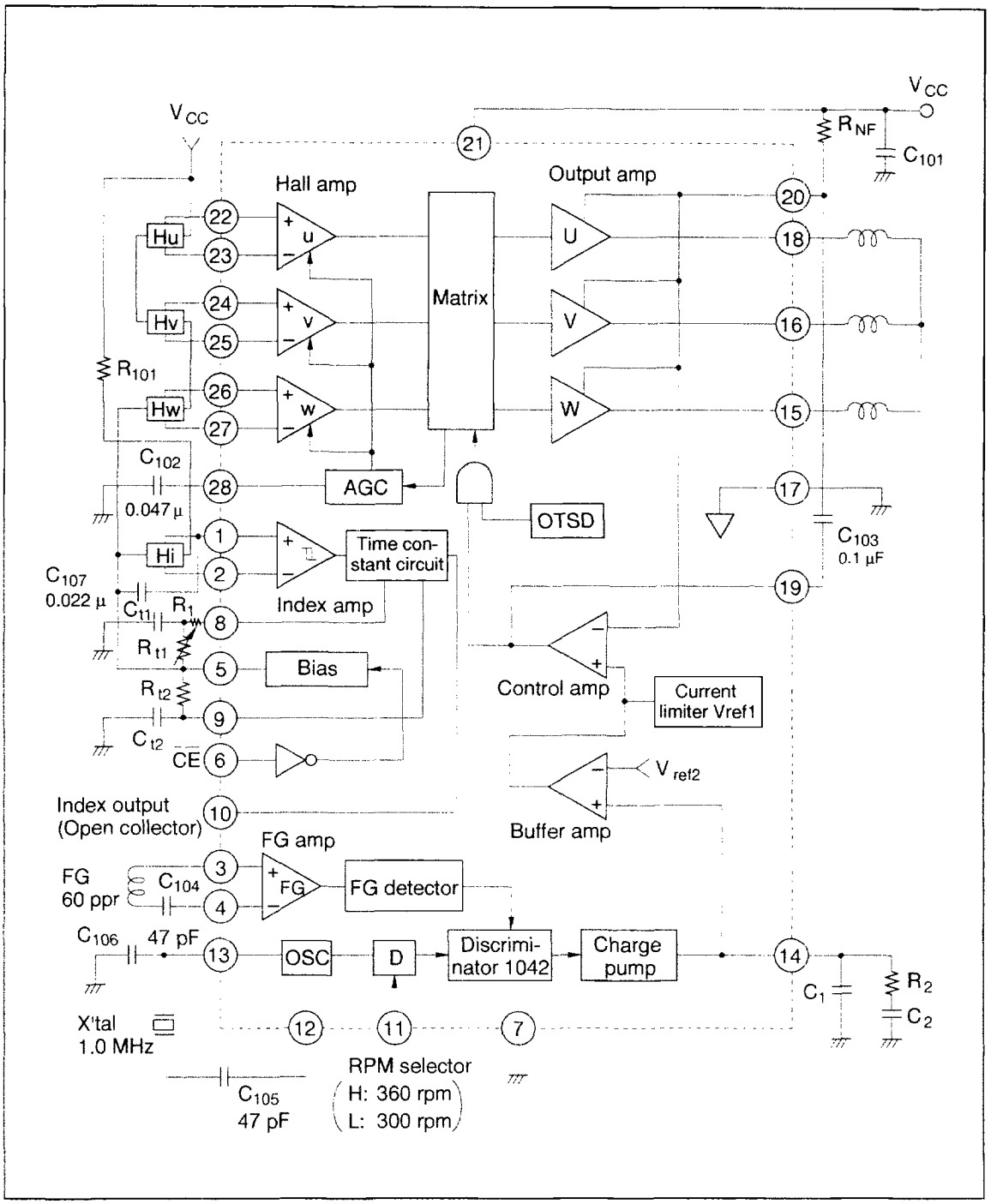
- Soft switching drive circuit
- No need for an output snubber circuit
- Low saturation voltage

Pin Arrangement



(Top View)

Block Diagram



External Parts

Part Number	Recommended Value	Purpose	Notes
R_1	1 kΩ	C_{t1} discharge current limitation	
R_2	—	Integration constant	1
R_{101}	—	Hall bias	
R_{NF}	0.47 Ω	Current detection and current limitation	2
R_{t1}	10 k to 100 kΩ	Index burst adjustment	3
R_{t2}	10 k to 100 kΩ	Index pulse width setting	3
C_1	—	Integration constant	1
C_2	—	Integration constant	1
C_{101}	≥ 0.1 µF	Power supply bypass	4
C_{102}	0.047 µF	AGC filter	
C_{103}	0.1 µF	Control amp phase compensation	
C_{104}	—	FG amp combination	5
C_{105}	47 pF	Oscillator coupling	6
C_{106}	47 pF	Oscillator stabilization	6
C_{107}	0.022 µF	Index initralize	
C_{t1}	—	Index burst adjustment	3
C_{t2}	—	Index pulse width setting	3
X'tal	1.0 MHz	Standard clock oscillator	7

Notes: 1. Determine the value from the following formulas.

$$\omega_o \leq \frac{2\pi f_{FG}}{20} \quad \text{(rad/s)}$$

$$R_2 = \frac{1}{9.55} \cdot \frac{J \omega_o N_o R_{NF}}{K_T G_{ctl} I_{CP}} \quad (\Omega)$$

$$C_1 = \frac{1}{\sqrt{10}} \cdot \frac{1}{\omega_o R_2} \quad \text{(F)}$$

$$C_2 = 10\, C_1 \quad \text{(F)}$$

In the above formulas:

f_{FG} = FG frequency in Hz

N_o = Motor speed in rpm

J = Motor moment of inertia in kg·cm·s^2

K_T = Motor torque constant in kg·cm/A

G_{ctl} = Control amp gain (see Electrical characteristics)

I_{CP} = Charge pump output current (see Electrical characteristics)

2. The current limiter functions as in the following formula.

$$I_{omax} = \frac{V_{ref1}}{R_{NF}} \quad (A)$$

However, note that V_{ref1} is the current limiter reference voltage (see Electrical characteristics)

3. The times t_1 and t_2 in the index timing chart are defined by:

$t_1 \cong C_{t1} \cdot R_{t1}$
$t_2 \cong C_{t2} \cdot R_{t2}$

However, R_{t1} and R_{t2} must be in the 10 kΩ to 100 kΩ range.

4. Place as close to the IC as possible.

5. Set this value according to the following formula.

$$C_{104} \geq \frac{100}{f_{FG}} \quad (\mu F)$$

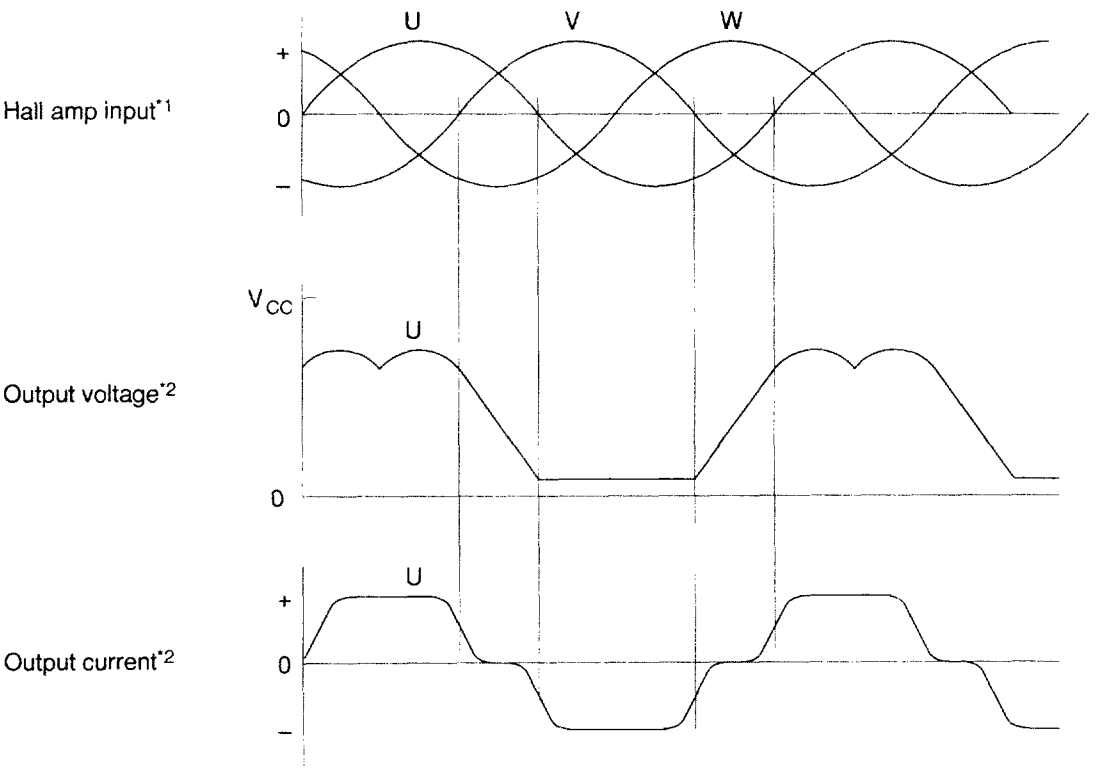
6. Determine in consultation with the oscillator manufacturer.

7. The relationship between f_{OSC} and f_{FG} is as follows. However, D is a divider which is determined by the RPM selector, and when this is H, D is 6/16; when this is L, D is 5/16.

$$f_{OSC} = \frac{1042\ f_{FG}}{D} \quad (Hz)$$

Timing Chart

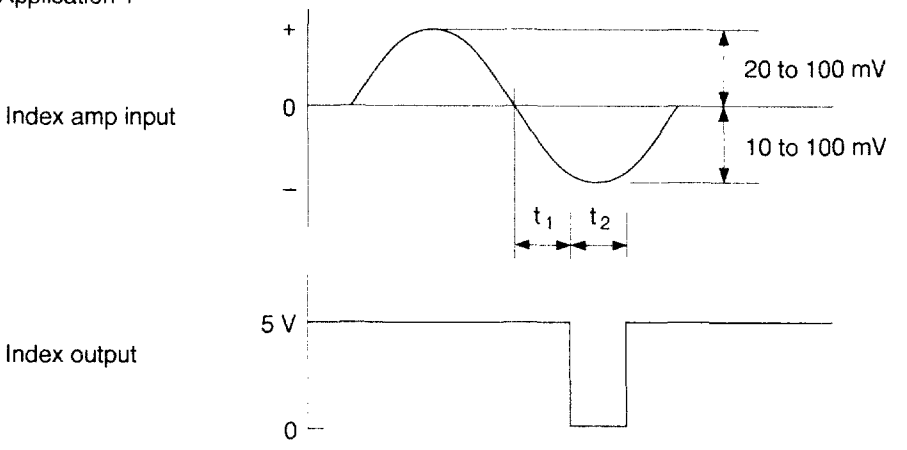
- Hall Amp Input vs. Output Current



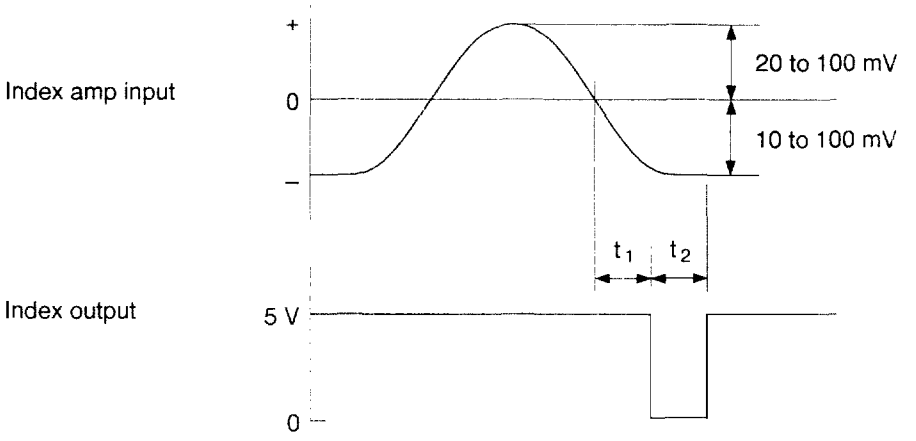
Notes: 1. The input waveforms to the hole amp should be sine waves with a third harmonic content of less than 20%.
2. Only the U phase output is shown.

• Index Amp Input vs. Output

Application 1



Application 2



Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating	Unit	Notes
Power supply voltage	V_{CC}	7	V	1
Instantaneous output current	$I_{O\ peak}$	1.0	A	2
Operating output current	I_O	0.7	A	
Input voltage	V_{in}	0.5 to V_{CC}	V	3
Power dissipation	P_T	1.5	W	4
Junction temperature	T_j	150	°C	1
Storage temperature range	T_{stg}	–55 to +125	°C	

Notes 1. The operating range is as follows:
V_{CC} = 4.25 to 6.5 V
T_{jopr} = 0 to +125°C
2. t ≤ 0.5 sec.
3. Applies to the $\overline{CE}$, and RPM selector pins.
4. This is the allowable value when T_{pin} is 66°C. However, thermal resistance is as follows:
$\theta_{j-pin} \leq 56$°C/W
$\theta_{j-a} \leq 80$°C/W (When mounted to a metal base plate.)

Electrical Characteristics (Ta = 25°C, V_{CC} = 5 V)

Item		Symbol	Min	Typ	Max	Units	Test Conditions	Applicable Pins	Notes
Current drawn		I_{CCO}	—	—	0.45	mA	$\overline{CE}$ = H, RPM = L, V_{CC} = 5.5V	21	
			—	—	0.9	mA	$\overline{CE}$ = H, RPM = H, V_{CC} = 6.5V		
		I_{CC}	—	15	23	mA	$\overline{CE}$ = L, V_{CC} = 6.5 V		
$\overline{CE}$	Input current	I_{CE}	—	—	±10	µA	$\overline{CE}$ = 0 to 5 V	6	
	Input low voltage	V_{CEL}	—	—	0.8	V	Enabled		
	Input high voltage	V_{CEH}	2.0	—	—	V	Disabled		
RPM selector	Input current	I_{rpm}	—	—	±10	µA	V_{rpm} = 0 to 5 V	11	
	Input low voltage	V_{rpmL}	—	—	1.0	V	300 rpm		
	Input high voltage	V_{rpmH}	3.5	—	—	V	360 rpm		
Hall amp	Input resistance	R_{hi}	—	10	—	kΩ		22 to 27	
	In-phase input voltage range	V_h	2.0	—	V_{CC}	V			
	Differential input voltage range	v_h	30	—	160	mV_{PP}			

Electrical Characteristics (Ta = 25°C, V_{CC} = 5 V) (cont)

Item		Symbol	Min	Typ	Max	Units	Test Conditions	Applicable Pins	Notes
Hall bias	Output voltage	V_{hb}	2.4	2.6	2.8	V	$\overline{CE}$ = L, I_h = 10 mA	5	
	Leakage current	I_{hoff}	—	—	±10	μA	$\overline{CE}$ = H, V_h = 7 V		
Output amp	Leakage current	I_{CER}	—	—	±1.0	mA	V_{CE} = 7 V	15, 16 18	
	Saturation voltage	V_{sat1}	—	1.3	1.8	V	I_O = 0.7 A		1
		V_{sat2}	—	1.0	1.2	V	I_O = 0.35 A		
	Loss current	I_{loss}	—	—	10	mA	Output open	20	
Buffer control amp	Voltage gain	G_{CTL}	—	−10	—	dB		14	2
	Reference	V_{ref1}	0.225	0.25	0.275	V	R_{NF} = 0.47 Ω		
		V_{ref2}	—	0.63	—	V			
Charge pump	Charging current	I_{CP-}	—	−18	—	μA	V_{pin14} = 0.0 V	14	
	Discharge current	I_{CP+}	—	18	—	μA	V_{pin14} = 0.63 V		
	Current ratio	IR	0.9	1.0	1.1	—	I_{CP+}/I_{CP-}		
	Clamping voltage	V_{max}	—	2.6	—	V			
	Leakage current	I_{off1}	—	—	±50	nA	V_{pin14} = 0.63 V		
FG amp	Input voltage range	V_{FG}	2	—	20	mV_{PP}	f = 450 Hz	3, 4	
	Noise margin	n_d	—	—	0.5	mV_{PP}	Differential noise		
		n_c	—	—	0.5	V_{PP}	In-phase noise		
OSC	Oscillator frequency range	f_{OSC}	—	1.0	1.2	MHz		12	
	Frequency error	Δf_{OSC}	—	—	±0.2	%	When a 1.0 MHz ceramic oscillator is used.		
Discriminator	Number of counts	N	—	1042	—	—		12	
	Operating frequency	f_d	—	1.0	1.2	MHz			
Index amp	Input current	I_{idx}	—	—	±10	μA		2	
	Offset voltage	ΔV_{idx}	—	—	±10	mV		1, 2	
	In-phase input voltage range	V_{idx}	2.0	—	V_{CC} − 1.2		V		

Electrical Characteristics (Ta = 25°C, V_{CC} = 5 V) (cont)

Item		Symbol	Min	Typ	Max	Units	Test Conditions	Applicable Pins	Notes
Index amp	Differential input voltage range	v_{idx}	40	—	200	mV_{PP}		1, 2	
	Noise margin	n_{didx}	—	—	20	mV_{PP}			
		n_{cidx}	—	—	1.0	V_{PP}			
	Hall bias voltage vs. index threshold voltage	v_{th}/v_{hb}	—	0.63	—		I_{hb} = 2 mA, $\overline{CE}$ = L	8	3
Time constant circuit	CR pin threshold voltage	V_{th}	—	1.64	—	V	I_{hb} = 10 mA	8, 9	
	CR pin leakage current	I_{oh1}	—	—	±2	µA	V_{oh} = 5 V		
	CR pin low voltage	V_{ol1}	—	—	0.4	V	I_o = 1 mA		
	Output leakage current	I_{oh2}	—	—	±2	µA	V_{oh} = 5 V	10	
	Output low voltage	V_{ol2}	—	—	0.4	V	I_o = 1 mA		
OTSD shutdown temperature		T_{sd}	125	150	—	°C			4

Notes: 1. Determined by the total of sink and source.
2. Refer to Figure 1. However, $G_{ctl} = \Delta V_{RNF}/\Delta V_{14}$
3. Refer to Figure 2. Apply to HA13499AMP only.
4. Design guide only.

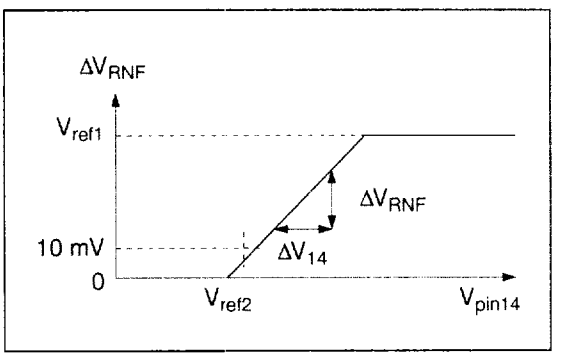


Figure 1

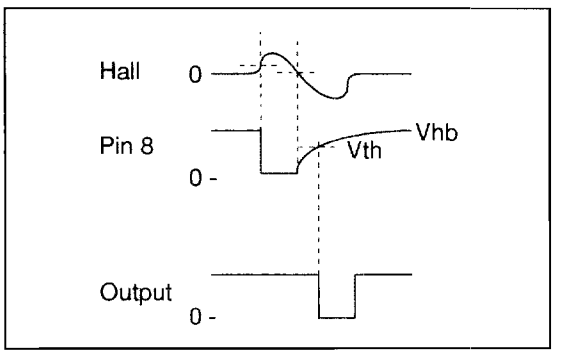


Figure 2

Reference Data

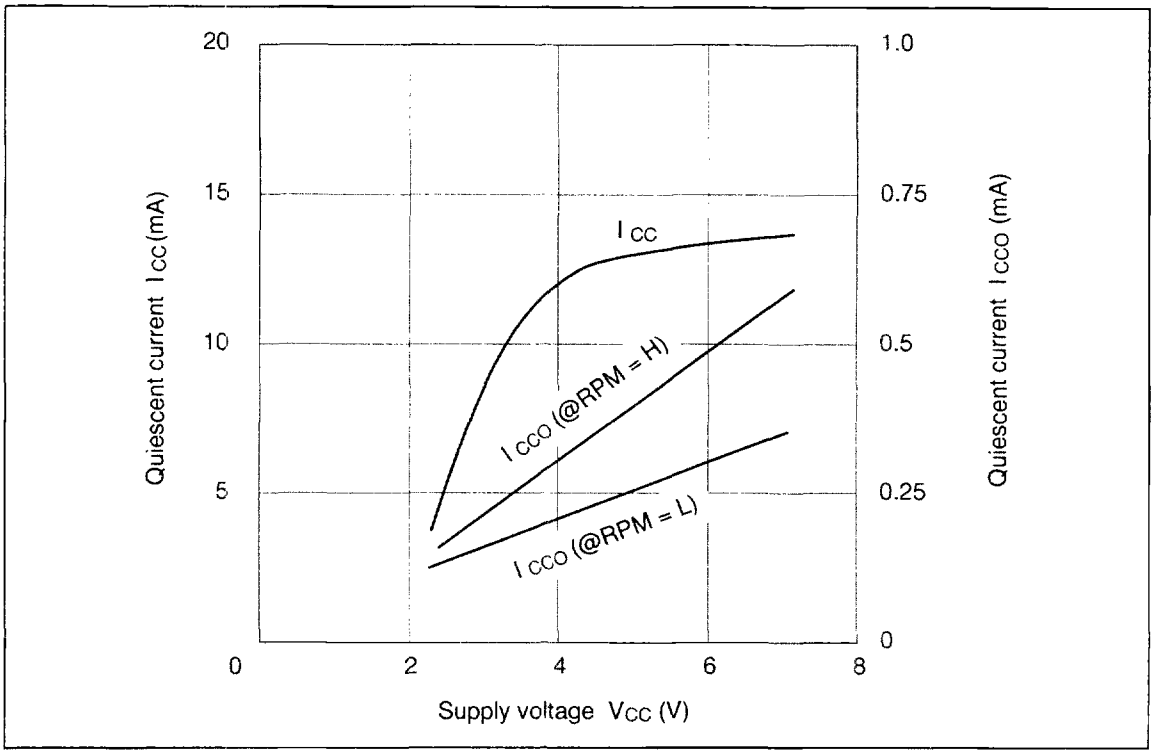


Figure 3

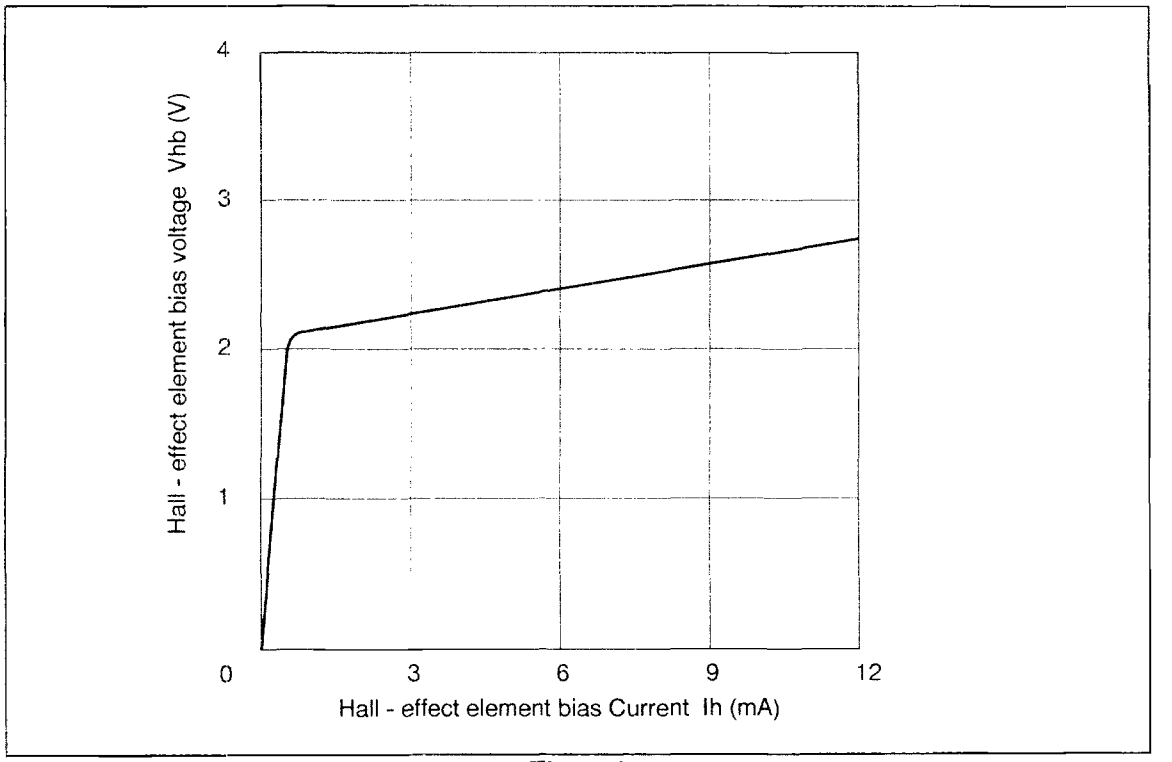


Figure 4

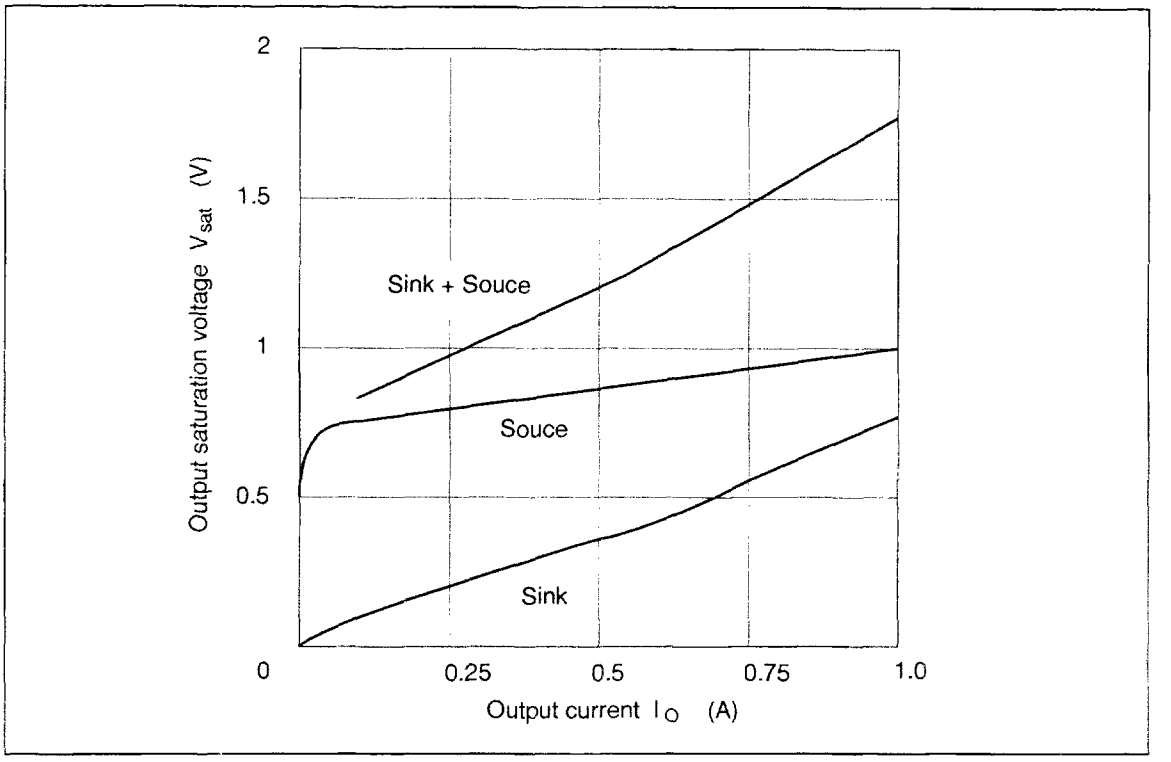


Figure 5

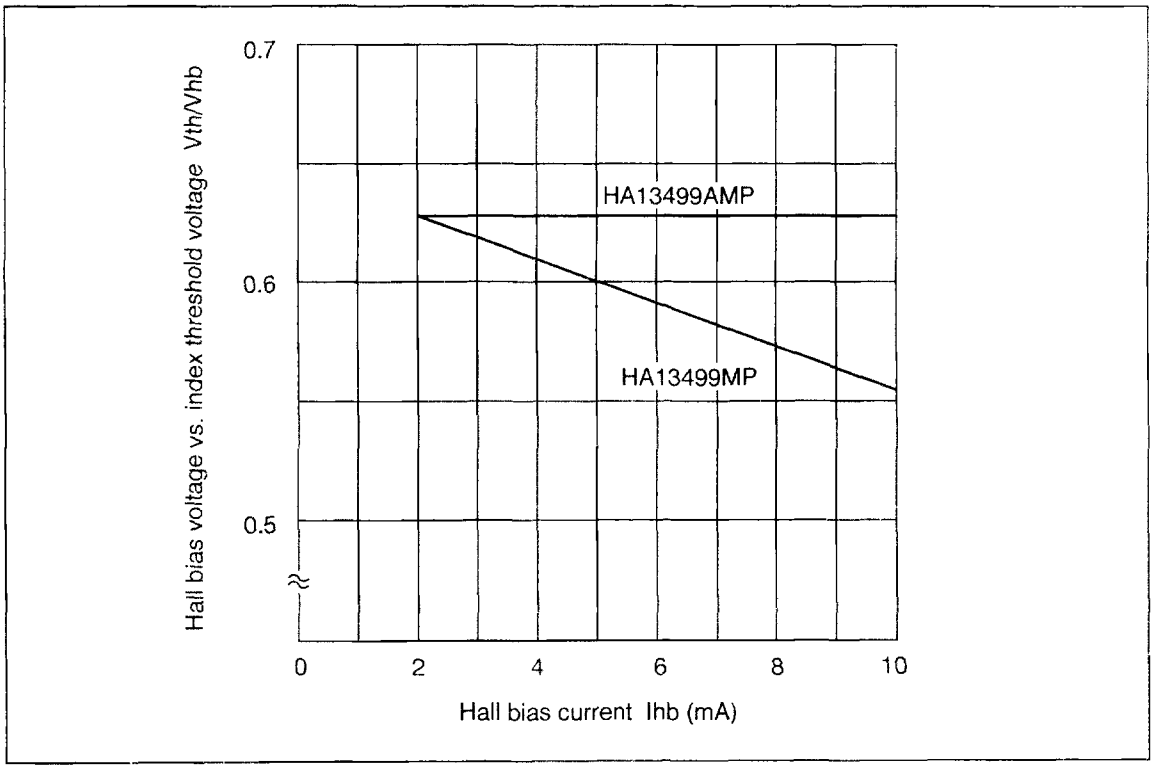


Figure 6

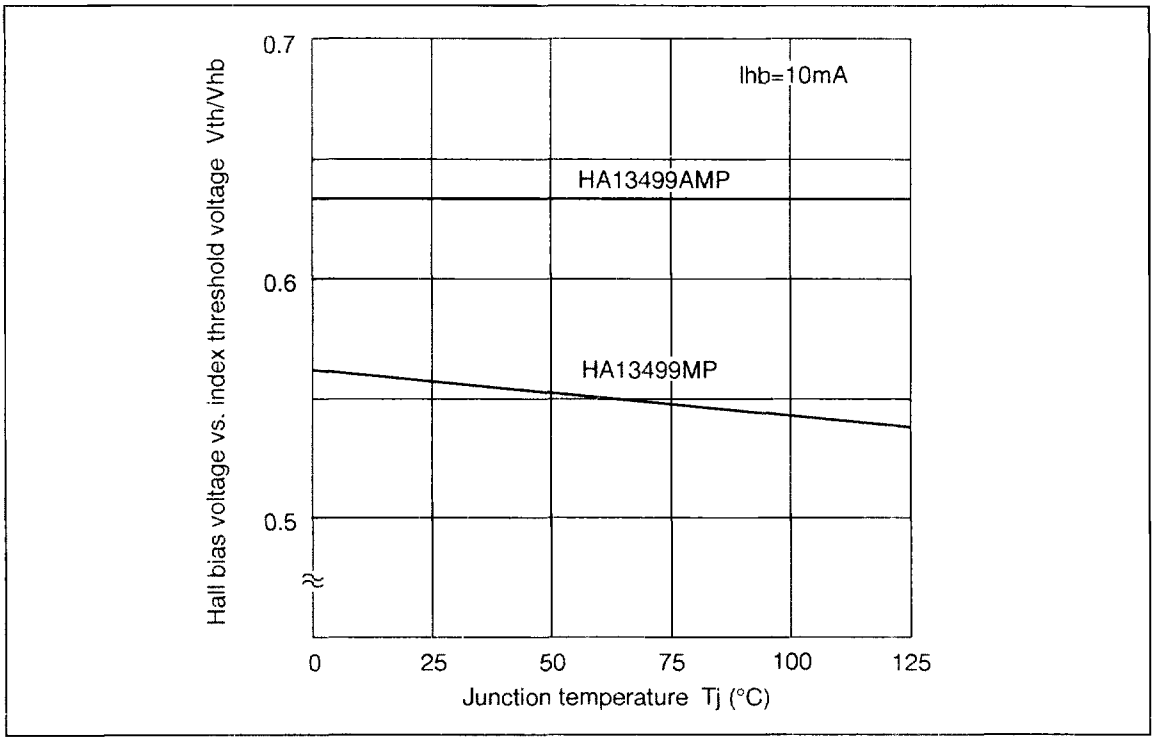


Figure 7

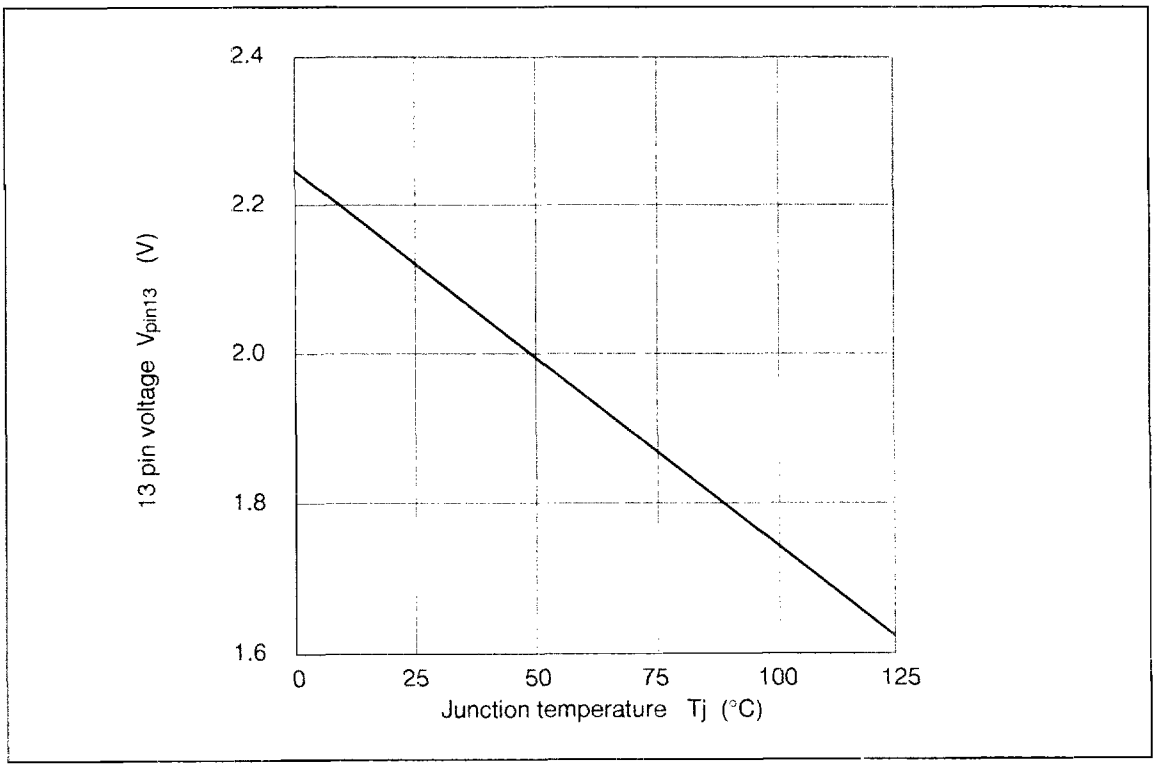


Figure 8