HA13491S

Three-Phase Motor Driver With Speed Discriminator

Description

The HA13491S is a 3-phase brushless motor drive IC designed for use as a 5- and 12-volt HDD spindle motor driver. It has the following functions and features.

- CLK and FG dividers
- Standby circuit
- Current control circuit
- OTSD temperature protection circuit

Functions

- 1.5 A/phase 3-phase drive circuit
- Digital speed control circuit
- Digital ready circuit
- FG amp
- Short brake circuit

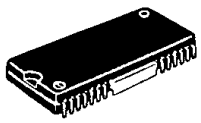
Features

- Soft switching driver circuit
- No need for output snubber circuits
- Low saturation voltage
- Wide operating voltage range

Ordering Information

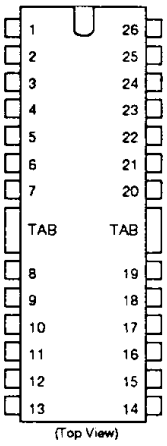
Type No.	Package
HA13491S	MP-26DT

HA13491S



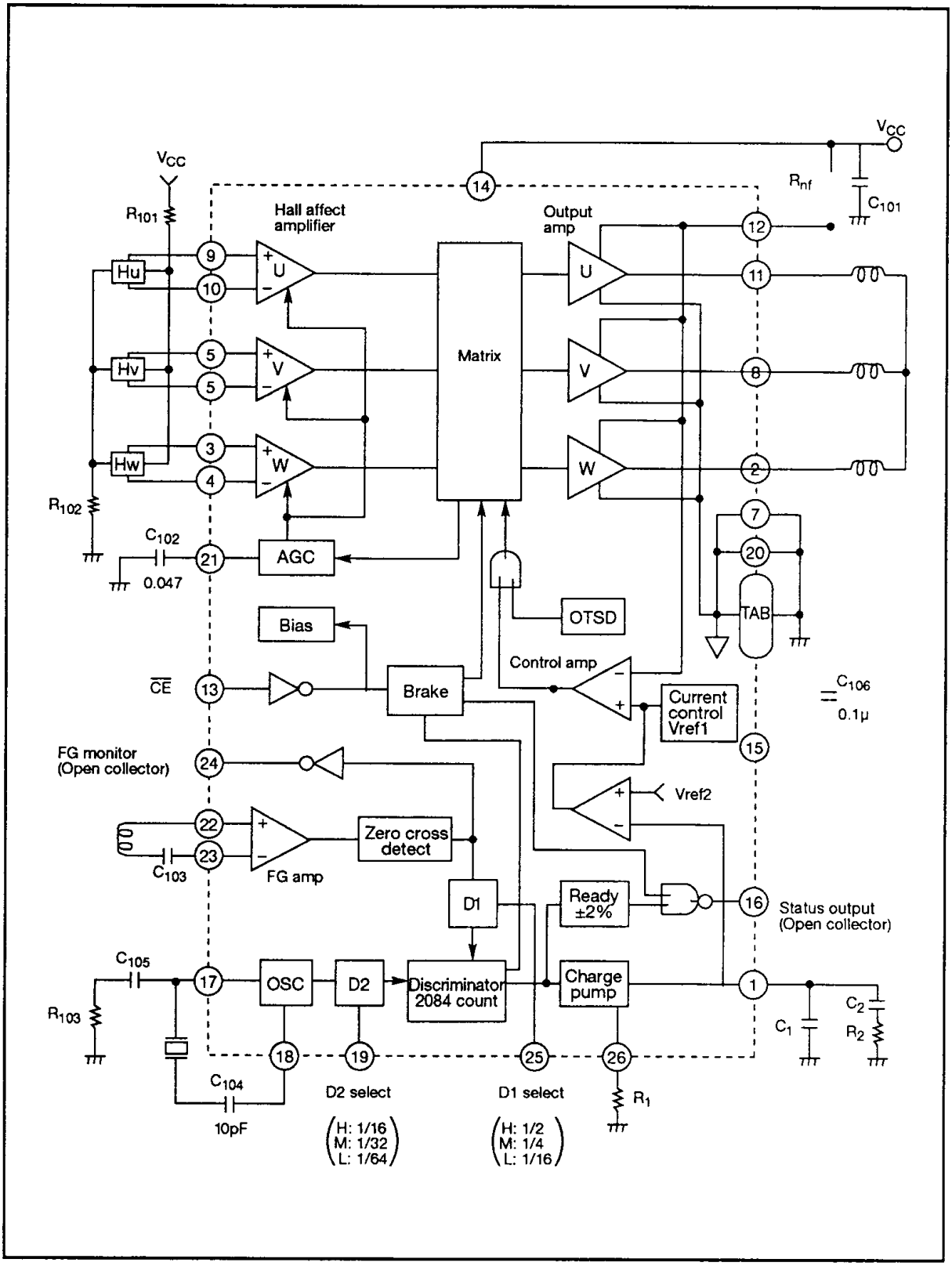
(MP-26DT)

Pin Arrangement



Pin No.	Function	Pin No.	Function
1	Charge pump output	16	Status output
2	W phase output	17	OSC input
3	W + input	18	OSC output
4	W – input	19	D2 select
5	V + input	20	GND
6	V – input	21	AGC filter
7	GND	22	FG + input
8	V phase output	23	FG – input
9	U + input	24	FG motor
10	U – input	25	D1 select
11	U phase output	26	Charge pump bias
12	Current detection		
13	$\overline{CE}$		
14	VCC		
15	Control amp phase compensation		

Block Diagram



External Parts

Part No.	Recommended Value	Purpose	Notes
R_1	≤ 10 kΩ	Integration constant	1
R_2	—	Integration constant	1
R_{101}, R_{102}	—	Hall effect bias	2
R_{103}	470 Ω	Oscillator stabilization	3
R_{nf}	≥ 0.27 Ω	Current detection	4
C_1	—	Integration constant	1
C_2	—	Integration constant	1
C_{101}	≥ 0.1 μF	Power supply bypass	5
C_{102}	0.047 μF	AGC filter	
C_{103}	—	FG coupling	6
C_{104}	10 pF	Oscillator coupling	
C_{105}	0.047 μF	Oscillator stabilization	3
C_{106}	0.1 μF	Control amp phase compensation	
X'tal	—	Reference oscillator	7

Notes: 1. Determine the value based on the following formulas.

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

$$\frac{R_2}{R_1} = \frac{4}{9.55} \times \frac{J\,\omega_o\,N_o\,R_{nf}}{K_T\,G_{CTL}\,V_{R1}}$$

$$C_1 = \frac{1}{10} \quad \frac{1}{\omega_o\,R_2} \quad [F]$$

$$C_2 = 10\,C_1 \quad [F]$$

Where:

f_{FG} = FG frequency (Hz)
N_O = Motor speed (rpm)
J = Motor moment of inertia (kg • cm • s^2)
K_T = Motor torque constant (kg • cm/A)
G_{ctl} = Control amp gain (see Electrical Characteristics)
V_{R1} = Charge pump bias voltage (see Electrical Characteristics)
R_{nf} = Current detector resistance (Ω)

2. Select these values so that the Hall effect amplifier in-phase and differential input voltage ranges are satisfied.
3. Unnecessary with crystal frequencies of 4.0 MHz and under.
4. Current control functions according to the following formula.

$$I_O\,max = \frac{V_{ref1}}{R_{nf}} \quad A$$

Here, V_{ref1} is the current control reference voltage (see Electrical Characteristics).

5. Locate as close to the IC as possible.
6. Determine the value based on the following formula:

$$C_{103} \geq \frac{200}{f_{FG}} \quad (\mu F)$$

7. The relation between the crystal frequency and f_{FG} is as follows:

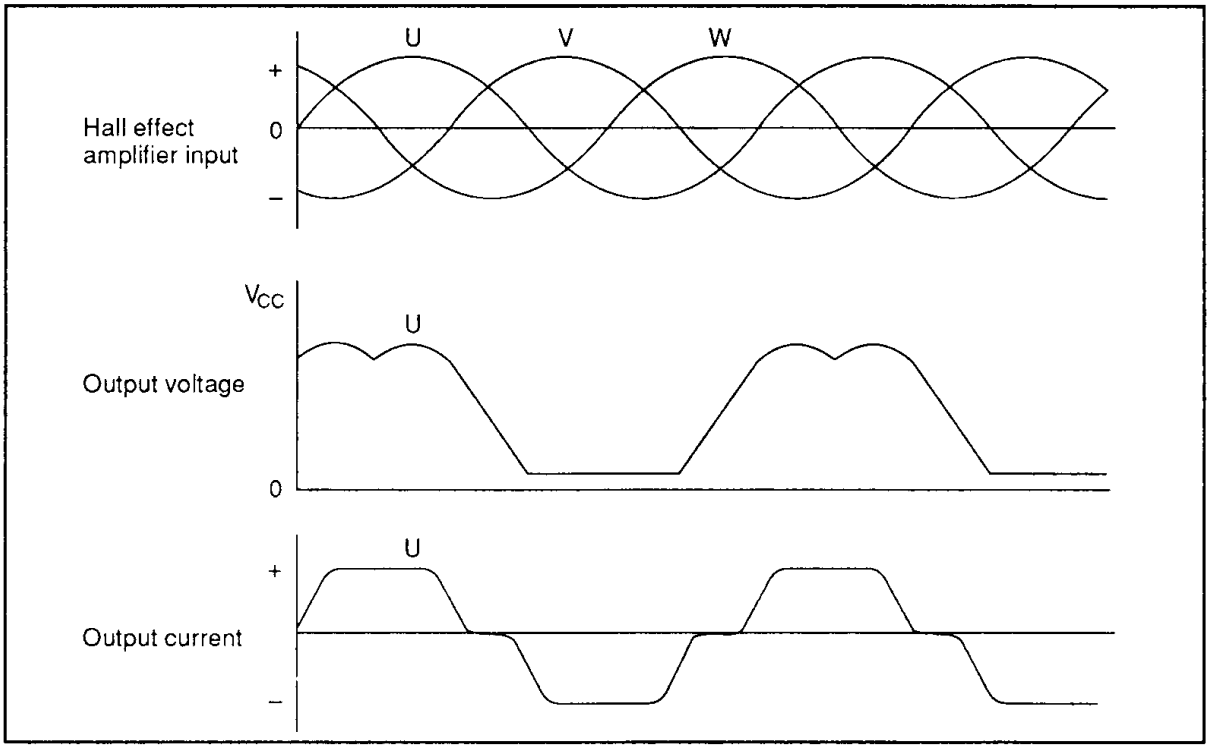
$$f_{osc} = \frac{2083.5\,D^1\,f^{FG}}{D_2} \quad (Hz)$$

Here, D_1 and D_2 specify the division ratio, and their relation to the voltage applied to the D select terminal is as follows:

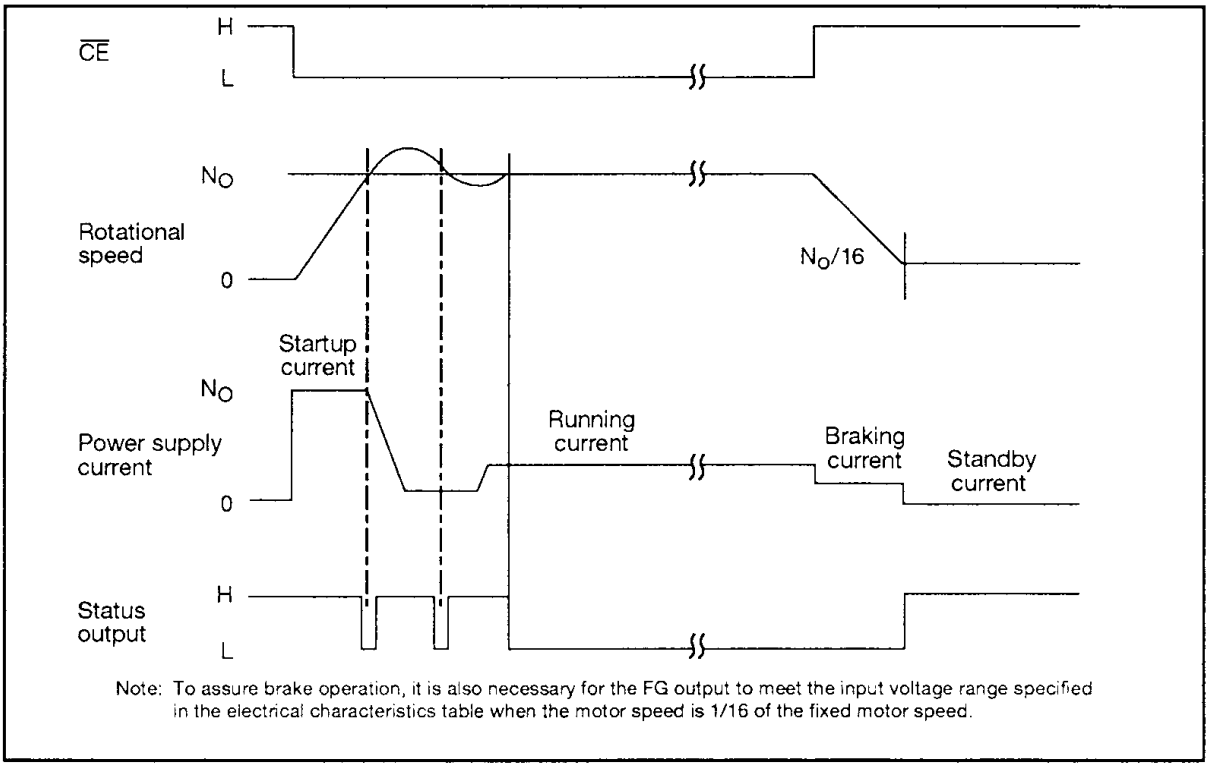
	D_1 select (pin 25)				D_2 select (pin 19)		
	H	M	L		H	M	L
D_1	1/2	1/4	1/16	D_2	1/16	1/32	/64

Timing Charts

1. Hall Effect Amplifier Input vs. Output Voltage and Current



2. Brake Operation and Status Output



Note: To assure brake operation, it is also necessary for the FG output to meet the input voltage range specified in the electrical characteristics table when the motor speed is 1/16 of the fixed motor speed.

Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating	Units	Notes
Power supply voltage	V_{CC}	+15	V	1
Input voltage	V_{in}	0 to V_{CC}	V	2
Instantaneous output current	I_{op}	1.5	A	3
Normal output current	I_{doc}	1.0	A	
Allowable dissipation	P_t	2	W	4
Junction temperature	T_j	+150	°C	5
Storage temperature	T_{stg}	−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 operating voltage range is as follows: V_{cc} = 4.25 to 13.8 V
2. Applies to $\overline{CE}$, D_1, and D_2 pins.
3. Refer to the Safe Operating Range figure in the Reference Data Section. Operating locus must be within the ASO.
4. This is the allowable value when T_C is 136°C. However, thermal resistance is as follows:
   $\theta_{j-c} \leq 7$°C/W
   $\theta_{j-a1} \leq 15$°C/W (When a metal base substrate is used.)
   $\theta_{j-a2} \leq 62$°C/W (When a glass epoxy substrate is used.)
5. The operating temperature range is as follows:
   T_{jopr} = 0 to 125°C.

Electrical Characteristics (Ta = 25°C, V_{CC} = 12 V)

Item		Symbol	Min	Typ	Max	Units	Measurement Conditions	Applicable Pins	Notes
Current drawn		I_{CCO}	—	3	5	mA	$\overline{CE}$ = H, V_{CC} = 13.8 V	12,14	1
		I_{CC}	—	20	25	mA	$\overline{CE}$ = L, V_{CC} = 13.8 V		
CE	Input current	I_{in1}	—	—	±50	μA	V^{in} = 0 to 12 V	13	
	Input high voltage	V_{ih1}	2.0	—	—	V	Disable		
	Input low voltage	V_{ih1}	—	—	0.8	V	Enable		
D_1 and D_2 select	Input current	I_{in2}	—	—	±0.35	mA	V_{in} = 0 to 5 V	19,25	
	Input high voltage	V_{ih2}	3.5	—	—	V			
	Input middle voltage	V_{im2}	1.2	—	3.0	V			
	Input low voltage	V_{il2}	—	—	0.8	V			
Hall effect amp	Input resistance	R_{hi}	7	10	13	kΩ		3 to 6, 9,10	
	In-phase input voltage range	V_{ch}	1.5	—	V_{CC} −2	V			
	Differential input voltage range	V_{dh}	60	—	200	mV_{PP}			
Output amp	Leakage current	I_{CER}	—	—	0.1	mA	V_{CE} = 15 V	2,8,11	
	Saturation voltage	V_{sat1}	—	1.2	1.8	V	I_O = 1.0		2
		V_{sat2}	—	1.0	1.2	V	I_O = 0.35 A		
Buffer control amp	Voltage gain	G_{ctl}	−7	−9	−11	dB	12		3
	Reference voltage	V_{ref1}	0.216	0.24	0.264	V	R_{nf} = 1 Ω		
		V_{ref2}	2.1	2.3	2.5	V			

Electrical Characteristics (Ta = 25°C, V_{CC} = 12 V)

Item		Symbol	Min	Typ	Max	Units	Measurement Conditions	Applicable Pins	Notes
Charge pump	R1 voltage	V_{R1}	1.15	1.25	1.35	V	R1 = 3.3 Ω	26	
	Charging current	1+	—	95	—	μA	R1 = 3.3 Ω	1	
	Discharge current	1−	—	−95	—	μA	R1 = 3.3 Ω		
	Current ratio	1+/1−	—	1.0	—	—			
	Clamp voltage	V_{max}	0.58	0.78	0.88	V			4
	Leakage current	I_{off}	—	—	±60	nA			
FG amp	Input voltage range	V_{FG}	10	—	60	mV_{PP}	CE = L	22,23	
			2	—	—		Brake mode		
	Noise margin	n_d	—	—	2	mV_{PP}	CE = L		
			—	—	0.5		Brake mode		
		n_c	1.0	—	—	V_{PP}			
OSC	Oscillator frequency range	f_{osc}	—	—	8.0	MHz	Crystal oscillator	18	
	Oscillator frequency error	$\triangle f_{osc}$	—	—	±0.1	%	4 MHz crystal oscillator		
Discriminator	Number of counts	N	—	2084	—	—	—		
	Operating frequency	f_d	—	—	500	KHz			
FG monitor status output	Leakage current voltage	I_{oh}	—	—	±20	μA	V_{oh} = 15 V	16,24	
	Output low voltage	V_{ol}	—	—	0.4	V	I_O = 2 mA		
OTSD	Operating temperature	T_{sd}	125	150	—	°C	—		

Notes: 1. Specified as the sum of the pin 12 and 14 currents.
2. Specified as the sum of the upper and lower saturation voltages.
3. Refer to figure 1, where:

$$G_{ctl} = \frac{\triangle V_{Rnf}}{\triangle V_{pin1}}$$

4. Specified as the difference with V_{ref}.

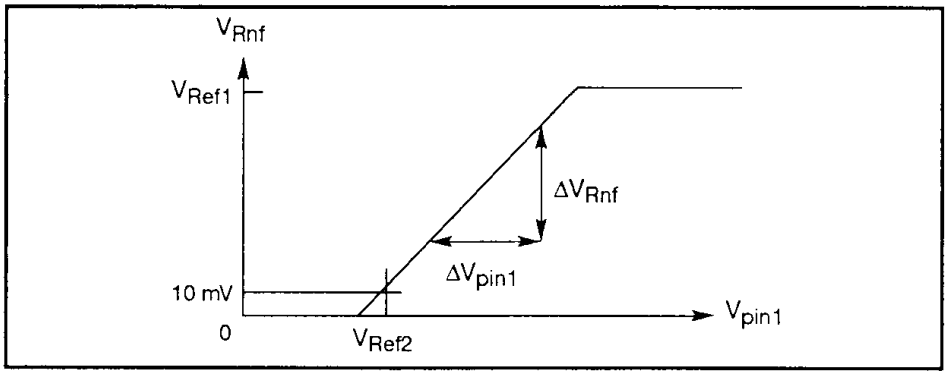


Figure 1 V_{Rnf} vs V_{pin1}

Reference Data

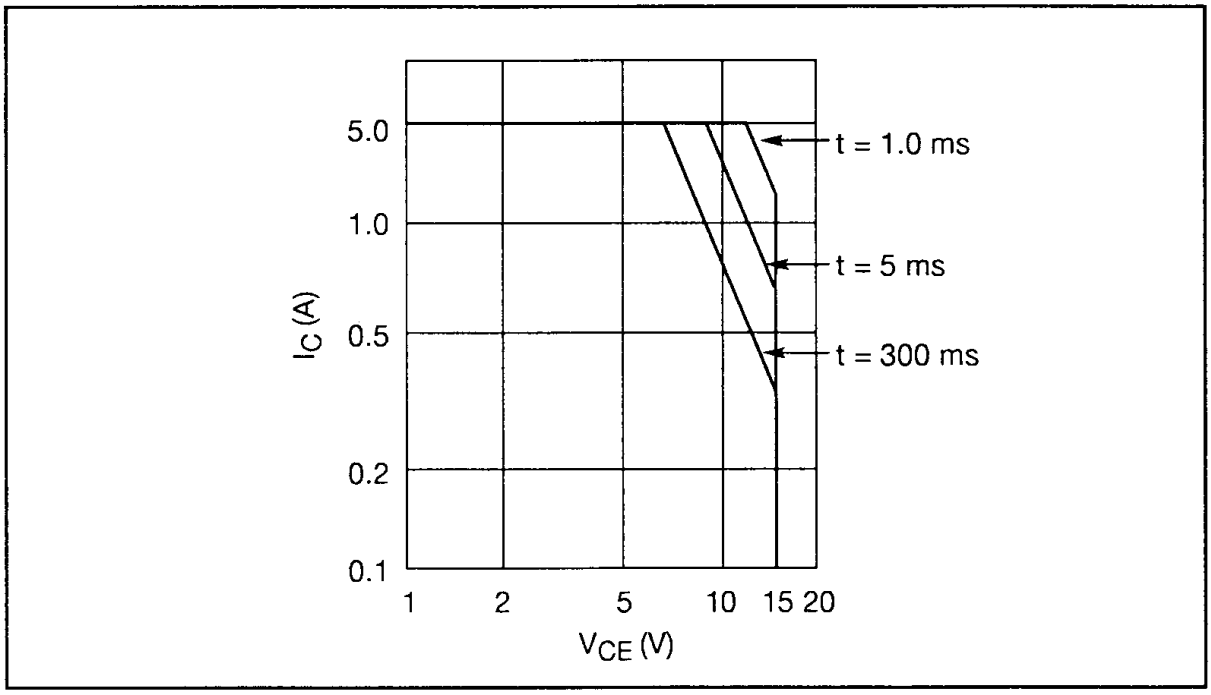


Figure 2 Output Transistor Safe Operating Range

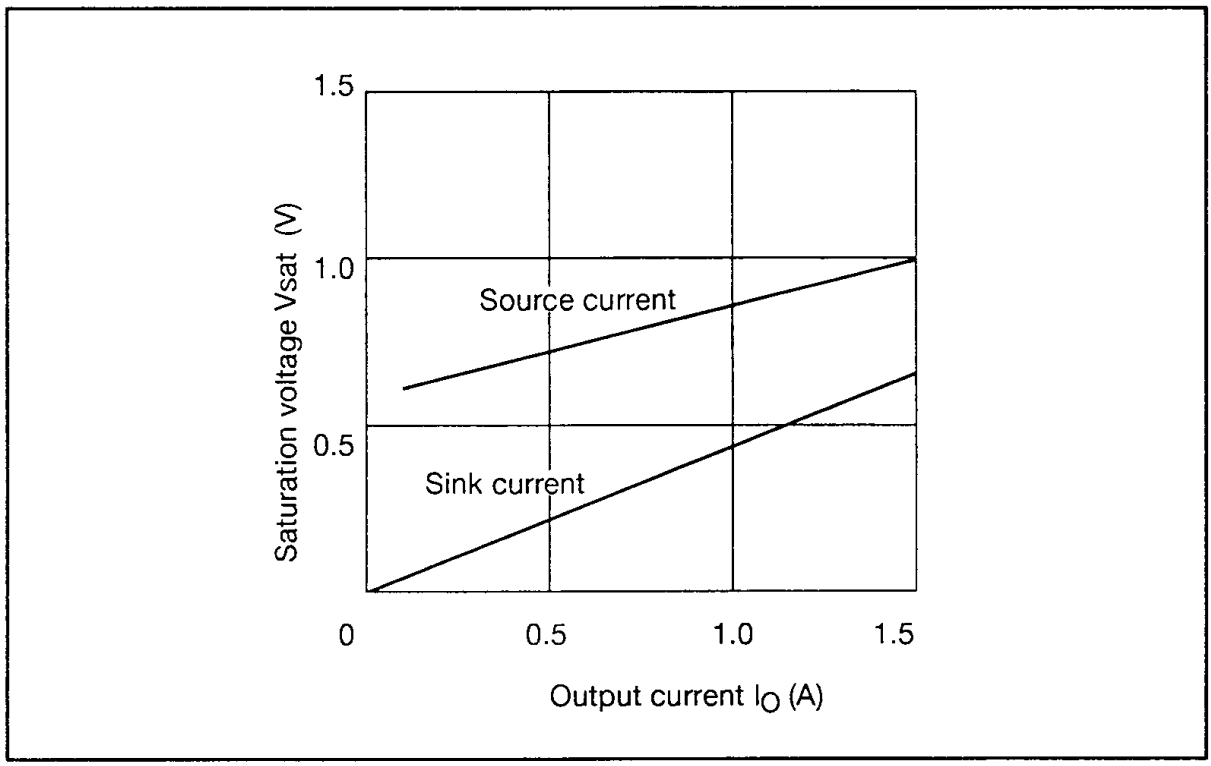


Figure 3 Output Transistor Saturation Characteristics

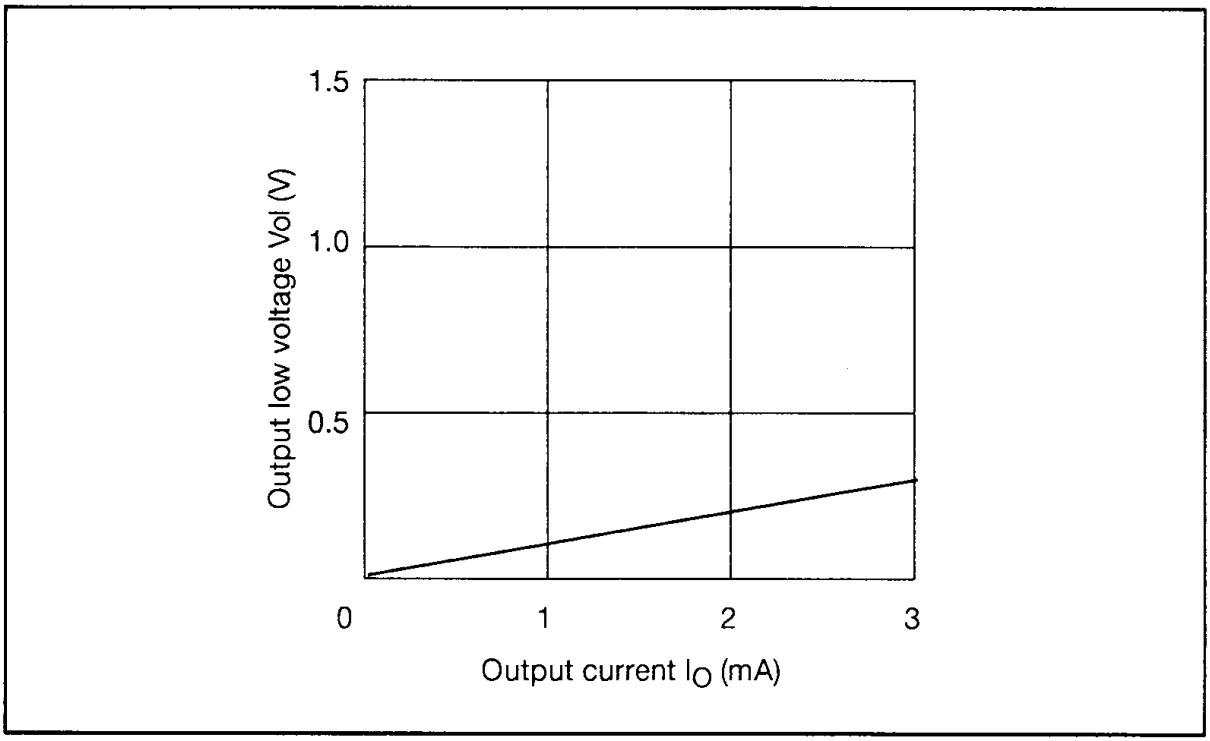


Figure 4 FG Monitor and Status Output Voltage Characteristics

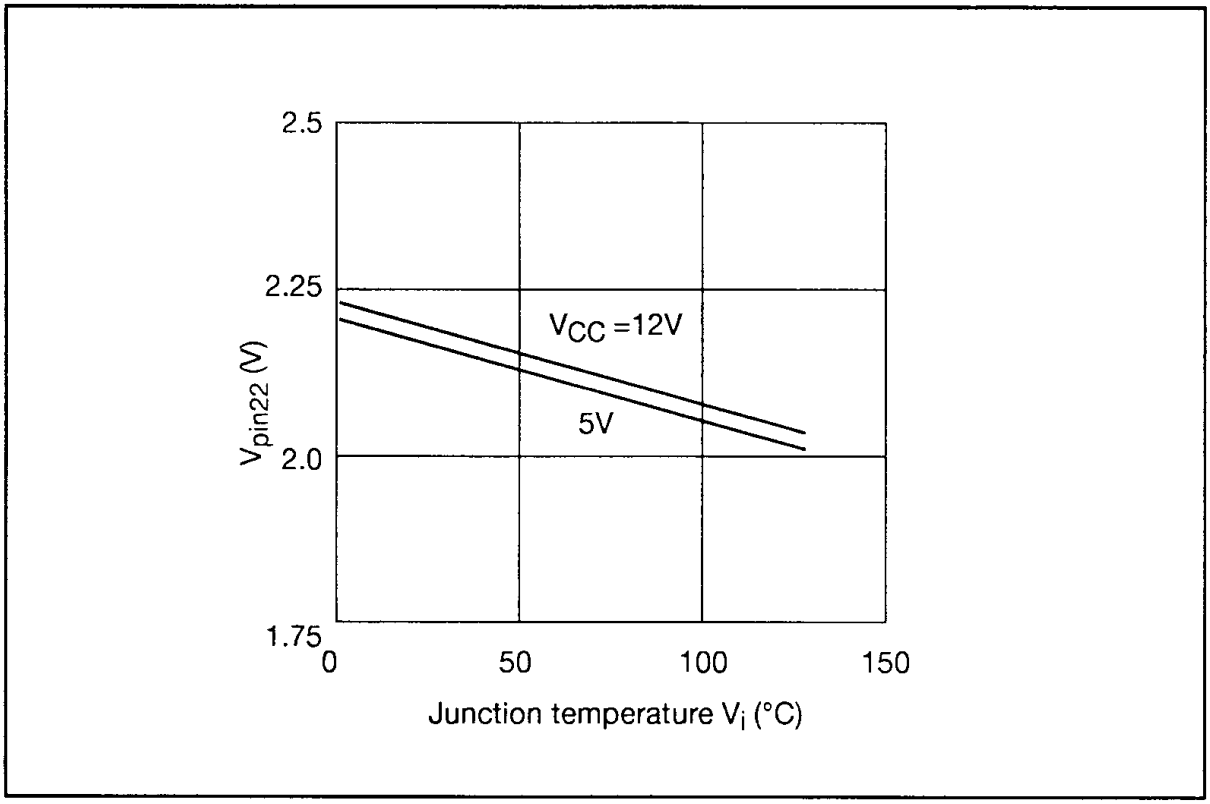


Figure 5 FG Amp Bias Voltage Temperature Characteristics