

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

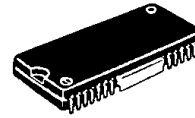
Features

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

Ordering Information

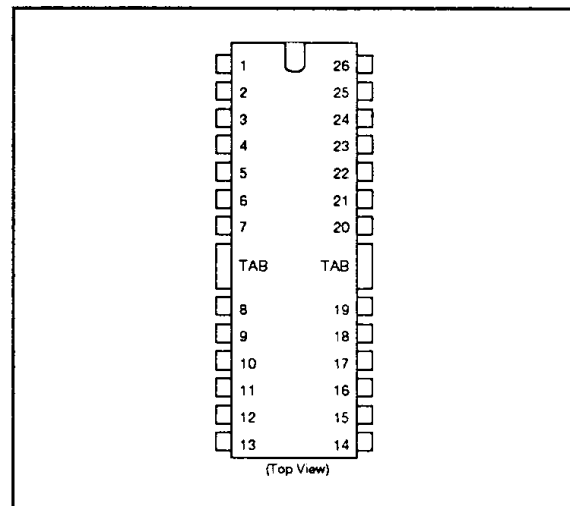
Type No.	Package
HA13491S	MP-26DT

HA13491S



(MP-26DT)

Pin Arrangement

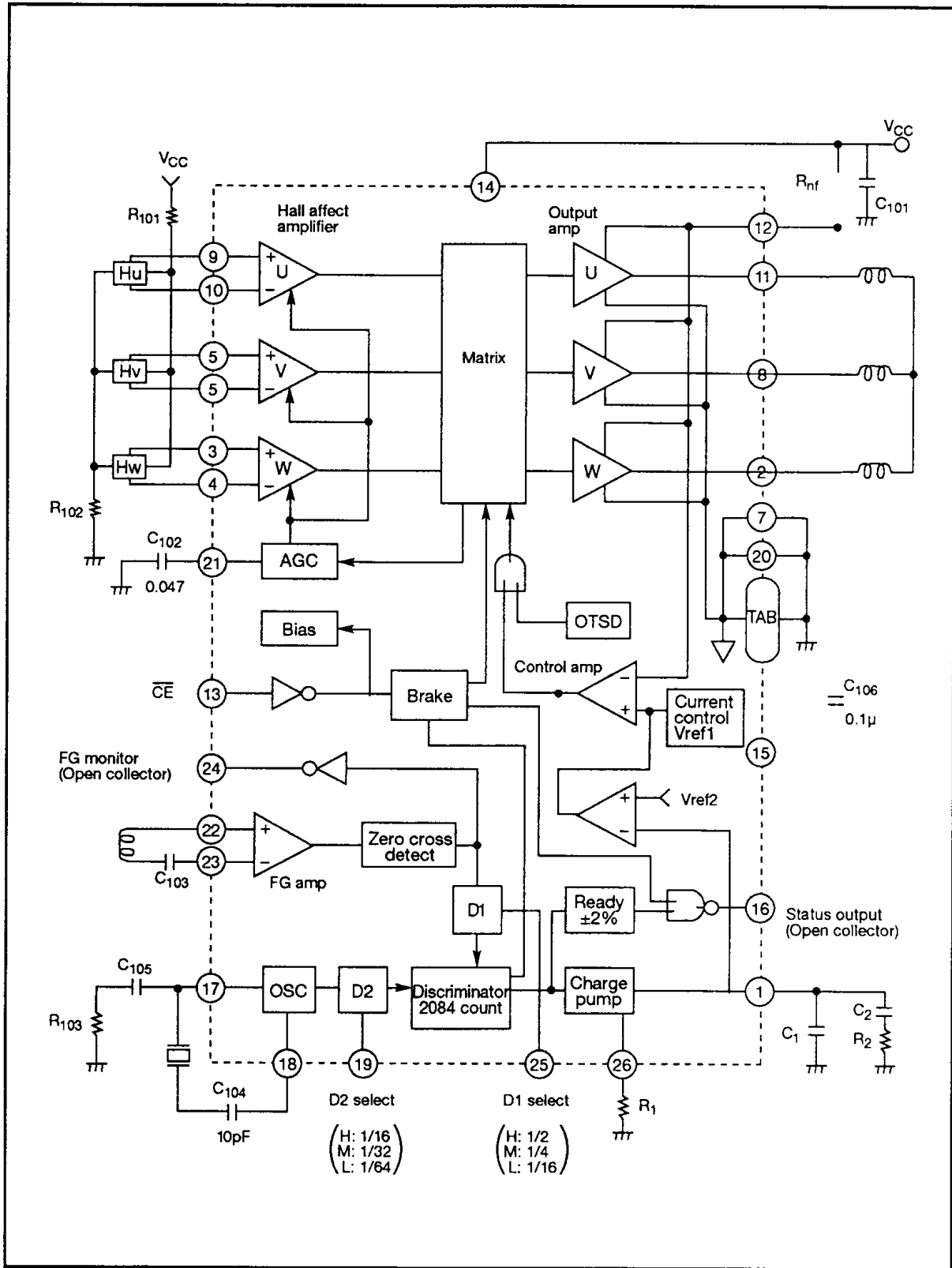


Pin No.	Function	Pin No.	Function
1	Charge pump output	16	Status output
2	W phase output	17	OSC input
3	W + input	18	OSC output
4	W - input	19	D2 select
5	V + input	20	GND
6	V - input	21	AGC filter
7	GND	22	FG + input
8	V phase output	23	FG - input
9	U + input	24	FG motor
10	U - input	25	D1 select
11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



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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.

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

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

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

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

Where:

- f_{FG} = FG frequency (Hz)
- N_o = Motor speed (rpm)
- J = Motor moment of inertia (kg • cm • s²)
- 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.

$$I_o \text{ max} = \frac{V_{ref1}}{R_{nf}} \text{ A}$$

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:

$$f_{osc} = \frac{2083.5 D_1 f_{FG}}{D_2} \quad (\text{Hz})$$

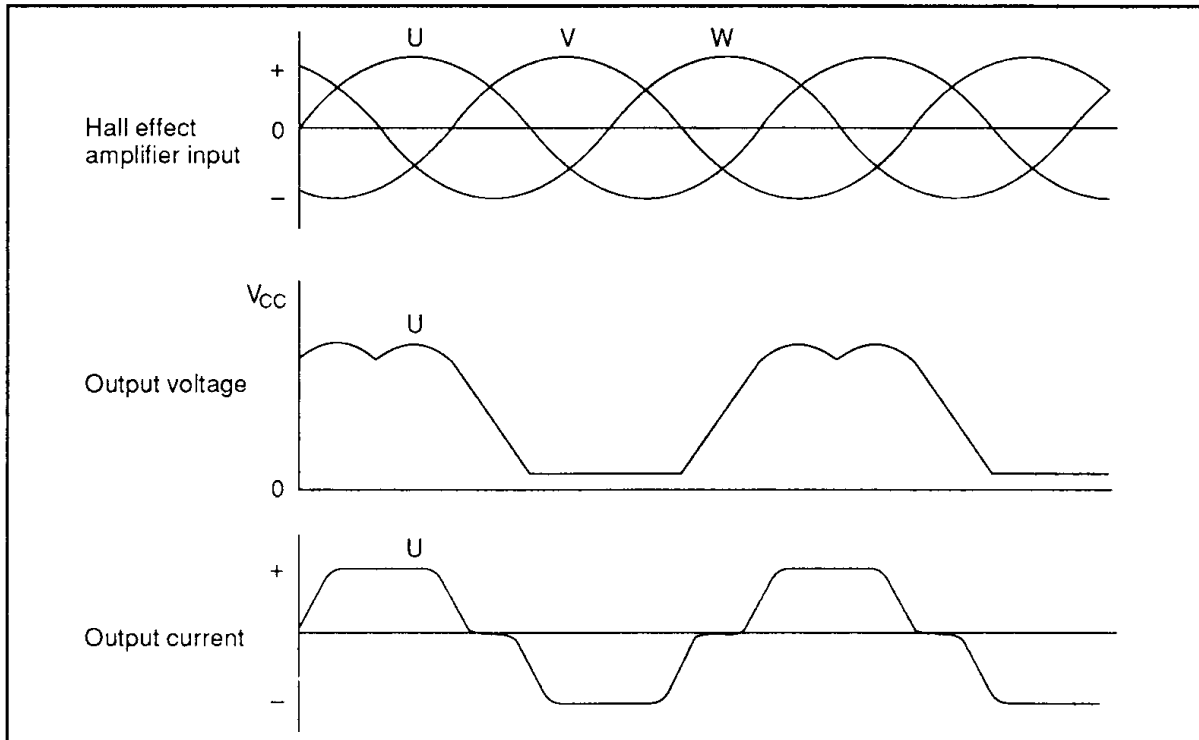
Here, D₁ and D₂ specify the division ratio, and their relation to the voltage applied to the D select terminal is as follows:

	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

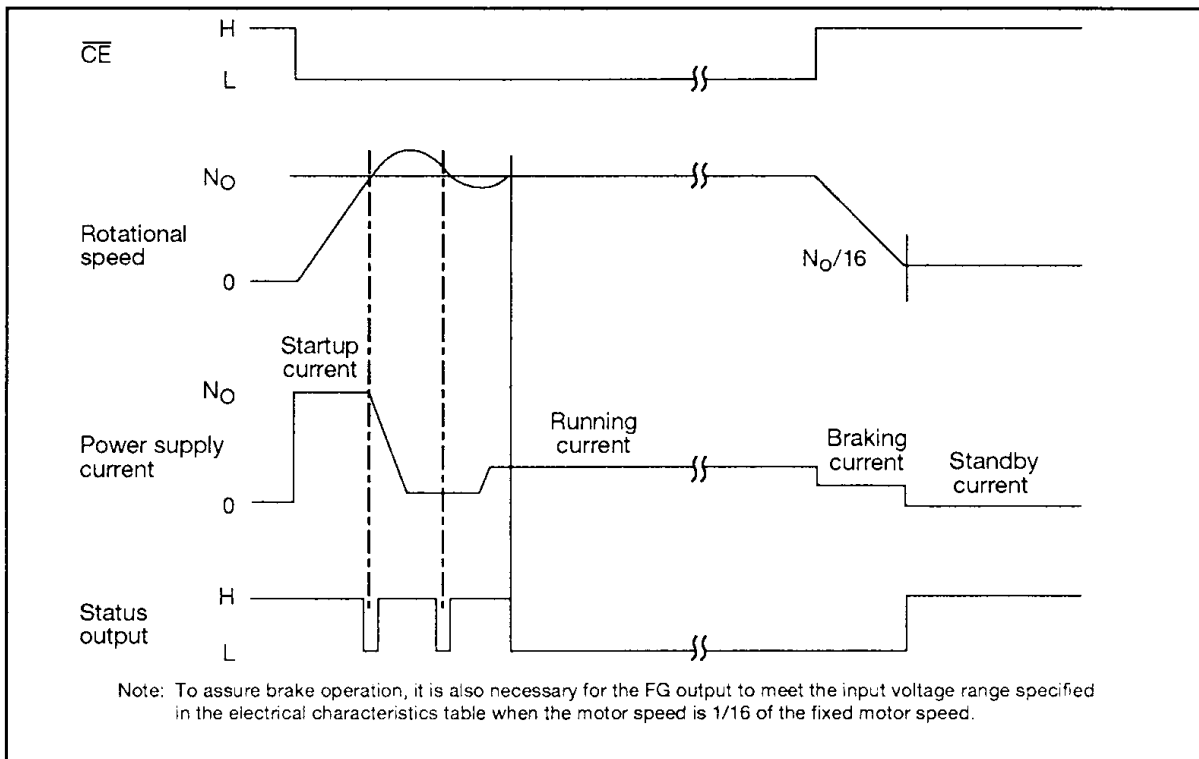


Timing Charts

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



2. Brake Operation and Status Output



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} , D₁, and D₂ 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:
 $\theta_{j-c} \leq 7^\circ\text{C/W}$
 $\theta_{j-a1} \leq 15^\circ\text{C/W}$ (When a metal base substrate is used.)
 $\theta_{j-a2} \leq 62^\circ\text{C/W}$ (When a glass epoxy substrate is used.)
 5. The operating temperature range is as follows:
 T_{opr} = 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 _{CC0}	—	3	5	mA	$\overline{CE} = H, V_{CC} = 13.8\text{ V}$	12,14	1	
	I _{CC}	—	20	25	mA	$\overline{CE} = L, V_{CC} = 13.8\text{ V}$			
CE	Input current	I _{in1}	—	±50	μA	V _{in} = 0 to 12 V	13		
	Input high voltage	V _{ih1}	2.0	—	—	Disable			
	Input low voltage	V _{il1}	—	—	0.8	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}			
	Leakage current	I _{CER}	—	—	0.1	mA	V _{CE} = 15 V	2,8,11	
Output amp	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 _{ct1}	-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			



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Electrical Characteristics (Ta = 25°C, VCC = 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	
		n _c	1.0	—	—	V _{PP}	Brake mode	
OSC	Oscillator frequency range	f _{osc}	—	—	8.0	MHz	Crystal oscillator	18
	Oscillator frequency error	Δf _{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	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:

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

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

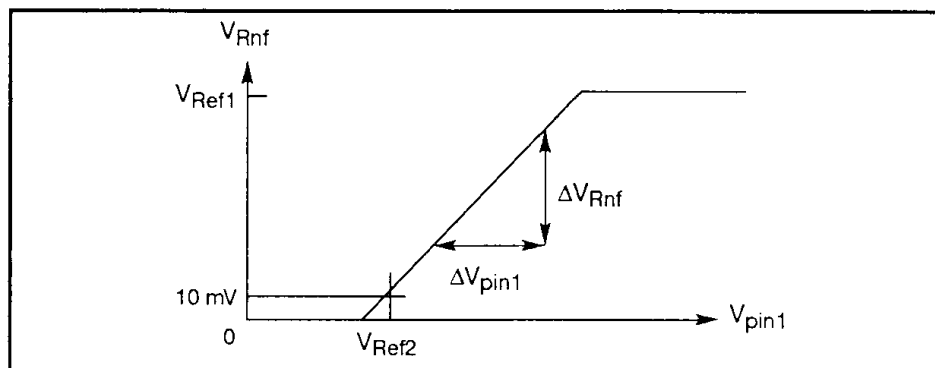


Figure 1 V_{Rnf} vs V_{pin1}

Reference Data

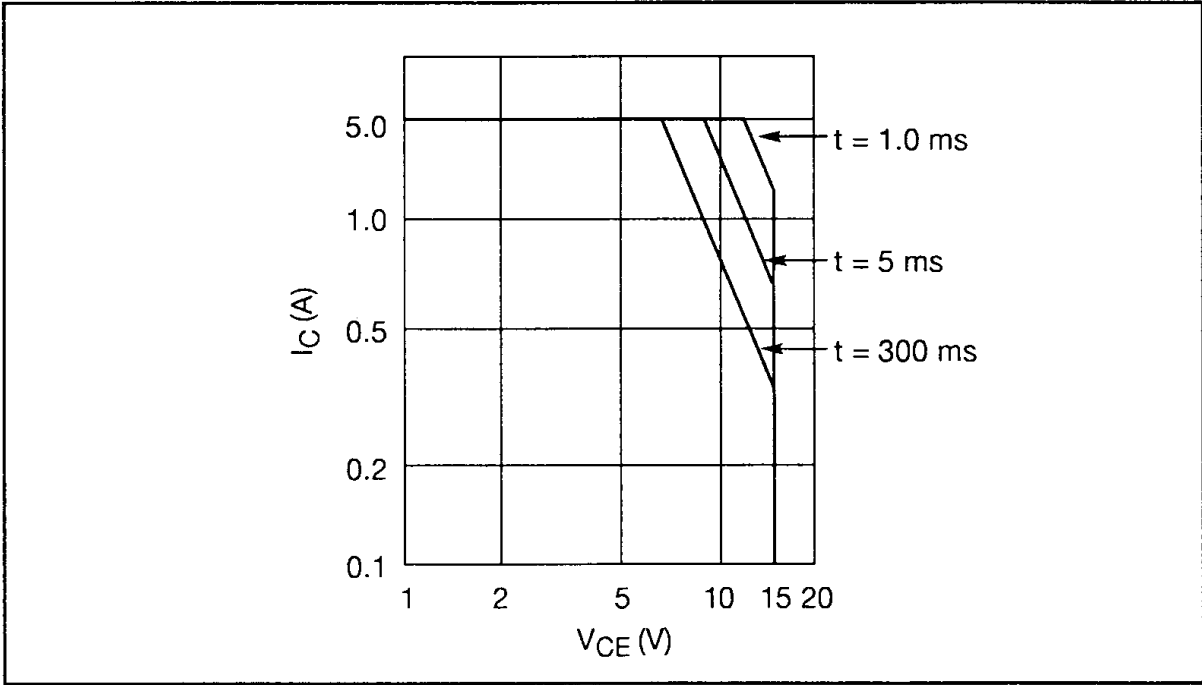


Figure 2 Output Transistor Safe Operating Range

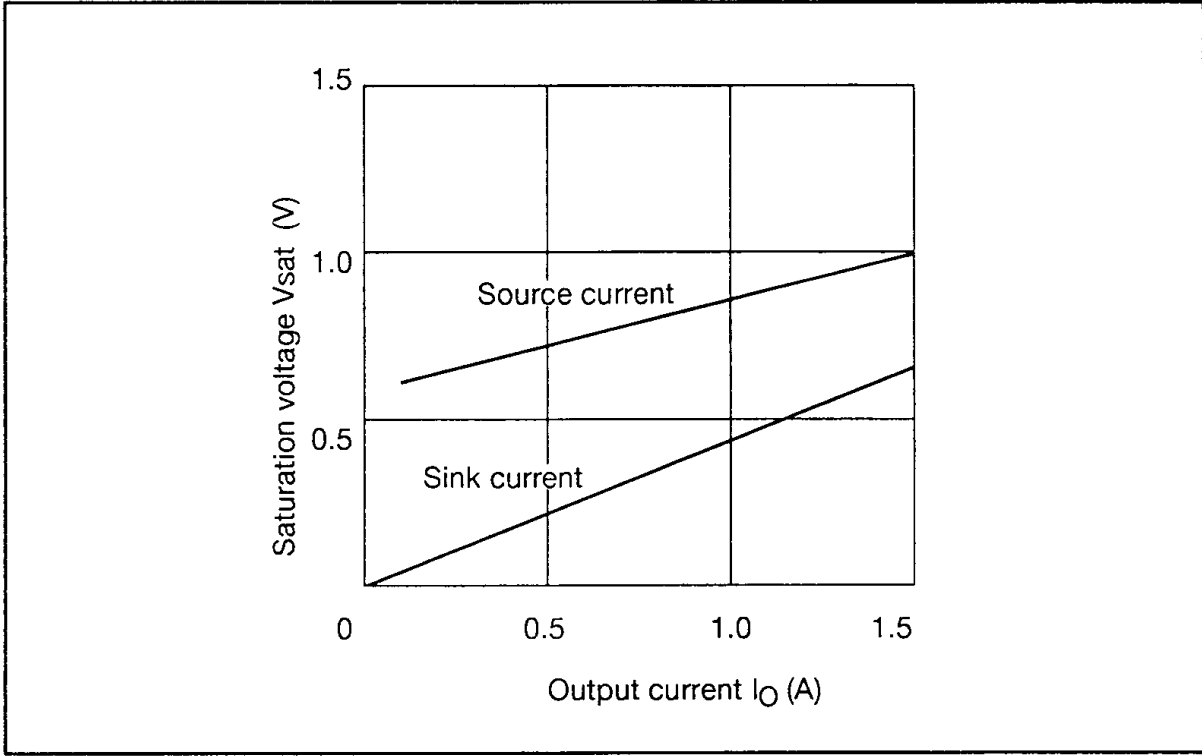


Figure 3 Output Transistor Saturation Characteristics



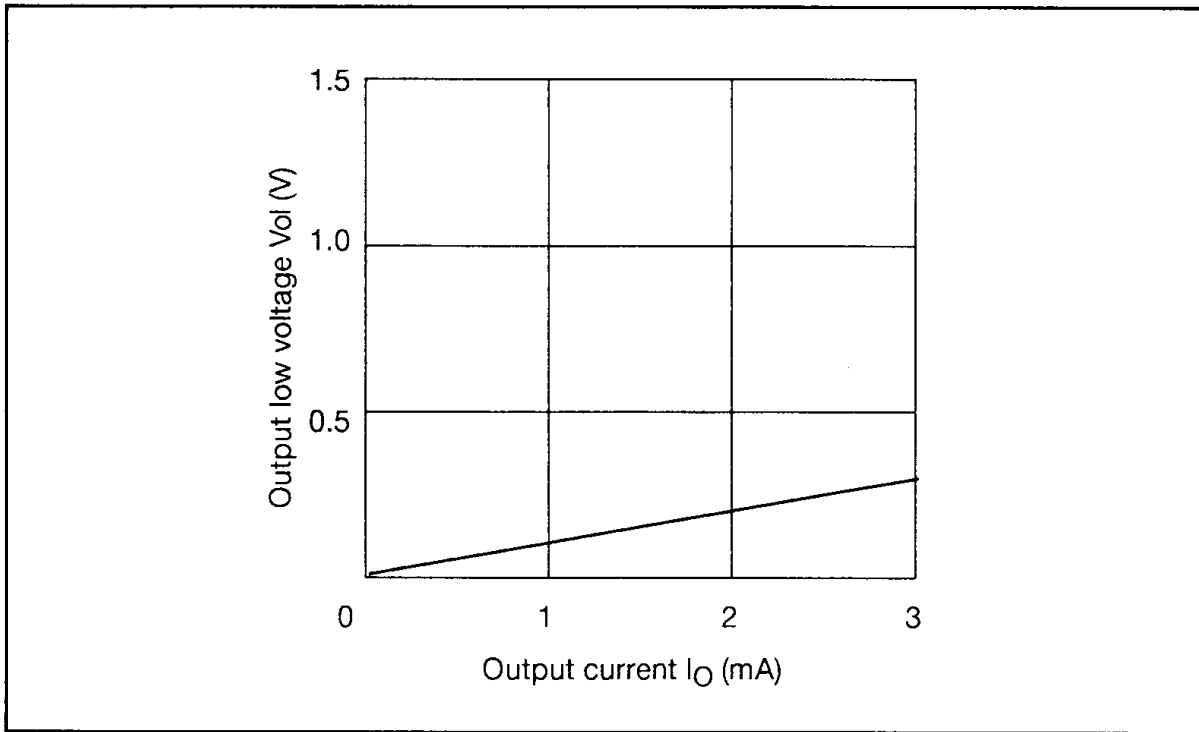


Figure 4 FG Monitor and Status Output Voltage Characteristics

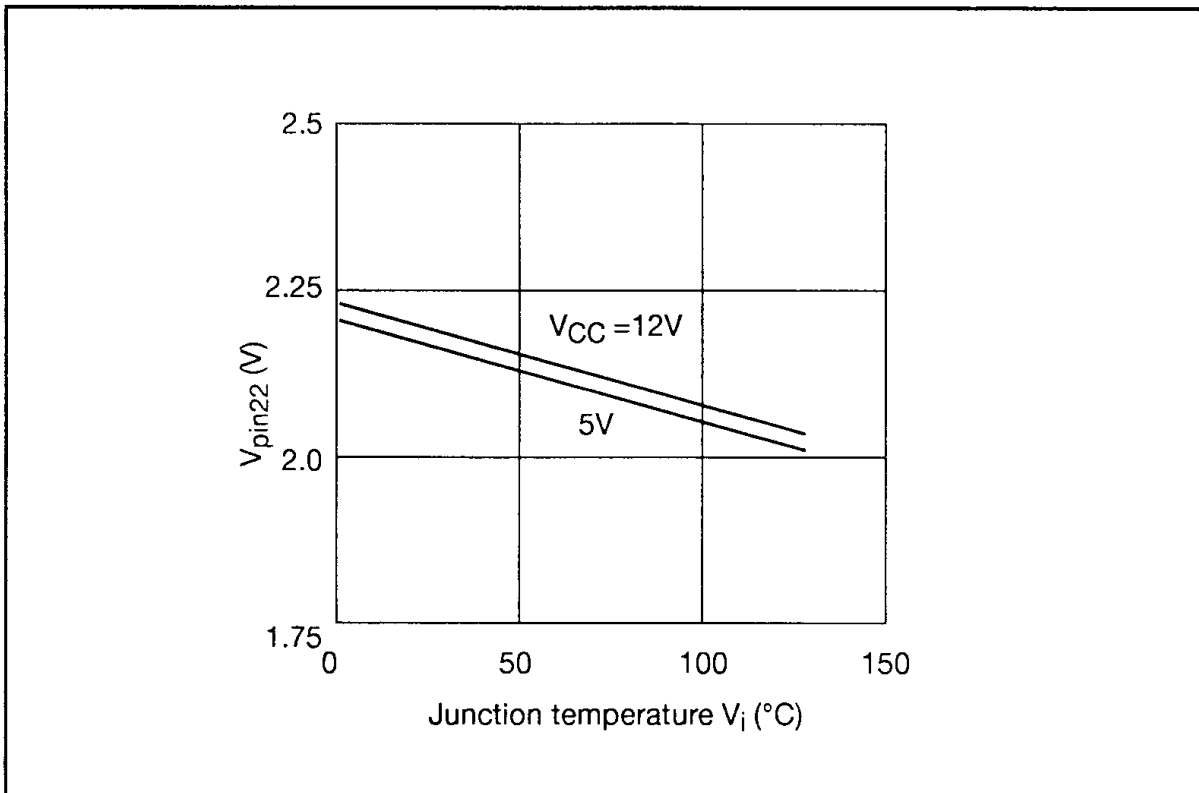


Figure 5 FG Amp Bias Voltage Temperature Characteristics