Ordering number : EN5974B

LB1980H

ON Semiconductor®

Monolithic Digital IC For VCR Capstan Motors 3-Phase Brushless Motor Driver

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Overview

The LB1980JH is a 3-phase brushless motor driver that is particularly appropriate for VCR capstan motor drivers.

Functions

- 3-phase full-wave drive
- Built-in torque ripple correction circuit (variable correction ratio)
- Current limiter circuit
- Upper and lower side output stage over-saturation prevention circuit that does not require external capacitors.
- FG amplifier
- Thermal shutdown circuit

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V _{CC} max		7	V
	V _S max		24	V
Maximum output current	I _O max		1.3	Α
Allowable power dissipation	Pd max	Mounted on a board *	1.81	W
		Independent IC	0.77	W
Operating temperature	Topr		-20 to 75	°C
Storage temperature	Tstg		-55 to +150	°C

^{*} Mounted on a 76.1mm×114.3mm×1.6mm, glass epoxy printed circuit board.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	VS		5 to 22	V
	Vcc		4.5 to 5.5	V
Hall input amplitude	V_{HALL}	Between the hall inputs	±30 to ±80	mVo-p
GSENSE pin input range	VGSENSE	With respect to the control system ground	-0.20 to +0.20	V

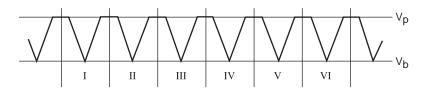
Electrical Characteristics at $Ta = 25^{\circ}C$, $V_{CC} = 5V$, $V_{S} = 15V$

Parameter	Symbol	Conditions	Ratings			Unit
i didilictoi	Cymbol	Conditions	min	typ	max	Onne
V _{CC} supply current	Icc	R _L =∞, V _{CTL} =0V, V _{LIM} =0V (Quiescent)		12	18	mA
Outputs						
Output saturation voltage	VO sat1	I _O =500mA, Rf=0.5Ω, Sink+Source V _{CTL} =V _{LIM} =5V(With saturation prevention)		2.1	2.6	V
	VO sat2	I _O =1.0mA, Rf=0.5Ω, Sink+Source V _{CTL} =V _{LIM} =5V(With saturation prevention)		2.6	3.5	V
Output leakage current	IO leak				1.0	mA
FR						
FR pin input threshold voltage	V_{FSR}		2.25	2.50	2.75	V
FR pin input bias current	I _B (FSR)		-5.0			mA
Control						
CTLREF pin voltage	VCREF		2.05	2.15	2.25	V
CTLREF pin input range	VCREFIN		1.50		3.50	V
CTL pin input bias current	I _B (CTL)	With V _{CTL} =5V and the CTLREF pin open			4.0	μΑ
CTL pin control start voltage	V _{CTL} (ST)	With Rf=0.5Ω, V _{LIM} =5V, I _O ≥10mA, Hall input logic fixed (U, V, W=H, H, L)	2.00	2.15	2.30	V
CTL pin control Gm	Gm(CTL)	With Rf=0.5 Ω , ΔI_{O} =200mA, Hall input logic fixed (U, V, W=H, H, L)	0.46	0.58	0.70	A / \
Current Limiter						
LIM current limit offset voltage	Voff(LIM)	With Rf=0.5Ω, V _{CTL} =5V, I _O ≥10mA, Hall input logic fixed (U, V, W=H, H, L)	140	200	260	mV
LIM pin input bias current	I _B (LIM)	With V _{CTL} =5V and the V _{CREF} pin open	-2.5			μΑ
LIM pin current control level	ILIM	With Rf=0.5Ω, V _{CTL} =5V, V _{LIM} =2.06V Hall input logic fixed (U, V, W=H, H, L)	830	900	970	mA
Hall Amplifier						
Hall amplifier input offset voltage	Voff(HALL)		-6		+6	mA
Hall amplifier input bias current	I _B (HALL)			1.0	3.0	μΑ
Hall amplifier common-mode input voltage range	V _{CM} (HALL)			1.3	3.3	V
TRC						
Torque ripple correction ratio	TRC	For the high and low peaks in the Rf waveform when I_0 =200mA. (Rf=0.5 Ω , with the ADJ pin open) *1		9		%
ADJ pin voltage	V _{ADJ}	(*** **********************************	2.37	2.50	2.63	V
FG Amplifier				I		
FG amplifier input offset voltage	Voff(FG)		-8		+8	mV
FG amplifier input bias current	I _B (FG)		-100			nA
FG amplifier output saturation voltage	V _O sat (FG)	Sink side, for the load provided by the internal pull-up resistor			0.5	V
FG amplifier voltage gain	V _G (FG)	For the open loop state with f=10kHz	41.5	44.5	47.5	dB
FG amplifier common-mode input voltage	V _{GM} (FG)		0.5		4.0	V
Saturation		, <u> </u>				
Saturation prevention circuit lower side voltage setting	VO sat(DET)	The voltages between each OUT and Rf pair when I _O =10mA, Rf=0.5Ω, and V _{CTL} =V _{LIM} =5V	0.175	0.25	0.325	V
TSD		<u> </u>				
TSD operating temperature	TSD	Design target value *2		180		°C
Hysteresis width	ΔTSD	Design target value *2		20		°C

Notes: *1. The torque ripple correction ratio is determined as follows from the Rf voltage waveform.

^{*2.} Parameters that are indicated as design target values in the conditions column are not tested.

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For each Hall logic setting

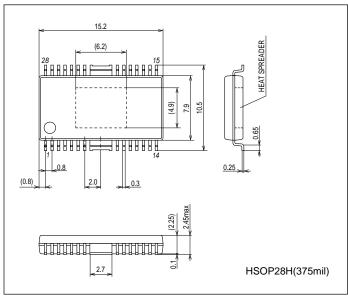
Ground level

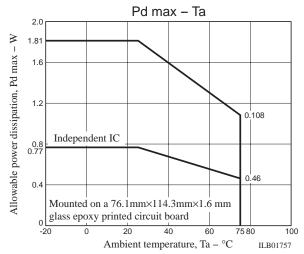
Correction ratio =
$$\frac{25(V_p - V_b)}{V_p - V_b} 1005(\%)$$

Package Dimensions

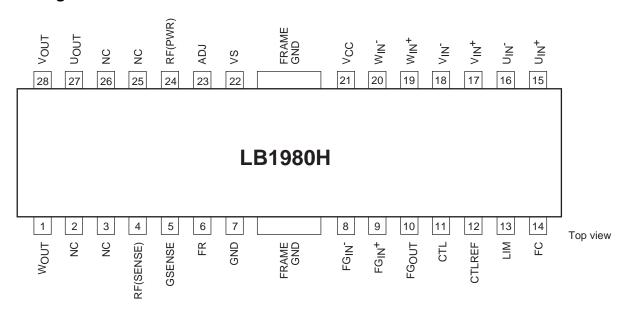
unit: mm (typ)

3233B

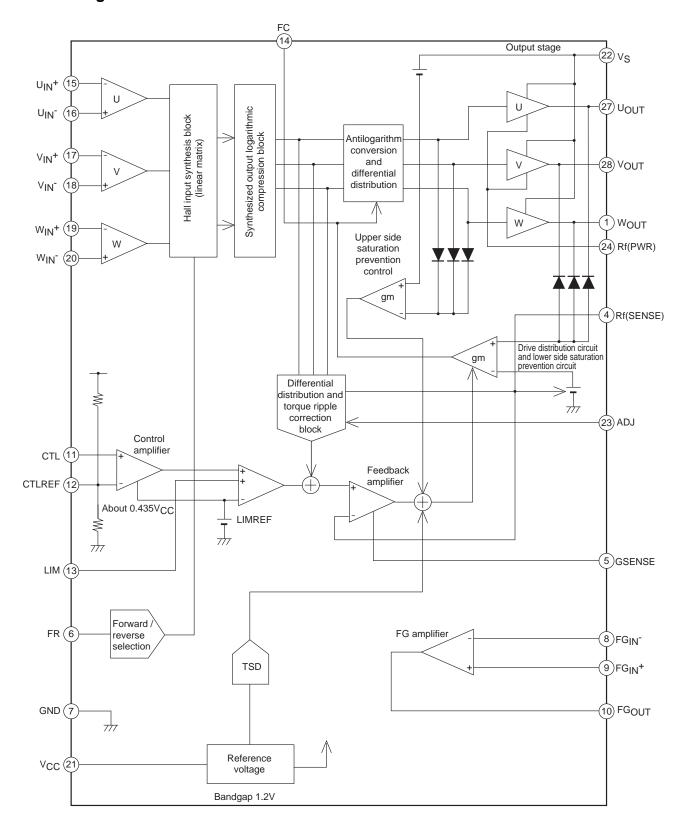




Pin Assignment



Block Diagram



Pin Function

	unction		
Pin No.	Pin Name	Function	Equivalent circuit
27	U _{OUT}	U phase output, Spark killer diodes are built-in.	
28	VOUT	V phase output, Spark killer diodes are built-in.	
1	WOUT	W phase output, Spark killer diodes are built-in.	22 tvcc
4	Rf	Output current detection. The control block current limiter	VS C
4		·	27 S 150μA 28 Lower side saturation
_	(SENSE)	operates using the resistor Rf connected between these	1 OUT Lower side saturation
5	Rf (DWD)	pins and ground. Also, the lower side saturation	prevention circuit input block
	(PWR)	prevention circuit and the torque ripple correction circuit	VCC 200Ω
		operate based on the voltages across this resistor. It is	≥ 30kΩ
		especially important to note that, since the saturation	
		prevention level is set using this voltage, the lower side	200Ω
		saturation prevention circuit will become less effective in	(4)—/// Rf (SENSE)
		the high current region if the value of Rf is lowered	Rf (PWR)
		excessively. Also, the PWR and SENSE pins must be	777
		connected together.	
22	٧s	Output block power supply	
5	GSENSE	Ground sensing. The influence of the common ground	
		impedance on Rf can be excluded by connecting this pin	
		to nearest ground for the Rf resistor side of the motor	
		ground wiring that includes Rf. (This pin must not be left	
		open.)	
6	FR	Forward / reverse selection. The voltage applied to this	
		pin selects the motor direction (forward or reverse).	Vcc Vcc∳ Vcc
		(Vth=2.5V at V _{CC} =5V (typical))	VCC A A Q 20µA
23	ADJ	Used for external adjustment of the torque ripple	200μΑ
		correction ratio. Apply a voltage externally with a	$\int \int $
		low-impedance circuit to the ADJ pin to adjust the	FR ADJ \$10kΩ \$
		correction ratio. The correction ratio falls as the applied	$6 \sim 0.00 \sim 0.0$
		voltage is increased, and increases as the applied voltage	★
		decreases. The torque ripple correction ratio can be	$\frac{10k\Omega}{M}$
		modified by factors in the range 0 to 2 times the ratio that	
		applies when his pin is left open. (The pin voltage is set to	$\frac{\partial}{\partial x} = \frac{\partial}{\partial x} \frac{\partial}{\partial x} = $
		about $V_{\mbox{\footnotesize{CC}}}$ / 2 internally, and the input impedance is about	
		5kΩ.)	
7	GND	Ground for all circuits other than the output transistors.	
		The lowest potential of the output transistors is that of the	
		Rf pin.	
8	FG _{IN} -	Input used when the FG amplifier is used as an inverting	Vcc ∮
		input. A feedback resistor must be connected between	
		FG _{OUT} and this pin.	5μΑ 😡
] Y
9	FG _{IN} +	Non-inverting input used when the FG amplifier is used as	FGIN(+)
		a differential input amplifier. No bias is applied internally.	9-///
			$\frac{1}{4} 300\Omega$
			<u> </u>
10	FC:	CC amplifier output. There is an internal arcinting to the	
10	FGOUT	FG amplifier output. There is an internal resistive load.	Vcc↑ ↑Vcc ↑Vcc
14	FC	Speed control loop frequency characteristics correction.	300Ω <u> </u>
	• =	,	
			<i>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</i>
			<i>717</i>

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Pin No.	Pin Name	Function	Equivalent circuit		
11	CTL	Speed control input. The control implemented is fixed current drive controlled by current feedback from Rf. Gm=0.58 / V (typical) when Rf=0.5W	VCC ↓VCC VCC↓ ≥10kΩ		
12	CTLREF	Control reference voltage. While this pin is set to about 0.43×V _{CC} internally, this voltage can be modified by applying a voltage from a low-impedance circuit. (The input impedance is about 4.3kΩ).	CTL 200μΑ θ πax θ 200μΑ θ πax		
13	LIM	Current limiter function control. The output current can be varied linearly by applying a voltage to this pin. The slope is $0.5A / V$ (typical) when Rf= 0.5Ω .	100µA		
15 16	U _{IN} + U _{IN} -	U phase Hall element inputs. Logic high is defined as states where IN ⁺ >IN ⁻ .	(+) input (-) input (5)		
17 18	V _{IN} + V _{IN} -	V phase Hall element inputs. Logic high is defined as states where IN ⁺ >IN⁻.	100μA (B) (B) (200Ω (D)		
19 20	w _{IN} + w _{IN} -	W phase Hall element inputs. Logic high is defined as states where IN ⁺ >IN ⁻ .	<u></u>		
21	VCC	Power supply for all internal blocks other than the output block. This voltage must be stabilized so that noise and ripple do not enter the IC.			

Truth Table and Control Functions

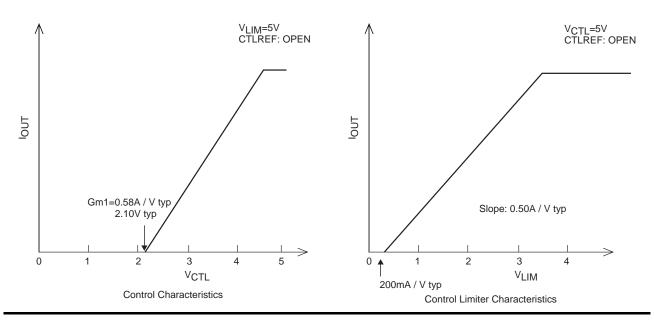
	Source → Sink	Hall input			
		U	V	W	FR
1	$Phase\:V\toPhase\:W$	Н	Н	L	Н
	Phase W → Phase V				L
2	Phase U → Phase W	Н	L	L	Н
	Phase W \rightarrow Phase U				L
3	Phase $U \rightarrow Phase V$	н	L	Н	Н
	Phase $V \rightarrow Phase U$				L
4	$Phase\:W\toPhase\:V$	L	L	Н	Н
	Phase V → Phase W				L
5	Phase W → Phase U		Н	Н	Н
	Phase U \rightarrow Phase W	L			L
6	$Phase\:V\toPhase\:U$		Н	L	Н
	Phase U \rightarrow Phase V	L			L

Note: In the FR column, "H" refers to a voltage of 2.75V or higher, and "L" refers to 2.25V or lower (when VCC=5V.)

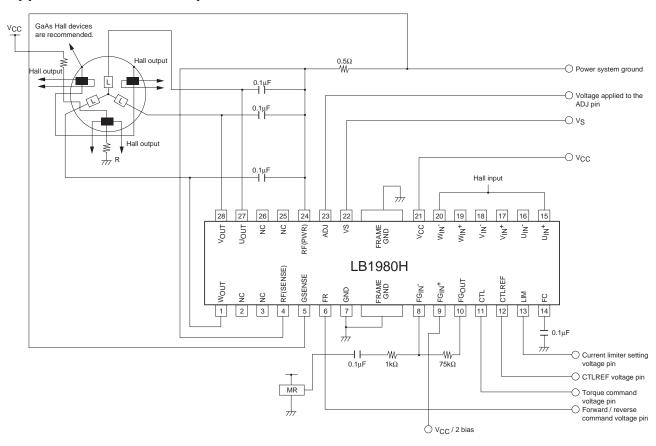
Note: In the Hall input column, "H" refers to the state in the corresponding phase where the +input is at a potential at least 0.01V higher than the -input, and "L" refers to the state where the -input is at a potential at least 0.01V higher than the +input.

Note: Since the drive technique adopted is a 180° technique, phases other than the sink and source phase do not turn off.

Control Function and Current Limiter Function



Application Circuit Example



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