Ordering number : EN5479

Monolithic Digital IC

LB1980

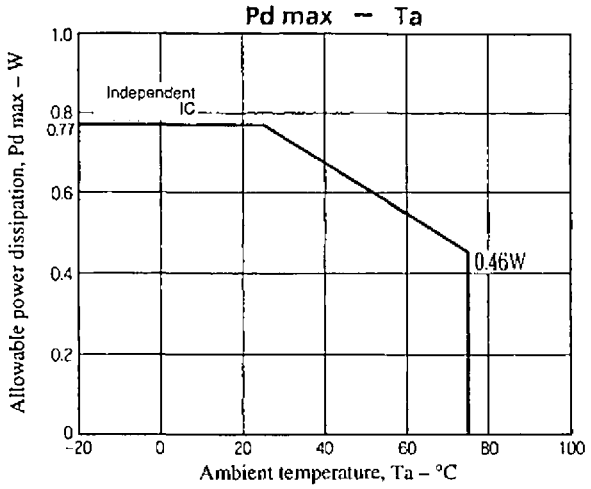
3-Phase Brushless Motor Driver for VCR Capstan Motors

Overview

The LB1980 is a 3-phase brushless motor driver IC that is particularly well suited for driving VCR capstan motors.

Functions

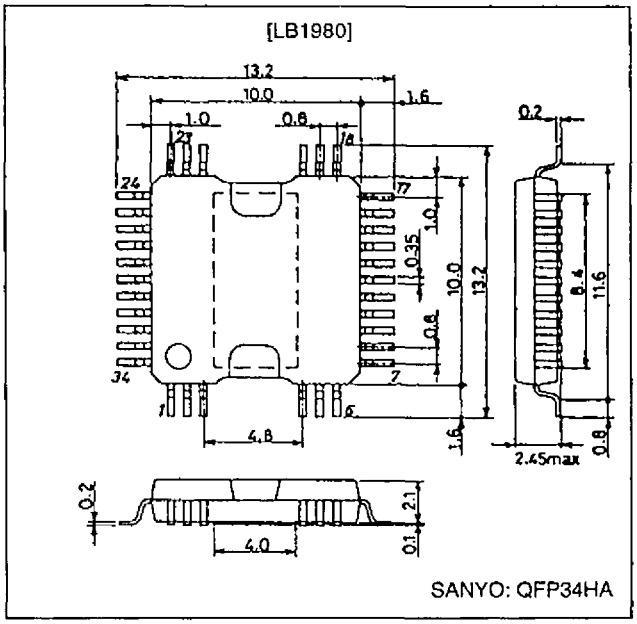
- Three-phase full wave current linear drive
- Torque ripple correction circuit with variable correction ratio
- Current limiter circuit
- Output stage up/down oversaturation protection circuit (no external capacitor required)
- FG amplifier
- Thermal shutdown circuit



Package Dimensions

unit: mm

3206A-QFP34HA



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	A
Allowable power dissipation	Pd max	With an arbitrarily large heat sink	12.5	W
		Independent IC	0.77	W
Operating temperature	Topr		–20 to +75	°C
Storage temperature	Tstg		–55 to +150	°C

Allowable Operating Ranges at Ta = 25°C

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

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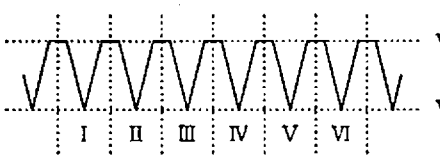
Electrical Characteristics at Ta = 25°C, V_{CC} = 5 V, V_S = 15 V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
V_{CC} current drain	I_{CC}	R_L = ∞, V_{CTL} = 0 V, V_{LIM} = 0 V(When stopped)	–	12	18	mA
[Output]						
Output saturation voltage	Vo(sat)1	I_O = 500 mA, Rf = 0.5 Ω, Sink + Source V_{CTL} = V_{LIM} = 5 V(With saturation protection)	–	2.1	2.6	V
	Vo(sat)2	I_O = 1.0 A, Rf = 0.5 Ω, Sink + Source V_{CTL} = V_{LIM} = 5 V(With saturation protection)	–	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	Ib(FSR)		–5.0	–	–	μA
[Control]						
CTLREF pin voltage	VC_{REF}		2.05	2.15	2.25	V
CTLREF pin input range	VC_{REFIN}		1.50	–	3.50	V
CTL pin input bias current	Ib(CTL)	V_{CTL} = 5 V, with CTLREF open	–	–	4.0	μA
CTL control start voltage	VCTL(ST)	With Rf = 0.5 Ω, V_{LIM} = 5 V, I_O ≥ 10 mA With the 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 = 200 mA With the Hall input logic fixed(u, v, w = H, H, L)	0.46	0.58	0.70	A/V
[Current Limiter]						
LIM current limiter offset voltage	Voff(LIM)	With Rf = 0.5 Ω, V_{CTL} = 5 V, I_O ≥ 10 mA With the Hall input logic fixed(u, v, w = H, H, L)	140	200	260	mV
LIM pin input bias current	Ib(LIM)	V_{CTL} = 5 V, CTLREF: OPEN, V_{LIM} = 0 V	–2.5	–	–	μA
LIM pin current limit level	Ilim	With Rf = 0.5 Ω, V_{CTL} = 5 V, V_{LIM} = 20.6 V With the 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	mV
Hall amplifier input bias current	Ib(HALL)		–	1.0	3.0	μA
Hall amplifier common-mode input voltage	Vcm(HALL)		1.3	–	3.3	V
[TRC]						
Torque ripple correction ratio	TRC	For the troughs and peaks in the Rf waveform at I_O = 200 mA(Rf = 0.5 Ω, ADJ: open)(note 1)	–	9	–	%
ADJ pin voltage	Vadj		2.37	2.50	2.63	V
[FG Amplifier]						
FG amplifier input offset voltage	Voff(FG)		–8	–	+8	mV
FG amplifier input bias current	Ib(FG)		–100	–	–	nA
FG amplifier output saturation voltage	Vo(sat)(FG)	For the sink side and the internal pull-up resistor load	–	–	0.5	V
FG amplifier voltage gain	VG(FG)	For open loop at f = 10 kHz	41.5	44.5	47.5	dB
FG amplifier common-mode input voltage	VCM(FG)		0.5	–	4.0	V
[Saturation]						
Saturation prevention circuit lower side voltage setting	Vo(sat)(DET)	I_O = 10 mA, Rf = 0.5 ΩThe voltage between each OUT and Rf when V_{CTL} = V_{LIM} = 5 V.	0.175	0.25	0.325	V
[TSD]						
TSD operating temperature	T-TSD	(Design target value)*	–	180	–	°C
TSD temperature hysteresis	ΔTSD	(Design target value)*	–	20	–	°C

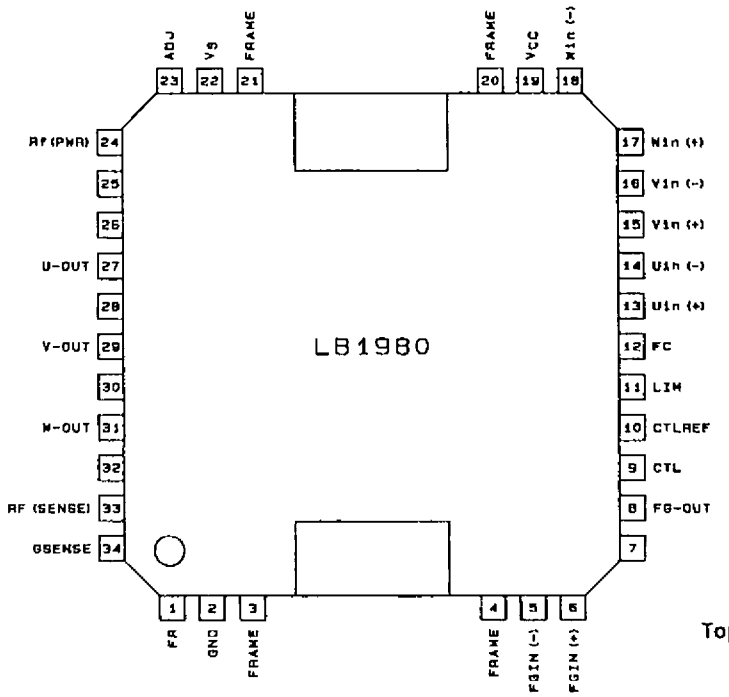
Notes: *Items marked with an asterisk are design target values and are not measured.

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



$$= \frac{2 \cdot (Vp - Vb)}{Vp + Vb} \cdot 100\,(\%)$$

Pin Assignment



Top view

Note: For ground potential stabilization, the FRAME pins must be connected to ground.

Truth Table and Control Functions

	Source → Sink	Hall input			FR
		U	V	W	
1	V → W	H	H	L	H
	W → V				L
2	U → W	H	L	L	H
	W → U				L
3	U → V	H	L	H	H
	V → U				L
4	W → V	L	L	H	H
	V → W				L
5	W → U	L	H	H	H
	U → W				L
6	V → U	L	H	L	H
	U → V				L

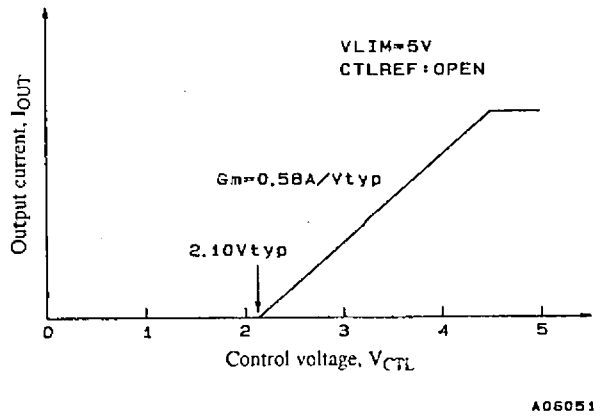
Note: An H in the FR column indicates a voltage of 2.75 V or higher, and an L indicates a voltage of 2.25 V or lower. (When V_{CC} = 5 V.)

Note: For the Hall inputs, H indicates that the + input is 0.01 V or more higher than the – input, and L indicates that the + input is 0.01 V or more lower than the - input, for all phases.

Note: Since this drive technique is a 180° conducting technique, the phases other than the sink and source phases are never off.

[Control Function and Current Limiter Function]

Control Characteristics



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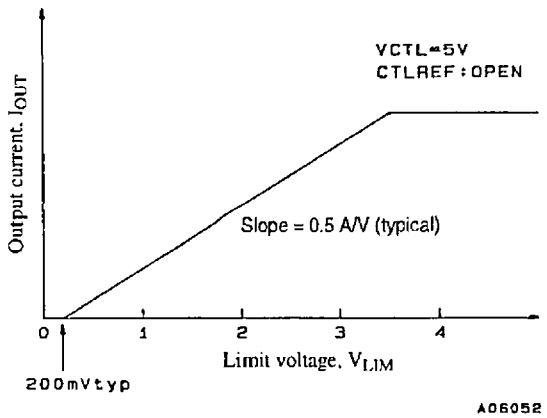
Current Limiter Characteristics



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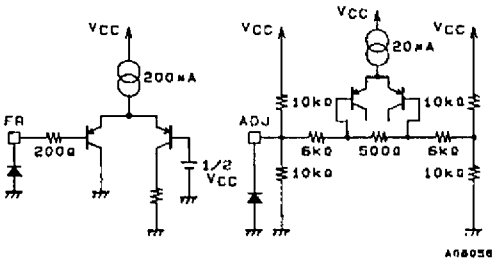
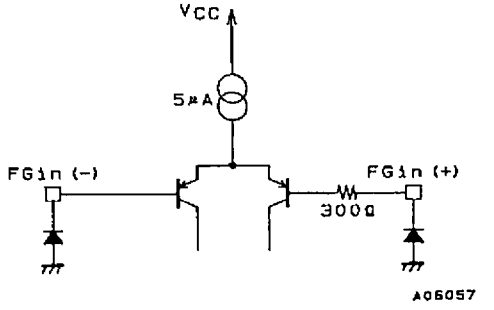
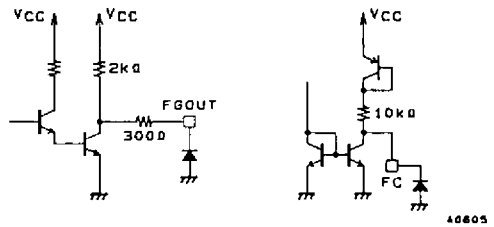
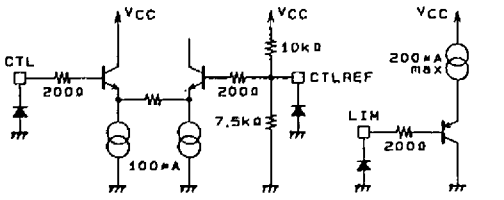
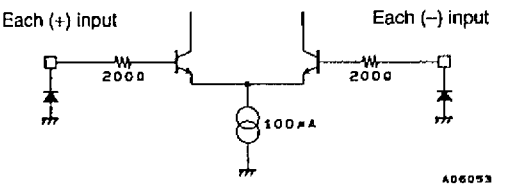
Pin Functions

Pin No.	Pin name	Pin functions	Equivalent circuit
1	FR	Forward/reverse selection pin. Forward or reverse is selected by the voltage applied to this pin. (Vth = 2.5 V (typical) at V_{CC} = 5 V)	
23	ADJ	This pin allows the torque ripple correction ratio to be adjusted externally. Applications that adjust the correction ratio should apply a voltage to the ADJ pin with a low-impedance circuit. The correction ratio falls as the applied voltage increases, and increases as the applied voltage decreases. The correction ratio can be varied over a range from about 0 to twice the ratio when this pin is left open. (This voltage is set internally to about $V_{CC}/2$, and the input impedance is about 5 kΩ.)	
2	GND	Ground for circuits other than the output transistors The output transistor minimum potential is that of the resistor Rf.	
5	FGin−	When the FG amplifier is used as an inverting input amplifier, a feedback resistor must be inserted between FG-OUT and this pin.	
6	FGin+	This is the noninverting input when the FG amplifier is used as a differential input amplifier. There is no internally applied bias.	
8	FG-OUT	This is the FG amplifier output. It has an internal load resistance.	
12	FC	Frequency characteristics correction for the speed control loop	
9	CTL	Speed control connection. Speed control is implemented as a fixed current drive in which current feedback is applied from Rf. Gm = 0.58 A/V (typical) at Rf = 0.5 Ω	
10	CTLREF	Control reference. Although this pin is set to about 0.43 * V_{CC} internally, it can be changed by applying a voltage with a low-impedance circuit. (It has an input impedance of about 4.3 kΩ (typical).)	
11	LIM	Current limiter function control. The voltage applied to this pin changes the output current linearly. Slope = 0.5 A/V (typical) at Rf = 0.5 Ω.	
13 14 15 16 17 18	Uin+ Uin− Vin+ Vin− Win+ Win−	U phase Hall element input. IN+ must be higher than IN− for a logical high input level. V phase Hall element input. IN+ must be higher than IN− for a logical high input level. W phase Hall element input. IN+ must be higher than IN− for a logical high input level.	

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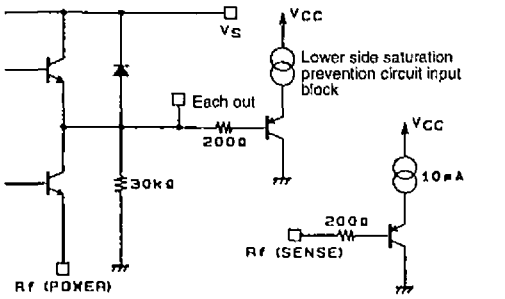
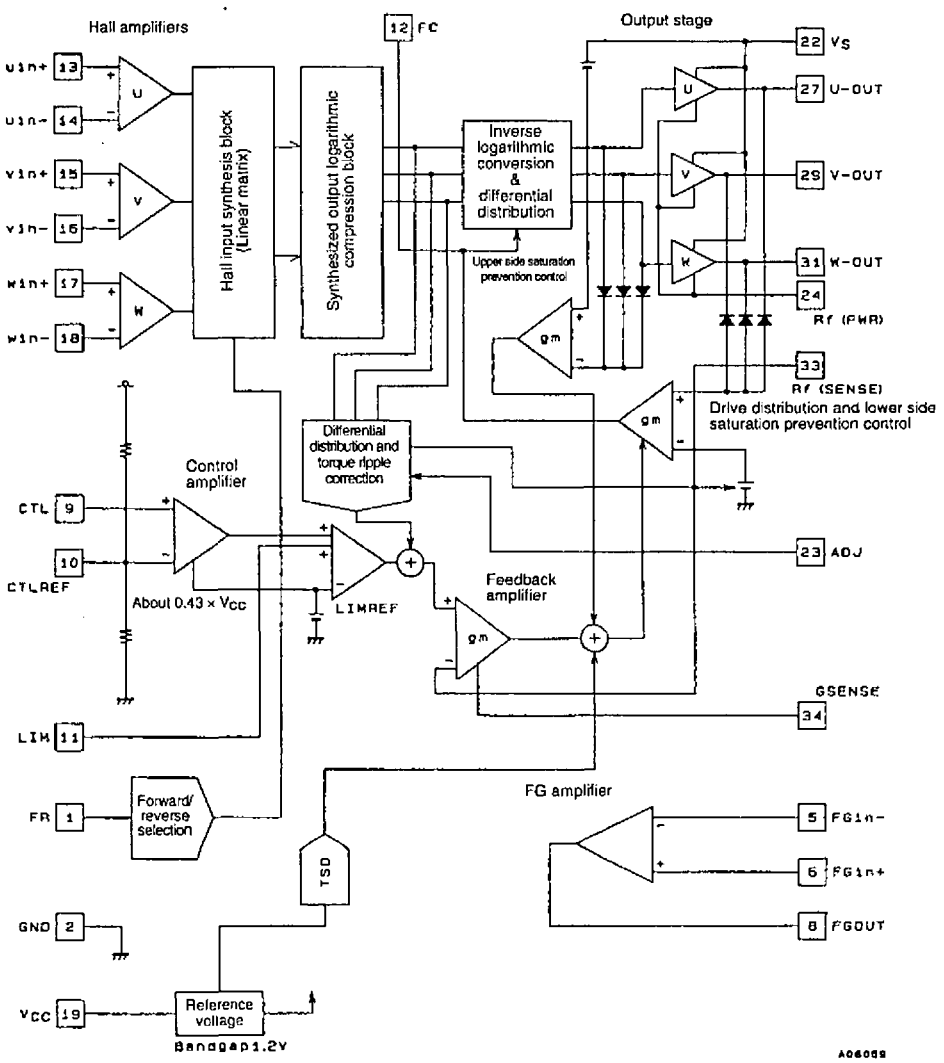
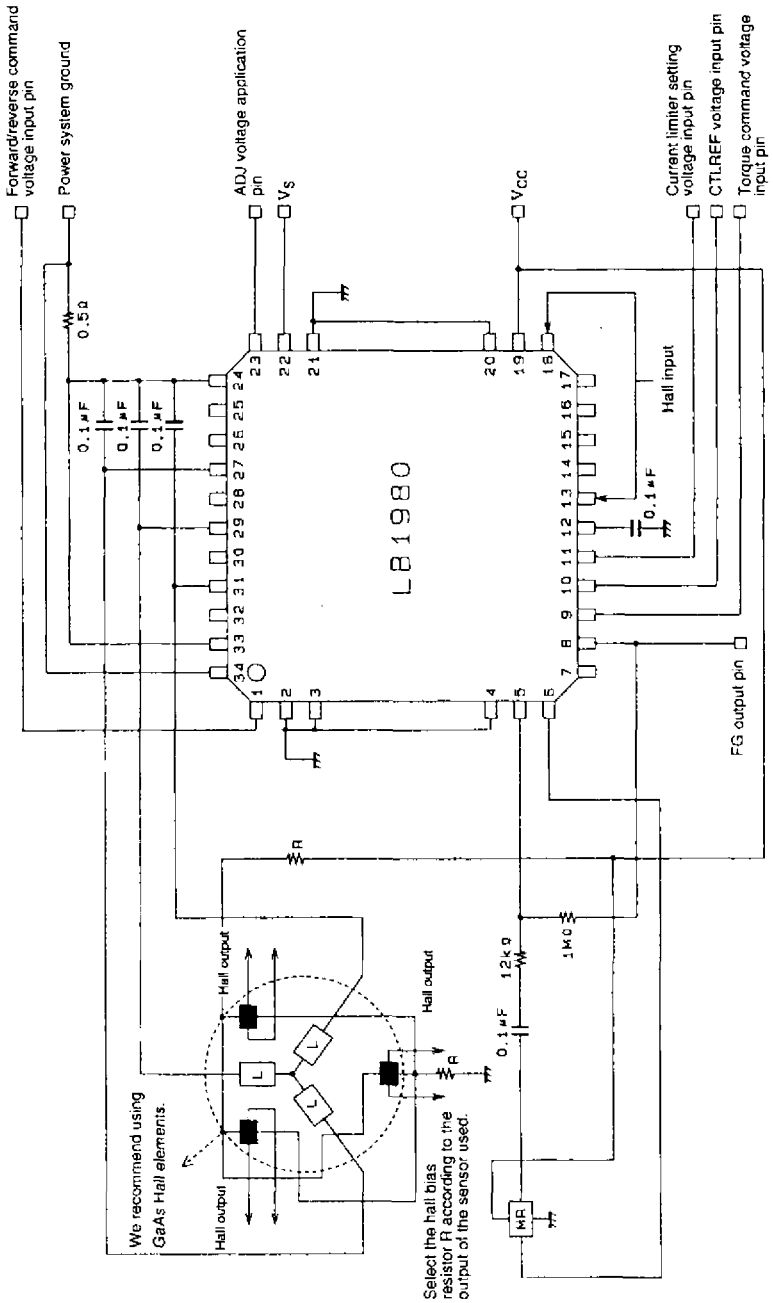
Pin No.	Pin name	Pin functions	Equivalent circuit
19	V_{CC}	Power supply for all IC internal circuits except for the output block. This voltage must be stabilized so that ripple and noise do not enter the IC circuits.	
22	V_S	Output block power supply	
24 (PWR) 33 Rf (SENSE)	Rf	These are the output current detection pins, and the control block current feedback is applied by connecting the resistor Rf between these pins and ground. Additionally, the lower side oversaturation protection circuit and the torque ripple correction circuit operate according to the voltages on these pins. In particular, since the oversaturation protection level is set by the voltages on these pins, if the value of Rf is lowered excessively, the effectiveness of the lower side oversaturation protection in the high-current region will be degraded. Note that the POWER and SENSE pins must be connected together.	
27	U-OUT	U phase output. (A spark killer diode is built in.)	
29	V-OUT	V phase output. (A spark killer diode is built in.)	
31	W-OUT	W phase output. (A spark killer diode is built in.)	
34	GSENSE	Ground sense. By connecting this pin near the ground for the Rf resistor side of the motor ground wiring that includes Rf, the influence that the common ground impedance has on Rf can be removed. (This pin must not be left open.)	

Block Diagram



Sample Application Circuit



Note: The constants presented in this sample application circuit are examples, and the circuit characteristics for these values are not guaranteed.