

LB1881M

# **Three-Phase Brushless Motor Driver IC**

### **Overview**

The LB1881M is a three-phase brushless motor driver IC designed for use as a camcorder capstan or drum motor driver, or as a digital audio tape player/recorder motor driver.

### **Features**

- $120^{\circ}$  voltage linear system
- Appropriate for portable applications, since the LB1881M reduces system power requirements by using motor voltage control for speed control.
- Built-in torque ripple compensation circuit
- Small external capacitances due to the adoption of a soft switching technique (chip capacitor).
- Built-in thermal shutdown circuit
- Built-in FG amplifier

## **Package Dimensions**

unit: mm

#### 3073A-MFP30S



# **Specifications**

#### Absolute Maximum Ratings at $Ta = 25^{\circ}C$

Parameter	Symbol	Conditions	Ratings	Unit
	V <sub>CC</sub> 1 max		7	V
Supply voltage	V <sub>CC</sub> 2 max		12	V
	V <sub>S</sub> max		V <sub>CC</sub> 2	V
Output applied voltage	V <sub>O</sub> max		V <sub>S</sub> + 2	V
Input applied voltage	V <sub>I</sub> max	All input pins	V <sub>CC</sub> 1	V
Output current	I <sub>O</sub> max		1.0	А
Allowable power dissipation	Pd max		1.0	W
Operating temperature	T <sub>opr</sub>		-20 to +75	°C
Storage temperature	T <sub>stg</sub>		-55 to +150	°C

#### Allowable Operating Ranges at $Ta = 25^{\circ}C$

Parameter	Symbol	Conditions	Ratings	Unit
	V <sub>CC</sub> 1	$V_{CC}1 \le V_{CC}2$	4.0 to 6.0	V
Supply voltage	V <sub>CC</sub> 2		4 to 10	V
	Vs		Up to V <sub>CC</sub> 2	V

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# Electrical Characteristics at Ta = 25°C, $V_{CC}1$ = 5 V, $V_{CC}2$ = 7 V, $V_S$ = 3 V

_			Ratings			
Parameter	Symbol	Conditions	min	typ	max	Unit
	I <sub>CC</sub> 1	V <sub>BR</sub> = 5 V		3.0	5.0	mA
Supply current	I <sub>CC</sub> 2	V <sub>BR</sub> = 5 V		6.5	10.0	mA
	Is	$V_{BR} = 5 V, R_L = \infty$			5.0	mA
Output quiescent ourrent	Iccoq	V <sub>STBY</sub> = 0 V			100	μA
	I <sub>SOQ</sub>	$V_{STBY} = 0 V, R_L = \infty$			150	μA
Output saturation voltage	V <sub>O(sat)</sub>	I <sub>OUT</sub> = 0.6 A, sink + source			1.7	V
Output TRS withstand voltage	V <sub>O(sus)</sub>	I <sub>OUT</sub> = 20 mA*1	12			V
Output quiescent voltage	V <sub>OQ</sub>	V <sub>BR</sub> = 5 V	1.45	1.55	1.65	V
Hall amplifier input offset voltage	VHOFFSET	*1	-5		+5	mV
Hall amplifier common mode input voltage range	V <sub>нсом</sub>		1.4		2.8	V
Hall I/O voltage gain	GV <sub>HO</sub>	Rangle = 8.2 k $\Omega$	34.0	37.0	40.0	dB
Brake pin high level voltage	V <sub>BRH</sub>		2.0			V
Brake pin low level voltage	V <sub>BRL</sub>				0.8	V
Brake pin input current	I <sub>BRIN</sub>				120	μA
Brake pin leakage current	IBRLEAK				-30	μA
FRC pin high level voltage	V <sub>FRCH</sub>		2.8			V
FRC pin low level voltage	V <sub>FRCL</sub>				1.2	V
FRC pin input current	I <sub>FRCIN</sub>				100	μA
FRC pin leakage current	IFRCLEAK				-30	μA
Upper side residual voltage	V <sub>XH</sub>	$I_{OUT}$ = 100 mA, $V_{CC}2$ = 6 V, $V_{S}$ = 2 V	0.285		0.455	V
Lower side residual voltage	V <sub>XL</sub>	$I_{OUT}$ = 100 mA, $V_{CC}2$ = 6 V, $V_{S}$ = 2 V	0.350		0.440	V
Residual voltage inflection point	V <sub>SAVX</sub>	I <sub>OUT</sub> = 100 mA, V <sub>CC</sub> 2 = 6 V*1		0.9		V
Overlap level	OL	$V_{CC}2 = 6 \text{ V}, \text{ V}_{S} = 3 \text{ V}, \text{ R}_{L} = 100 \Omega \text{ (Y)}$	60	70	80	%
Overlap vertical difference	ΔOL	$V_{CC}2 = 6 \text{ V}, \text{ V}_{S} = 3 \text{ V}, \text{ R}_{L} = 100 \Omega (\text{Y})$	-10	0	+10	%
Standby on voltage	V <sub>STBYL</sub>	*2	-0.2		+0.8	V
Standby off voltage	V <sub>STBYH</sub>		2		5	V
Standby pin bias current	I <sub>STBYIN</sub>				100	μA
Thermal protection circuit operating temperature	T <sub>TSD</sub>	*1	150	180	210	°C
Thermal protection circuit hysteresis	$\Delta T_{TSD}$	*1		15		°C
FG amplifier input offset voltage	V <sub>FG OFFSET</sub>		-8		+8	mV
Open loop voltage gain	GV <sub>FG</sub>	f = 10 kHz		43		dB
Source output saturation voltage	V <sub>FG OU</sub>	$I_0 = -2 \text{ mA}$	3.7			V
Sink output saturation voltage	V <sub>FG OD</sub>	I <sub>O</sub> = 2 mA			1.3	V
Common mode signal exclusion ratio	G <sub>HR</sub>	*1		80		dB
FG amplifier common mode input voltage range	V <sub>FG CH</sub>		0		3.5	V
Phase margin	φM	*1		20		deg
Schmitt amplifier threshold voltage	V <sub>FGS SH</sub>	$V_{FGIN}^+$ = 2.5 V, when $V_{FGOUT}^2$ goes from high to low	2.45	2.50	2.55	V
Schmitt amplifier hysteresis width	V <sub>FGS HIS</sub>	V <sub>FGIN</sub> <sup>+</sup> = 2.5 V	20	40	60	mV

Note: 1. These are target settings, and are not measured. The overlap ratings are taken as test ratings without change.2. When the standby pin is open the IC will be in the standby state.

#### **Pin Assignment**



**Block Diagram** 







Top view

Pin No.	Symbol	Pin voltage	Equivalent circuit	Pin function
4	Vs	≤ V <sub>CC</sub> 2		Power supply input that determines the output amplitude. It must be set to a voltage equal or lower than $V_{CC}2$ .
5	V <sub>CC</sub> 2	4 to 10 V		Power supply for power amplifier systems other than motor drive transistors. Power supply pin that provides voltage for blocks other than control blocks supplied by V <sub>CC</sub> 1.
6	V <sub>CC</sub> 1	4 to 6 V		Power supply that provides voltage for the Hall amplifier, the forward/reverse circuit, the FG amplifier, and the thermal shutdown circuit.
7	ST. BY	(H): 2.0 V max (L): 0.8 V min (When V <sub>CC</sub> 1 is 5 V)	7 100k	All circuits can be made inoperative either by connecting this pin to GND, or by leaving it open. In that state the supply current will be approximately 0 µA. Hold at 2 V or higher during normal operation.
8	ANGLE		V <sub>CC1</sub> V <sub>CC1</sub> B m A01381	Connect a resistor between this pin and GND. Changing the value of this resistor will change the Hall input-output gain (motor waveform slope).
10 11	FG <sub>IN</sub> − FG <sub>IN</sub> +	0 V min 3.5 V max (When V <sub>CC</sub> 1 is 5 V)	VCC1 VCC1	FG signal input pin
12	FG <sub>OUT</sub> 1		VCC1 38 36 12 77 401383	FG amplifier output pin

### **Pin Functions**

Unit (resistance:  $\Omega$ )

Continued on next page

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Continued from preceding page. Unit (resistance: Ω)						
Pin No.	Symbol	Pin voltage	Equivalent circuit	Pin function		
13	FG <sub>OUT</sub> 2		VCC1	FG Schmitt amplifier output pin		
18	FRC	(H): 2.8 V min (L): 1.2 V max (When V <sub>CC</sub> 1 is 5 V)	VCC1	Pin for setting the motor to forward or reverse rotation Low level: Forward rotation (under 1.2 V: when $V_{CC}$ 1 is 5 V) High level: Reverse rotation (over 2.8 V: when $V_{CC}$ 1 is 5 V)		
19	BR	(H): 2.0 V min (L): 0.8 V max	V <sub>CC2</sub> V <sub>CC1</sub> 19 50k 50k 50k 50k 50k 50k 50k 50k	Motor brake pin Low level: Motor drive (under 0.8 V) High level: Motor brake (over 2.0 V)		
20 21 22 23 24 25	W <sub>IN</sub> 2 W <sub>IN</sub> 1 V <sub>IN</sub> 2 V <sub>IN</sub> 1 U <sub>IN</sub> 2 U <sub>IN</sub> 1	1.4 V min 2.8 V max (When V <sub>CC</sub> 1 is 5 V)	25 200 23 21 777 401387	W phase Hall element input pins. Logic high is defined to be states where $W_{IN}1 > W_{IN}2$ . V phase Hall element input pins. Logic high is defined to be states where $V_{IN}1 > V_{IN}2$ . U phase Hall element input pins. Logic high is defined to be states where $U_{IN}1 > U_{IN}2$ .		
26	R <sub>f</sub>			Output transistor GND		
27 28 3	U <sub>OUT</sub> Vout Wout		28 3 401388	Output pin		
1, 2, 14, 15, 16, 17, 29, 30	FRAME (GND)			GND for all circuits other than output transistors.		

#### **Sample Application Circuit**



Units (resistance:  $\Omega$ , capacitance: F)

#### Logic Value Table

$\smallsetminus$	Source		Input		Forward and reverse control
	Sink	U	V	W	F/RC
1	W phase $\rightarrow$ V phase	н	н	L	L
	V phase $\rightarrow$ W phase				н
2	W phase $\rightarrow$ U phase	ц	L	L	L
2	U phase $\rightarrow$ W phase				н
3	V phase $\rightarrow$ W phase		L	н	L
	W phase $\rightarrow$ V phase				н
4	U phase $\rightarrow$ V phase		н	L	L
4	V phase $\rightarrow$ U phase				н
5	V phase $\rightarrow$ U phase		L	н	L
	U phase $\rightarrow$ V phase				н
6	U phase $\rightarrow$ W phase		н	Н	L
	W phase $\rightarrow$ U phase				Н

Inputs:

High: For each phase, the input 1 potential is at least 0.2 V higher than the input 2 potential. Low: For each phase, the input 1 potential is at least 0.2 V lower than the input 2 potential.

Forward/reverse control:

High: 2.8 V to  $V_{CC}$ 1

Low: 0 to 1.2 V

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