Monolithic Digital IC

LB1857M

Three-Phase Brushless Motor Driver IC

Overview

The LB1857M 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

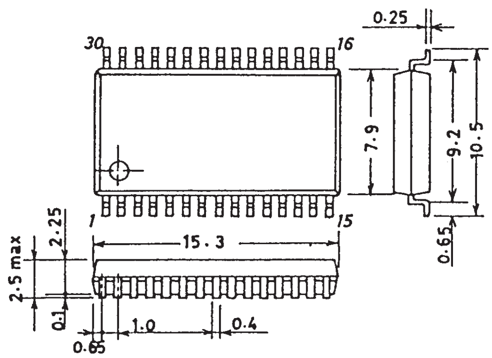
- 120° voltage linear system
- Appropriate for portable applications, since the LB1857M reduces system power requirements by using motor voltage control for speed control.
- Built-in torque ripple compensation circuit
- Small external capacitances due to the adoption of a soft switching technique (chip capacitor).
- Built-in thermal shutdown circuit
- Built-in FG amplifier

Package Dimensions

unit: mm

3073A-MFP30S

[LB1857M]



SANYO: MFP30S

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{CC}1$ max		7	V
	$V_{CC}2$ max		16	V
	V_S max		$V_{CC}2$	V
Output applied voltage	V_O max		V_S + 2	V
Output current	I_O max		1.5	A
Allowable power dissipation	Pd max		1.0	W
Operating temperature	Topr		–20 to +75	°C
Storage temperature	Tstg		–55 to +125	°C

Allowable Operating Ranges at Ta = 25°C

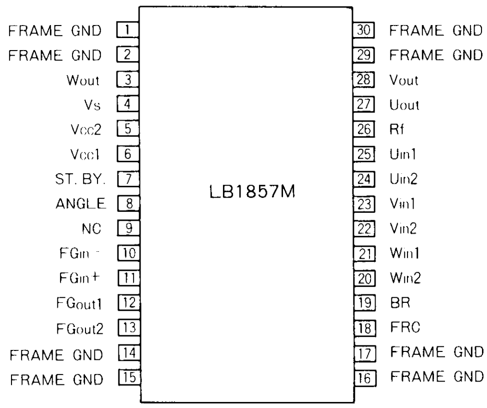
Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	$V_{CC}1$	$V_{CC}1 \leq V_{CC}2$	4.0 to 6.0	V
	$V_{CC}2$		4 to 14	V
	V_S		Up to $V_{CC}2$	V

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

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply current	$I_{CC}1$	V_{BR} = 5 V		4.5	6.5	mA
	$I_{CC}2$	V_{BR} = 5 V		13	20	mA
	I_S	V_{BR} = 5 V, R_L = ∞		6.5	9.0	mA
Output quiescent current	I_{CCOQ}	V_{STBY} = 0 V			180	µA
	I_{SOQ}	V_{STBY} = 0 V, R_L = ∞			150	µA
Output saturation voltage	$V_{O(sat)}$	I_{OUT} = 0.6 A, sink + source			2.3	V
Output TRS withstand voltage	$V_{O(sus)}$	I_{OUT} = 20 mA*1	16			V
Output quiescent voltage	V_{OQ}	V_{BR} = 5 V	1.4	1.5	1.6	V
Hall amplifier input offset voltage	$V_{HOFFSET}$	*1	–5		+5	mV
Hall amplifier common mode input voltage range	V_{HCOM}		1.4		2.8	V
Hall I/O voltage gain	GV_{HO}	Rangle = 8.2 kΩ	32.0	35.0	38.0	dB
Brake pin high level voltage	V_{BRH}		2.0			V
Brake pin low level voltage	V_{BRL}				0.8	V
Brake pin input current	I_{BRIN}				100	µA
Brake pin leakage current	I_{BRLEAK}				–30	µA
FRC pin high level voltage	V_{FRCH}		2.8			V
FRC pin low level voltage	V_{FRCL}				1.2	V
FRC pin input current	I_{FRCIN}				100	µA
FRC pin leakage current	$I_{FRCLEAK}$				–30	µA
Upper side residual voltage	V_{XH}	I_{OUT} = 100 mA, $V_{CC}2$ = 6 V, V_S = 2 V	0.32		0.49	V
Lower side residual voltage	V_{XL}	I_{OUT} = 100 mA, $V_{CC}2$ = 6 V, V_S = 2 V	0.39		0.48	V
Overlap level	OL	$V_{CC}2$ = 6 V, V_S = 3 V	60	70	80	%
Standby on voltage	V_{STBYL}	*2	–0.2		+0.1	V
Standby off voltage	V_{STBYH}		2		5	V
Standby pin bias current	I_{STBYIN}				10	µA
Thermal protection circuit operating temperature	T_{TSD}	*1	150	180	210	°C
Thermal protection circuit hysteresis	ΔT_{TSD}	*1		15		°C
[FG amplifier]						
Input offset voltage	$V_{FG\ OFFSET}$		–8		+8	mV
Open loop voltage gain	GV_{FG}	f = 1 kHz		60		dB
Source output saturation voltage	$V_{FG\ OU}$	I_O = –2 mA	3.7			V
Sink output saturation voltage	$V_{FG\ OD}$	I_O = 2 mA			1.3	V
Common mode signal exclusion ratio	CHR	*1		80		dB
FG amplifier common mode input voltage range	$V_{FG\ CH}$		0		3.5	V
Phase margin	φM	*1		20		deg
Schmitt amplifier threshold voltage	$V_{FGS\ SH}$	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	$V_{FGS\ HIS}$	V_{FGIN}^+ = 2.5 V	20	40	60	mV

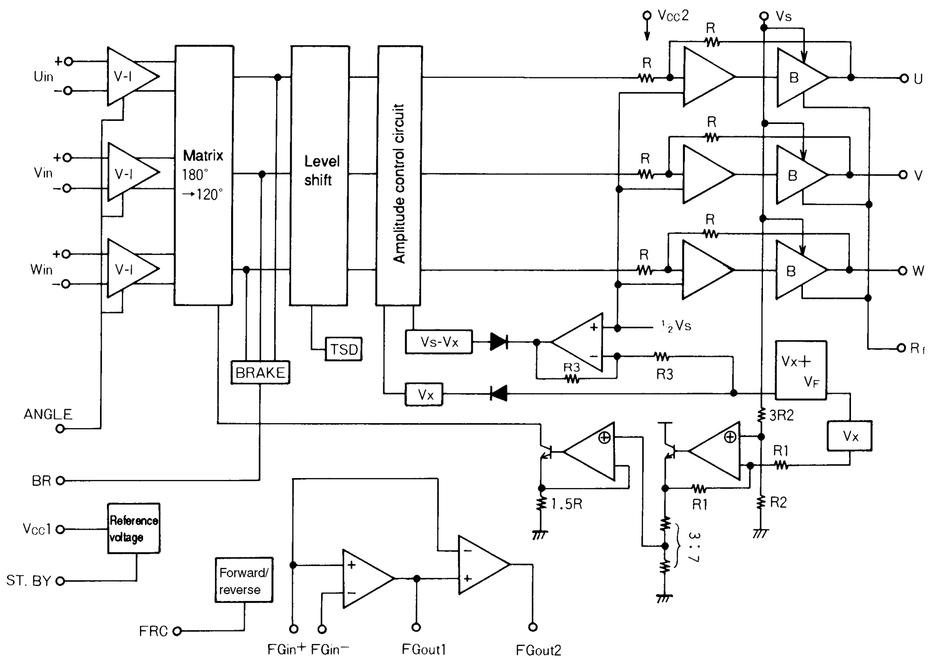
Note: 1. These are target settings, and are not measured. The overlap ratings are taken as test ratings without change.
2. When the standby pin is open the IC will be in the standby state.

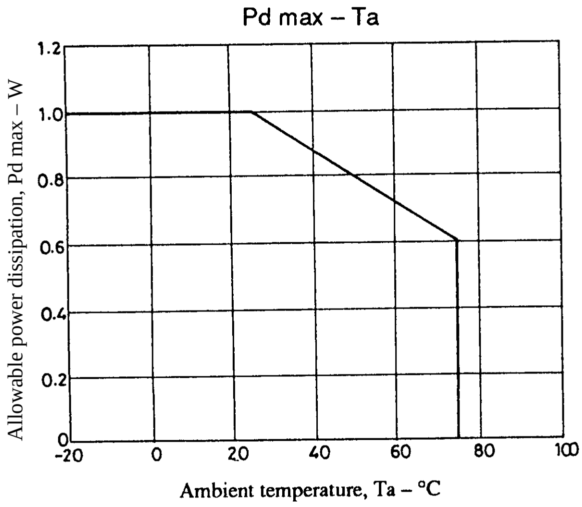
Pin Assignment



Top view

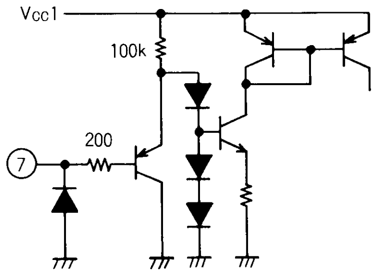
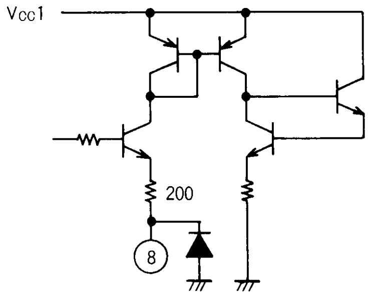
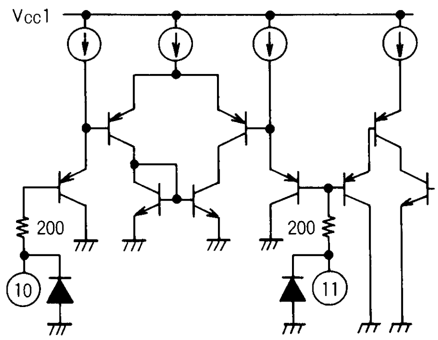
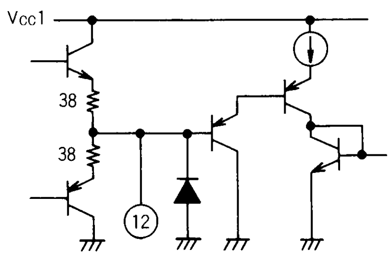
Block Diagram





Pin Functions

Unit (resistance: Ω)

Pin No.	Symbol	Pin voltage	Equivalent circuit	Pin function
4	V_S	≤ $V_{CC}2$		Power supply input that determines the output amplitude. It must be set to a voltage equal or lower than $V_{CC}2$.
5	$V_{CC}2$	4 to 14 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 $V_{CC}1$.
6	$V_{CC}1$	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): 0.1 V max (L): 2.0 V min (When $V_{CC}1$ is 5 V)		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 100 µA. Hold at 2 V or higher during normal operation.
8	ANGLE			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_{IN}^- FG_{IN}^+	0 V min 3.5 V max (When $V_{CC}1$ is 5 V)		FG signal input pin
12	$FG_{OUT}1$			FG amplifier output pin

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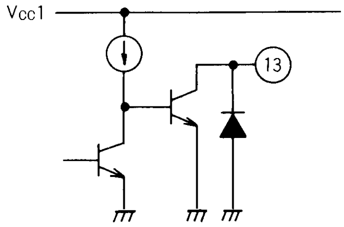
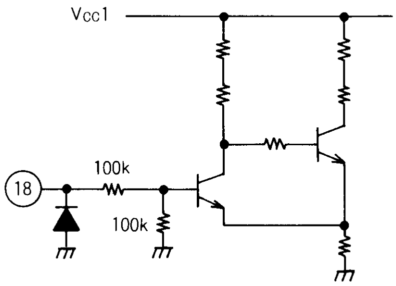
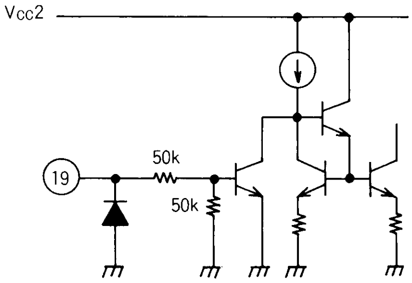
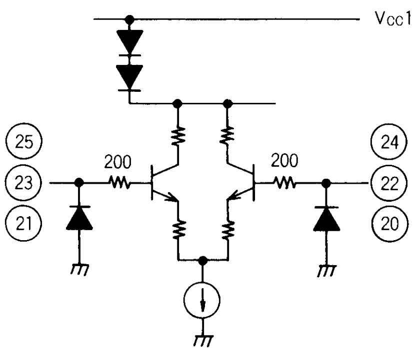
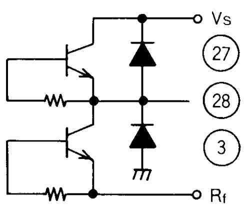
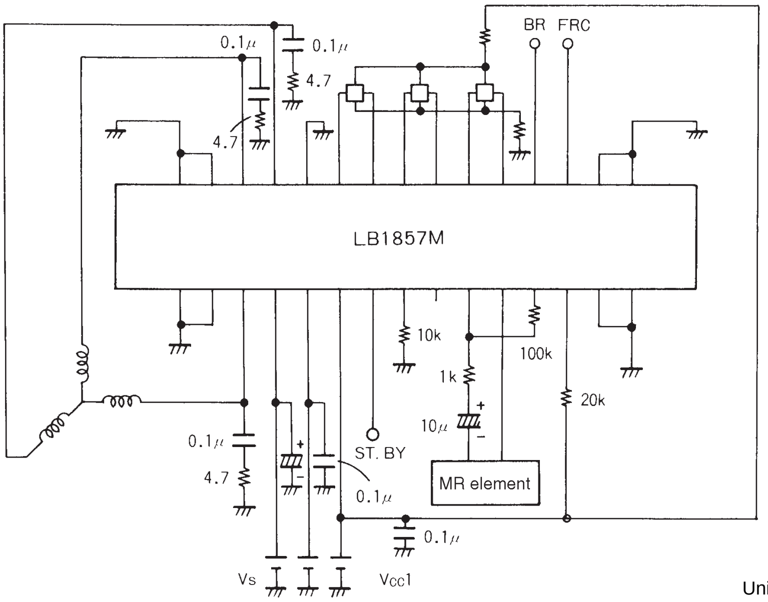
Unit (resistance: Ω)

Pin No.	Symbol	Pin voltage	Equivalent circuit	Pin function
13	$FG_{OUT}2$			FG Schmitt amplifier output pin
18	FRC	(H): 2.8 V min (L): 1.2 V max (When $V_{CC}1$ is 5 V)		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		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	$W_{IN}2$ $W_{IN}1$ $V_{IN}2$ $V_{IN}1$ $U_{IN}2$ $U_{IN}1$	1.4 V min 2.8 V max (When $V_{CC}1$ is 5 V)		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_f			Output transistor GND
27 28 3	U_{OUT} V_{OUT} W_{OUT}			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: Ω, capacitance: F)

Logic Value Table

	Source / Sink	Input U	Input V	Input W	Forward and reverse control F/RC
1	W phase → V phase	H	H	L	L
	V phase → W phase				H
2	W phase → U phase	H	L	L	L
	U phase → W phase				H
3	V phase → W phase	L	L	H	L
	W phase → V phase				H
4	U phase → V phase	L	H	L	L
	V phase → U phase				H
5	V phase → U phase	H	L	H	L
	U phase → V phase				H
6	U phase → W phase	L	H	H	L
	W phase → U phase				H

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