Monolithic Digital IC

No.4695A

LB1885M

SANYO

Three-Phase Bipolar Brushless/ Sensorless Motor Driver

Overview

The LB1885M is a sensorless three-phase brushless motor driver that does not use a Hall-effect element.

Functions

• Three-phase brushless motor driver
• Sensorless drive
• Soft switching
• Support for forward and reverse rotation
• Built-in thermal shutdown circuit
• Built-in FG and PG amplifiers
• The LB1885M can also drive motors with a Vs of 1 V or lower.

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Ratings	Unit
Supply voltage	$V_{CC}1$	7	V
	$V_{CC}2$	12	V
	$V_{CC}3$	7	V
Motor supply voltage	V_S	$V_{CC}2$	V
Output applied voltage	V_O	$V_{CC}2 + 1$	V
Output current	I_O	800	mA
Allowable power dissipation	Pd max	0.9	W
Operating temperature	Topr	−20 to +75	°C
Storage temperature	T_{stg}	−50 to +150	°C

Allowable Operating Conditions at Ta = 25°C

Parameter	Symbol	Ratings	Unit
Supply voltage	$V_{CC}1$	4 to 6	V
	$V_{CC}2$	4 to 10	V
	$V_{CC}3$	4 to 6	V
Motor supply voltage	V_S	1 to $V_{CC}2 - 1$	V

Pd max – Ta
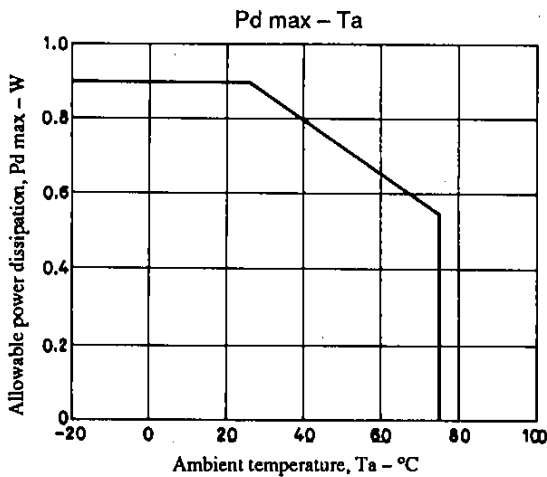
Package Dimensions

unit: mm

3129-MFP36S

SANYO: MFP36S
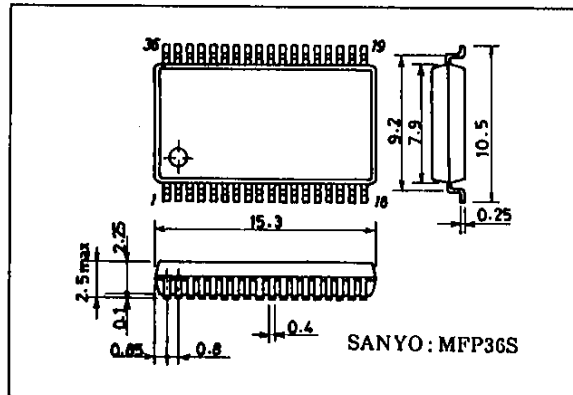
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Electrical Characteristics

Motor Drive Block at Ta = 25°C, $V_{CC}1 = 5$ V, $V_{CC}2 = 5$ V, $V_{CC}3 = 5$ V, $V_S = 2$ V

Parameter		Symbol	Conditions	min	typ	max	Unit	Note
Current dissipation		$I_{CC}1$			18	23	mA	
		$I_{CC}2$	$I_O = 0.1$ A		1.5	6.0	mA	
		$I_{CC}3$	$V_{CC}3 = 5$ V		1.3	2.5	mA	
V_S current dissipation		I_S	$I_O = 0.1$ A		100		mA	
Output saturation voltage (high)		VsatH	$I_O = 0.4$ A		0.25	0.40	V	
Output saturation voltage (low)		VsatL	$I_O = 0.4$ A		0.25	0.40	V	
Reversing pin	High-level voltage	$VI_{LR}H$		1			V	
	Low-level voltage	$VI_{LR}L$				0.3	V	
	Input current	$II_{LR}L$	L/R = GND		−50	−100	μA	
Start-up oscillator frequency		$F_{OSC}S$	R13 = 51 kΩ, C13 = 0.22 μF		156		Hz	*
Trapezoidal wave amplitude	Start-up	VpSS		320	360	400	mV	*
	Drive	VpSD		180	200	220	mV	*
Restart cycle		$F_{OSC}R$	R23 = 56 kΩ, R24 = 390 kΩ, C24 = 683		19.6		Hz	*
Current limiter amplifier	Common mode input voltage range	VlimCM		0		3	V	
	Input offset voltage	VlimOFF		−8		+8	mV	*
	Voltage gain	VGlim		30			dB	*
TSD operating temperature		TSD		150	180	210	°C	*
TSD hysteresis		TSDHIS			40		°C	*

Note: Items marked with an asterisk are design targets, not measurements.

FG Amplifier Block at Ta = 25°C, $V_{CC}3 = 5$ V

Parameter	Symbol	Conditions	min	typ	max	Unit	Note
Input offset voltage	VfgOFF		−8	±1	+8	mV	*
Input bias current	IfgB				250	nA	*
Common mode input voltage range	VfgICM		1		4	V	*
Output current (sink)	IfgOL				2.0	mA	
Output on voltage	VfgOL			0.2	0.4	V	
Output off voltage	VfgOH		4.8			V	
Hysteresis width	VfgHIS			115		mV	*
Voltage gain	VGfg			80		dB	*

Note: Items marked with an asterisk are design targets, not measurements.

PG Amplifier Block

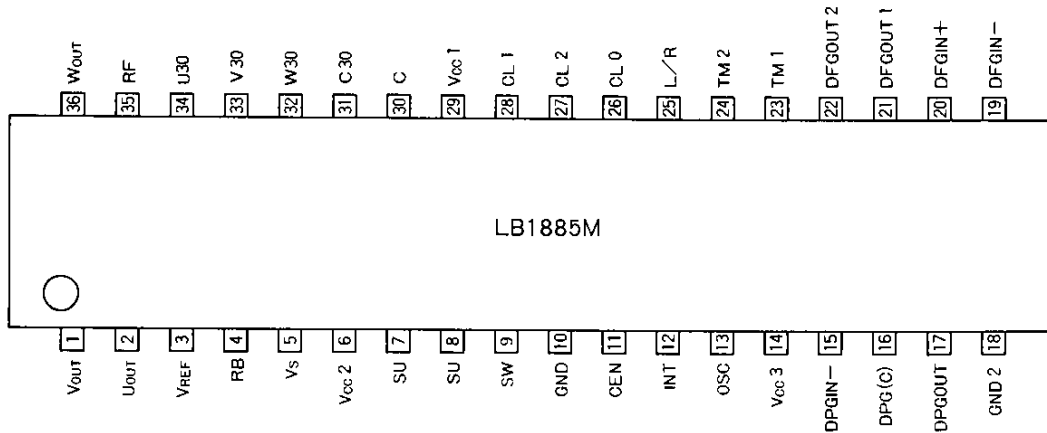| Parameter	Symbol	Conditions	min	typ	max	Unit	Note
Input offset voltage	VpgOFF		−8	±1	+8	mV	*
Input bias current	IpgB				500	nA	*
Common mode input voltage range	VpgICM		1.0		4.0	V	*
Output current (sink)	IpgOL				2.0	mA	
Output on voltage	VpgOL			0.2	0.4	V	
Output off voltage	VpgOH		4.8			V	
Schmitt amplifier hysteresis width	VshHIS			20		mV	*

Note: Items marked with an asterisk are design targets, not measurements.

Amplification Ratios

Rank	Amplification ratio
A	130 to 240
B	200 to 300
C	240 to 380

Pin Assignment (top view)

LB1885M

Pin labels (top, left to right): 36 W$_{OUT}$, 35 RF, 34 U30, 33 V30, 32 W30, 31 C30, 30 C, 29 V$_{CC}$1, 28 CL 1, 27 CL 2, 26 CL 0, 25 L/R, 24 TM 2, 23 TM 1, 22 DFGOUT 2, 21 DFGOUT 1, 20 DFGIN+, 19 DFGIN−

Pin labels (bottom, left to right): 1 V$_{OUT}$, 2 U$_{OUT}$, 3 V$_{REF}$, 4 RB, 5 V$_S$, 6 V$_{CC}$2, 7 SU, 8 SU, 9 SW, 10 GND, 11 CEN, 12 INT, 13 OSC, 14 V$_{CC}$3, 15 DFGIN−, 16 DPG(C), 17 DPGOUT, 18 GND 2

Motor Driver Block Pin Functions

Pin No.	Symbol	Pin description
1	V$_{OUT}$	Motor connection pin (V phase)
2	U$_{OUT}$	Motor connection pin (U phase)
3	V$_{REF}$	Reference voltage pin (Also functions as the I$_{IL}$ injector power supply for the 2.2 V output voltage. Also used as the reference voltage for the current limiter and the thermal shutdown function.)
4	R$_B$	Pin for the resistor that determines the drive current by comparison with RF.
5	V$_S$	Motor supply voltage pin
6	V$_{CC}$2	Driver state supply voltage pin. Set to at least 1 V higher than V$_S$.
7	SU	U phase drive signal pin. (The trapezoidal wave amplitude can be adjusted (reduced) by inserting a resistor between this pin and CEN.)
8	SV	V phase drive signal pin. (The trapezoidal wave amplitude can be adjusted (reduced) by inserting a resistor between this pin and CEN.)
9	SW	W phase drive signal pin. (The trapezoidal wave amplitude can be adjusted (reduced) by inserting a resistor between this pin and CEN.)
10	GND	Motor driver block ground
11	CEN	The trapezoidal wave is formed with this potential (about 2.2 V) as its midpoint.
12	INT	Capacitor connection pin for the integration circuit that generates the triangle wave used in trapezoidal wave synthesis
13	OSC	Start-up oscillator capacitor connection pin. The capacitor is charged and discharged by the fixed current supplied by this pin.
14	V$_{CC}$3	Power supply for the FG and PG amplifier systems
15	DP G$_{IN}$−	PG amplifier input pin
16	DP G(C)	Peak hold capacitor connection pin
17	DP G OUT	PG amplifier output pin
18	GND 2	FG and PG amplifier system GND
19	DF G$_{IN}$−	FG amplifier − input pin
20	DF G$_{IN}$+	FG amplifier + input pin
21	DF G OUT1	FG amplifier output pin 1
22	DF G OUT2	FG amplifier output pin 2
23	TM1	Start-up/drive switching timer charging pin
24	TM2	Start-up/drive switching timer discharging pin
25	L/R	Start-up/drive switching timer discharging pin
26	CL0	Current limiter output pin (NPN open collector)
27	CL2	Current limiter + input pin
28	CL1	Current limiter − input pin (connected to RF internally)
29	V$_{CC}$1	Trapezoidal wave synthesis circuit, reference voltage circuit
30	C	Motor midpoint connection pin
31	C30	Midpoint 30° filter output pin
32	W30	W point 30° filter output pin
33	V30	V point 30° filter output pin
34	U30	U point 30° filter output pin
35	RF	Current feedback resistor connection pin
36	W$_{OUT}$	Motor connection pin (W phase)

Sample Application Circuit
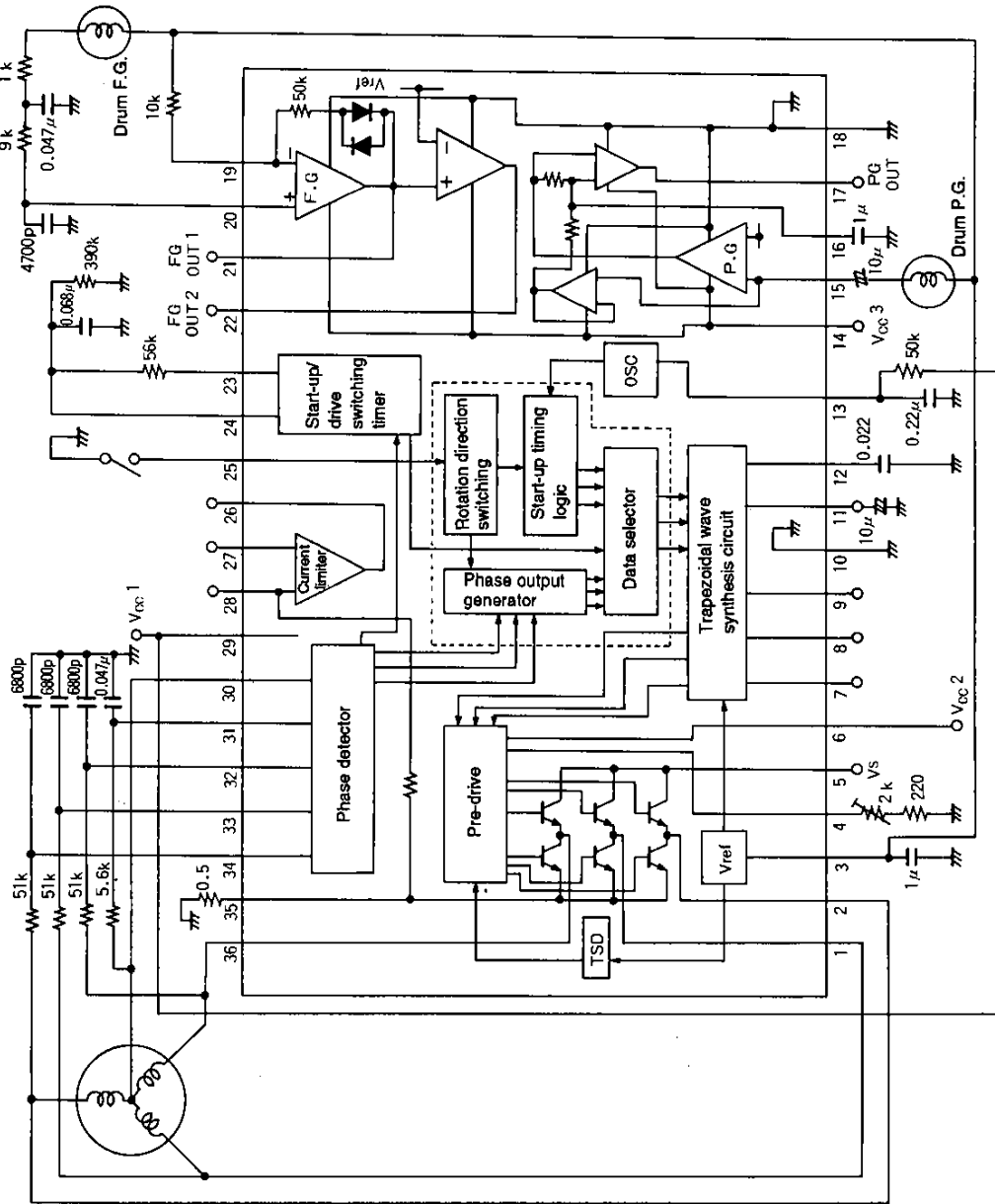
The LB1885M functions differ from those of the LB1880M only in the following point. In the LB1885M, the function that forcibly switches the system to start-up mode when Vs falls to 0.7 V or lower has been removed.

External Component Constants

1. Vref
   Capacitor (to GND)
   1 μF

2. RB
   Resistor (to GND)
   Specified for each rank:
   - A: 560 Ω
   - B: 820 Ω
   - C: 1 kΩ

   If a value larger than the specified value is used, the drive capacity will become insufficient, and the motor speed will not increase even if V_S is increased. Inversely, if the value is too small, invalid currents will increase when V_S is raised. Also, the motor speed will not increase.

3. SU, SV, SW
   Capacitor (to GND)

   If noise or oscillations appear in the output voltage, these components are effective to stop noise or oscillation.

4. INT
   Capacitor (to GND)

   Creates a clean triangle wave corresponding to the motor speed. If too small, the top of the waveform will be clipped, and if too large, the triangle wave will become smaller.

5. OSC
   Resistor (to V_{CC})
   Capacitor (to GND)

6. TM1, TM2
   R1 (inter-pin)
   R2 (to GND)
   C (to GND)
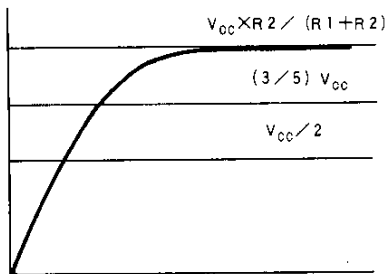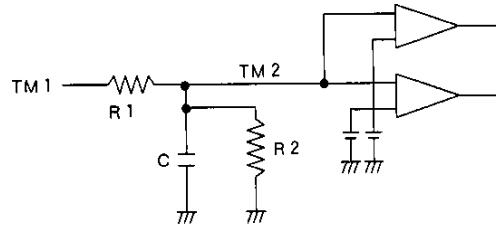
The TM1 output is generated by taking the logical exclusive OR of three signals generated by comparing the IC output voltages U, V and W with 3/5 of V_S. During normal rotation, C is charged by the pulses generated by the iteration of high, medium and low levels on the U, V and W output. Therefore the TM2 pin voltage rises until it reaches $5 \times R2/(R1 + R2)$ V.

While the threshold level between start-up mode and drive mode is $V_{CC}/2$, the threshold from drive mode to start-up mode has a hysteresis of about 0.64 V (typical).

The condition for entering restart is:
$R2 \times Ib \times 1.5 < 0.64$
At that time: $R2 < 520$ kΩ.

The threshold for changing the amplitude of the trapezoidal wave is:
   $(3/5)\ V_{CC}$
   Therefore, resistor values such that
   $R2\ /\ (R1 + R2) > 3/5$
   must be chosen.

7. U30, V30, W30
   These are computed at $f = \sqrt{3}/(3 \times 2\ \pi\ CR)$.

8. C30
   R must be 20 kΩ or less. (This is to maintain the back voltage detection sensitivity.)
   Otherwise the comparator offset will become large and the circuit will be unable to detect the back voltage.