Ordering number : ENN6656A

Monolithic Digital IC

LB11981

Three-Phase Sensorless Motor Driver

Applications

Refrigerator fan motors

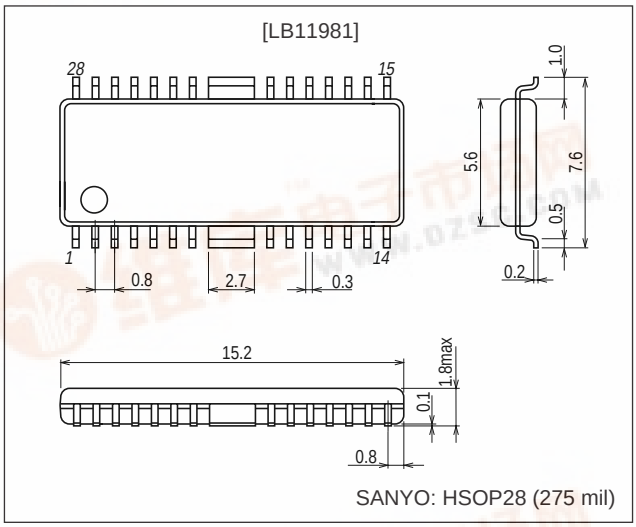
Features

- No Hall sensors required.
- No FG sensors required.
- Lock detection circuit (Can be set to operate in either automatic recovery or latching mode.)
- Thermal shutdown circuit
- Current limiter circuit
- Low-voltage shutdown circuit
- Forward/reverse switching
- Supports both single- and dual-power supply circuits.

Package Dimensions

unit: mm

3222-HSOP28 (275 mil)



Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V_{CC} max		30	V
Supply voltage 2	V_{CC} max	Power supply for output stage	30	V
Applied output voltage	V_O max		30	V
Applied input voltage	V_I max		–0.3 to V_{CC} + 0.3	V
Maximum output current	I_O max		1.0	A
Allowable power dissipation	Pdmax	Independent IC	0.5	W
Operating temperature	Topr		–20 to +75	°C
Storage temperature	Tstg		–55 to +150	°C

Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V_{CC}		*8 (5) to 28	V
Supply voltage 2	$V_{CC}M$		8 to 28	V

Note: * This device should normally be used with $V_{CC} \geq 8$ V. If used with 5 V ≤ V_{CC} < 8 V, short the V_{CC} and V_{REG} pins together. Note that in this case the electrical characteristics of the device become more easily influenced by fluctuations in the V_{CC} supply voltage.

Electrical Characteristics at Ta = 25°C, V_{CC} = V_{CCM} = 18 V

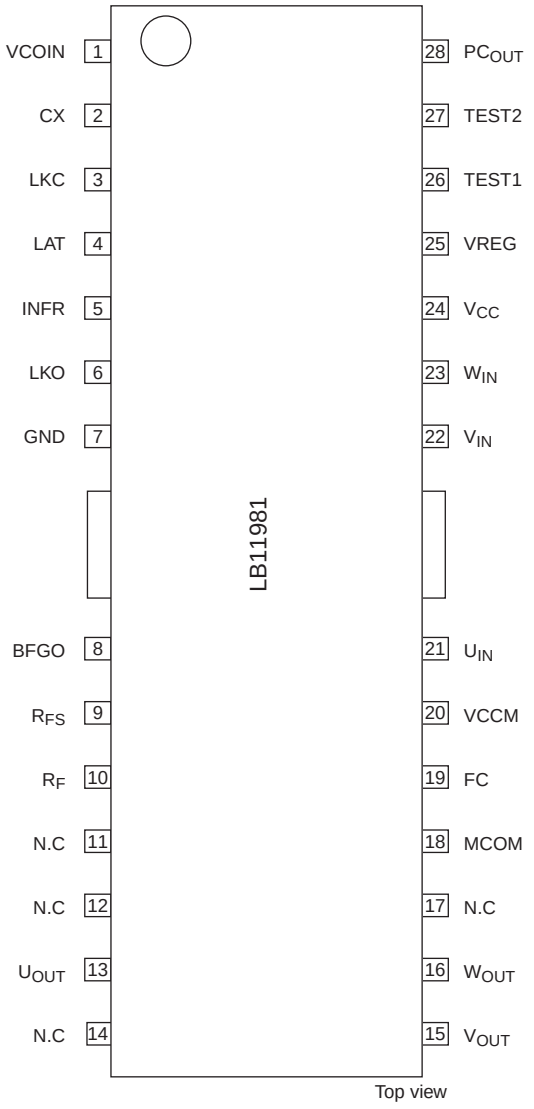
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply current 1	ICC		8.8	11	13.2	mA
Supply current 2	I_{CCM}	LKC = 5 V	480	600	720	µA
Internal power supply	V_{REF}		4.75	5.0	5.25	V
Internal supply load regulation	ΔV_{REF}	ILOAD = –5 mA		30	50	mV
Output saturation voltage 1	$V_{OSAT}1$	IO = 0.4 A, Source + Sink		1.4	1.7	V
Output saturation voltage 2	$V_{OSAT}2$	IO = 0.8 A, Source + Sink		2.0	2.4	V
MCOM pin common-mode input voltage range	V_{IC}		0		V_{CC} – 2	V
PCOUT pin output current 1	IPCOU	Source side	–120	–100	–80	µA
PCOUT pin output current 2	IPCOD	Sink side	80	100	120	µA
VCOIN pin input current	IVCOIN	VCOIN = 4 V		1	2	µA
Minimum VCO frequency	fVCOmin	VCOIN = open	0.85	1	1.15	kHz
Maximum VCO frequency	fVCOmax	VCOIN = 5 V	36	42	48	kHz
Maximum CX pin charge/discharge current	Icxmax	VCOIN = 5 V	550	650	750	µA
Minimum CX pin charge/discharge current	Icxmin	VCOIN = open	11	14	17	µA
Thermal shutdown circuit operating temperature	TTSD	Design target value *	150	180	210	°C
Thermal shutdown circuit hysteresis	ΔTTSD	Design target value *		15		°C
BFGO pin output saturation voltage	VsatFG	ILOAD = 1 mA		0.2	0.4	V
[Lock Detection Circuit]						
LKC pin voltage threshold	Vth		3.7	4	4.3	V
Threshold level hysteresis	ΔVth		1.8	2	2.2	V
LKC pin charge current	Ichg	V (LKC) = 0 V	0.8	1	1.2	µA
LKC pin discharge current	Idis	V (LKC) = 4.2 V	0.52	0.65	0.78	µA
LAT pin input current	ILAT	V (LAT) = 0 V, V (LKC)= 4.2 V	3.2	4	4.8	µA
LKO pin saturation voltage	VsatLKO	ILOAD = 1 mA, V(LKC) = 4.2 V		0.2	0.4	V
[Low-Voltage Cutoff Circuit]						
Low-voltage detection voltage	VT	VREG pin detection	38	4	4.2	V
Hysteresis	ΔVF		150	180	210	mV
[Forward/Reverse Circuit]						
INFR pin input current	IINFR	V (INFR) = 5 V	38	43	48	µA
INFR pin high-level input threshold voltage	VINH		3.0			V
INFR pin low-level input threshold voltage	VINL				1.0	V

Note: * Design target values are not tested.

Pin Functions

Pin No.	Pin	Function
1	VCOIN	VCO circuit voltage input. Inputs the PCOUT pin voltage filtered by an RC circuit.
2	CX	The value of the capacitor between this pin and ground determines the operating frequency range and the minimum operating frequency of the VCO circuit.
3	LKC	Connection for the lock detection circuit capacitor. The value of the capacitor between this pin and ground determines the lock state monitoring period. The lock detection circuit can be disabled by connecting this pin to ground.
4	LAT	Lock detection circuit mode switching input
5	INFR	Forward/reverse switching input
6	LKO	Lock state detection signal. (A pull-up resistor is required.)
7	GND	Ground
8	BFGO	Motor back electromotive force detection FG output (3 phases combined). (A pull-up resistor is required.)
9	R_{FS}	Current limit sensing. The output current can be detected and current limiting applied by connecting this pin to the RF pin.
10	R_F	Lowest potential of the motor driver output transistor. The value of the resistor between this pin and ground determines the current that flows in the output transistor.
11, 12, 14	N.C	Not connected
13	U_{OUT}	Motor driver output
15	V_{OUT}	
16	W_{OUT}	
17	N.C	Not connected
18	MCOM	Motor coil midpoint input. The coil voltage waveform is detected using this voltage as the reference level.
19	FC	Frequency characteristics correction. Closed loop oscillation in the current control system can be stopped by inserting a capacitor between this pin and ground.
20	V_{CCM}	Motor drive output stage power supply
21	U_{IN}	Coil waveform detection comparator input These are connected to the outputs for each phase through internal 10 kΩ resistors.
22	V_{IN}	
23	W_{IN}	
24	V_{CC}	Power supply
25	V_{REG}	Internal 5 V regulator output
26, 27	TEST	Test pin. This pin must be left open during normal operation.
28	PC_{OUT}	V_{CO} circuit PLL output

Pin Assignment



Truth Tables

Pin 4 (LAT): Lock detection circuit mode switching

LAT	Mode
OPEN	Automatic recovery mode
“L”	Output latched in the off state when lock detected.

Pin 5 (INFR): Motor rotation direction switching

INFR	Mode
OPEN or “L”	Forward
“H”	Reverse

Pin 3 (LKC): Lock detection time setting capacitor connection

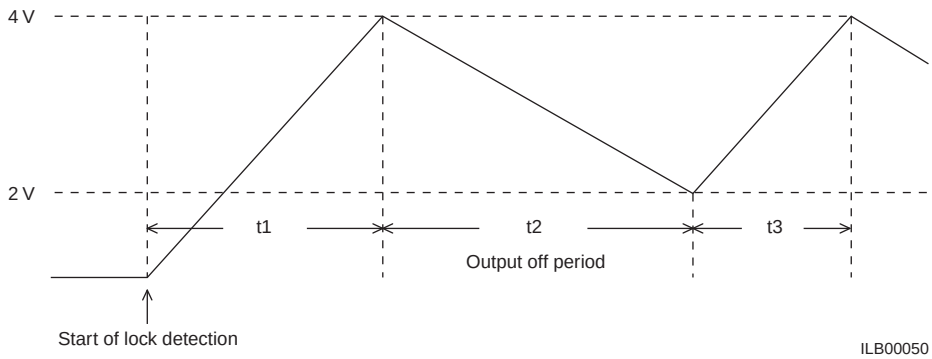
LKC	Mode
GND	Disabled
Capacitor inserted	Enabled

Pin 6 (LKO): Lock state detection signal (A pull-up resistor is required.)

LKO	State
“H”	Lock not detected
“L”	Lock detected

Lock Detection Time Setting (automatic recovery mode)

[LKC pin]



The following formula gives the time, t1, from the point the motor speed is locked until the output is turned off.
t1[s] = C [µF] × 4 [V] / 1 [µA]
The output off time, t2, is as follows.
t2[s] = C [µF] × 2 [V] / 0.65 [µA]
The time, t3, following the output off state until the motor speed locked state is monitored, is as follows.
t3[s] = C [µF] × 2 [V] / 1 [µA]
When pin 4 (LAT) is low (output off latching mode), after the t1 period lock state monitoring, the output is turned off and the output is held in the off state until either the V_{CC} or $V_{CC}M$ power supply is switched.

Sample Application Circuit (Note that the values of the external components depend on the motor used.)