



**SANYO Semiconductors**

# DATA SHEET

An ON Semiconductor Company

## LB11961 — Monolithic Digital IC Single-Phase Full-Wave Fan Motor Driver

### Overview

The LB11961 is a single-phase bipolar drive motor driver that easily implements direct PWM motor drive systems with excellent efficiency. The LB11961 is optimal for fan motor drive in personal computer power supply systems and CPU cooling fan systems.

### Features

- Single-phase full-wave drive (16V, 1.0A transistors are built in)
- Built-in variable speed function controlled by a thermistor input  
The LB11961 can implement quiet, low-vibration variable speed control using externally clocked high side transistor direct PWM drive.
- Built-in regenerative diode (Di); only requires a minimal number of external components.
- Built-in HB
- Minimum speed setting pin (allows full-speed mode operation at startup)
- Operates in full-speed mode when the thermistor is removed.
- Built-in lock protection and automatic recovery circuits
- FG (speed detection) and RD (lock detection) outputs
- Built-in thermal shutdown circuit

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# LB11961

## Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
$V_{CC}$ maximum output voltage	$V_{CC}$ max		18	V
OUT pin maximum output current	$I_{OUT}$ max		1.0	A
OUT pin output voltage	$V_{OUT}$ max		18	V
HB maximum output current	IHB max		10	mA
VTH input pin voltage	VTH max		6	V
RD/FG output pin output voltage	VRD/FG max		18	V
RD/FG output current	IRD/FG max		10	mA
Allowable power dissipation	Pd max	When mounted on a circuit board *1	1.1	W
Operating temperature	Topr		-30 to +90	$^\circ\text{C}$
Storage temperature	Tstg		-55 to +150	$^\circ\text{C}$

\*1 Specified circuit board :  $114.3 \times 76.1 \times 1.6\text{mm}^3$ , glass epoxy.

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.

Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

### Recommended Operating Conditions at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
$V_{CC}$ supply voltage	$V_{CC}$		4.5 to 16	V
VTH input level voltage range	VTH		0 to 9	V
Hall sensor input common-mode input voltage range	VICM		0.2 to 3	V

### Electrical Characteristics Unless otherwise specified $T_a = 25^\circ\text{C}$ , $V_{CC} = 12\text{V}$

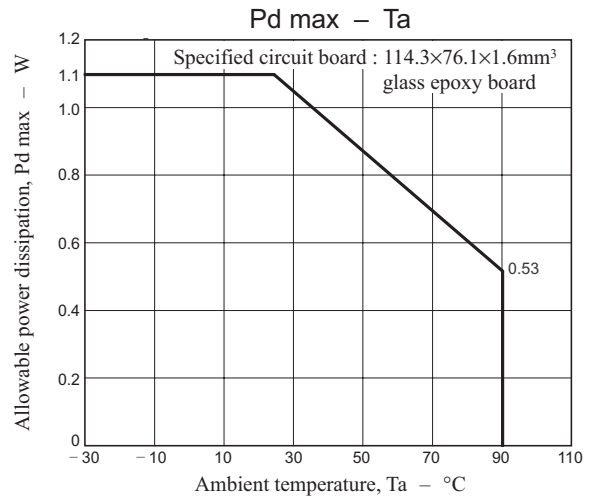
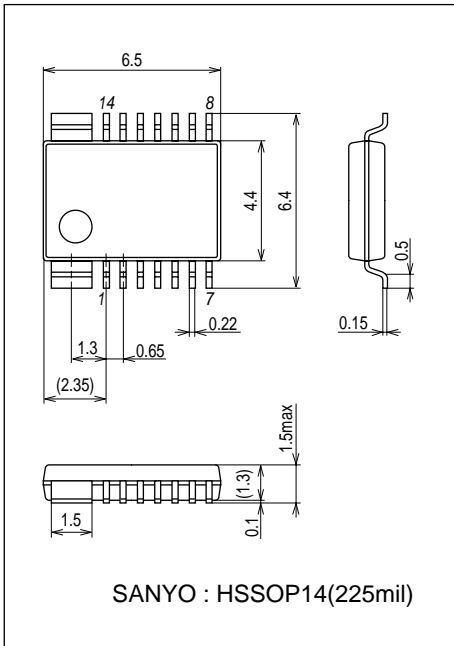
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Circuit current	$I_{CC1}$	Drive mode	12	18	24	mA
	$I_{CC2}$	Lock protection mode	8	11	16	mA
6VREG voltage	V6VREG	I6VREG = 5mA	5.8	6	6.2	V
HB voltage	VHB	IHB = 5mA	1.10	1.25	1.40	V
CPWM high-level voltage	VCRH		3.45	3.6	3.75	V
CPWM low-level voltage	VCRL		1.95	2.05	2.15	V
CPWM oscillator frequency	FPWM	C = 100pF	18	25	32	kHz
CT pin high-level voltage	VCTH		3.45	3.6	3.75	V
CT pin low-level voltage	VCTL		1.55	1.7	1.85	V
ICT charge current	ICT1		1.5	2	2.5	$\mu\text{A}$
ICT discharge current	ICT2		0.15	0.2	0.25	$\mu\text{A}$
ICT charge/discharge current ratio	RCT		8.5	10	11.5	
OUT output low saturation voltage	$V_{OL}$	$I_O = 200\text{mA}$		0.2	0.3	V
OUT output high saturation voltage	$V_{OH}$	$I_O = 200\text{mA}$		0.9	1.1	V
Hall sensor input sensitivity	VHN	Zero peak value (including offset and hysteresis)		10	20	mV
RD/FG output pin low-level voltage	VRDL/FGL	IRD/FG = 5mA		0.2	0.3	V
RD/FG output pin leakage current	IRDL/FGL	VRD/FG = 7V			30	$\mu\text{A}$

# LB11961

## Package Dimensions

unit : mm (typ)

3313



## Truth Table

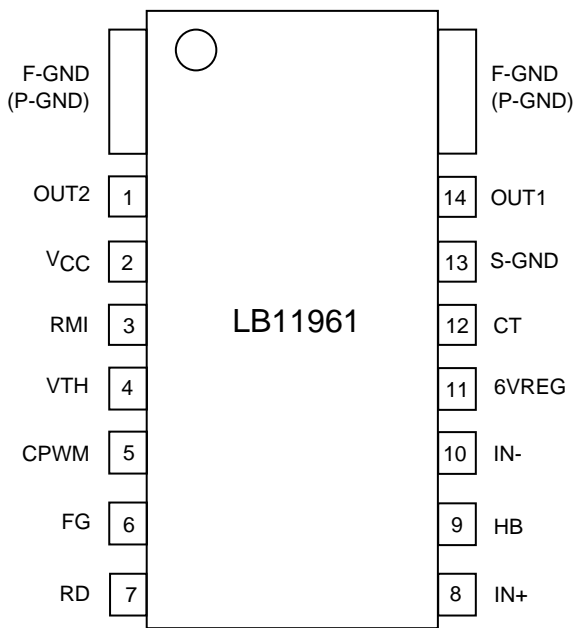
VTH	IN-	IN+	CPWM	CT	OUT1	OUT2	FG	RD	Mode
Low (open)	High	Low	High	Low	High	Low	Low	On	During rotation - drive (PWM off)
	Low	High			Low	High	Off		
High	High	Low	Low		Off	Low	Low		During rotation - regeneration (PWM on)
	Low	High			Low	Off	Off		
-	High	Low	-	High	High	Off	Low	Off	Lock protection
-	Low	High			Off	High	Off		

CPWM - High is the state where  $CPWM > VTH$ , and CPWM - Low is the state where  $CPWM < VTH$ .

Open : The LB11961 operates in full-speed mode when the thermistor is removed.

# LB11961

## Pin Assignment

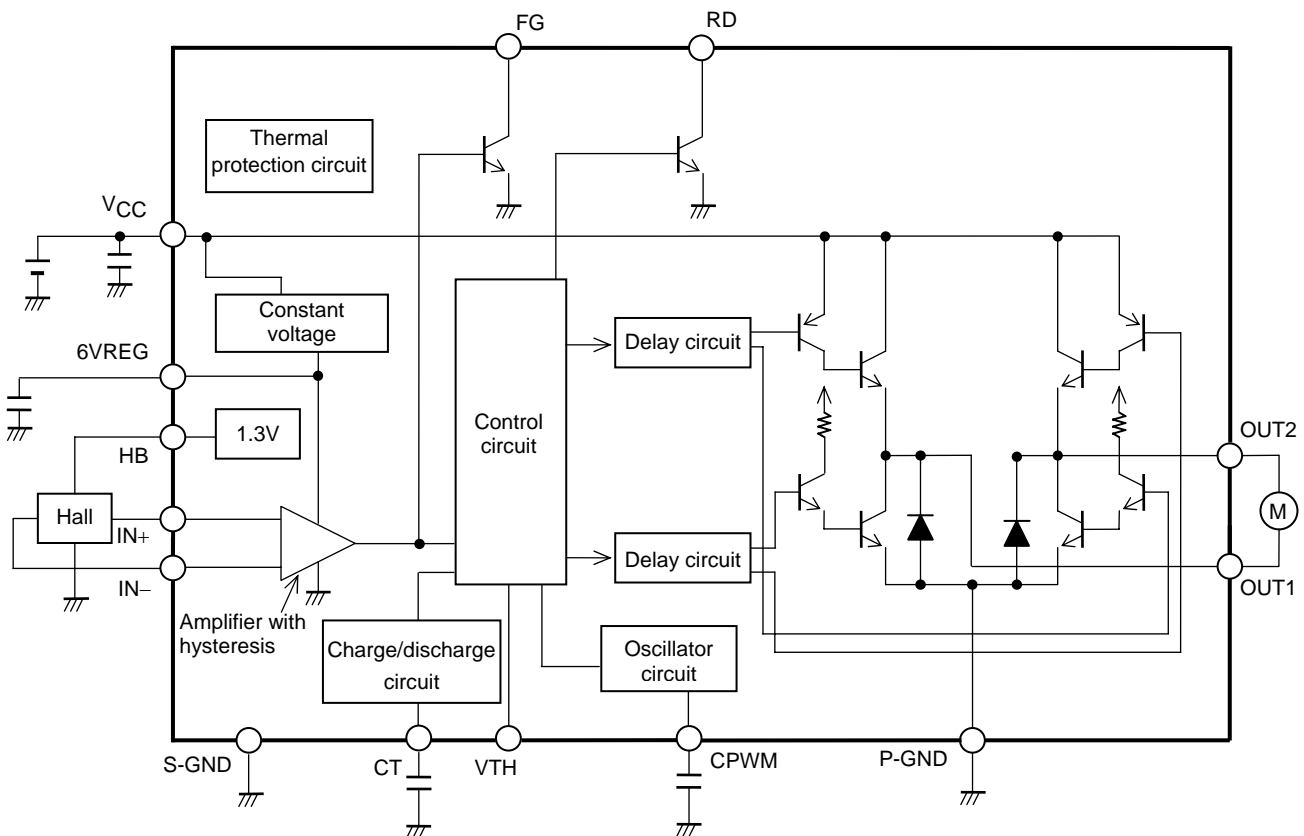


Top view

F-GND (P-GND) : The motor system ground and the heat sink. Since the heat generated by the chip is dissipated through F-GND, the thermal resistance is lowered by increasing the area of the copper foil and solder surface in the printed circuit pattern.

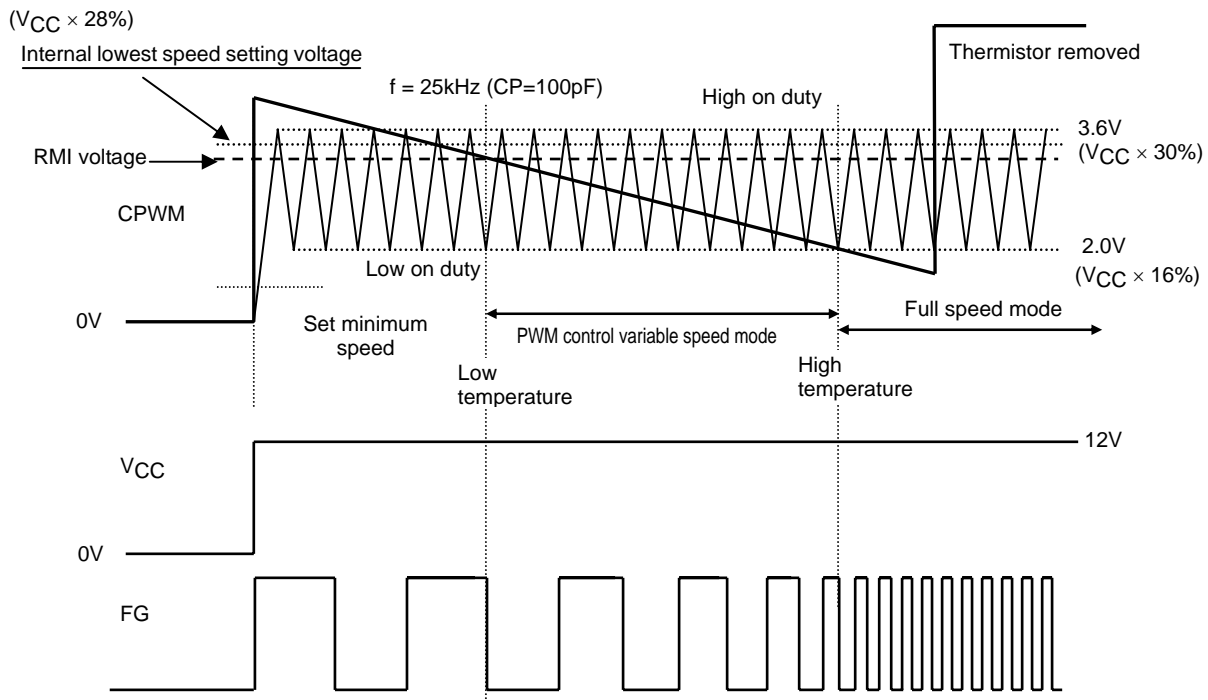
S-GND : Control system ground

## Block Diagram





Control Timing Chart



1. Set minimum speed mode

A VTH voltage level is generated when the thermistor detects the set temperature. At low temperatures, the fan motor turns at the lowest speed, which is set with the RMI pin. The LB11961 compares the CPWM oscillator voltage with the RMI pin voltage and sets the duty for the lowest drive state.

2. High speed ↔ low speed mode

The PWM signal is controlled by comparing the CPWM oscillation voltage that cycles between 1.2V and 3.8V and the VTH voltage.

When the VTH voltage is lower, the high and low side transistors are turned on, and when the VTH voltage is higher, the high side transistor is turned off and the coil current is regenerated through the low side transistor. Thus the output on duty increases as the VTH voltage becomes lower, the coil current increases, and the motor speed increases.

Rotation speed feedback is provided by the FG output.

3. Full-speed mode

The LB11961 switches to full-speed mode above a certain temperature.

4. Thermistor removed mode

If the thermistor is removed, the VTH input voltage will rise. However, the output will go to full drive at 100% and the motor will run at full speed.

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