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LB11970FV

Monolithic Digital IC
For Fan Motor

Single-phase Full-wave Driver

Overview

The LB11970FV is a single-phase full-wave driver for fan motor.

Functions

- Single-phase full-wave drive (16V to 1.2A output transistor incorporated)
- Variable speed function using thermistor input and external signal incorporated
→ Enables silent and low-vibration variable speed control through direct PWM control with separately-excited upper Tr
- Current limiter circuit (limit at $I_O=480\text{mA}$ with $R_L=1\Omega$ connection, the limiter value determined with Rf)
- Kick-back absorption circuit incorporated
- Low-consumption, low-loss, and low-noise drive enabled by the soft switching circuit during phase shift
- Regeneration Di incorporated with less external parts
- HB incorporated
- Lock protection and automatic reset functions incorporated
- FG (rotation detection) output
- Thermal shutdown circuit incorporated

Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
V_{CC} maximum supply voltage	$V_{CC\text{ max}}$		17	V
VM maximum supply voltage	$V_M\text{ max}$		17	V
OUT pin maximum output current	$I_{OUT\text{ max}}$		1.2	A
OUT pin output withstand voltage	$V_{OUT\text{ max}}$		18	V
HB maximum output current	HB		10	mA
VTH, RMI input pin withstand voltage	$V_{TH\text{ RMI max}}$		7	V
P-IN input pin withstand voltage	$V_{P-IN\text{ max}}$		V_{CC}	V
FG output pin output withstand voltage	$V_{FG\text{ max}}$		18	V
FG output current	$I_{FG\text{ max}}$		10	mA
Allowable power dissipation	$P_d\text{ max}$	Specified substrate *	0.8	W
Operating temperature range	T_{opr}		-30 to 90	$^\circ\text{C}$
Storage temperature range	T_{stg}		-55 to 150	$^\circ\text{C}$

* Specified substrate: 30mm×30mm×0.8mm, paper phenol.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

LB11970FV

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

Parameter	Symbol	Conditions	Ratings	Unit
V_{CC} supply voltage	V_{CC}		4.5 to 16	V
V_M supply voltage	V_M		3.5 to 16	V
V_{TH} , RMI input level voltage range	V_{TH} , RMI		0 to 6	V
P-IN input level voltage range	V_{P-IN}		0 to V_{CC}	V
Triangular wave input range	V_{RM}		0.5 to 4	V
Hall input common phase input voltage range	V_{ICM}		0.2 to 3	V

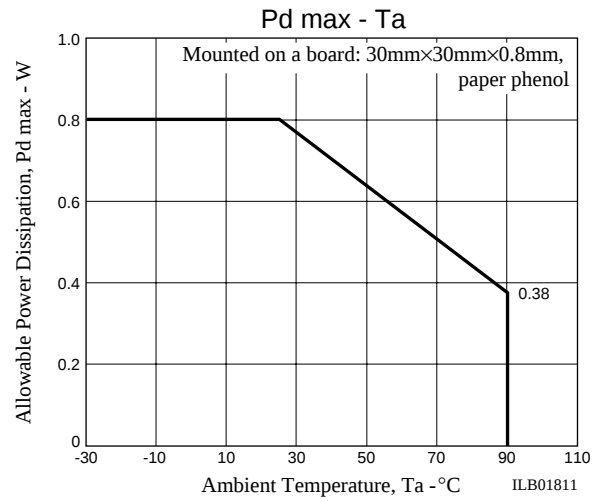
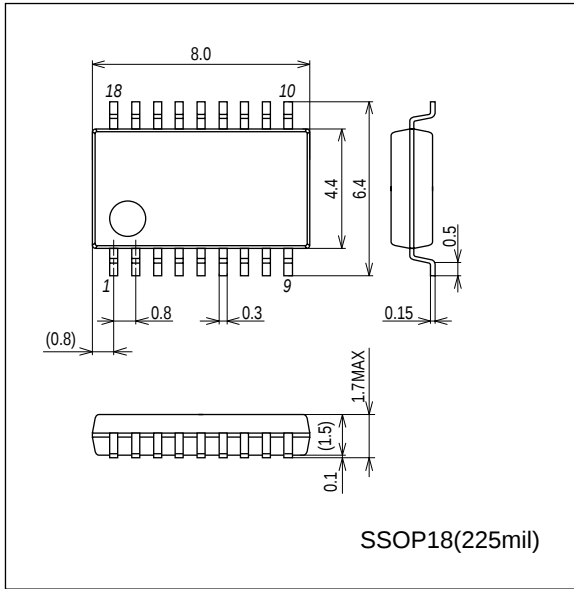
Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC} = 12\text{V}$, $R_f = 0\Omega$, unless otherwise specified.

Parameter	Symbol	Conditions	Ratings			unit
			min	typ	max	
Circuit current	I_{CC1}	During drive	12	15	18	mA
	I_{CC2}	During lock protection	11	14	17	mA
HB voltage	V_{HB}	$I_{HB}=5\text{mA}$	1.12	1.22	1.32	V
6VREG voltage	V_{6VREG}	$I_{6VREG}=5\text{mA}$	5.85	5.95	6.10	V
CT pin H level voltage	V_{CTH}		3.4	3.6	3.8	V
CT pin L level voltage	V_{CTL}		1.4	1.6	1.8	V
CT pin charge current	I_{CT1}		1.8	2.2	2.6	μA
CT pin discharge current	I_{CT2}		0.18	0.22	0.26	μA
CT charge/discharge current ratio	R_{CT}		8	10	12	
OUT output L saturation voltage	V_{OL}	$I_O=200\text{mA}$		0.1	0.2	V
OUT output H saturation voltage	V_{OH}	$I_O=200\text{mA}$, $R_f=1\Omega$		0.6	0.8	V
Current limiter	V_{RF}			480		mV
Hall input sensitivity	V_{HN}	Zero peak value (including offset and hysteresis)		10	20	mV
FG output pin L voltage	V_{FG}	$I_{FG}=5\text{mA}$		0.2	0.3	V
FG output pin leak current	I_{FGL}	$V_{FG}=7\text{V}$			30	μA
Overheat protection circuit	THD	* Design guarantee value		180		$^\circ\text{C}$

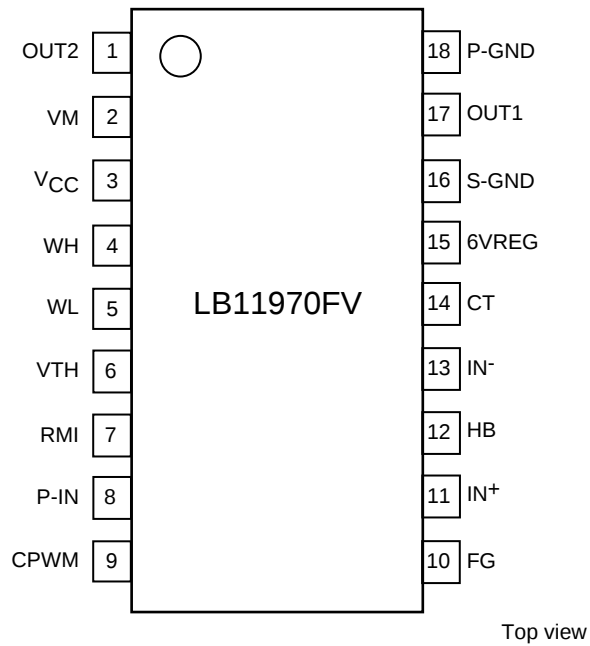
*: Design target value and no measurement was made.

Package Dimensions

unit : mm (typ)
3338

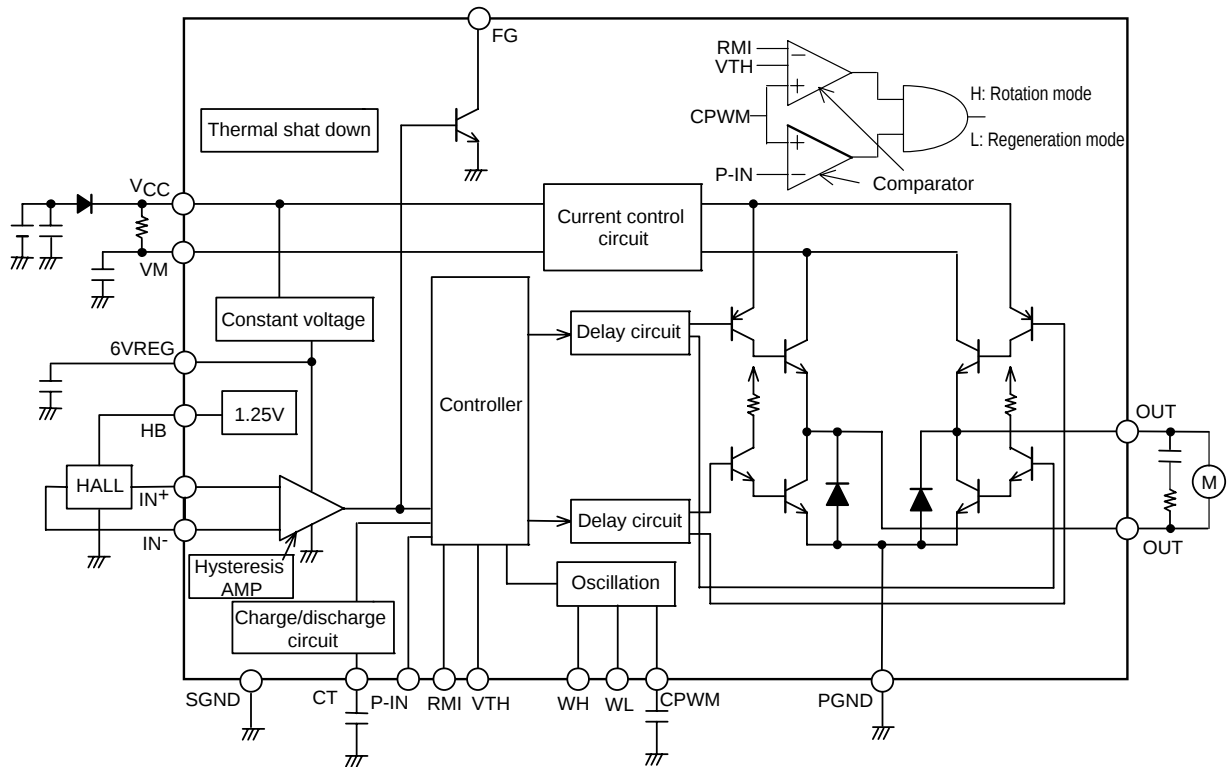


Pin Assignment



PGND: Motor system GND
SGND: Control system GND

Equivalent Circuit Diagram

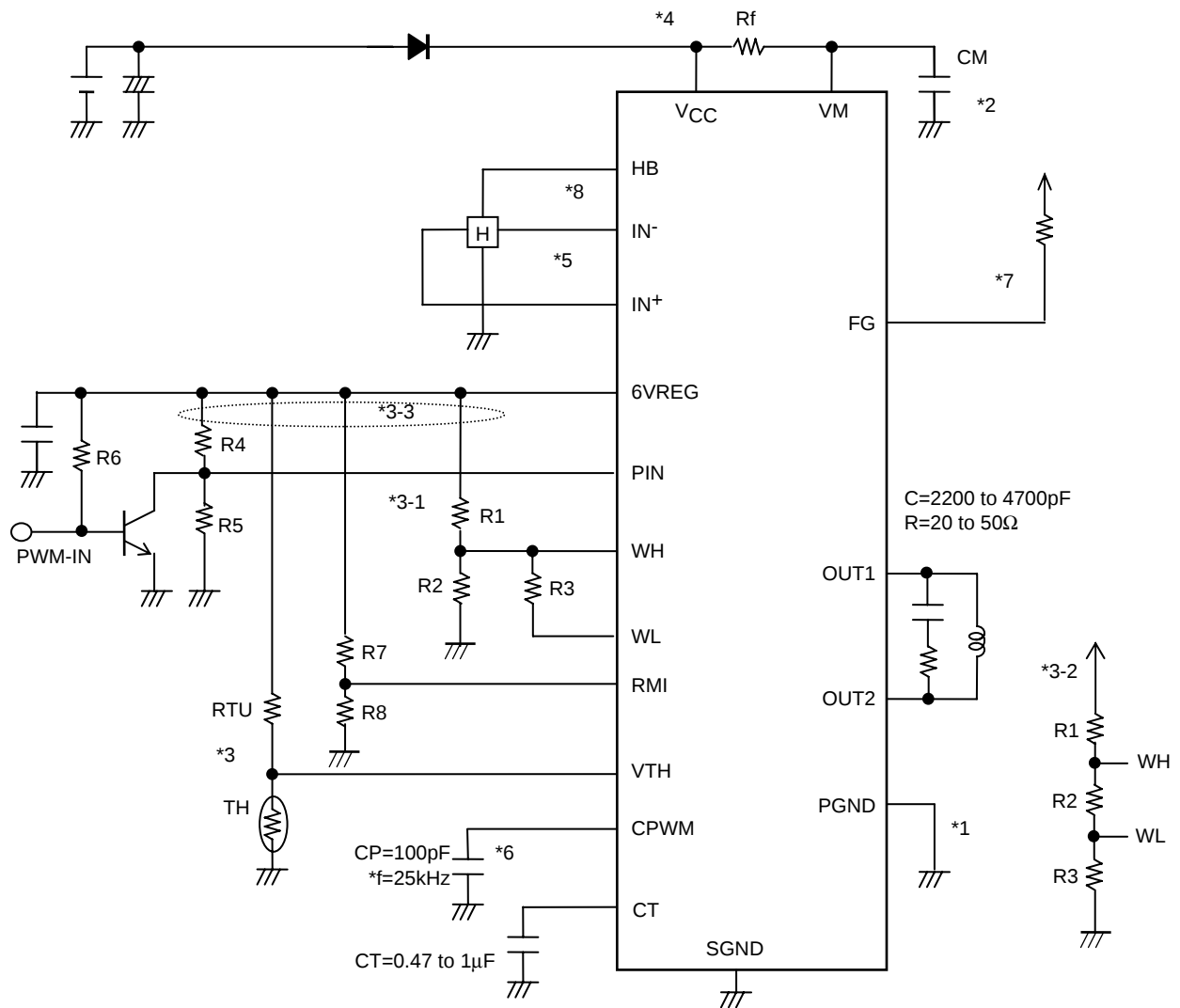


Truth Table

VTH	PIN	IN-	IN+	CT	OUT1	OUT2	FG	Mode
L (OPEN)	L	H	L	L	H	L	L	Running - drive
	L	L	H		L	H	OFF	
H	L	H	L		OFF	L	L	Running - regeneration
	L	L	H		L	OFF	OFF	
-	H	H	L	L	OFF	L	L	Output regeneration mode with external signal
-	H	L	H		L	OFF	OFF	
-	-	H	L	H	OFF	L	L	Lock protection
-	-	L	H	H	L	OFF	OFF	

VTH, P-IN = L means VTH, P-IN < CPWM VTH, P-IN = H means VTH, P-IN > CPWM

Application Circuit Example



***1. Power supply - GND wiring**

PGND is connected to the motor power system while SGND is connected to the control circuit power system.

Wiring is made separately for PGND and SGND, and external parts of each control system are connected to SGND.

***2. Power stabilization capacitor for regeneration**

CM capacitor is a power stabilizing capacitor for PWM drive and kick-back absorption and has the capacitance of 4.7μF or more. Since this IC performs current regeneration with the lower Tr through switching of the upper Tr, connect CM with the thick and shortest possible pattern between VM and PGND.

***3. Setting of the temperature detection variable speed**

Setting of the triangular wave oscillation voltage

The rotation speed variable range for the temperature is set with the triangular wave oscillation voltage.

There are two setting methods as follows:

3-1 The upper voltage (VCPH) of triangular wave is determined by $V[\text{voltage of the R1 connection counterpart}] \times (R2/(R1+R2))$ and the lower voltage (VCPL) of triangular wave is determined by $V \times ((R2//R3) / (R1+R2//R3))$.

3-2 The upper voltage (VCPH) of triangular wave is determined by $V \times ((R2+R3) / (R1+R2+R3))$ and the lower voltage (VCPL) of triangular wave is determined by $V \times (R2/(R1+R2))$.

Setting of the thermistor

The resistance (RTU from VCC or 6VREG and the voltage generated through division of thermistor (TH) are input in the VTH pin. When the voltage at the VTH pin drops below VCPL due to temperature change, the full speed (thermistor input speed control side only) is obtained.

To set the full speed with the thermistor tripping, connect each pin of 3-3 to VCC and each input voltage is generated by divided resistance from VCC. When the thermistor trips and the VTH pin is pulled up to VCC, the full speed (thermistor input speed control side only) is obtained.

***4. Setting the current limiter**

The current limiter is activated when the voltage between current detection resistors exceeds 0.48V between VCC and VM.

The current limiter is activated at $I_O = 480\text{mA}$ when $R_L = 1\Omega$. Setting is made with the Rf resistance.

Short-circuit VCC and VM when the current limiter is not to be used.

When 12V is used, the current limiter must be applied at 1A or less if the coil resistance is 10Ω or less.

***5. Hall input**

Wiring must be as short as possible to prevent carrying of noise. The Hall input circuit is a comparator with hysteresis of 20mV. The Hall input level is recommended to be three times (60mVp-p) or more of this hysteresis.

***6. Capacitor to set the PWM oscillation frequency**

Oscillation with $f = 25\text{kHz}$ occurs at $CP = 100\text{pF}$ and PWM voltage width of 1.6V, and becomes the reference frequency of PWM.

***7. FG output**

This is the open collector output, enabling detection of the rotation speed using the FG output corresponding to the phase shift. Keep this output OPEN when not used.

***8. HB pin**

Hall element bias pin, which is a 1.22V constant-voltage output pin

***9. RMI pin**

Minimum speed setting pin for thermistor speed control, which must be pulled up with 6 VREG when not used.

By connecting the capacitor, the time to ignore thermistor input at startup can be set.

***10. PIN pin**

Direct PWM speed control pin. Pull down the P-IN input to GND when not using this pin.

The lowest output DUTY setting is made with R4 and R5. Keep R5 open for stop with DUTY at 0%.

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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: ocean@oceanchips.ru

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А