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# LB11660FV

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Monolithic Digital IC

## Single-Phase Full-Wave Fan Motor Driver

### Overview

The LB11660FV is a single-phase bipolar drive half-predriver motor driver that can easily implement a direct PWM driver motor driver circuit with excellent efficiency. The LB11660FV is particularly well suited for the miniature fans used in servers.

### Features

- Single-phase full-wave drive (15V, 1.5A transistors are built in)  
Half predriver with integrated high side transistor
- Built-in variable speed function controlled by an external input  
The LB11660FV can implement quiet, low-vibration variable speed control using externally clocked high side transistor direct PWM drive.
- Minimum speed setting pin
- Current limiter circuit (The limit value is determined by  $R_f$ ;  $I_O = 1A$  when  $R_F = 0.5\Omega$ )
- Built-in kickback absorption circuit
- Soft switching circuit makes low current consumption, low loss, and low noise drive possible at phase switching
- Built-in HB
- Built-in lock protection and automatic recovery circuits (built-in on/off ratio switching circuit controlled by the supply voltage)
- FG (speed detection) output
- Built-in thermal protection circuit (design guarantee)

# LB11660FV

## Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
$V_{CC}$ maximum supply voltage	$V_{CC}$ max		20	V
$V_M$ maximum supply voltage	$V_M$ max		20	V
OUT pin maximum output current	$I_{OUT}$ max	$R_f \geq 0.39\Omega$	1.5	A
OUT pin output voltage 1	$V_{OUT}$ max 1		20	V
OUT pin output voltage 2	$V_{OUT}$ max 2	$T \leq 0.4\mu\text{s}$	26.5	V
PRE pin maximum source current	$I_{PSO}$ max		30	mA
PRE pin maximum sink current	$I_{PSI}$ max		-7	mA
PRE pin output voltage	$V_P$ max		20	V
HB maximum output current	$I_{HB}$ max		10	mA
VTH input pin voltage	$V_{TH}$ max		7	V
FG output pin voltage	$V_{FG}$ max		18	V
FG output current	$I_{FG}$ max		10	mA
Allowable power dissipation	$P_d$ max	When mounted on a circuit board *1	0.8	W
Operating temperature	$T_{opr}$	*2	-30 to +90	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-55 to +150	$^\circ\text{C}$

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

\*2:  $T_j$  max is  $150^\circ\text{C}$ . This device must be used under conditions such that the chip temperature does not exceed  $T_j = 150^\circ\text{C}$  during operation.

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.

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

Parameter	Symbol	Conditions	Ratings	Unit
$V_{CC}$ supply voltage	$V_{CC}$		4 to 15	V
$V_M$ supply voltage	$V_M$		3 to 15	V
Current limiter operation range	$I_{LIM}$		0.6 to 1.2	V
VTH input level voltage range	$V_{TH}$		0 to 6	V
Hall sensor input common-mode input voltage range	$V_{ICM}$		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		9	12	mA
HB voltage	$V_{HB}$	$I_{HB} = 5\text{mA}$	1.05	1.25	1.40	V
6VREG voltage	$V_{6VREG}$	$6VREG = 5\text{mA}$	5.80	6	6.20	V
CT pin high-level voltage	$V_{CTH}$		3.4	3.6	3.8	V
CT pin low-level voltage	$V_{CTL}$		1.4	1.6	1.8	V
ICT pin charge current 1	$I_{CTC1}$	$V_{CC} = 12\text{V}$	1.7	2.2	2.7	$\mu\text{A}$
ICT pin charge current 2	$I_{CTC2}$	$V_{CC} = 6\text{V}$	1.3	1.8	2.3	$\mu\text{A}$
ICT pin discharge current 1	$I_{CTD1}$	$V_{CC} = 12\text{V}$	0.11	0.15	0.19	$\mu\text{A}$
ICT pin discharge current 2	$I_{CTD2}$	$V_{CC} = 6\text{V}$	0.34	0.44	0.54	$\mu\text{A}$
ICT charge/discharge current ratio 1	$R_{CT1}$	$V_{CC} = 12\text{V}$	12	15	18	Times
ICT charge/discharge current ratio 2	$R_{CT2}$	$V_{CC} = 6\text{V}$	3	4	5	Times
ICT charge/discharge ratio threshold voltage	$V_{RCT}$		6	6.6	7.3	V
VTH bias current	$I_{BVTH}$		-2	-1	0	$\mu\text{A}$
OUT output high saturation voltage	$V_{OH}$	$I_O = 200\text{mA}$ , $R_L = 1\Omega$		0.6	0.8	V

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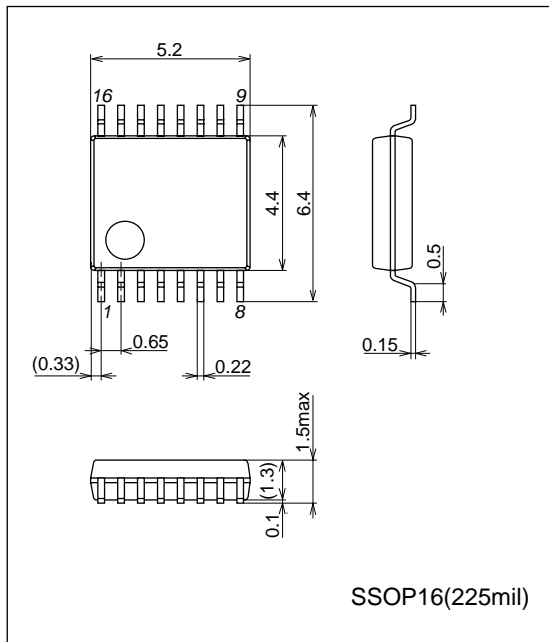
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
PRE output low saturation voltage	V <sub>PL</sub>	I <sub>O</sub> = 5mA		0.2	0.4	V
PRE output high saturation voltage	V <sub>PH</sub>	I <sub>O</sub> = -20mA		0.9	1.2	V
Current limiter	VR <sub>f</sub>	V <sub>CC</sub> - VM	450	500	550	mV
PWM output pin high-level voltage	VPWMH		2.2	2.5	2.8	V
PWM output pin low-level voltage	VPWML		0.4	0.5	0.7	V
PWM external C charge current	IPWM1		-23	-18	-14	μA
PWM external C discharge current	IPWM2		18	24	30	μA
PWM oscillator frequency	FPWM	C = 200pF	19	23	27	kHz
Hall sensor input sensitivity	VHN	Zero peak value (including offset and hysteresis)		15	25	mV
FG output pin low-level voltage	VFG/RD	IFG/RD = 5mA		0.2	0.3	V
FG output pin leakage current	IFGL/IRDL	VFG/RD = 7V			30	μA
Thermal protection circuit	THD	Design target value*3	150	180	210	°C

\*3: This is a design guarantee and is not tested in individual units. The thermal protection circuit is included to prevent any thermal damage to the IC. Since this would imply operation outside the IC's guaranteed temperature range, the application thermal design must be such that the thermal protection circuit will not operate if the fan is operating constantly.

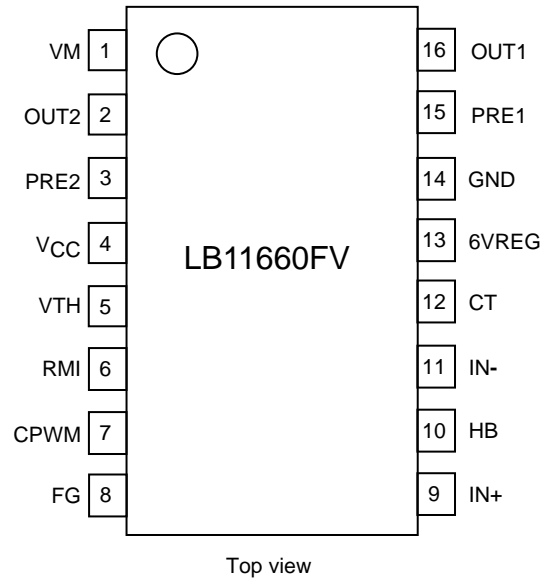
## Package Dimensions

unit : mm (typ)

3178B



## Pin Assignment

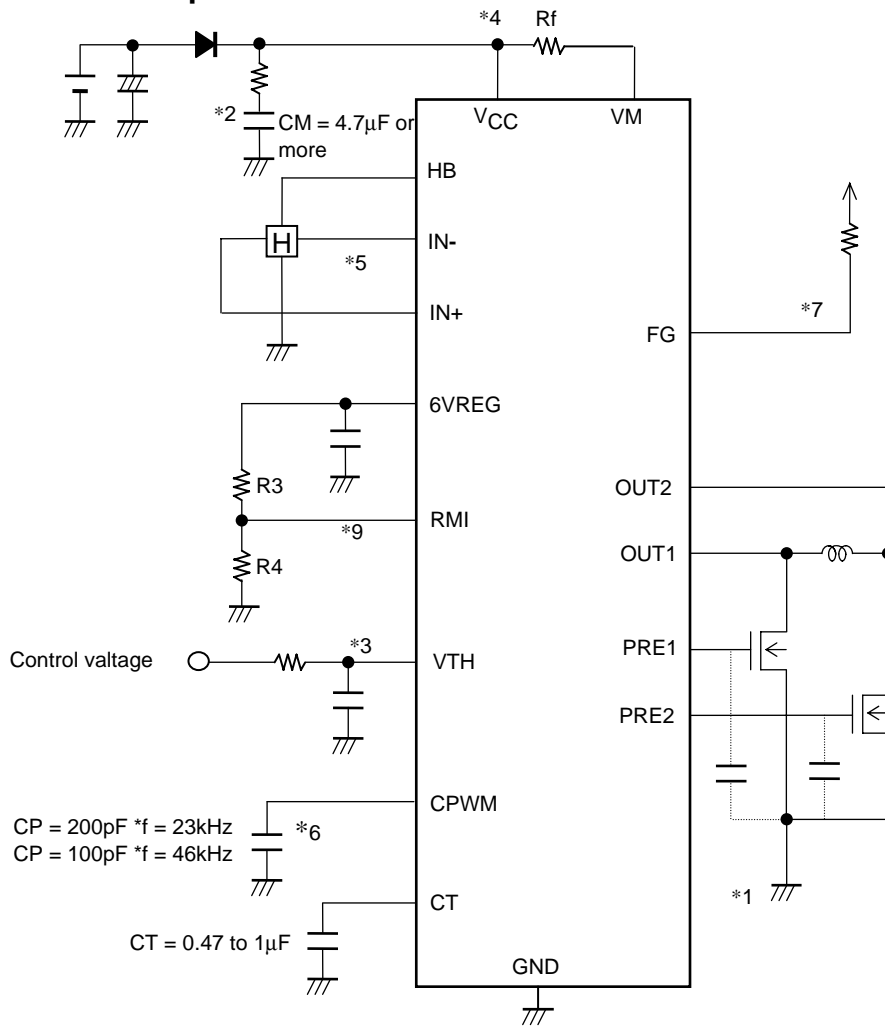


## Truth Table

IN-	IN+	VTH	CPWM	CT	OUT1	OUT2	PRE1	PRE2	FG	Mode
High	Low	Low	High	Low	High	Off	Low	High	Low	During rotation – drive
Low	High				Off	High	High	Low	Off	
High	Low	High	Low		Off	Off	Low	High	Low	During rotation – regeneration
Low	High				Off	Off	High	Low	Off	
High	Low	-	-	High	Off	Off	Low	High	Low	Lock protection
Low	High				Off	Off	High	Low	Off	

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

Application Circuit Example 1



**\*1. Power supply and ground lines**

The IC ground is the control current power supply system ground, and the external n-channel transistor ground is the motor power supply system ground.

These two systems should be formed from separate lines and the control system external components should be connected to the IC ground.

**\*2. Regeneration power supply stabilization capacitor**

Use a 4.7µF/25V capacitor at least for CM, which is the power supply stabilization capacitor for both PWM drive and kickback absorption.

The capacitor CM must be connected to prevent destruction of the IC when power is applied or removed.

**\*3. Speed Control**

(1) Control voltage

The PWM duty is determined by comparing the VTH pin voltage with the PWM oscillator waveform.

When the VTH voltage falls, the on duty increases and when the VTH voltage falls below the PWM output low level, the duty will go to 100%.

(2) Thermistor

For thermistor applications, normally the 6VREG level will be resistor divided and the divided level input to the VTH pin.

The PWM duty is changed by changes in the VTH pin voltage due to changes in temperature.

**\*4. Current limiter setting**

The current limiter circuit operates if the voltage across the resistor between VCC and the VM pin exceeds 0.5V.

Since the current limiter circuit applies limitation at a current determined by  $I_O = VRf/Rf$  (where  $VRf = 0.5V$  (typical),  $Rf$ : resistance of the current detection resistor), the current limiter will operate at  $I_O = 1A$  when  $Rf = 0.5\Omega$ .

The resistor  $Rf$  must be connected in the circuit and it must have a value such that the circuit operates within the recommended current limiter operating range.

**\*5. Hall sensor input**

Lines that are as short as possible must be used to prevent noise from entering the system. The Hall sensor input circuit consists of a comparator with hysteresis (20mV). We recommend that the Hall sensor input level be at least three times this hysteresis, i.e. at least 60mVp-p.

**\*6. PWM oscillator frequency setting capacitor**

The PWM oscillator oscillates at  $f = 23\text{kHz}$  when CP is 200pF and at  $f = 46\text{kHz}$  when CP is 100pF, and this frequency becomes the PWM reference frequency.

Note that the PWM frequency is given approximately by the following equation.

$$f [\text{kHz}] \approx (4.6 \times 10^6) \div C [\text{pF}]$$

**\*7. FG output**

This is an open collector output, and a rotation count detection function can be implemented using this FG output, which corresponds to the phase switching. This pin must be left open if unused.

**\*8. HB pin**

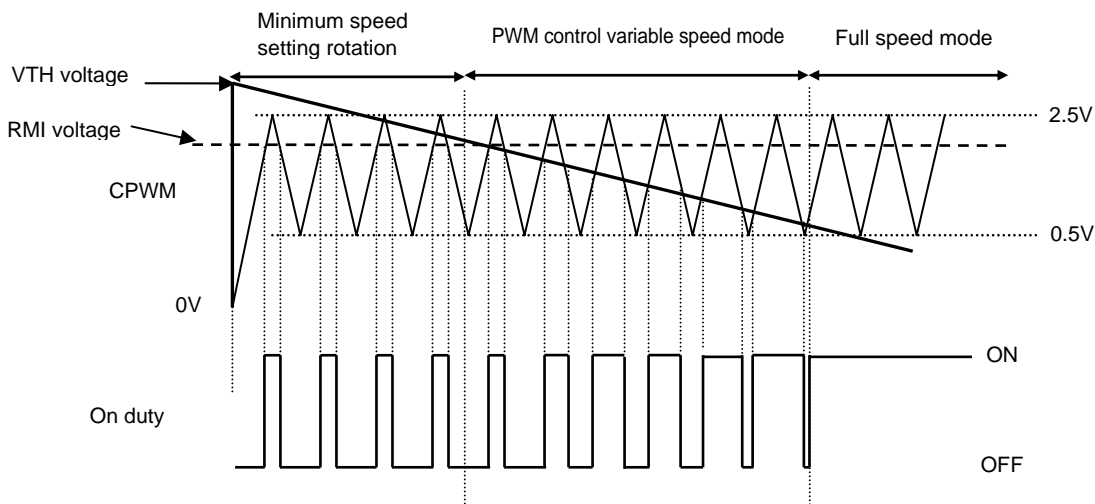
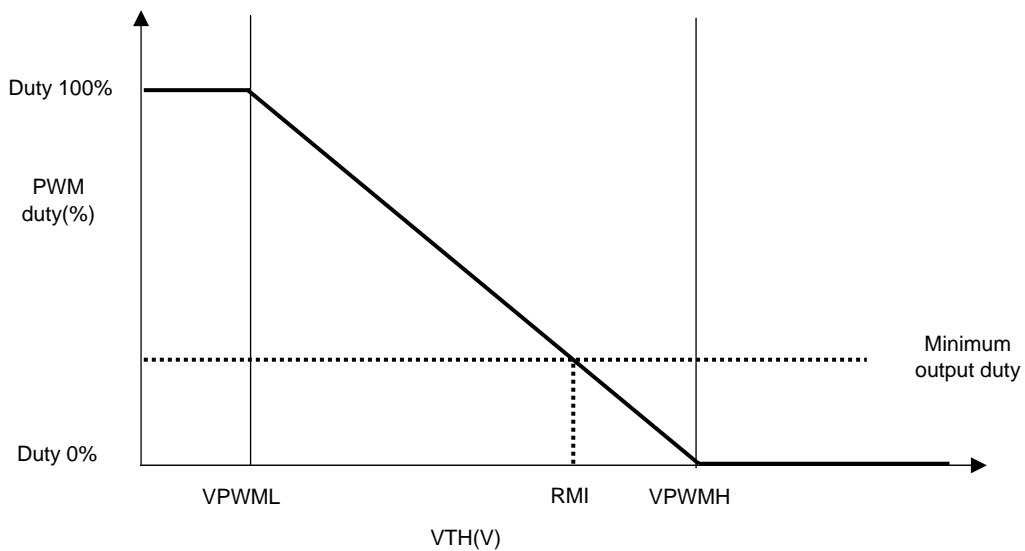
This pin provides a Hall effect sensor bias constant-voltage output of 1.25V.

**\*9. RMI pin**

This pin is the speed control minimum speed setting.

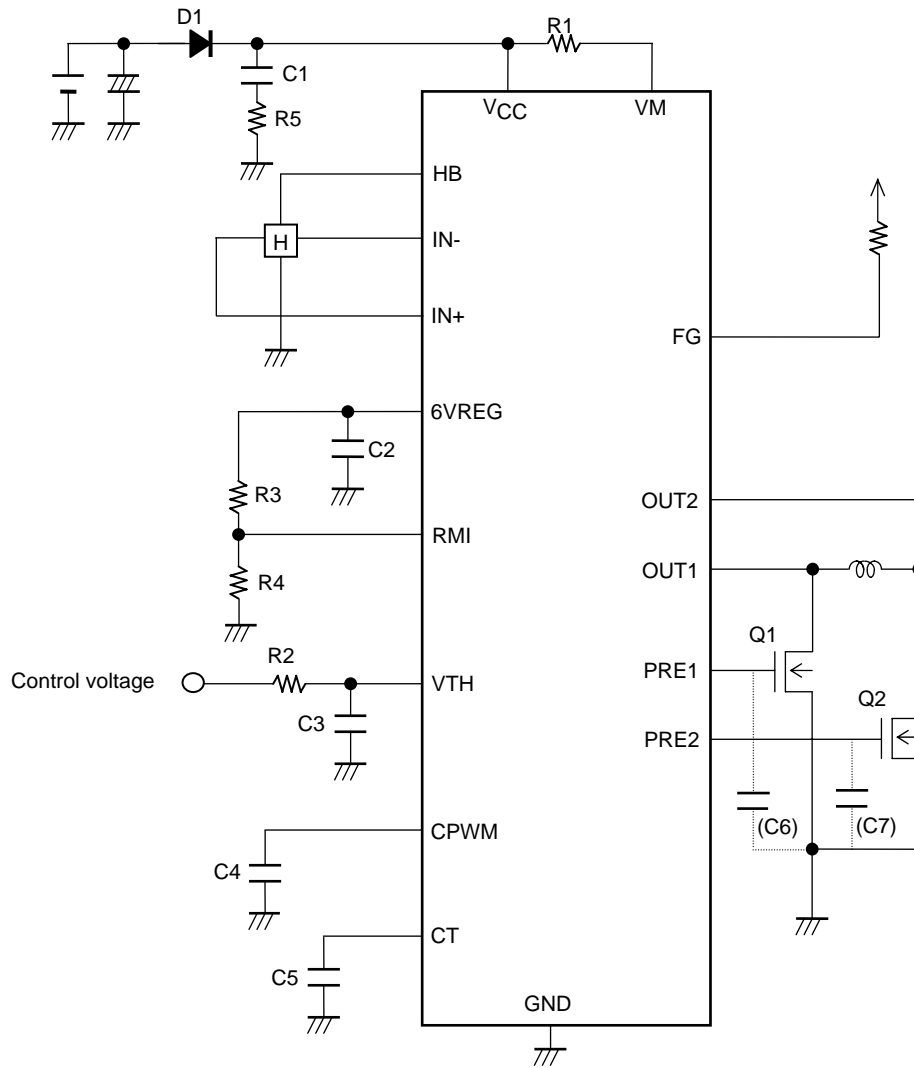
The minimum output duty is set by R3 and R4. Leave R4 open to have the motor stop when the duty is 0%.

**Rotation Control Timing Chart**



**Application Circuit Example 2**

Mounting circuit board (Component values are provided for reference purposes)

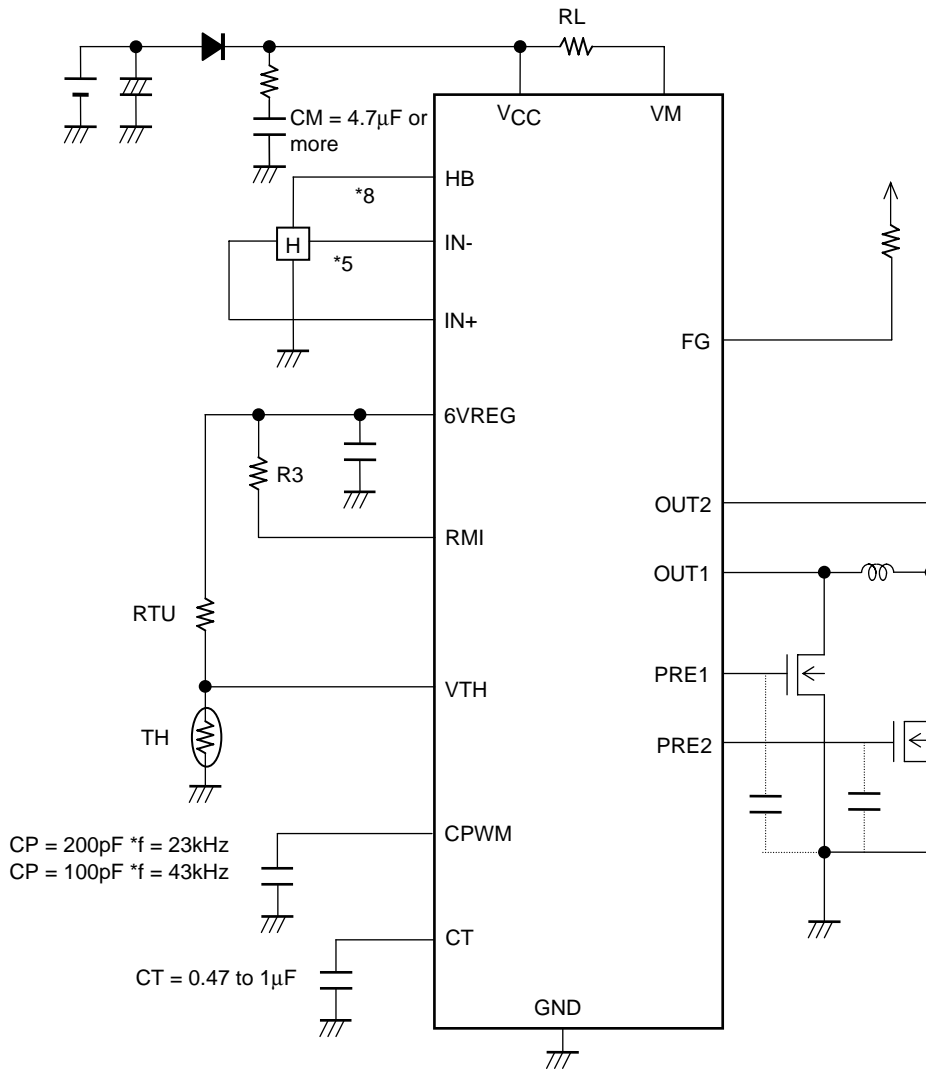


**Parts List**

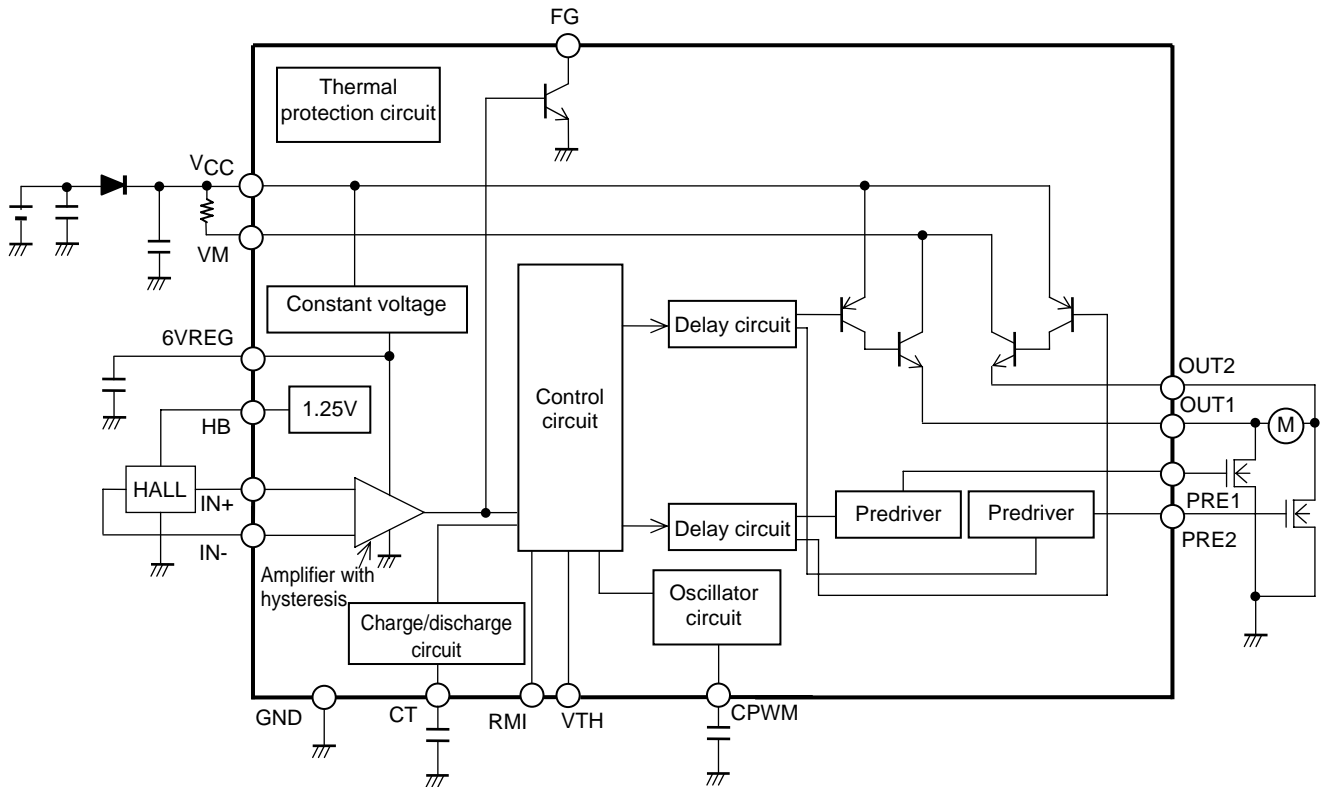
- D1 : SBM30-03-Tr (Our product)
- Q1, 2 : CPH3418 (Our product)
- R1 : 0.51Ω size 3225
- R2 : 15kΩ size 1608
- R3 : 39kΩ size 1608
- R4 : 20kΩ size 1608
- R5 : 2.2Ω size 1608
- C1 : 4.7μF/25V size 3216
- C2 : 2.2μF size 1608
- C3 : 2.2μF size 1608
- C4 : 220pF size 1005
- C5 : 0.47μF size 1608
- C6, 7 : No connection

**Application Circuit Example 3**

No minimum speed setting, thermistor input used



Internal Equivalent Circuit Diagram



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