



**SANYO Semiconductors**

# DATA SHEET

## LB11660FV — 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)

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**SANYO Semiconductor Co., Ltd.**

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# 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.

### 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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# LB11660FV

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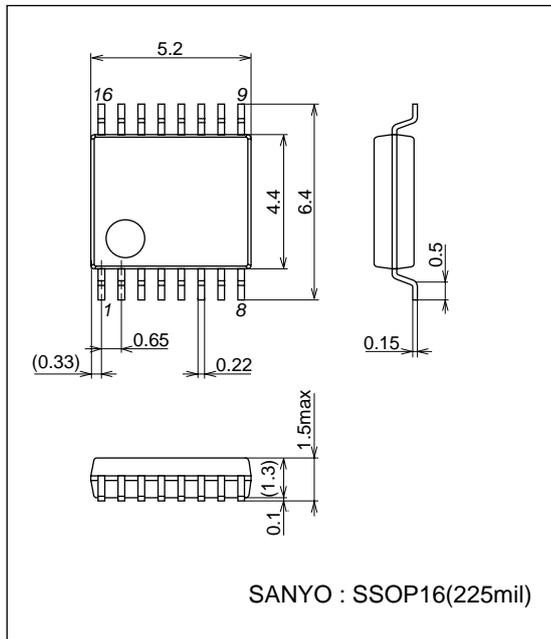
| Parameter                          | Symbol          | Conditions  | Ratings |     |     | Unit |
|------------------------------------|-----------------|---|---------|-----|-----|------|
|                                    |                 |   | min     | typ | max |      |
| PRE output low saturation 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.

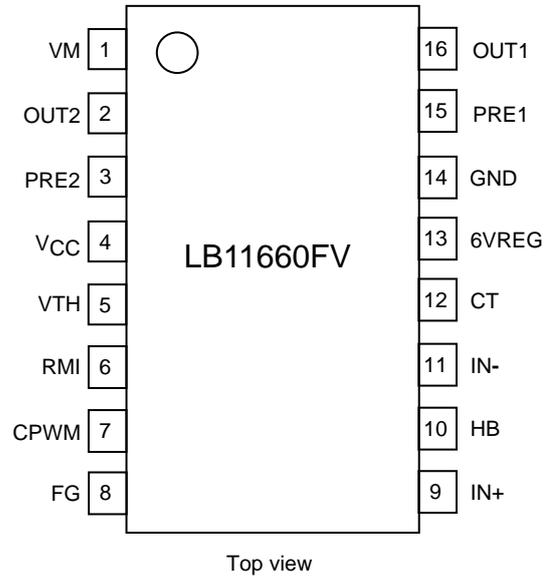
## Package Dimensions

unit : mm (typ)

3178B



## Pin Assignment

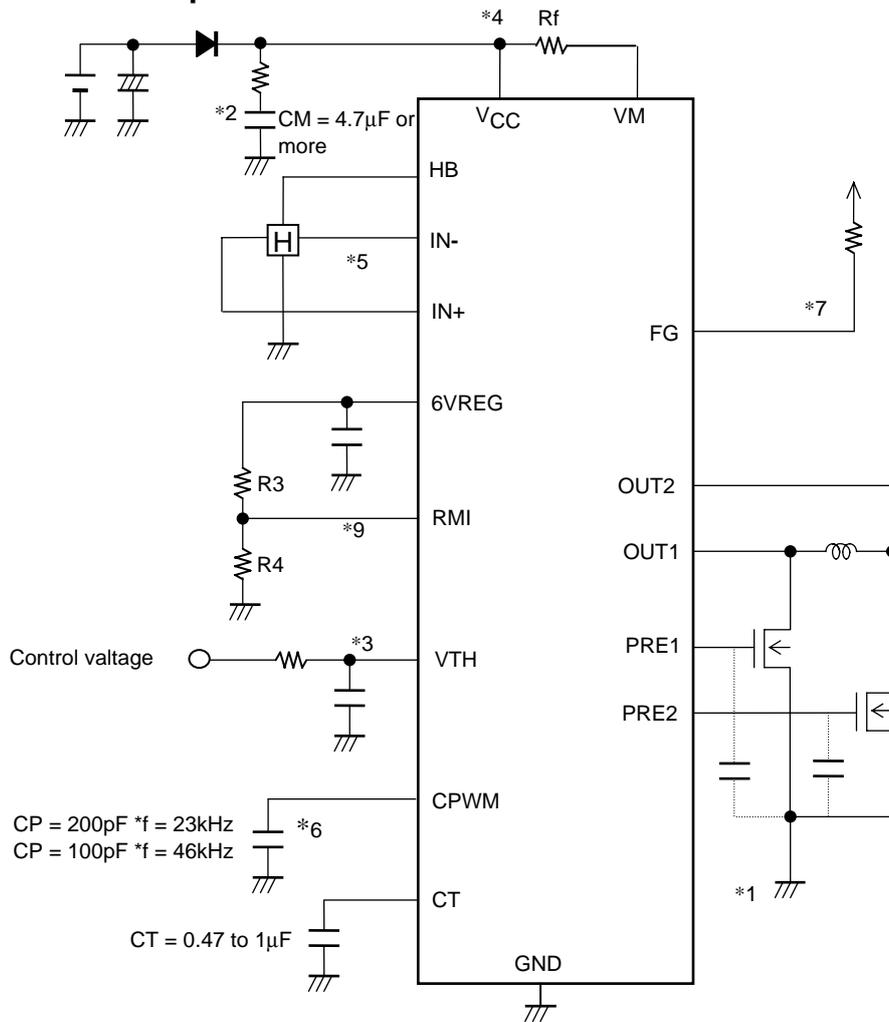


## Truth Table

| 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  $I_O = VRf/R_f$  (where  $VRf = 0.5V$  (typical),  $R_f$ : resistance of the current detection resistor), the current limiter will operate at  $I_O = 1A$  when  $R_f = 0.5\Omega$ .

The resistor  $R_f$  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**

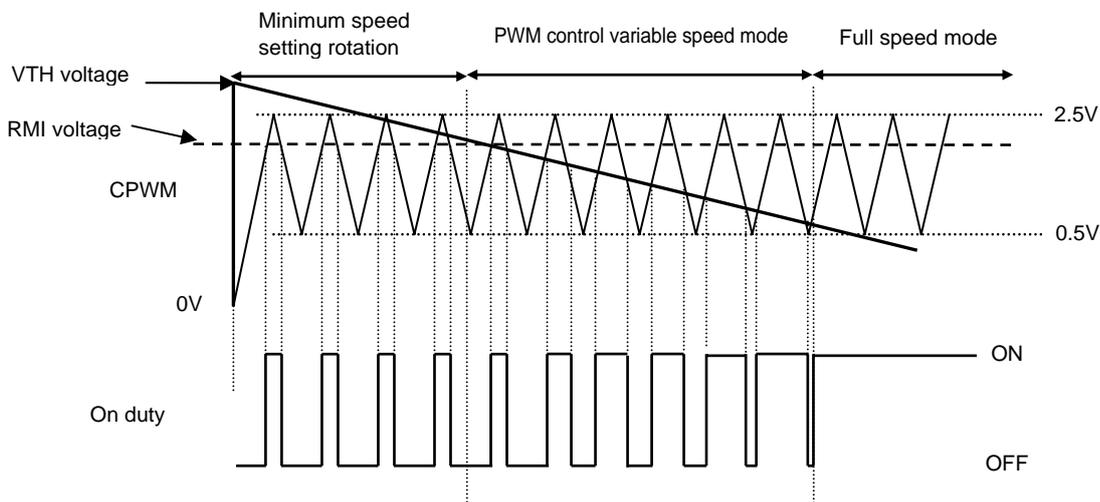
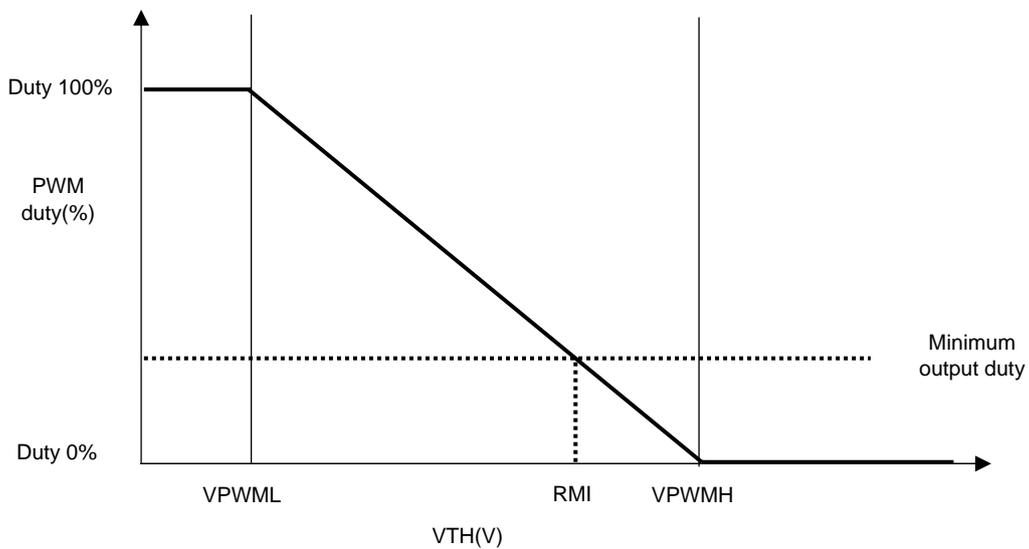
This pin provides a Hall effect sensor bias constant-voltage output of 1.25V.

**\*9. RMI pin**

This pin is the speed control minimum speed setting.

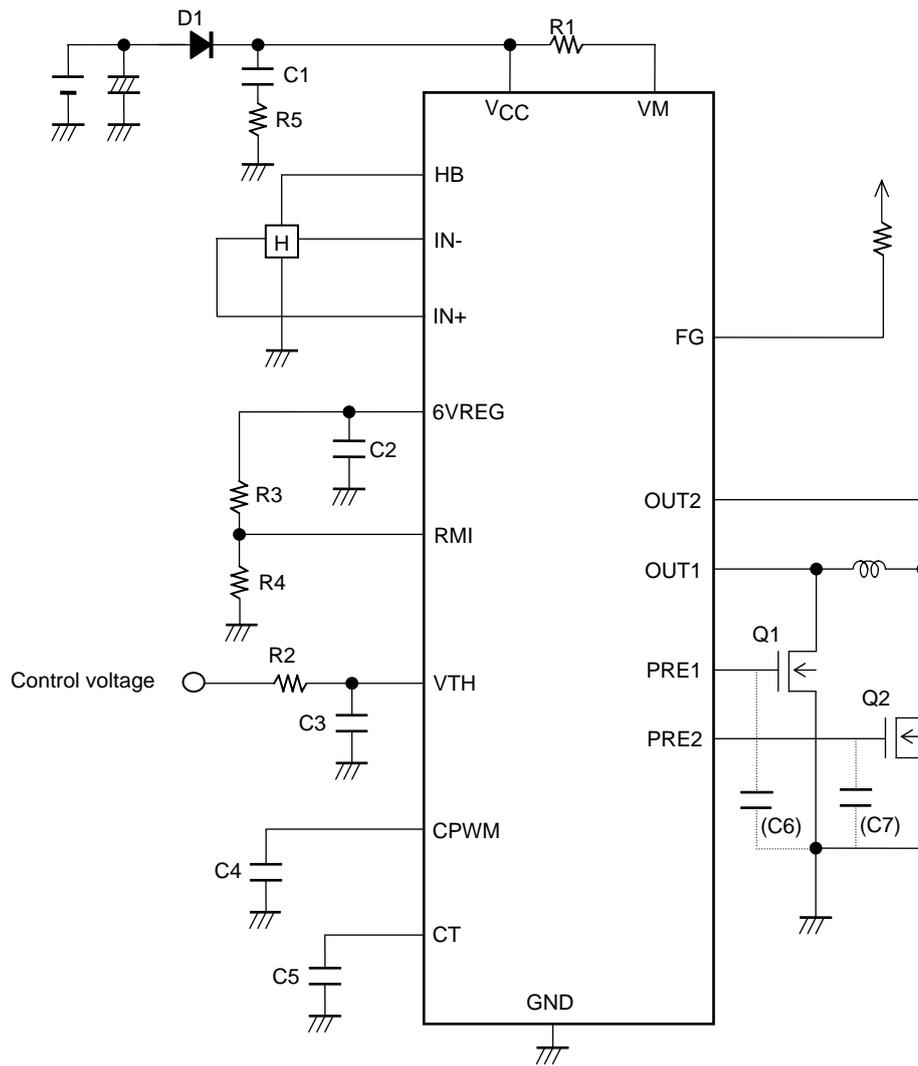
The minimum output duty is set by R3 and R4. Leave R4 open to have the motor stop when the duty is 0%.

**Rotation Control Timing Chart**



**Application Circuit Example 2**

SANYO mounting circuit board (Component values are provided for reference purposes)

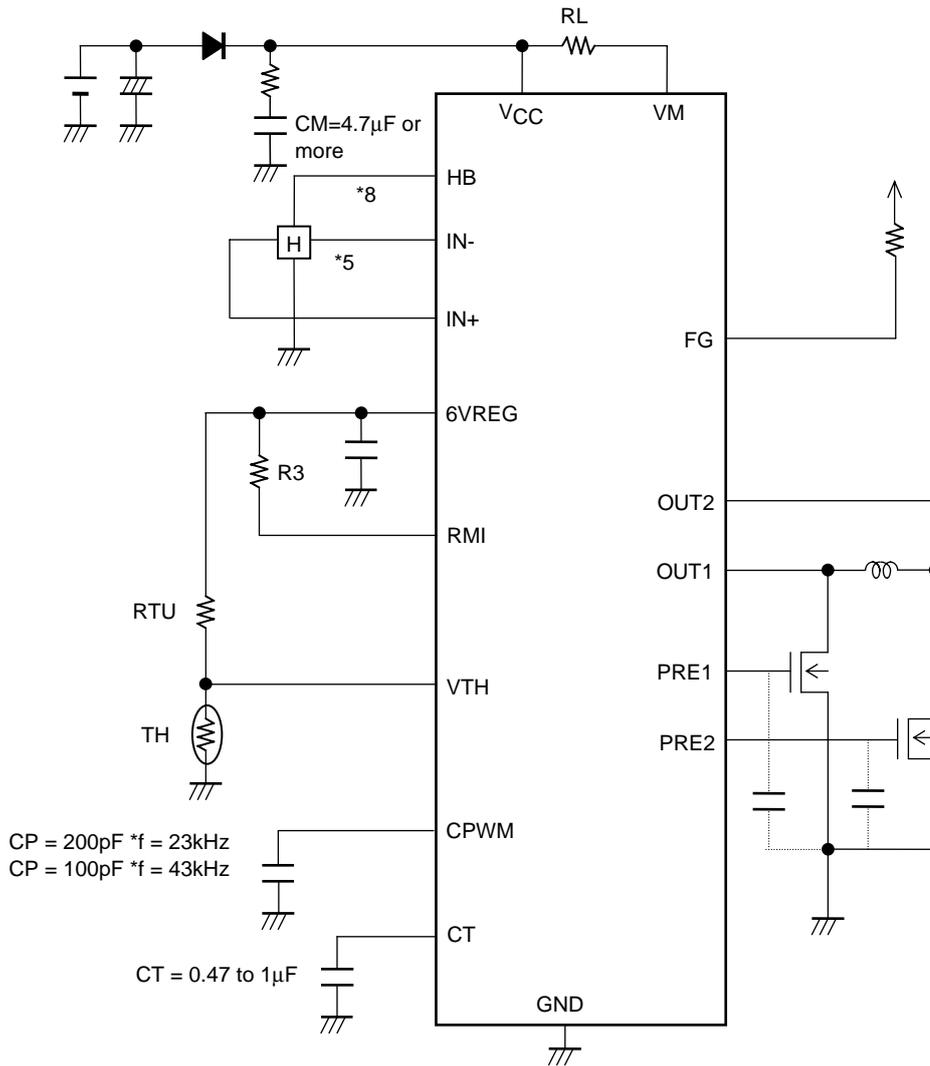


**Parts List**

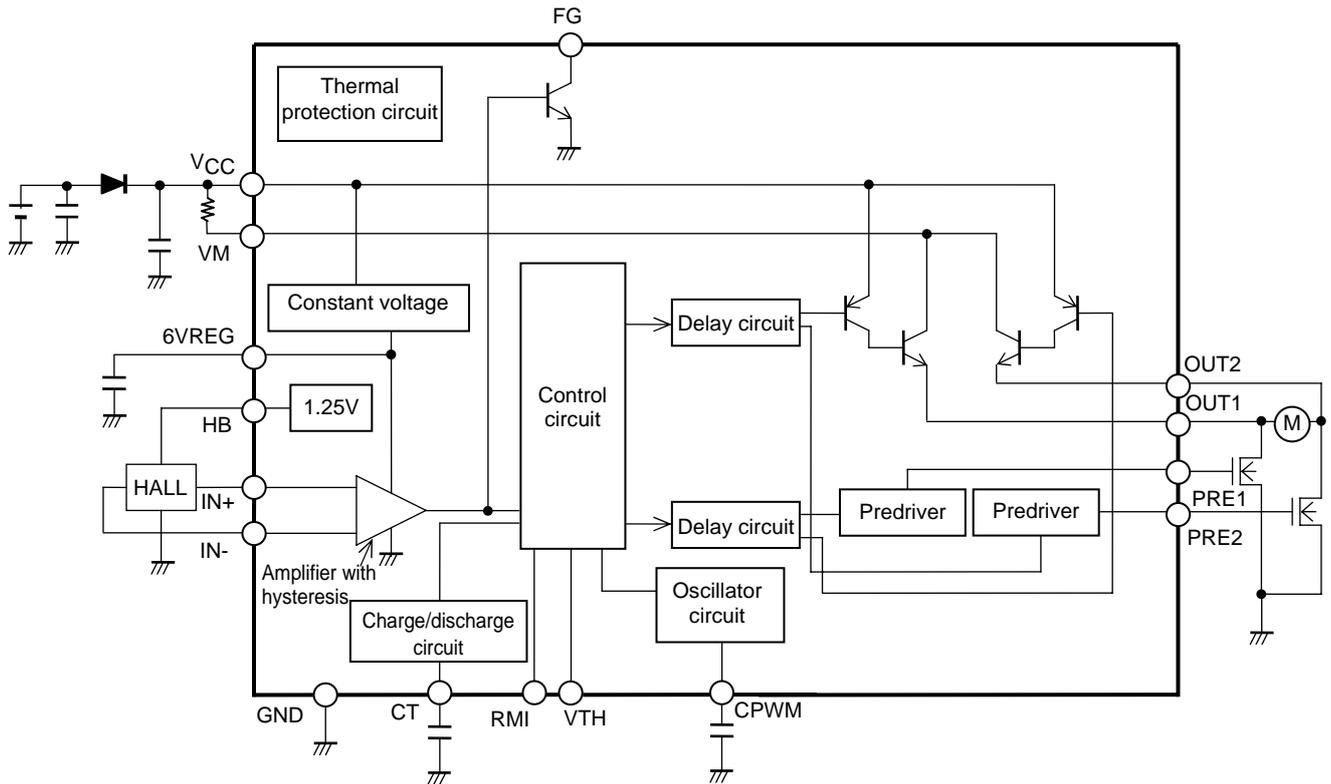
- D1 : SBM30-03-Tr (SANYO)
- Q1, 2 : CPH3418 (SANYO)
- R1 : 0.51Ω size 3225
- R2 : 15kΩ size 1608
- R3 : 39kΩ size 1608
- R4 : 20kΩ size 1608
- R5 : 2.2Ω size 1608
- C1 : 4.7μF/25V size 3216
- C2 : 2.2μF size 1608
- C3 : 2.2μF size 1608
- C4 : 220pF size 1005
- C5 : 0.47μF size 1608
- C6, 7 : No connection

**Application Circuit Example 3**

No minimum speed setting, thermistor input used



Internal Equivalent Circuit Diagram



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