Ordering number : ENA1441C

LV8804FV

Bi-CMOS LSI

PC and Server
Fan Motor Driver

ON Semiconductor®

http://onsemi.com

Overview

The LV8804FV is a motor driver for PC and server fans.

Feature

- Direct PWM 3-phase sensorless motor driver

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
V_{CC} maximum supply voltage	V_{CC} max		16	V
VG maximum supply voltage	VG max		21	V
OUT pin maximum output current	I_{OUT} max	UO, VO, and WO pins	1.2	A
SOFTST pin withstand voltage	V_{SOFTST} max		6	V
FR pin withstand voltage	V_{FR} max		6	V
CTL pin withstand voltage	V_{CTL} max		6	V
MINSP pin withstand voltage	V_{MINSP} max		6	V
FG output pin withstand voltage	V_{FG} max		16	V
FG pin maximum output current	I_{FG} max		5	mA
Allowable Power dissipation	Pd max1	Independent IC	0.3	W
	Pd max2	Mounted on specified board *	0.95	W
Operating temperature	Topr		-30 to +95	°C
Storage temperature	Tstg		-55 to +150	°C

* Specified board: 76.1mm × 114.3mm × 1.6mm, glass epoxy board (single-layer)

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.

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.

Allowable Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
V_{CC} supply voltage	V_{CC}		6 to 15	V
SOFTST input voltage range	V_{SOFTST}		0 to VREG	V
FR input voltage range	V_{FR}		0 to VREG	V
CTL input voltage range	V_{CTL}		0 to VREG	V
MINSP input voltage range	V_{MINSP}		0 to VREG	V

Electrical Characteristics at Ta = 25°C, V_{CC} = 12V, unless otherwise specified

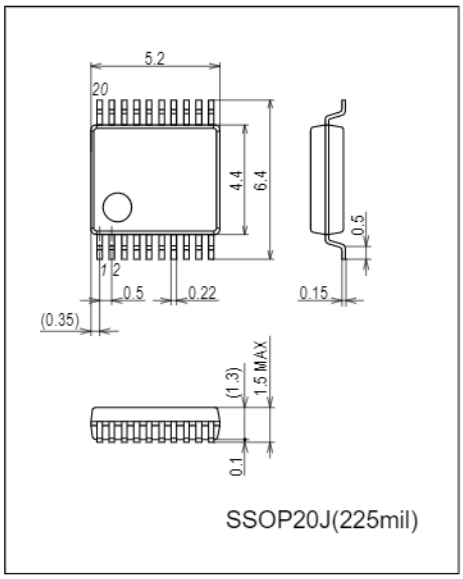
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Circuit current 1	$I_{CC}1$			3	4	mA
Charge pump block						
Charge pump output voltage	V_{VG}			17		V
Regulator block						
5V regulator voltage	V_{VREG}		4.75	5	5.25	V
Output on resistance						
High-side output transistor on resistance	Ron (H)	I_O = 0.7A, VG = 17V		0.6	1.0	Ω
Low-side output transistor on resistance	Ron (L)	I_O = 0.7A, V_{CC} = 12V		0.6	1.0	Ω
Sum of high-/low-side output transistor on resistance	Ron (H+L)	I_O = 0.7A, V_{CC} = 12V, VG = 17V		1.2	2	Ω
Startup oscillator (OSC) pin						
OSC pin charge current	$I_{OSC}C$			-2.5		µA
OSC pin discharge current	$I_{OSC}D$			2.5		µA
Control voltage input (CTL) pin						
Motor drive on voltage input range	$V_{CTL}ON$		0		3	V
Motor drive off voltage input range	$V_{CTL}OFF$		3.5		VREG	V
Minimum speed setting pin						
Minimum speed setting voltage input range	$V_{MINSP}1$		1		3	V
Minimum speed releasing voltage input range	$V_{MINSP}2$		4		VREG	V
Forward/reverse switching pin						
High-level input voltage range	$V_{FR}H$	Order of current application : UOUT→VOUT→WOUT	4		VREG	V
Low-level input voltage range	$V_{FR}L$	Order of current application : UOUT→WOUT→VOUT	0		1	V
FG output pin						
FG output pin low-level voltage	V_{FG}	When I_O is 2mA		0.25	0.35	V
Current limiter circuit						
Limiter voltage	V_{RF}	Limit current set to 1A when RF is 0.25Ω.	0.225	0.25	0.275	V
Constraint protection circuit						
CT pin high-level voltage	$V_{CT}H$		2.25	2.8	2.95	V
CT pin low-level voltage	$V_{CT}L$		0.43	0.5	0.65	V
CT pin charge current	$I_{CT}C$		-2.9	-2.5	-2.2	µA
CT pin discharge current	$I_{CT}D$		0.23	0.25	0.32	µA
ICT charge/discharge ratio	R_{CT}		7	10	13	
Soft start circuit						
Soft start releasing voltage	V_{SOFTST}			2.5		V
SOFTST pin charge current	I_{SOFTST}			0.6		µA
Thermal protection circuit						
Thermal protection circuit operating temperature	TSD	Design target *	150	180	210	°C

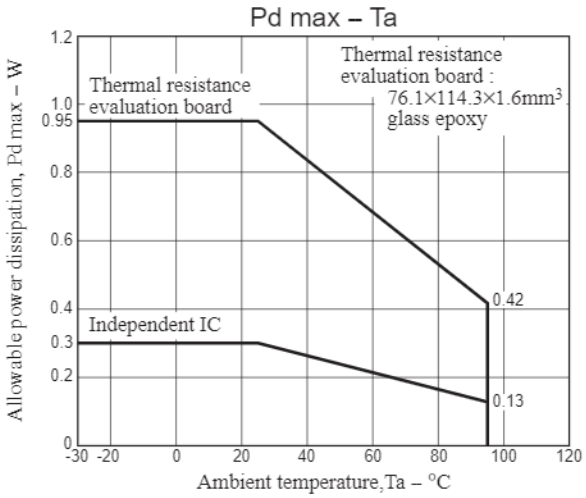
* : Design target value and no measurement is made. The thermal protection circuit is incorporated to protect the IC from burnout or thermal destruction. Since it operates outside the IC's guaranteed operating range, the customer's thermal design should be performed so that the thermal protection circuit will not be activated when the fan is running under normal operating conditions.

Package Dimensions

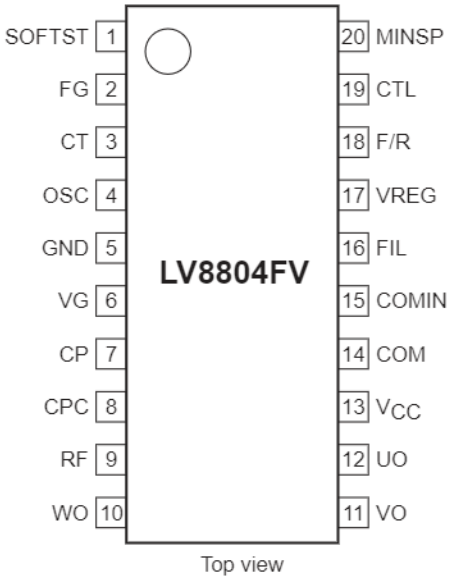
unit : mm (typ)

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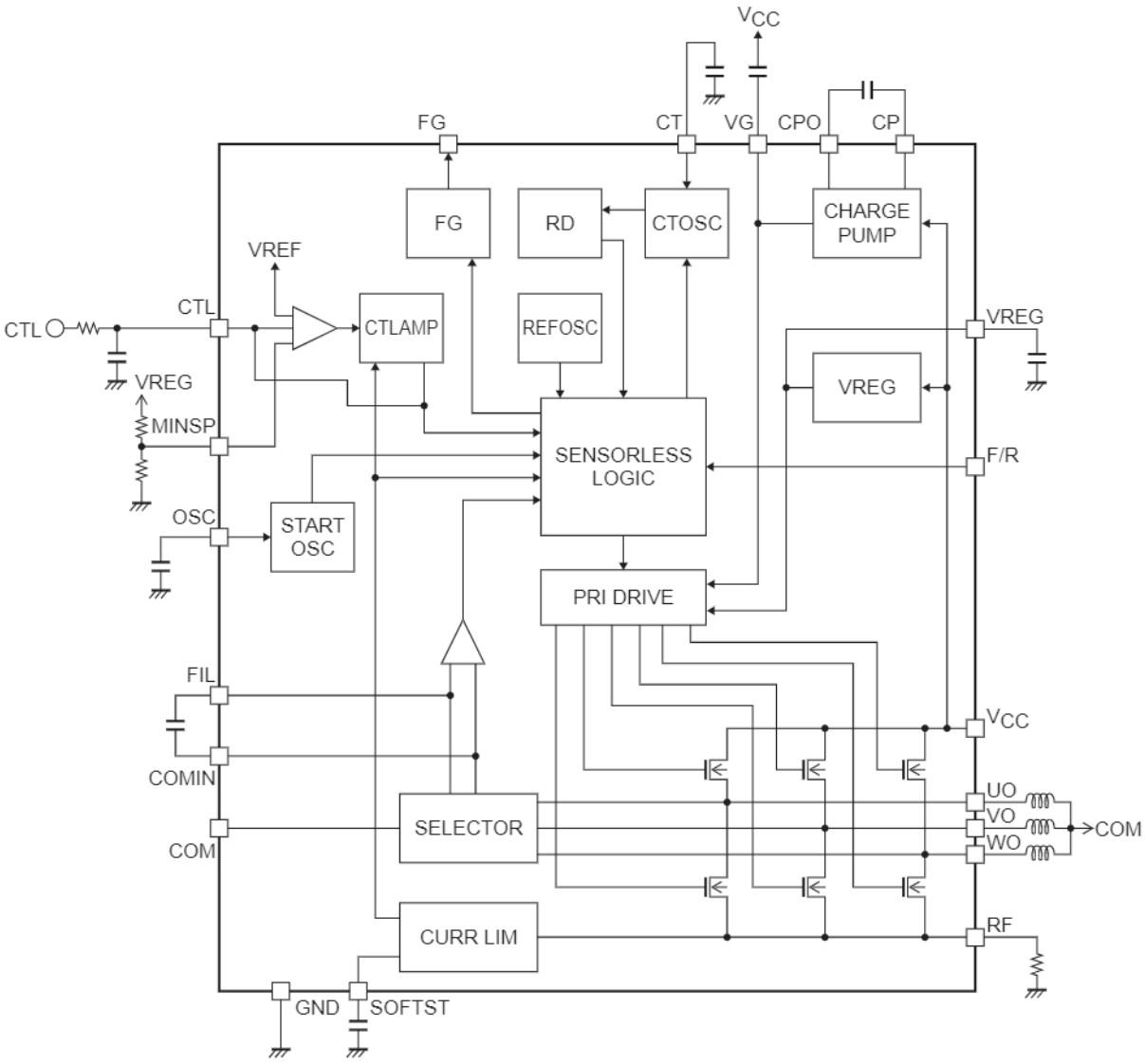




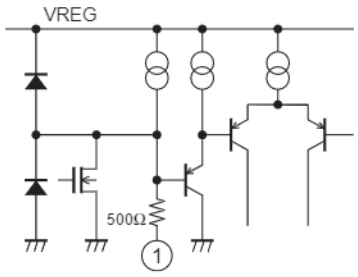
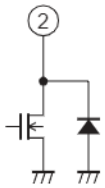
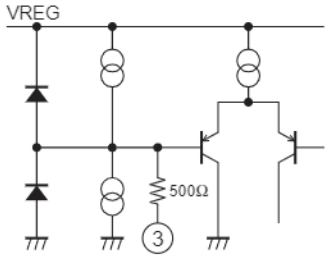
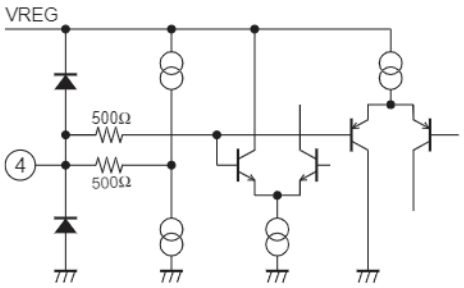
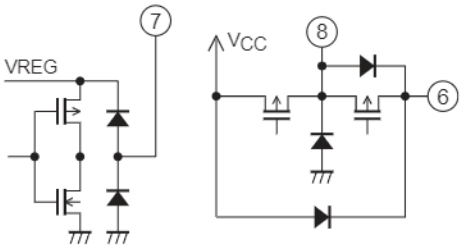
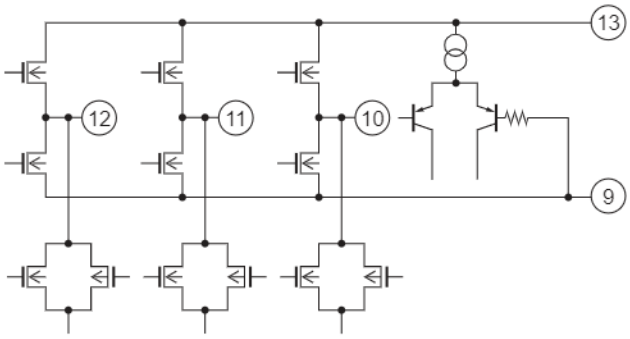
Pin Assignment



Block Diagram

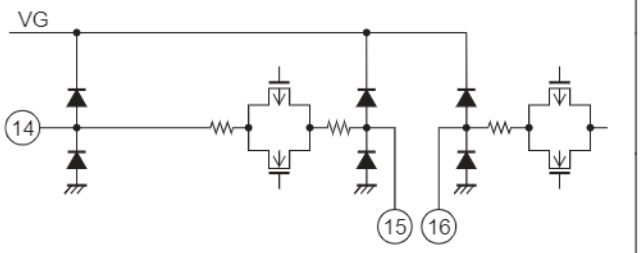
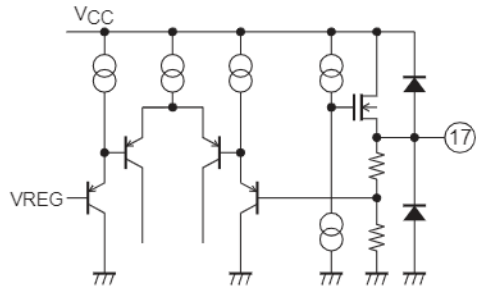
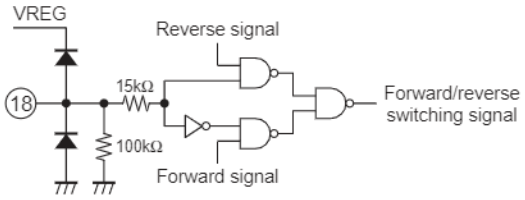
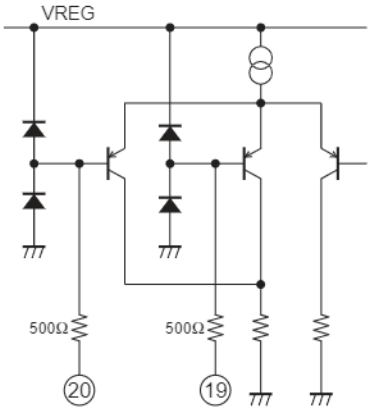


Pin Function

Pin No.	Pin name	Function	Equivalent circuit
1	SOFTST	Soft start time setting. The motor can be started smoothly by connecting a capacitor between this pin and ground.	
2	FG	FG pulse output. This pin outputs a Hall sensor system equivalent pulse signal.	
3	CT	Motor lockup detection time setting. When the motor lockup condition is detected, the protection time period before the protection circuit is activated is set by connecting a capacitor between this pin and ground.	
4	OSC	Motor startup frequency setting. A capacitor must be connected between this pin and ground. The startup frequency is adjusted by controlling the charge/discharge current and capacitance of the capacitor.	
5	GND	GND pin.	
6	VG	Charge pump step-up voltage output. A capacitor must be connected between this pin and the V_{CC} pin or ground.	
7	CP	Charge pump step-up pulse output pin. A capacitor must be connected between this pin and the CPC pin (pin 14).	
8	CPC	Charge pump step-up pin. A capacitor must be connected between this pin and the CP pin (pin 13).	
13	V_{CC}	Power supply for the IC and motor. Capacitors must be connected between these pins and ground.	
12 11 10	UO VO WO	Output pins. Connect these pins to the U, V, and W of the motor coil.	
9	RF	Output current detection pins. The drive current is detected by connecting a resistor between these pins and ground.	

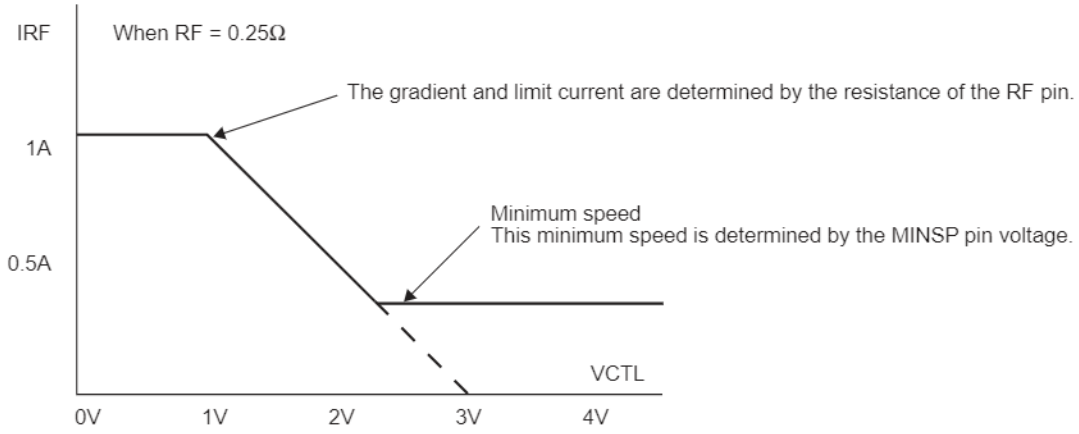
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Pin No.	Pin name	Function	Equivalent circuit
14	COM	Motor middle point connection.	
15	COMIN	Motor position detection comparator filter pin. A capacitor must be connected between this pin and the FIL pin (pin 16).	
16	FIL	Motor position detection comparator filter pin. A capacitor must be connected between this pin and the COMIN pin (pin 15).	
17	VREG	Regulator voltage (5V) output. A capacitor must be connected between these pins and ground.	
18	F/R	Motor rotation direction switching. A high-level input causes current to flow into the motor in the order of U, V, and W and a low-level input in the order of U, W, and V. Changing the order of current application turns the motor in the opposite direction.	
19	CTL	Motor control voltage input. When the control voltage is higher than 3V (3V < CTL voltage), the motor stops. The motor speed is controlled by varying the control voltage within the range of 3V to 1V (3V > CTL voltage > 1V). When the control voltage becomes lower that 1V (1V > CTL voltage), the current limit set by the RF resistor is reached.	
20	MINSP	Minimum speed setting voltage input. The minimum speed of the motor can be set by resistor-dividing the regulator voltage and feeding the resultant voltage that is within the range of 1V to 3V (1 V < MINSP < 3V).	

LV8804FV Functional Description

1. Control Characteristics

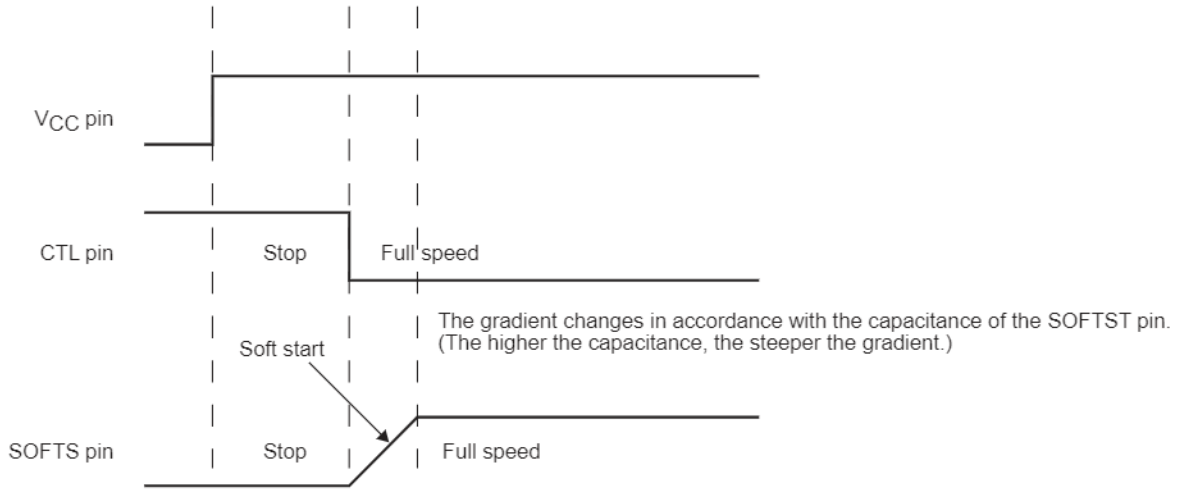


The current flowing to the motor and the control characteristics are determined by adjusting the resistance of the RF resistor.
By connecting a resistor with a resistance of 0.25Ω between the RF pin and GND, the limit current is set at a motor current of 1A, and the control characteristics shown in the diagram above are achieved.
By increasing the RF resistance, the limit current is reduced; conversely, by reducing the RF resistance, the limit current is increased.
Since I_O max. is 1.2A, the RF resistance must be set in such a way that the current flowing to the motor does not exceed this maximum value.

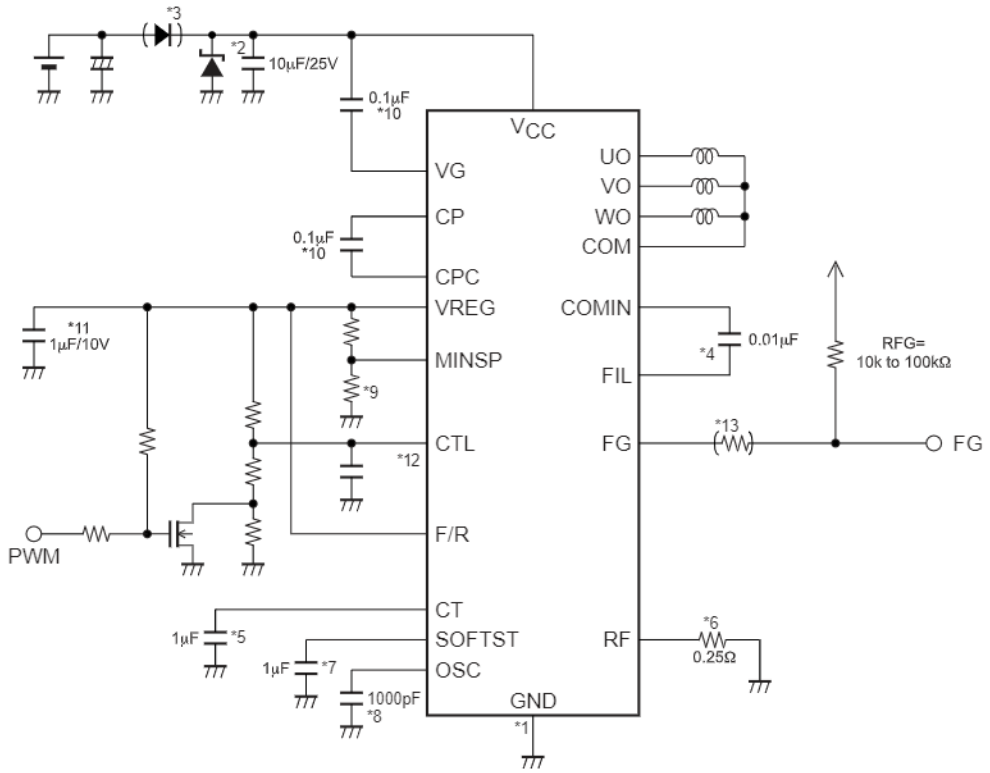
By varying the CTL voltage between 1V and 3V, the current flowing to the output is limited.
PWM control is exercised within the voltage range above (1V to 3V) to control the motor speed.
When the CTL voltage is less than 1V, the current limiter value determined by the RF resistance is reached, and the motor speed is limited.
When the CTL voltage is greater than 3V, PWM is reduced to 0%, and the motor stops. (However, the motor does not stop if the minimum speed has been set.)

The minimum speed can be set by resistor-dividing the REG voltage (5V) to create a voltage of 1V to 3V, and inputting this voltage to the MINSP pin.
If the minimum speed is not going to be set, the MINSP pin and CTL pin (pin 8) must be short-circuited.

2. Timing at Startup (soft start)



Application Circuit Example



*1. Power supply and GND wiring
The GND is connected to the control circuit power supply system.

*2. Power-side power stabilization capacitor
For the power-side power stabilization capacitor, use a capacitor of 10µF or more.
Connect the capacitor between V_{CC} and GND with a thick and along the shortest possible route.

LV8804FV uses synchronous rectification for high efficiency drive. Synchronous rectification is effective for heat reduction and higher efficiency. However, it may increase supply voltage.
If the supply voltage shall increase, make sure that it does not exceed the maximum ratings by inserting a zener diode between power supply and GND.

*3. Reverse connection protection diode
This diode protects reverse connection.
Insert a diode between power supply and V_{CC} pin to protect the IC from destruction due to reverse connection.
Connection of this diode is not necessary required.

*4. COMIN and FIL pins
These pins are used to connect the filter capacitor. The LV8804FV uses the back EMF signal generated when the motor is running to detect the information on the rotor position. The IC determines the timing at which the output block applies current to the motor based on the position information obtained here. Insert a filter capacitor (1,000pF to 10,000pF) between the COMIN pin and FIL pin to prevent any motor startup miss-operation that is caused by noise. However, care must be taken since an excessively high capacitance will give rise to deterioration in efficiency and delays in the output power-on timing while the motor is running at high speed.
Furthermore, connect the capacitor between the COMIN pin and FIL pin as close as possible in order to avoid the effects of noise from other sources.

*5. CT pin
This pin is used to connect the lock detection capacitor.
The constant-current charging and constant-current discharging circuits incorporated causes locking when the pin voltage reaches 2.5V, and releasing the lock protection when it drops to 0.5V. This pin must be connected to the GND when it is not going to be used.

*6. RF pins

These pins are used to set the current limit.
When the pin voltage exceeds 0.25V, the current is limited, and regeneration mode is established. In the application circuit, this voltage is set in such a way that the current limit will be established at 1A.
The calculation formula is given below.
RF resistance = 0.25V/target current limit value

*7. SOFTST pin

This pin is used to set the soft start.
By connecting a capacitor between this pin and GND, the motor speed can be increased gradually.
When the pin voltage exceeds 2.5V, the soft start is released, and the LV8804FV is switched to normal control.
If the soft start function is not going to be used, connect the pin to the VREG pin.

*8. OSC pin

This pin is used to connect the capacitor for setting the startup frequency.
A capacitor with a capacitance ranging from about 500pF to 2,200pF (recommended value) must be connected between this pin and GND.
The OSC pin determines the motor startup frequency, so be sure to connect a capacitor to it.
<How to select the capacitance>
Select a capacitance value that will result in the shortest possible startup time for achieving the target speed and produce minimal variations in the startup time. If the capacitance is too high, variations in the startup time will increase; conversely, if it is too low, the motor may idle. The optimum OSC constant depends on the motor characteristics and startup current, so be sure to recheck them when the type of motor used or circuit specifications are changed.

*9. MINSP pin

This pin is used to input the voltage to set the minimum speed.
The minimum speed can be set by resistor-dividing the VREG voltage (5V) to create a voltage of 1 to 3V, and inputting this voltage to the MINSP pin.
If the minimum speed is not going to be set, the MINSP pin and CTL pin must be short-circuited.

*10. VG, CP, and CPC pins

These pins are used to connect the capacitors to generate the pre-drive voltage and stabilize the pre-drive power supply.
Be sure to connect these capacitors in order to generate the drive voltage for the high-side (upper) output DMOS transistor.

*11. VREG pins

These are the control system power supply pin and regulator output pin, which create the power supply of the control unit. Be sure to connect a capacitor between this pin and GND in order to stabilize control system operation.
Since these pins are used to supply current for control and generate the charge pump voltage, connect a capacitor with a capacitance that is higher than that of the capacitor connected to the charge pump.

*12. CTL pins

Change by the Slew Rate of 0.5V/ms or more and use the voltage of the CTL pin.
The current might return to the power supply when using it below the above-mentioned Slew Rate and IC be destroyed.

*13. Pin protection resistor

It is recommended that resistors higher than 1kΩ are connected serially to protect pins against misconnection such as GND open and reverse connection.

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