Ordering number : EN8336

SANYO Semiconductors
DATA SHEET

Monolithic Digital IC

LB8500M — DC Fan Motor Speed Control IC

Overview

The LB8500M easily and simply implements feedback-based motor speed control in combination with a general-purpose motor driver IC.

Compared to open-loop control, the use of speed feedback allows the motor speed precision to be improved and the speed fluctuations due to load variations to be minimized.

- LB8500M : For use as a driver IC that increases the motor speed as the command voltage falls (single phase systems)

Features

- Achieves linear speed control
  Applications can set the slope of the change in motor speed with change in the input duty.
- Minimized speed fluctuations in the presence of line or load variations
- Allows a minimum speed to be set
- Soft start function
- Settings using external capacitors and resistors (to support easier mass production of end products)
- Supports both PWM duty and analog voltage control inputs

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{CC} max	V_{CC} pin	18	V
Output current	I_O max	E0 pin	3	mA
Allowable power dissipation	Pd max	When mounted on a circuit board *1	0.87	W
Operating temperature	Topr		-30 to +95	°C
Storage temperature	Tstg		-55 to +150	°C

*1 Specified circuit board : 114.3 × 76.1 × 1.6mm^3, glass epoxy.

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Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range 1	$V_{CC}1$	V_{CC} pin	7.5 to 17	V
Supply voltage range 2	$V_{CC}2$	V_{CC} pin, with V_{CC} shorted to 6VREG	5.5 to 6.5	V
Output current	I_O	E0 pin	2.5	mA
6V constant voltage output current	I_{REG}		-5	mA
CTL pin voltage	V_{CTL}		0 to VREG	V
LIM pin voltage	V_{LIM}		0 to VREG	V

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

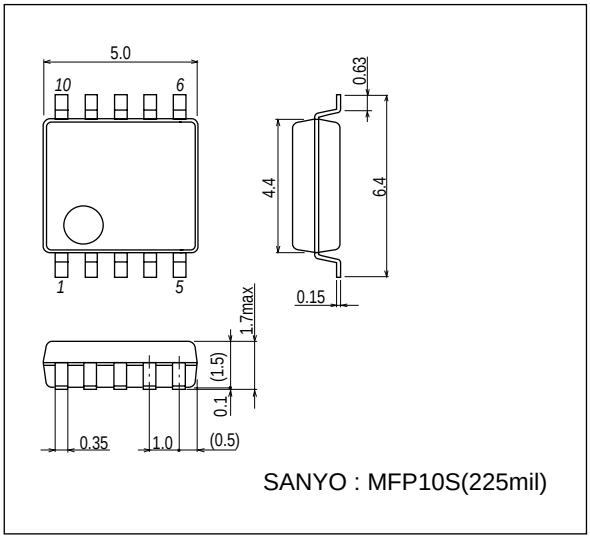
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply current	I_{CC}			4.5	6.5	mA
6V constant voltage output (VREG pin)						
Output voltage	VREG		5.8	6.0	6.2	V
Line regulation	ΔVREG1	V_{CC} = 8 to 17V		40	100	mV
Load regulation	ΔVREG2	I_O = 0 to 5mA		50	100	mV
Temperature coefficient	ΔVREG3	Design target*		0		mV/°C
Integrating Amplifier Block						
Common-mode input voltage range	VICM		2.0		VREG	V
High-level output voltage	V_{OH}	IEO = -0.2mA	VREG - 1.2	VREG - 0.8		V
Low-level output voltage	V_{OL}	IEO = 0.2mA		0.8	1.0	V
FGIN pin						
High-level input voltage	VFGH		3.0		VREG	V
Low-level input voltage	VFGL		0		1.5	V
Input open voltage	VFGO		VREG - 0.5		VREG	V
Hysteresis	VFGS		0.2	0.25	0.4	V
High-level input current	IFGH	VFGIN = 6VREG	-10	0	10	μA
Low-level input current	IFGL	VFGIN = 0V	-140	-110		μA
RC pin						
High-level output voltage	V_{OH}(RC)		3.2	3.45	3.7	V
Low-level output voltage	V_{OL}(RC)		0.8	0.95	1.05	V
Clamp voltage	V_{CLP}(RC)			1.6		V
CTL pin						
High-level input voltage	VCTH		2.0		VREG	V
Low-level input voltage	VCTL		0		1.0	V
Input open voltage	VCTO		VREG - 0.5		VREG	V
High-level input current	ICTH	VFGIN = 6VREG	-10	0	10	μA
Low-level input current	ICTL	VFGIN = 0V	-140	-110		μA
C pin						
High-level input voltage	V_{OH}(C)		VREG - 0.3	VREG - 0.1	VREG - 0.01	V
Low-level input voltage	V_{OL}(C)		1.8	2.0	2.2	V
LIM pin						
Input bias current	IB(LIM)		-1		1	μA
Common-mode input voltage range	VILIM		2.0		VREG	V

* The design specification items are design guarantees and are not measured.

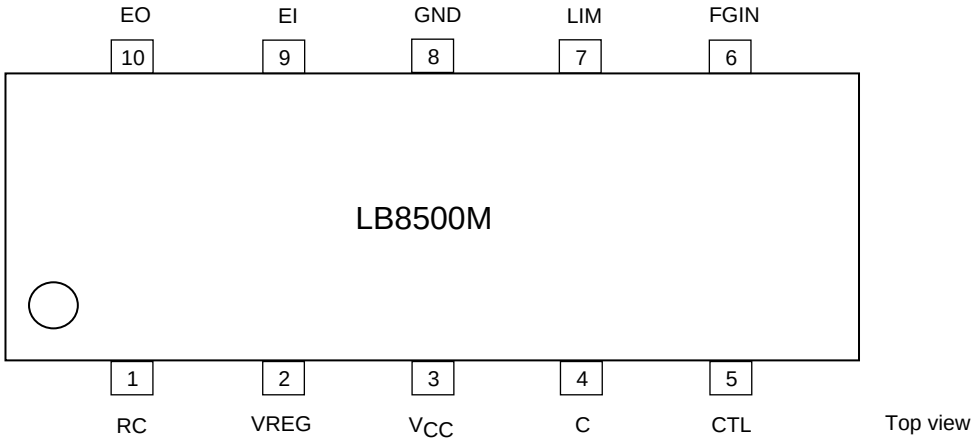
Package Dimensions

unit : mm (typ)

3086B



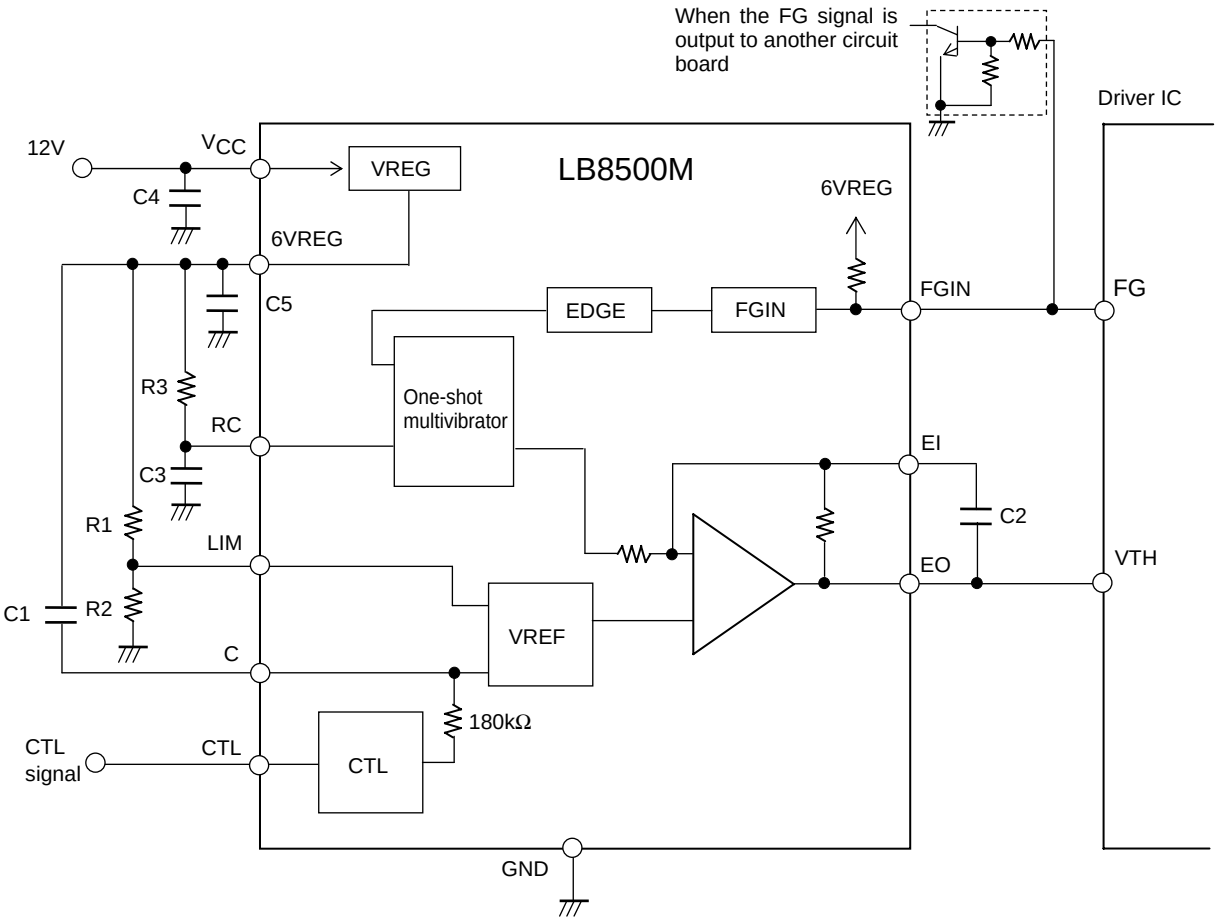
Pin Assignment



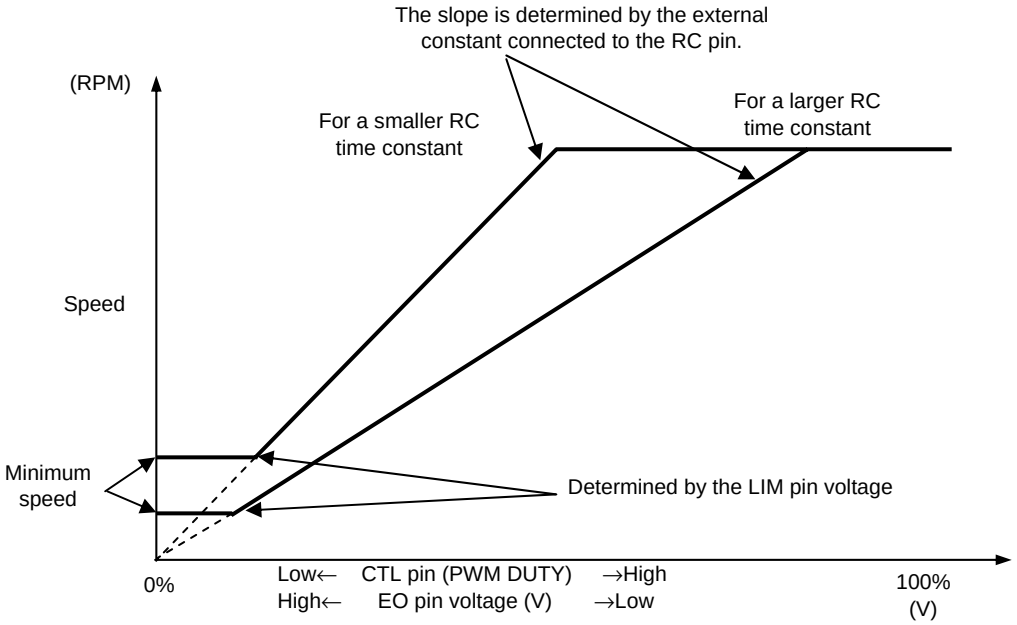
Pin Functions

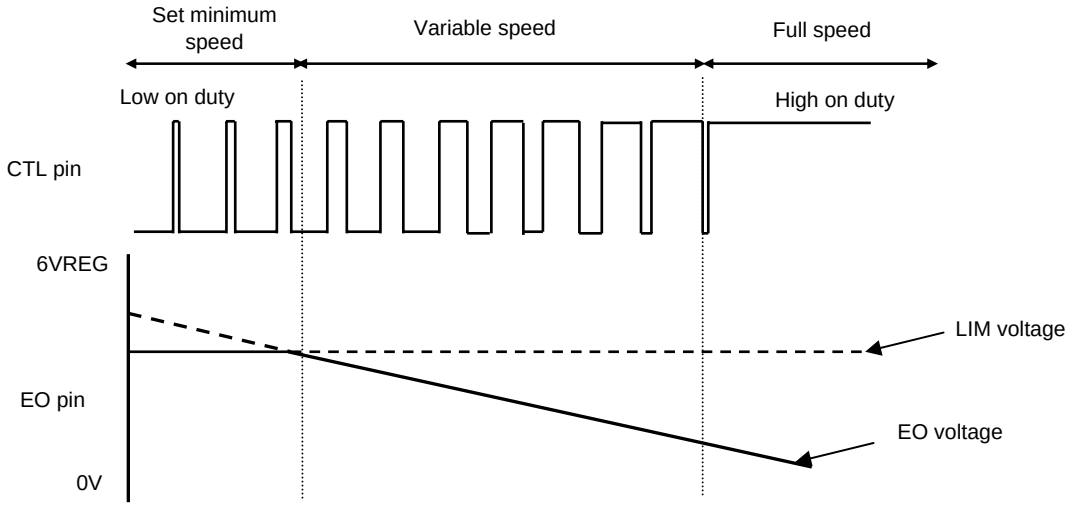
Pin	Pin No.	Description
1	RC	One-shot multivibrator pulse width setting. Connect a resistor between this pin and VREG, and a capacitor between this pin and ground.
2	VREG	6V regulator output. Connect a capacitor between this pin and ground for stabilization.
3	V_{CC}	Power supply. Connect a capacitor between this pin and ground for stabilization.
4	C	Duty pulse signal smoothing and soft start time setting. Connect a capacitor between this pin and VREG.
5	CTL	Duty pulse signal input. The speed is controlled by the duty of this pulse signal.
6	FGIN	FG pulse input
7	LIM	Minimum speed setting. Normally, the 6V regulator level is resistor divided to set this pin's input level.
8	GND	Ground pin
9	EI	One-shot multivibrator output and integrating amplifier input. A capacitor must be connected between this pin and EO for this integration.
10	EO	Integrating amplifier output.

Block Diagrams and Application Examples

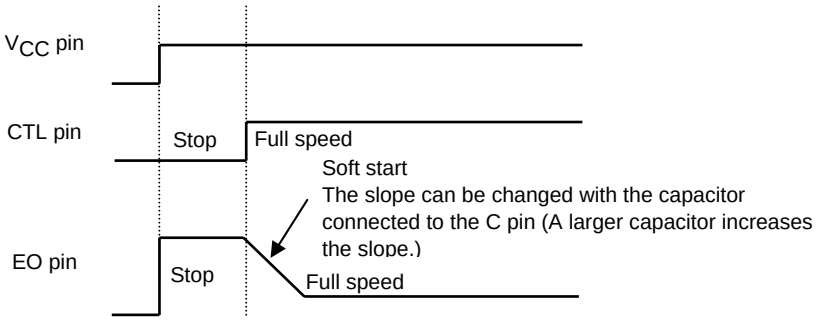


Speed Control Diagrams



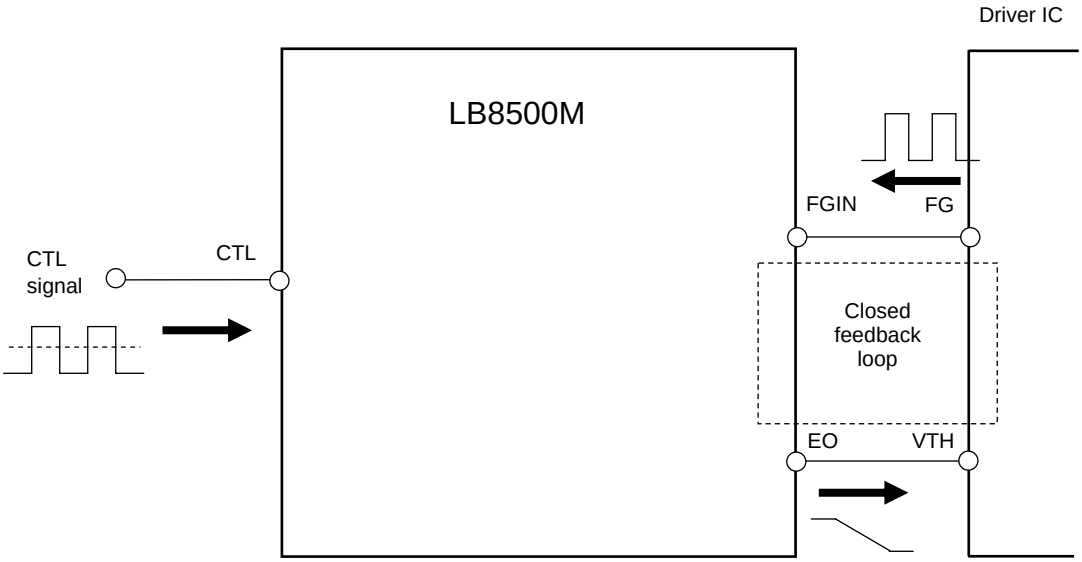


Startup Timing (soft start)

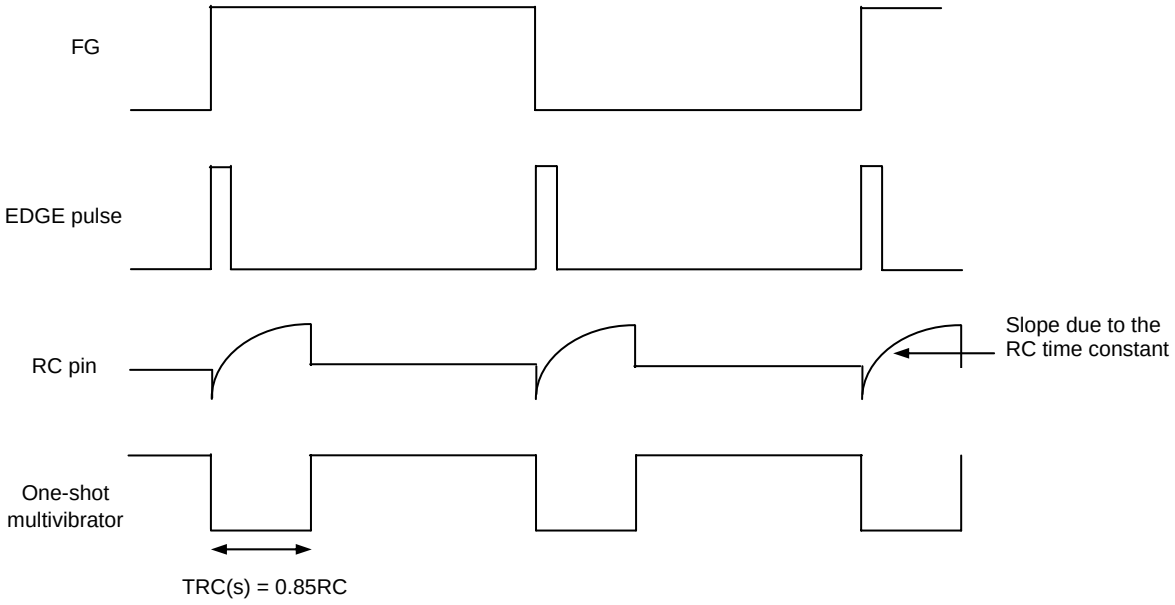


Supplementary Operational Descriptions

The LB8500M accepts a duty pulse input and an FG signal from the driver IC, and generates the driver IC control voltage so that the FG period (motor speed) becomes proportional to the control voltage.



As shown in the figure below, the LB8500M generates a pulse signal from edges on the FG signal and then generates a pulse width waveform determined by the RC time constant in a one-shot multivibrator.
The LB8500M then integrates that pulse waveform to create the output driver IC control voltage (a DC voltage).



It is also possible to change the slope of the VCTL/speed relationship as shown in the speed control diagram in the previous section by changing the pulse width with the RC time constant.
Note, however, that since pulses determined by this RC time constant are used, variation in the RC components will appear as speed control errors.

Pin Setting Procedures (Provided for reference purposes)

1. RC pin

The one-shot multivibrator pulse width can be calculated with the following equation.

$TRC(s) \approx \underline{0.85} \times R \times C$ ..... Equation 1

If the FG signal frequency at full motor speed is fFG (Hz) and the control duty desired for full speed is DUTY (for example: 50% → 0.5), the values of the resistor and capacitor connected to the RC pin can be determined from the following equation.

$R \times C = DUTY/(3 \times \underline{0.85} \times fFG)$ ..... Equation 2

Note that if "rpm" is the full motor speed, since one revolution will be two FG periods, the following equation gives the FG frequency, fFG (Hz).

$fFG(Hz) = 2rpm/60$ ..... Equation 3

For reference purposes, the following table lists the RC pin external component values determined from equations 2 and 3 when the control duty at full speed will be 80% for a variety of full motor speed values.

Note that the capacitor value must be in the range 0.01µF to 0.015µF due to the RC pin discharge capacity of the IC.

Full motor speed	R × C	R	C
10000rpm	0.94×10^{-3}	63kΩ	0.015µF
8000rpm	1.18×10^{-3}	78kΩ	0.015µF
6000rpm	1.57×10^{-3}	105kΩ	0.015µF
4000rpm	2.39×10^{-3}	157kΩ	0.015µF
2000rpm	4.68×10^{-3}	312kΩ	0.015µF

The table below lists the RC pin external component values when the control duty for full motor speed is changed for a full motor speed of 10,000rpm.

Duty at full speed	R × C	R	C
80% (= 0.8)	0.94×10^{-3}	94kΩ	0.01µF
60% (= 0.6)	0.71×10^{-3}	71kΩ	0.01µF
40% (= 0.4)	0.47×10^{-3}	47kΩ	0.01µF

Also, note that the FG frequency can be determined from the following equation for various control duty input states.

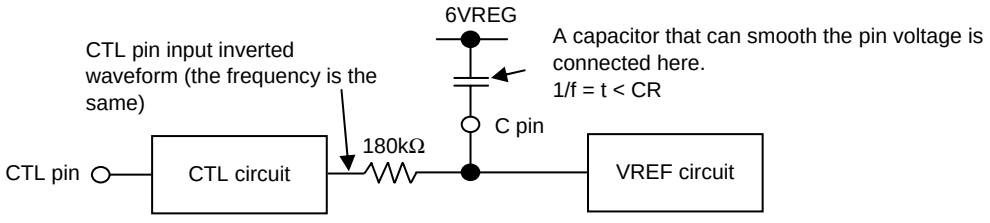
$fFG = DUTY/(3 \times \underline{0.85} \times RC)$ ..... Equation 4

2. C Pin

Since a capacitor that can smooth the pin voltage is connected to the C pin, if the CTL pin input signal frequency is f (Hz), then the capacitor must meet the following condition. (Here, R is the IC internal resistance of 180kΩ (typical).)

$1/f = t < RC$

Note that the larger the capacitor, the longer the soft start time will be and its response to changes in the input signal will be slower.



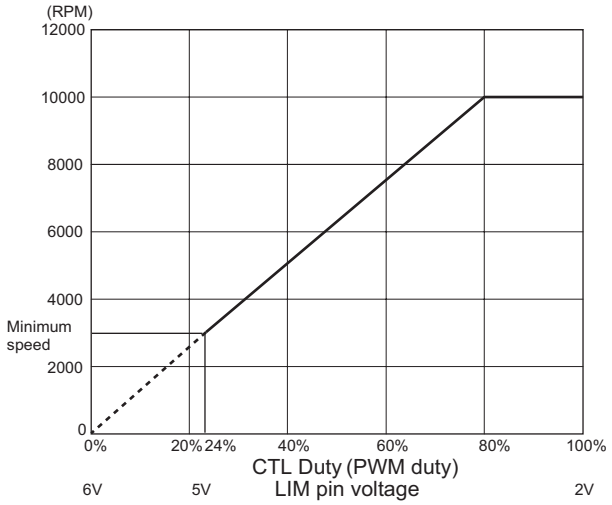
3. LIM pin

The LIM pin external component values can be derived as follows for the case where a motor whose maximum speed of 10,000rpm is to be achieved with an 80% duty, and a minimum speed of 3000rpm is to be set.

Ra = minimum speed/full speed = 3000/10,000 = 0.3
Full-speed duty × Ra = 0.8 × 0.3 = 0.24
LIM pin voltage = 6 - (4 × 0.24) ≈ 5V

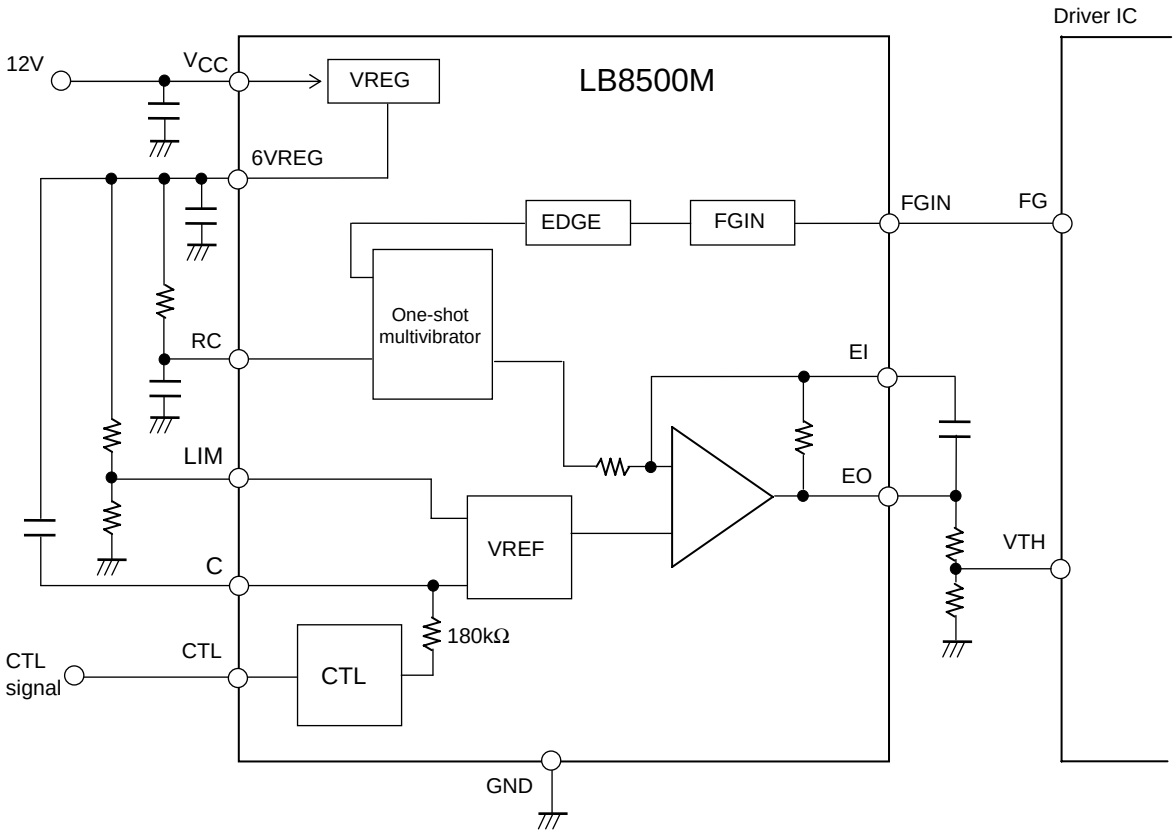
From the above, the required LIM pin voltage is about 5V.
To generate this 5V level by resistor dividing the 6 V regulator level, the resistor ratio will be 1:5, and the resistors connected to the LIM pin will have the following values.

Between 6VREG and LIM pin : 10kΩ
Between LIM pin and GND : 50kΩ



Application Example 2

[Used in Combination with the LB11660FV]

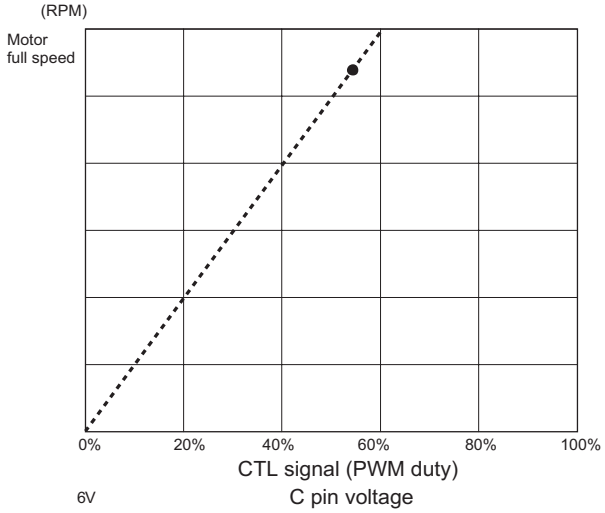


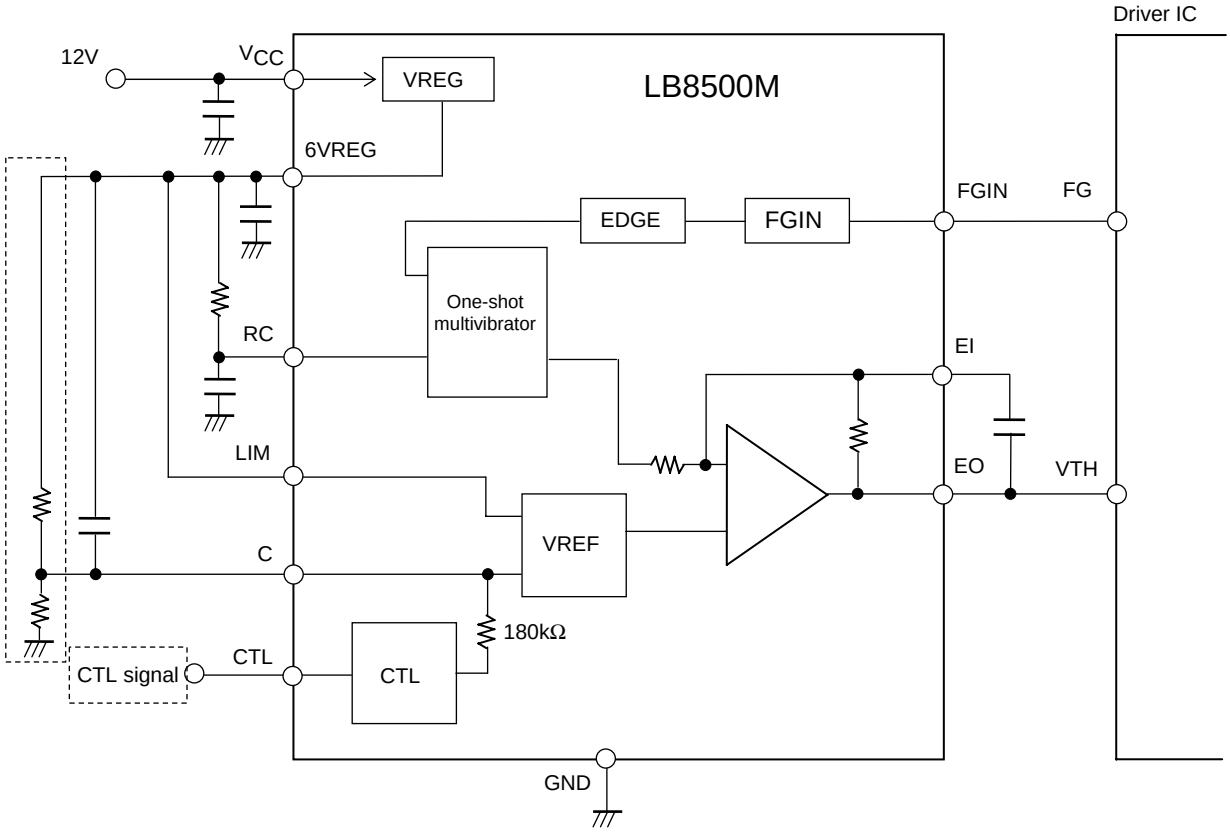
In this circuit, the dynamic range of the LB8500M EO pin (the range from the amplifier block output high to output low levels) must be wider than the dynamic range (from the high to low levels of the PWM signal) of VTH pin of driver IC with which this IC is combined.
However, since the LB11660FV PWM low-level voltage is lower than the LB8500M amplifier output low-level voltage, it must be resistor divided.

Application Example 3

[Fixed Speed + Soft Start]

With this circuit, the motor speed remains constant even if there are fluctuations in the supply voltage or static voltage.



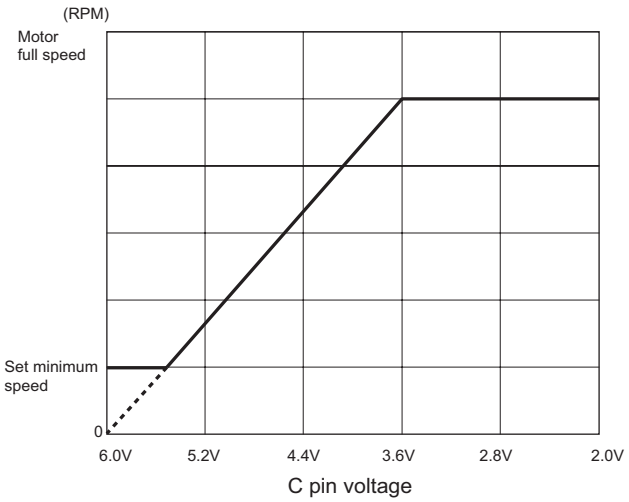


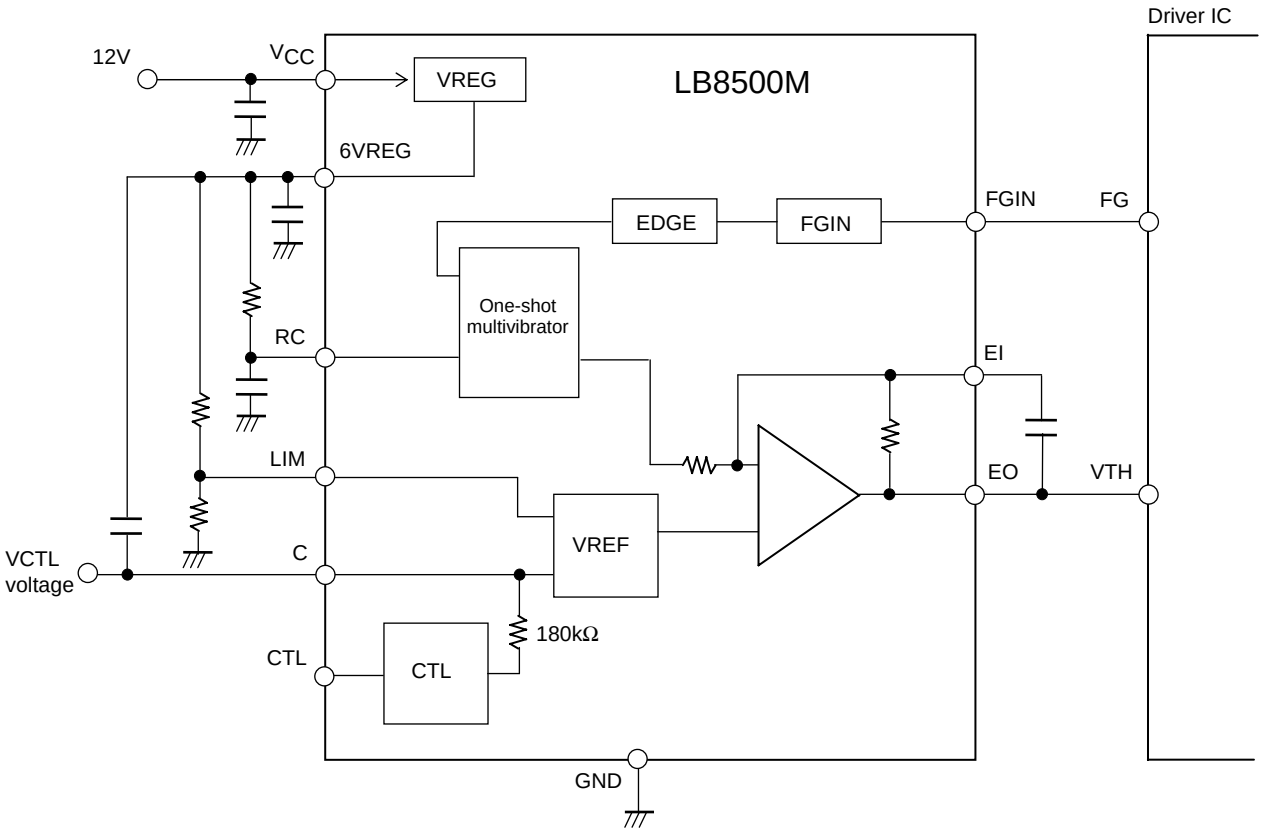
Input a fixed-duty signal to the CTL pin signal input as an input signal for which soft start is enabled at startup. Alternatively, apply a constant voltage to the C pin. (In this case, the CTL pin must be left open.)

Application Example 4

[Analog Input]

DC voltage speed control

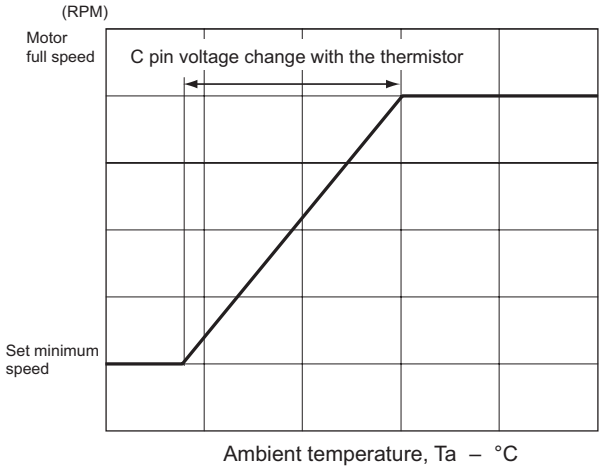


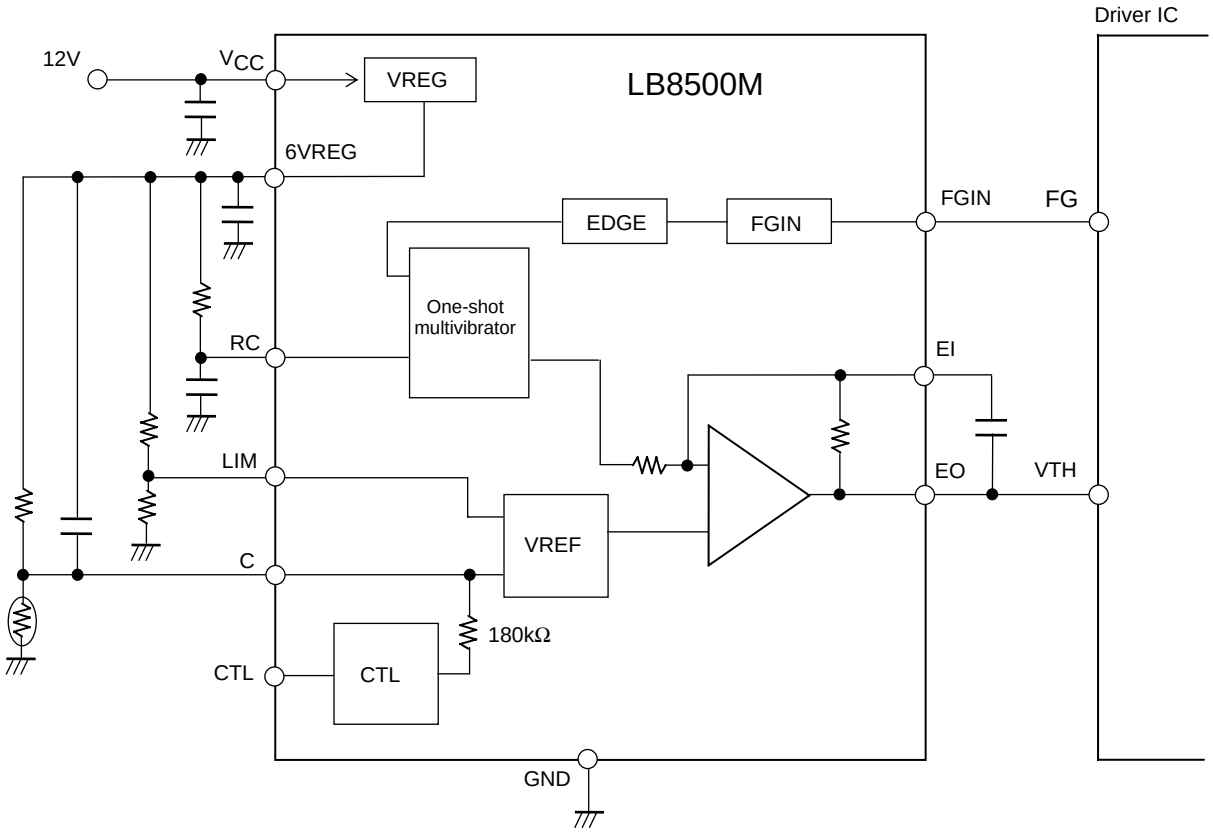


Application Example 5

[Thermistor + Soft Start]

Ambient temperature based speed control using a thermistor

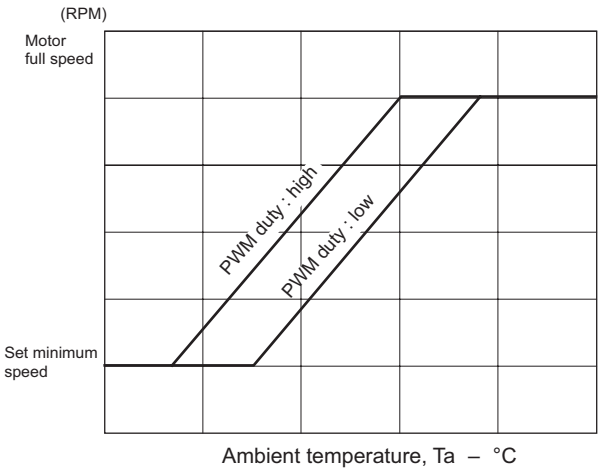


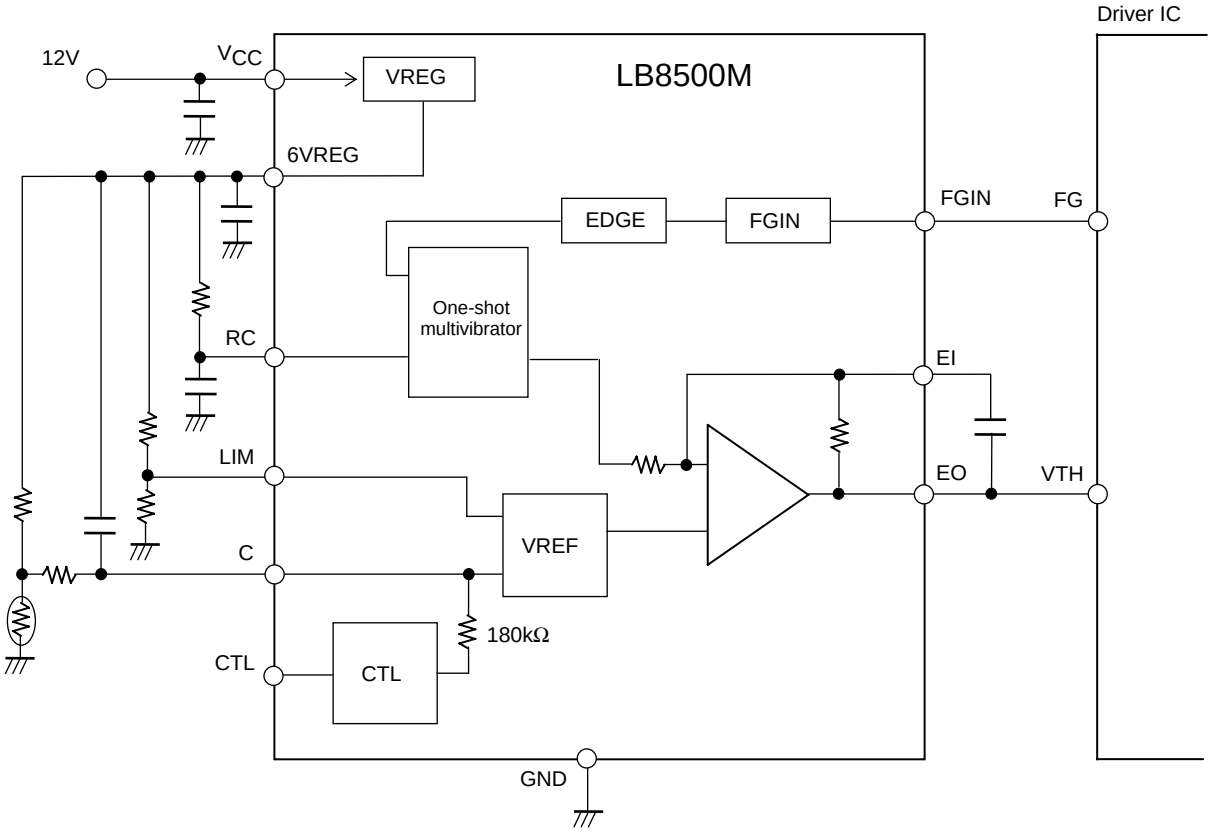


Application Example 6

[Thermistor + External PWM]

Ambient temperature plus external PWM duty based speed control using a thermistor





Application Example 7

[Origin Shift]

Changing the origin from 0rpm at 0% to a state where there is rotation at 0%