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SANYO Semiconductors
DATA SHEET

LB11610P — Monolithic Digital IC Three-Phase Brushless Motor Driver

Overview

The LB11610P is a brushless motor driver IC that implements three-phase full-wave linear drive. Since this drive technique produces quiet operation, it is optimal for use in indoor and passenger compartment equipment, such as seat fan motors in car air conditioning systems.

The LB11610P also includes a speed control circuit that can implement arbitrary speed curves.

Functions and Features

- Three-phase full-wave linear drive
- Built-in torque ripple correction circuit
- Built-in current limiter circuit
- Built-in output stage high and low side oversaturation prevention circuit
- Built-in thermal shutdown circuit
- Built-in motor constraint protection circuit
- Built-in speed control circuit
- Built-in forward/reverse switching circuit

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Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage1	V_{CC} max	V_{CC} pin	7	V
Supply voltage 2	VS max	VS pin	27	V
Output current	I_O max		1.5	A
Allowable power dissipation 1	Pd max1	When mounted on a circuit board *1	2.1	W
Allowable power dissipation 2	Pd max2	Independent IC	0.9	W
Operating temperature	Topr		-40 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

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

Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range 1	VS	VS pin	5 to 25	V
Supply voltage range 2	V_{CC}	V_{CC} pin	4.5 to 5.5	V
Hall sensor input amplitude	VHALL	Between the Hall sensor inputs	±30 to ±80*	mVp-p
FG output current	IRG		0 to 10	mA
GSENSE input range	VGSENSE	With respect to the control system ground	-0.20 to +0.20	V

* Although Hall input amplitudes up to the common-mode input voltage range are allowable, since kickback may occur in the output waveforms, it is desirable to restrict the input amplitude to under 80mVp-p.

Electrical Characteristics at Ta = 25°C, V_{CC} = 5V, VS = 12V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
V_{CC} supply current	I_{CC}	RL = ∞, VCTL = 0V, VLIM = 0V (Motor stopped)		17	23	mA
Output Block						
Output saturation voltage 1	$V_O$sat1	I_O = 500mA, Rf = 0.5Ω, sink + source VCTL = VLIM = 5 (With saturation prevention)		2.1	2.6	V
Output saturation voltage 2	$V_O$sat2	I_O = 500mA, Rf = 0.5Ω, sink + source VCTL = VLIM = 5 (With saturation prevention)		2.6	3.5	V
Output leakage current	$I_O$leak				1.0	mA
Hall Sensor Amplifier Block						
Input offset voltage	Voff(HALL)		-6		+6	mV
Input bias current	IB(HALL)			1.0	3.0	μA
Common-mode input voltage range	VCM(HALL)		1.3		3.3	V
INT Amplifier Block						
Input offset voltage	VIO(INT)		-10		10	mV
Input bias current	IB(INT)		-1		1	μA
Common-mode input voltage range	VICM		0		V_{CC} - 1.7	V
High-level output voltage	V_{OH}(INT)	ITOC = -0.2mA	V_{CC} - 1.1	V_{CC} - 0.8		V
Low-level output voltage	V_{OL}(INT)	ITOC = 0.1mA		0.2		V
Open-loop gain		f(CONT) = 1kHz	45	51		dB
Current limiter circuit (LIM pin)						
Input offset voltage	Voff(LIM)	Rf = 0.5Ω, VCTL = 5V, I_O ≥ 10mA Fixed Hall sensor input logic (U, V, W = H, H, L)	140	200	260	mV
Input bias current	IB(LIM)		-2.5			μA
Current control level	ILIM	Rf = 0.5Ω, VCTL = 5V, VLIM = 2.06V Fixed Hall sensor input logic (U, V, W = H, H, L)	830	900	970	mA

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Parameter	Symbol	Conditions	Ratings min	Ratings typ	Ratings max	Unit
Motor Constraint Protection Circuit Block (CSD and CSDEG pins)						
CSD saturation voltage	VSCSD	I_O = -0.5mA, V_{CC} - VCSD		0.1	0.3	V
CSD off voltage	VCSDOFF		0.55	0.6	0.65	V
CSD voltage	VCSD	CSDEG = 4.9V	4.7	4.9		V
CSDEG pin current	ICSDEG	CSDEG = 4.8V	35	50	65	µA
CSDEG pin on voltage	VCSDEGON	V_{CC} - CSDEG pin		0.1	0.3	V
CSDEG pin off voltage	VCSDEGOFF	V_{CC} - CSDEG pin	0.6	0.7	0.85	V
PWMRE pin						
PWMRE pin current	IPWMRE	PWMRE = 0V	-260	-200	-140	µA
Threshold voltage	PWMRETH		1.12	1.25	1.38	V
Hysteresis	PWMREHYS		0.44	0.7	1.1	V
CEG pin						
CEG pin current	ICEG	CEG = 4.8V	35	50	65	µA
CEG pin on voltage	VCEGON	V_{CC} - CEG pin		0.1	0.3	V
CEG pin off voltage	VCEGOFF	V_{CC} - CEG pin	0.6	0.7	0.85	V
FV pin						
Charge current	ICHG1		-420	-300	-230	µA
Disharge current	ICHG2		230	300	420	µA
High-level voltage	VOFVH	I_O = -200µA	4.7	4.9		V
Low-level voltage	VOFVL	I_O = 200µA		0.15	0.3	V
RC pin						
High-level output voltage	VOH(RC)		3.12	3.4	3.68	V
Low-level output voltage	VOL(RC)	I_O = -200µA	0.67	0.75	0.83	V
Clamp voltage	VCLP(RC)	I_O = 200µA	1.3	1.45	1.6	V
F/R pin						
Threshold voltage	VFSR		2.25	2.50	2.75	V
Input open voltage	VFRO		V_{CC} - 0.5		V_{CC}	V
High-level input current	IFRH	VFRIN = V_{CC}	-10	0	10	µA
Low-level input current	IFRL	VFRIN = 0V	-130	-100		µA
Control Block (CTLREF pin, CTL pin)						
CTLREF pin voltage	VCREF		1.43	1.5	1.57	V
CTLREF pin input voltage range	VCREFIN		1.40		3.50	V
CTL pin input bias current	Ib(CTL)	VCTL = 5V, CTLREF : OPEN			4.0	µA
CTL pin control start voltage	VCTL(ST)	Rf = 0.5Ω, VLIM = 5V, $I_O \geq$ 10mA Fixed Hall sensor input logic (U, V, W = H, H, L)	1.4	1.5	1.6	V
CTL pin control Gm	Gm(CTL)	Rf = 0.5 Ω, ΔI_O = 200mA Fixed Hall sensor input logic (U ,V, W = H, H, L)	0.46	0.58	0.70	A/V
Low-Voltage Protection Circuit						
Operating voltage	VSDL		3.6	3.8	4.0	V
Release voltage	VSDH		4.1	4.3	4.5	V
Hysteresis	ΔVSD		0.35	0.5	0.65	V
FGFIL pin						
Charge current	ICHG1		-7	-5	-3	µA
Disharge current	ICHG2		3	5	7	µA
FG pin						
Output saturation voltage	V_{OL}(FG)	I_{FG} = 5mA		0.1	0.3	V
Output leakage current	I_L(FG)	V_{FG} = 28V			10	µA

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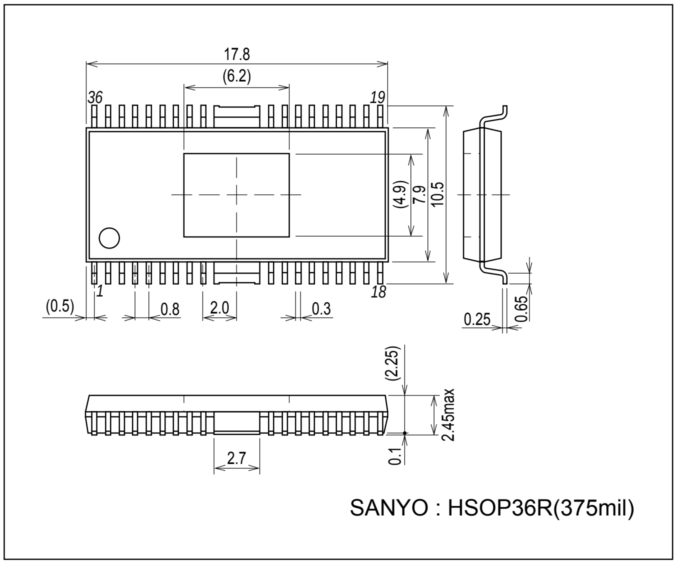
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
FVREF pin						
Input range	FVREF IN		0		4.0	V
Input bias current	Ib(FVREF)		-5.0			μA
Saturation Protection Circuit						
Low side setting voltage	$V_O$sat(DET)	The voltage between each OUT/Rf pair at IO = 10 mA, Rf = 0.5 Ω VCTL = VLIM = 5 V.	0.175	0.25	0.325	V
Thermal shutdown circuit						
Thermal shutdown operating temperature	T-TSD	Design target value*		180		°C
Thermal shutdown temperature hysteresis	ΔTSD	Design target value*		20		°C

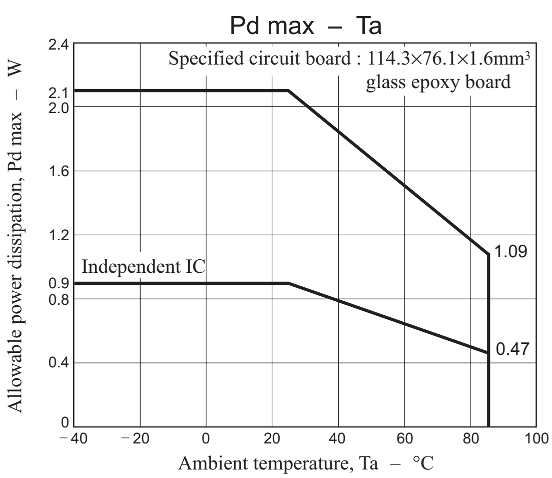
Note: * The design specification items are design guarantees and are not measured.

Package Dimensions

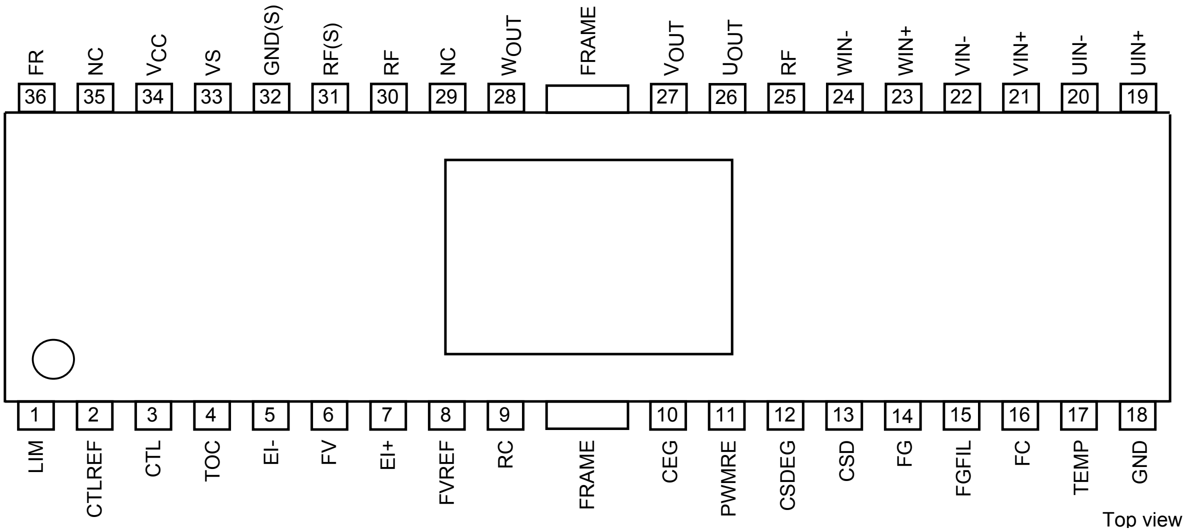
unit : mm (typ)

3251





Pin Assignment



Truth Table and Control Function

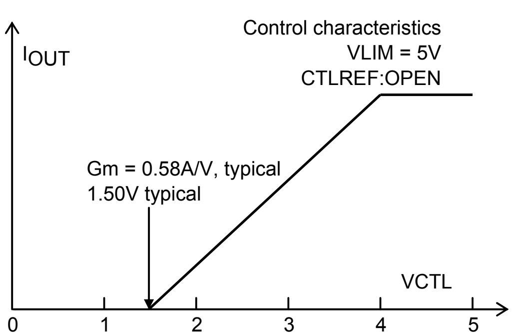
	Source – Sink	Hall sensor inputs			FR
		U	V	W	
1	V → W	H	H	L	H
	W → V				L
2	U → W	H	L	L	H
	W → U				L
3	U → V	H	L	H	H
	V → U				L
4	W → V	L	L	H	H
	V → W				L
5	W → U	L	H	H	H
	U → W				L
6	V → U	L	H	L	H
	U → V				L

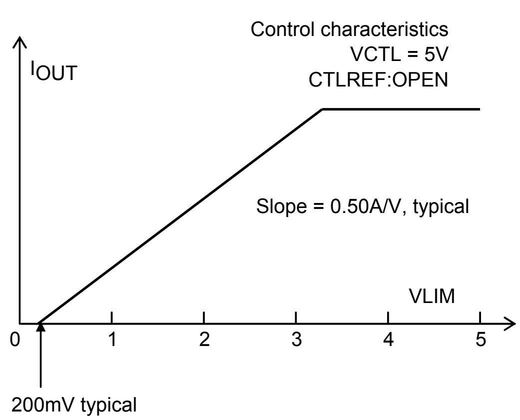
Note: The FR "H" state refers to a voltage of 2.75V or higher, and the FR "L" state refers to a voltage of 2.25V or lower (when V_{CC} is 5V).

Note: For the Hall sensor inputs, the input "H" state indicates the state where the + input is at a potential 0.01V or more higher than the - input. Similarly, the input "L" state indicates the state where the + input is at a potential 0.01V or more lower than the - input.

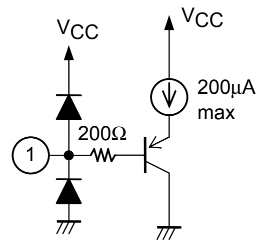
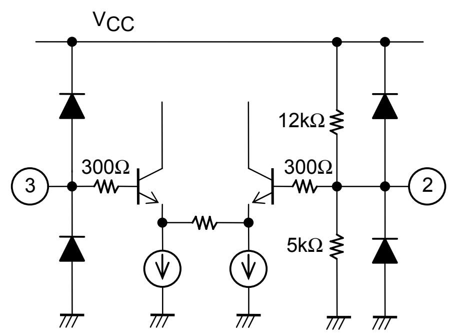
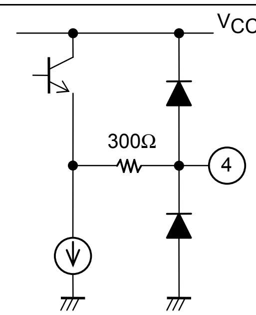
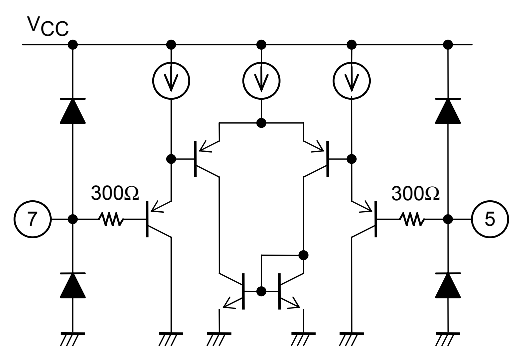
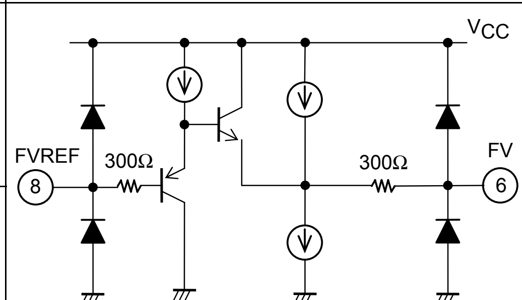
Note: Since this drive method is a 180° excitation method, the phases other than the sink and source phase will not be off.

Control and Current Limiter Functions





Pin Functions

Pin No.	Pin	Description	Equivalent Circuit
1	LIM	**Current limiter function control pin** The output current can be modified linearly by the voltage applied to this pin. Slope = 0.5A/V typical at Rf = 0.5Ω	
2	CTLREF	**Control reference voltage pin** Although this level is set to about 0.3 × V_{CC} internally, this voltage can be changed by applying an external voltage with a low-impedance circuit. (The input impedance is about 3.5kΩ.)	
3	CTL	**Speed control pin** Control consists of constant current control in which current feedback is applied from Rf. Gm = 0.58A/V typical at Rf = 0.5Ω	
4	TOC	**Integrating amplifier output pin**	
5	EI-	**Integrating amplifier inverting input pin**	
7	EI+	**Integrating amplifier noninverting input pin**	
6	FV	**Hall sensor signal one-shot multivibrator output pin** This pin must be left open when unused.	
8	FVREF	**Input adjustment pin (for speed control)** This pin must be shorted to ground when unused.	

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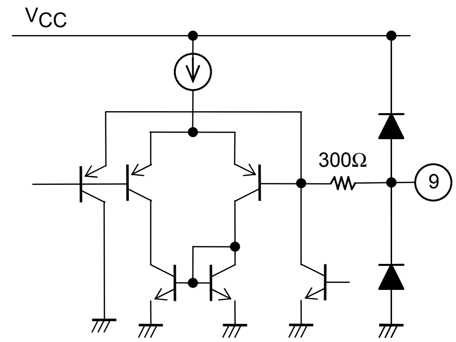
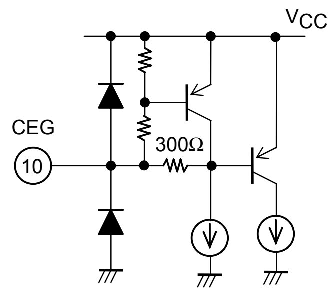
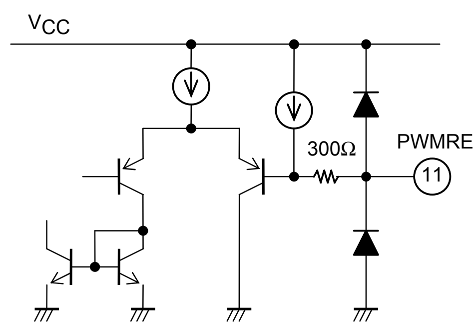
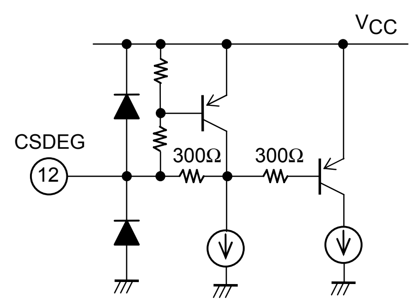
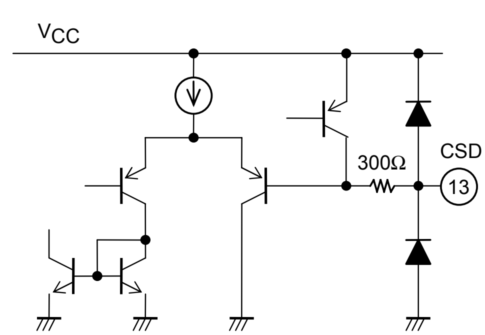
Pin No.	Pin	Description	Equivalent Circuit
9	RC	**One-shot multivibrator pulse hysteresis setting pin** Connect a resistor between this pin and V_{CC} and a capacitor between this pin and ground. This pin must be shorted to ground when unused.	
10	CEG	**Rotation pulse edge detection pin** (For use by the one-shot multivibrator circuit) Connect a capacitor between this pin and V_{CC}.	
11	PWMRE	**PWM input reset pin** Connect a resistor and a capacitor between this pin and ground.	
12	CSDEG	**Motor constraint protection circuit rotation input pulse detection pin** Connect a capacitor between this pin and V_{CC}.	
13	CSD	**Motor constraint detection sense input pin** Connect a capacitor between this pin and V_{CC} and a resistor between this pin and ground.	

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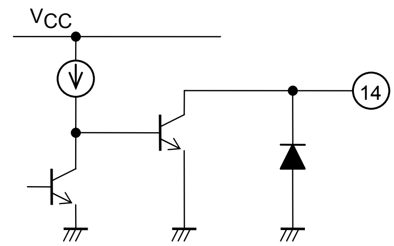
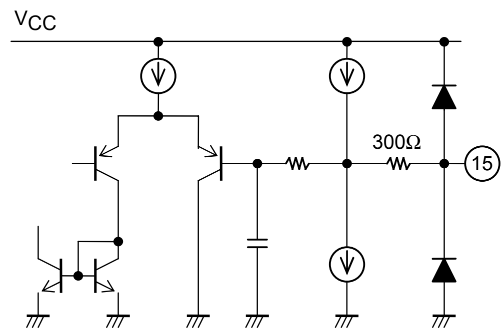
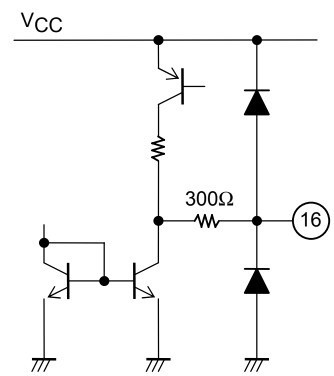
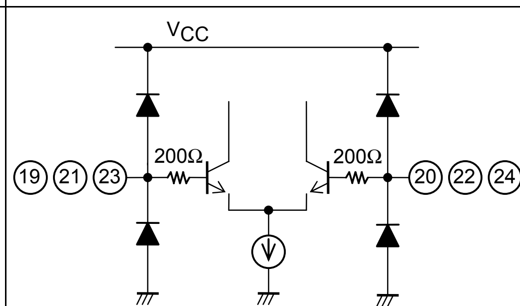
Pin No.	Pin	Description	Equivalent Circuit
14	FG	**Single Hall sensor system FG output pin** (This is an open-collector output.)	
15	FGFIL	**FG filter connection pin** This pin is normally used in the open state. However, if noise is a problem on the FG signal, connect a capacitor between this pin and ground.	
16	FC	**Control loop frequency characteristics correction pin** Connect a capacitor between this pin and ground.	
17	TEMP	**Junction temperature monitor pin**	
18	GND	**Ground for circuits other than the output transistors** The lowest potential of the output transistors will be that of the resistor Rf.	
19 20 21 22 23 24	UIN+ UIN- VIN+ VIN- WIN+ WIN-	**Hall effect sensor input pins** These input are "H" when IN+ > IN-, and "L" in the reverse state. An amplitude of 30mVp-p or higher is desirable for the Hall sensor signals. If noise on the Hall sensor signals is a problem connect capacitors between the IN+ and IN- pins.	

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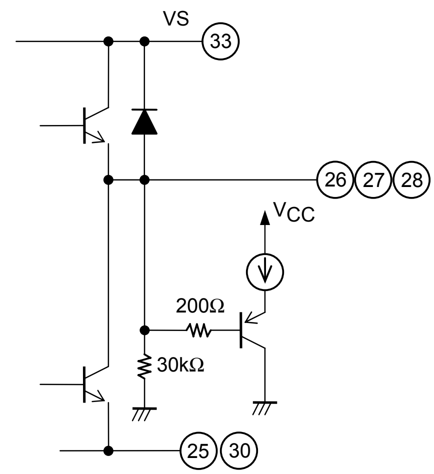
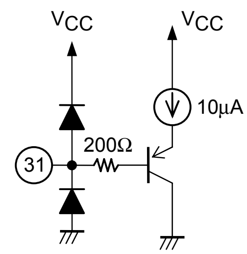
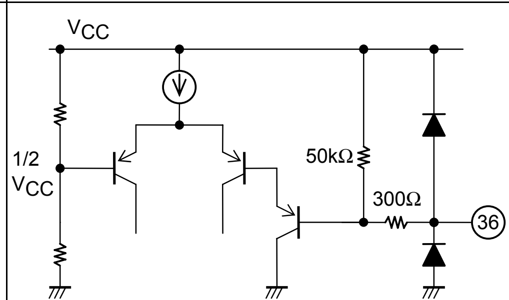
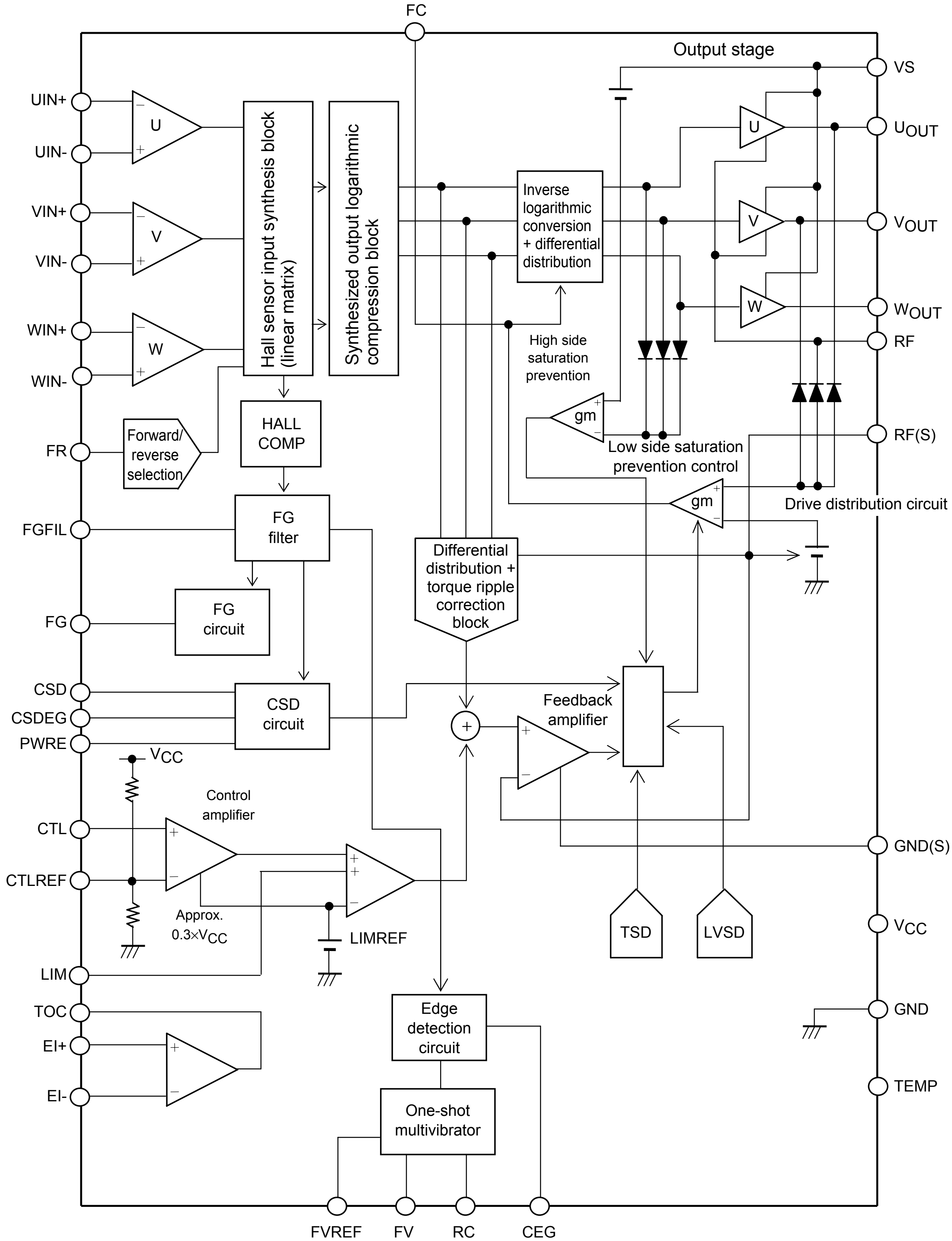
Pin No.	Pin	Description	Equivalent Circuit
25 30	RF	**Output current detection pins** Current feedback is applied to the control block by connecting the resistor Rf between this pin and ground. The low side saturation prevention circuit and the torque ripple correction circuit operate based on this voltage as well. In particular, note that the low side saturation prevention operation in the high-current region may be degraded if the value of this resistor is reduced radically. Also note that the RF pin and the RF(S) pin must be connected together.	
26 27 28	U_{OUT} V_{OUT} W_{OUT}	**Motor drive output pins** U phase output (A spark killer diode, Di, is built in.) V phase output (A spark killer diode, Di, is built in.) W phase output (A spark killer diode, Di, is built in.)	
33	VS	**Output block power supply**	
31	RF(S)	**RF sensing pin** (This pin must not be left open.)	
32	GND(S)	**Ground sensing pin** The influence of the ground shared impedance on Rf can be excluded by connecting this pin to ground in the vicinity of the Rf resistor side of the motor ground wiring including Rf. (This pin must not be left open.)	
34	V_{CC}	**Power supply for all circuit other than the output block** This level must be stabilized so that ripple and noise do not enter the IC.	
36	F/R	**Forward/reverse control pin** When low, the motor turns in the forward direction, and when high or open, the motor turns in the reverse direction. That is, the forward/reverse direction is selected with this pin voltage. (Vth = 2.5V typical at V_{CC} = 5V)	
29 35	NC	**No connection** This pin can be used for wiring connections.	
	FRAME	**Frame connection pin** The FRAME pin is connected to the metal parts on the package front internal in the package.	

Block Diagrams



LB11610 Operation Description

(1) PWMRE Circuit

At V_{CC} power supply startup, a reset period created by a resistor and capacitor connected to the PWMRE pin is set up (the outputs are turned off for the CSD pin rapid charge time). This is to prevent incorrect operation of the motor constraint protection circuit when the motor is stopped (in particular, to prevent the motor constraint protection circuit from operating immediately since the CSD pin voltage is low) by assuring that the CSD pin voltage is reliably set high (which requires waiting for the capacitor charge time). The outputs are set to the off state in the reset period, the period until the PWMRE pin voltage due to the PWMRE pin charge current and capacitor/resistor reaches 1.25V (typical).
The LB11610P switches to normal operating mode when the PWMRE potential exceeds 1.25V (typical), and the outputs will be once again set to the off state (reset state) if the PWMRE potential falls to under 0.55V (typical).
The LB11610P outputs operate when the PWMRE potential is over 1.25V (typical) and the CSD pin potential is over $0.76 \times V_{CC}$ (3.8V typical when V_{CC} is 5V).
The following equation is used to set the PWMRE reset time (Treset).

$\text{Treset} = -RC \times \ln\{1 - V_O/(\text{Ipwmre} \times R)\}$

Ipwmre: PWMRE pin charge current – 200µA (typical)
VO: The PWMRE initial potential – 0V
C: The PWMRE pin external capacitor
R: The PWMRE pin external resistor (It is desirable that this resistor value be 30kΩ or higher.)

PWMRE reset time setup example
When V_{CC} = 5V, PWMRE: C = 0.068µF, R = 220kΩ:

$$\begin{aligned}\text{Treset} &= -RC \times \ln\{1 - VO/(\text{Ipwmre} \times R)\} \\ &= -220k\Omega \times 0.068\mu F \times \ln\{1 - 1.25/(200\mu A \times 220k\Omega)\} \\ &\cong 431\mu(s)\end{aligned}$$

(2) Low-voltage protection circuit

This IC starts up (output operation turns on) when the V_{CC} voltage is 4.3V (typical) or higher and stops (output operation is turned off) when the V_{CC} voltage falls below 3.8V (typical).

(3) Thermal protection circuit

If the junction temperature (Tj) exceeds a stipulated level (TSD = 180°C, typical), the outputs are turned off.

(4) Forward/reverse operation

This IC is designed assuming that the forward/reverse (F/R) direction will not be switched while the motor is turning. We recommend that the F/R pin be held fixed at either high (forward) or low (reverse) during use.
Although this pin will go to the high level due to an internal pull-up resistor (about 50kΩ) if left open, this pull-up operation should be strengthened with an external resistor or other means if there large fluctuations in voltage or current levels during IC operation.

(5) Motor constraint protection circuit

The LB11610P includes a built-in motor constraint protection circuit to protect the IC itself and the motor if the motor is physically constrained from moving. If the Hall sensor input signals do not switch states for a period in excess of a certain fixed time with the motor in the driven state, the outputs are turned off. This time is set by the discharge time of the capacitor and resistor connected to the CSD pin.
The rotation detection pulse signal is detected with the timing of the falling edge (high to low) of the FG signal.

This rotation pulse detection signal time is set by the discharge time of the capacitor connected to the CSDEG pin.
The charge current is supplied to the CSD pin during the rotation detection pulse signal time.
When the motor is constrained and the CSD potential discharges to under 0.6V, the outputs are turned off.
After motor constraint protection circuit operation, the outputs are latched in the off state.
Either of the following operations must be performed to release this latched state.

- Set the IC to the reset state by setting the CTL pin voltage to under 1V and the PWMRE potential to under 0.55V (typical).

- Set the PWMRE potential directly to under 0.55V (typical) (the reset state).

*: Note that if the CSD pin resistor has a relatively high value, the internal comparator's bias current will cause the CSD pin potential to rise, and the protection operation may not be performed. A value of under 470kΩ for this resistor is desirable.

Rotation pulse signal detection time: Tps = Cs × VBE/ICSDEG(s)
Cs: The CSDEG pin external capacitor (connected between V_{CC} and the CSDEG pin)
VBE: Motor constraint protection circuit block transistor VBE: 0.7V (typical)
ICSDEG: The CSDEG pin discharge current: 50µA (typical)

Motor constraint time: Tcsd = ln(V_{CC}/(0.6 – Ibcd × Rc)) × Cc × Rc(s)
Cc: The CSD pin external capacitor (connected between V_{CC} and the CSD pin)
Rc: The CSD pin external resistor (connected between the CSD pin and ground)
Ibcd: CSD pin internal comparator bias current (0.5µA, typical)
CSD pin discharge potential threshold voltage: 0.6V (typical)

Latch release time: Toff = ln(V_{CC}/0.55) × Cre × Rre (s)
Cre: The PWMRE pin external capacitor (connected between the PWMRE pin and ground)
Rre: The PWMRE pin external resistor (connected between the PWMRE pin and ground)

CSD voltage rise time (fast charge time): Tchg ≅ Cc × Rc × ln{(V1 – Ic × Rc)/(V2 – Ic × Rc)}(s)
Cc: The CSD pin external capacitor (connected between V_{CC} and the CSD pin)
Rc: The CSD pin external resistor (connected between the CSD pin and ground)
Ic: The CSD pin transistor current (7mA: design target value maximum)
V1: The CSD pin initial voltage
V2: The CSD pin voltage value (when the transistor is on) (4.9V, typical)

CSD voltage rise time (when the motor is turning): Tchg ≅ Cc×Rc×ln{(V1 - Ic×Rc)/(V2 - Ic×Rc)}(s)
Cc: The CSD pin external capacitor (connected between V_{CC} and the CSD pin)
Rc: The CSD pin external resistor (connected between the CSD pin and ground)
Ic: The CSD pin transistor current (3.5mA: design target value maximum)
V1: The CSD pin initial voltage
V2: The CSD pin voltage value (when the transistor is on) (4.9V, typical)

Constraint Time Setting Example

To set up a motor constraint protection time of 3 seconds when V_{CC} = 5V.
Let the CSD pin capacitor Cc be 10µF and resistor Rc be 130kΩ.
Motor constraint protection time
Tcsd = ln{5/(0.6 - 130kΩ × 0.5µF)}× 10µF × 130kΩ
= 2.36 × 10 × 0.5µF × 130kΩ ≈ 3s

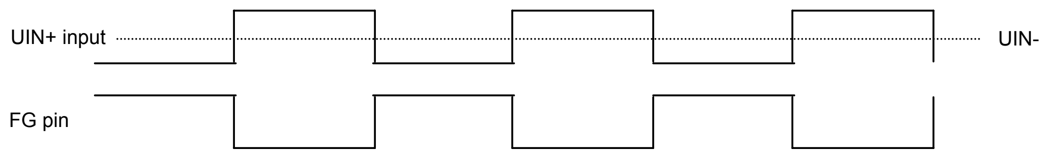
The time for the pulse signal that detects motor rotation is set with the CSDEG pin capacitor.
If the CSDEG pin capacitor Cs is set to 0.022µF:
Rotation detection pulse signal time: Tps = 0.022µF × 0.7/50µF = 308µs

*: Note that if the rotation detection pulse signal time is too short, the charge time for the CSD pin capacitor will be insufficient and the CSD pin potential will fail to rise adequately.

If the CSD pin capacitor is too small and the discharge time quick, the rotation detection pulse signal will not be output for the motor rotation period at the start of motor rotation (or low-speed rotation), and the motor constraint protection circuit may operate.
For example, if the motor speed is under 100rpm, the UIN output period will be 300ms. Here, a motor constraint protection time setting of 600ms or higher will be required.

(6) FG Output

An inverted Hall sensor signal formed from the UIN± pins Hall sensor amplifier input signal is output from the FG pin. The FG pin is an open-collector output.
Hall sensor amplifier input conditions: UIN- = fixed potential, FG pin: Pulled up to V_{CC} with a resistor.



(7) One-shot multivibrator circuit block (CEG pin, RC pin, and FV pin)

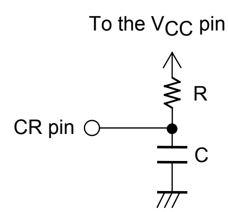
The LB11610P includes a one-shot multivibrator circuit to support speed feedback control.

The CEG pin is provide to set the rotation detection pulse signal time.
The rotation detection pulse signal is detected with the timing of the falling edge (high to low) of the FG signal.
This rotation pulse detection signal time is set by the discharge time of the capacitor connected to the CEG pin.

Rotation pulse signal detection time: Tps=Ce×VBE/Iceg(s)
Ce: The CEG pin external capacitor (connected between V_{CC} and the CEG pin)
VBE: CEG edge detection circuit block transistor VBE: 0.7V (typical)
Iceg: The CEG pin discharge current: 50μA (typical)

The RC pin sets the pulse width (high period) generated at the FG pin for each CEG pin signal.
The pulse width is set by the resistor and capacitor connected between the RC pin and the V_{CC} pin and between the RC pin and ground, respectively.
The pulse width TRC can be approximated with the following formula.

$$TRC \approx 1.1 \times R \times C(s)$$



If the FG output frequency at the highest motor speed is fFG (Hz), then TRC is set up so that the following relationship holds.

$$TRC \leq 1 \div fFG(s)$$

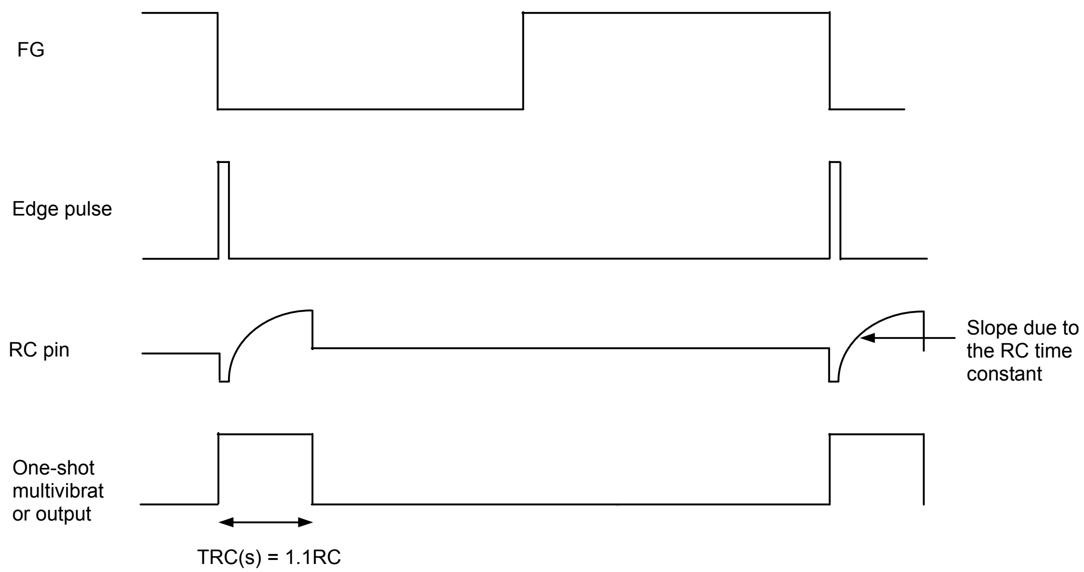
In this case, the FV voltage will range from 0V to about 5V according to the motor speed.
If the FV output is not used, connect the RC pin to ground and leave the FV pin open.

(8) Power Supply Stabilization

Capacitors adequately large for power supply stabilization must be connected between the VS pin and ground and between the V_{CC} pin and ground. The power supply lines will be particularly susceptible to fluctuations if diodes are inserted in the power supply lines to prevent destruction of the IC on reverse connection of the power supply. In this case, even larger capacitors must be used.
When the power supply is turned on or off with a switch, if the power supply switch and these capacitors are separated by a significant distance, the power supply can be disrupted significantly by the inrush current to the line inductance and these capacitors. The voltage handling capacity of the IC may be exceeded if this occurs. To prevent this problem do not use ceramic capacitors that have a low series impedance, but rather use electrolytic capacitors to suppress this inrush current and prevent voltage increases.

• Speed Control Circuit - Supplementary Documentation

The IC internal operation consists of creating a pulse signal from the FG signal edges as shown in the figure below, and generating a pulse width waveform determined by the RC time constant in a one-shot multivibrator circuit. The IC then integrates this pulse width waveform to create the IC control voltage (DC voltage) output.



Since the pulse width can be changed with the RC time constant, the slope of the VCTL - speed graph can be changed. However, since pulses determined by the RC time constant are used, sample-to-sample variations in the RC components will appear as speed control errors.

• Notes on the FVREF Pin

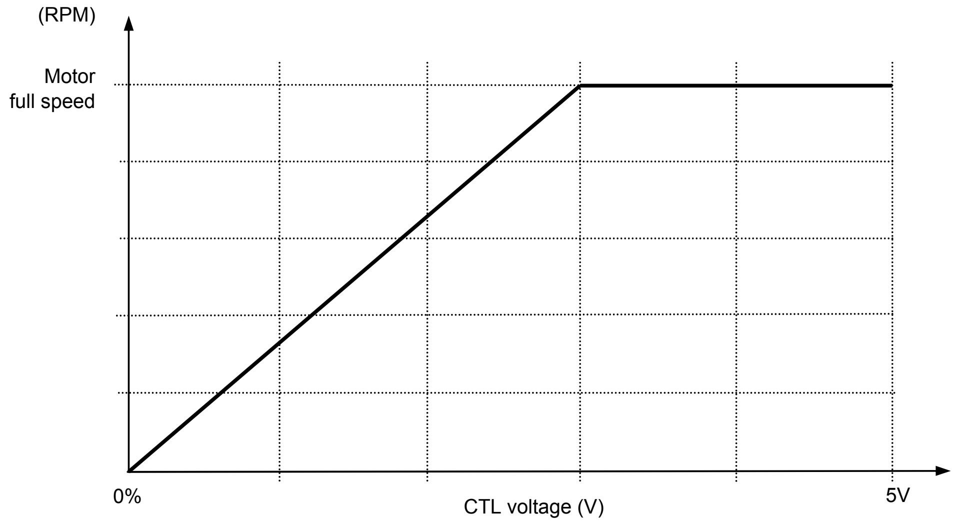
Set the FVREF pin to the ground level to set the speed control diagram origin to 0% = 0 rpm. (See application circuit 1.)

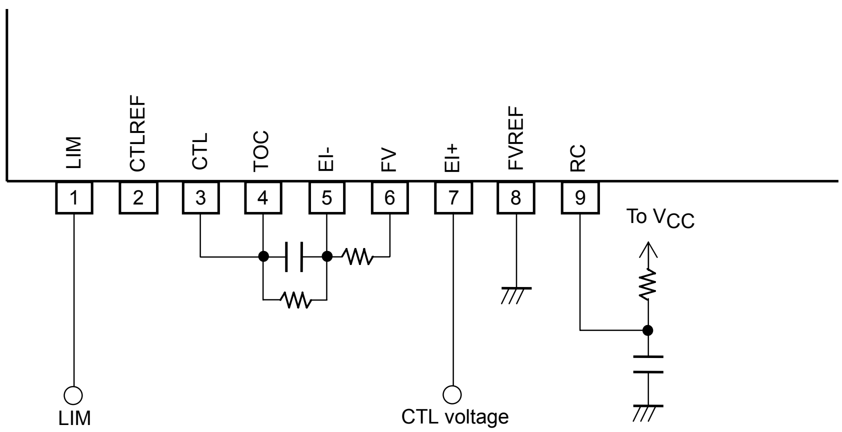
Input a voltage to the FVREF pin to shift the origin of the speed control diagram in the X direction from 0% = 0 rpm. (See application circuit 2)

Provide inputs such as those shown in application circuit 3 to shift the origin of the speed control diagram in the Y direction from 0% = 0 rpm.

Application Example 1

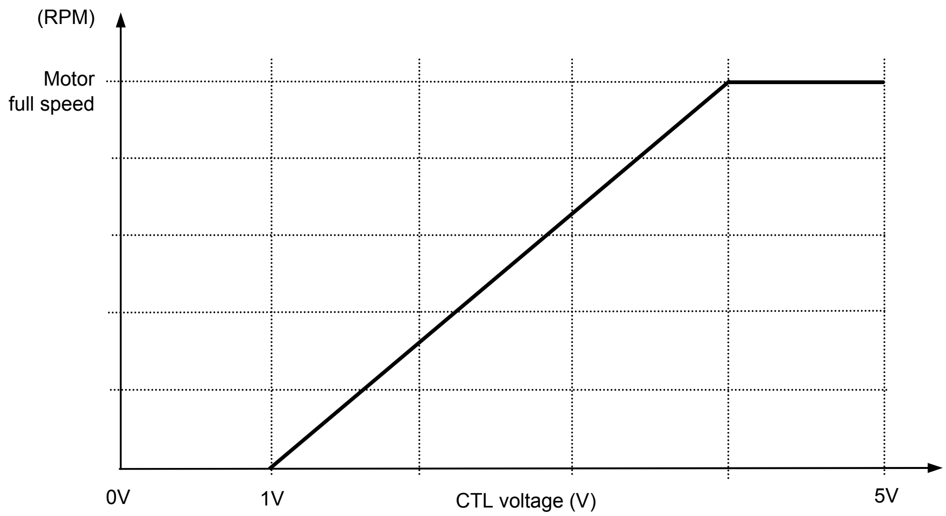
[Origin 0% = 0rpm]

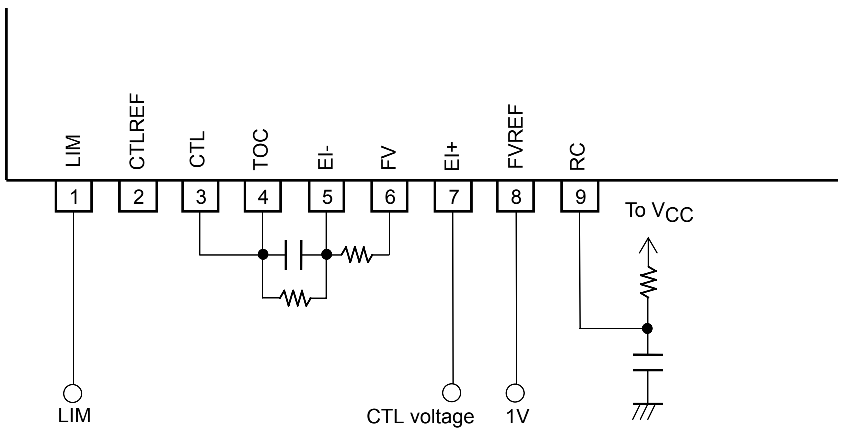




Application Example 2

[Origin Shift - The Motor Turns at 1V and Higher]

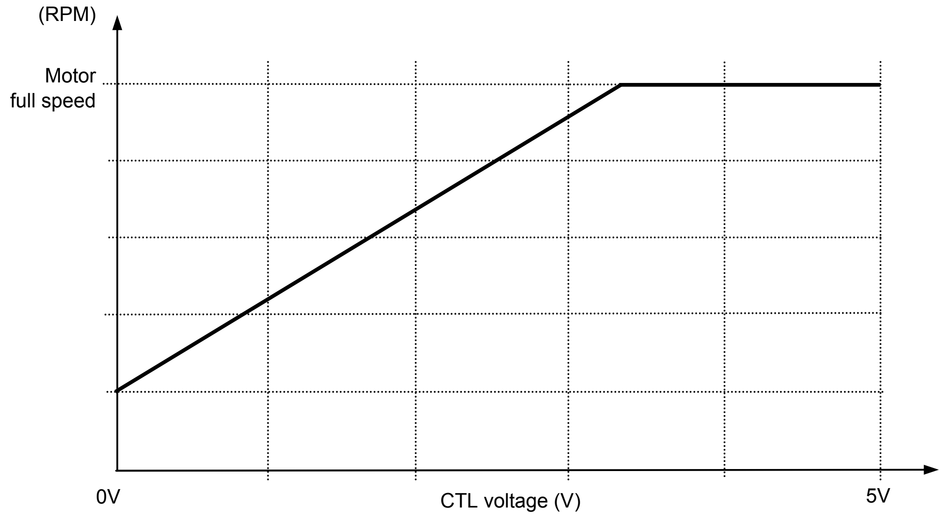


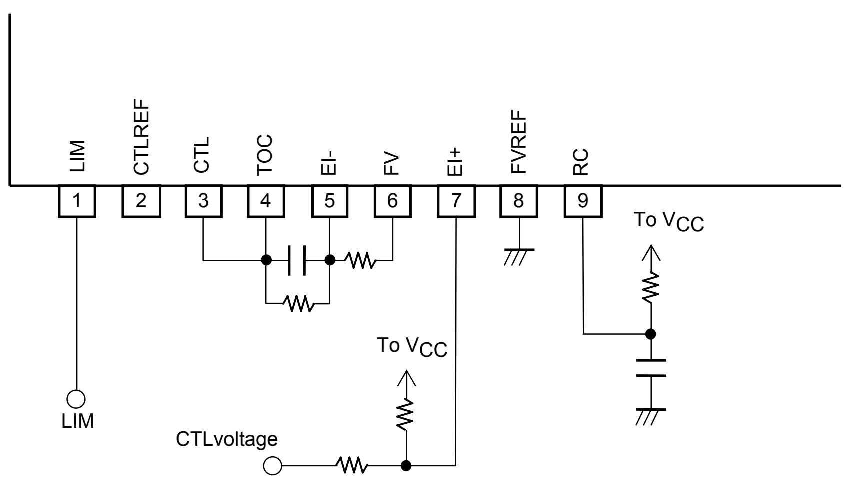


Input the voltage at which you want rotation to start to the FVREF pin.

Application Example 3

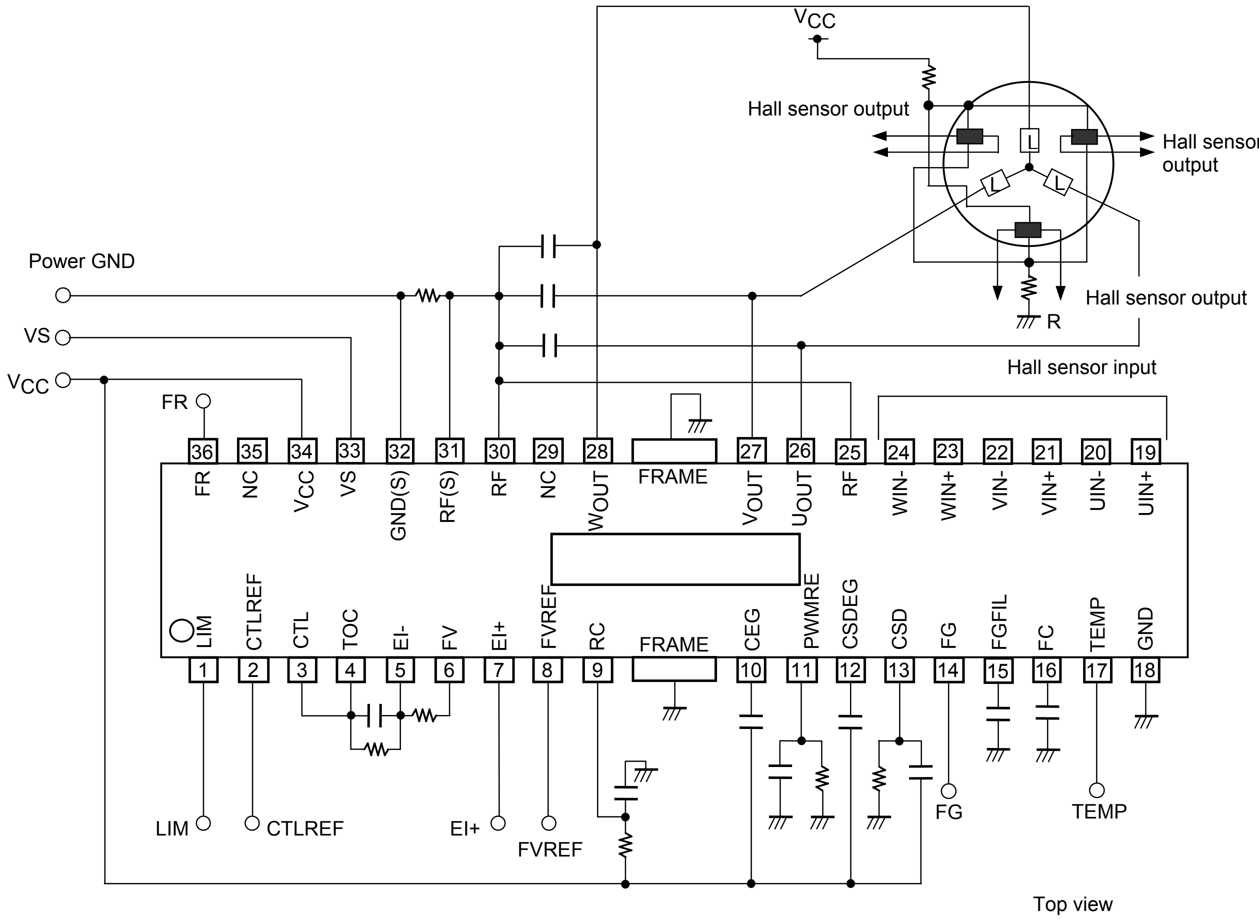
[Origin Shift - The Motor Turns at a 0V Input]





To set up the speed control diagram so that the motor turns at 0V, voltage divide the potential between the V_{CC} pin and the CTL input, and apply the divided level to the EI+ pin. The motor speed at a 0V input can be changed by changing the ratio of the voltage divider resistors.

Peripheral Circuit Example



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