

LB11620GP

Three-Phase Direct PWM Brushless Motor Driver

Overview

The LB11620GP is a direct PWM drive pre-driver IC that is optimal for three-phase power brushless motors. A motor driver circuit with the desired output capability (voltage and current) can be implemented by adding discrete transistors or other power devices to the outputs of this IC. Since the LB11620GP is provided in a miniature package, it is also appropriate for use with miniature motors as well.

Features

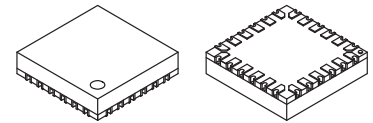
- Three-phase bipolar drive
- Direct PWM drive (input of either a control voltage or a variable-duty PWM signal)
- Built-in forward/reverse switching circuit
- 5V regulator output (VREG pin)
- Built-in current limiter circuit (0.25V (typical) reference voltage)
- Built-in under voltage protection circuit
- Built-in automatic recovery type constraint protection circuit (ON: OFF=1:18) with protection operating state discrimination output (RD pin)
- Hall signal pulse outputs

Typical Applications

- Server
- Home appliance



ON Semiconductor®
www.onsemi.com



VCT24 (3.5x3.5)

GENERIC MARKING DIAGRAM*



XXXXXX = Specific Device Code
Y = Year
M = Month
DDD = Additional Traceability Data

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present.

ORDERING INFORMATION

Ordering Code:
LB11620GP-TE-L-H

Package
VCT24
(Pb-Free / Halogen Free)

Shipping (Qty / packing)
2000 / Tape & Reel

† For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
http://www.onsemi.com/pub_link/Collateral/BRD8011-D.PDF

LB11620GP

Specifications

MAXIMUM RATINGS / $T_a = 25^\circ\text{C}$ (Note 1)

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V_{CC} max	V_{CC} pin	18	V
Output current	I_O max	UL, VL, WL, UH, VH, WH pins	30	mA
Allowable power dissipation	P_d max	*Mounted on a circuit board.	1.0	W
Operating temperature	T_{opr}		-30 to +100	$^\circ\text{C}$
Storage temperature	T_{stg}		-55 to +150	$^\circ\text{C}$

1. Stresses exceeding those listed in the Absolute Maximum Rating table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

2. Mounted on a circuit board: 40.0mm×50.0mm×0.8mm, glass epoxy board.

RECOMMENDED OPERATING RANGES at $T_a = 25^\circ\text{C}$ (Note 3)

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage range 1-1	V_{CC1-1}	V_{CC} pin	8 to 17	V
Supply voltage range 1-2	V_{CC1-2}	V_{CC} pin, with V_{CC} shorted to VREG	4.5 to 5.5	V
Output current	I_O	UL, VL, WL, UH, VH, WH pins	25	mA
5 V constant voltage output current	IREG		-30	mA
HP pin voltage	VHP		0 to 17	V
HP pin output current	IHP		0 to 15	mA
RD pin voltage	VRD		0 to 17	V
RD pin output current	IRD		0 to 15	mA

3. Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

ELECTRICAL CHARACTERISTICS at $T_a = 25^\circ\text{C}$, $V_{CC} = 12\text{V}$ (Note 4)

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage 1	I_{CC1}			12	16	mA
5V constant voltage output (VREG pin)						
Output voltage	VREG		4.7	5.0	5.3	V
Line regulation	ΔV_{REG1}	$V_{CC} = 8$ to 17V		40	100	mV
Load regulation	ΔV_{REG2}	$I_O = -5$ to -20mA		10	30	mV
Temperature coefficient	ΔV_{REG3}	Design target		0		mV/ $^\circ\text{C}$
Low-voltage protection circuit (VREG pin)						
Operating voltage	VSDL		3.5	3.7	3.9	V
Clear voltage	VSDH		3.95	4.15	4.35	V
Hysteresis	ΔV_{SD}		0.3	0.45	0.6	V
Output Block						
Output voltage 1-1	V_{OUT1-1}	Low level $I_O = 400\mu\text{A}$		0.2	0.5	V
Output voltage 1-2	V_{OUT1-2}	Low level $I_O = 10\text{mA}$		0.9	1.2	V
Output voltage 2	V_{OUT2}	High level $I_O = -20\text{mA}$	$V_{CC-1.1}$	$V_{CC-0.9}$		V
Output leakage current	I_{Oleak}				10	μA

Continued on next page

LB11620GP

Continued from preceding page.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Hall Amplifier Block						
Input bias current	IHB (HA)		-2	-0.5		μA
Common-mode input voltage range 1	VICM1	When a Hall effect sensor is used	0.5		V _{CC} -2.0	V
Common-mode input voltage range 2	VICM2	For single-sided input bias (Hall IC application)	0		V _{CC}	V
Hall input sensitivity			80			mVp-p
Hysteresis	ΔV _{IN} (HA)		15	24	40	mV
Input voltage low → high	VSLH (HA)		5	12	20	mV
Input voltage high → low	VSHL (HA)		-20	-12	-5	mV
PWM Oscillator (PWM pin)						
High-level output voltage	V _{OH} (PWM)		2.75	3.0	3.25	V
Low-level output voltage	V _{OL} (PWM)		1.2	1.35	1.5	V
External capacitor charge current	ICHG	VPWM = 2.1V	-120	-90	-65	μA
Oscillator frequency	f (PWM)	C = 2000pF		22		kHz
Amplitude	V (PWM)		1.4	1.6	1.9	Vp-p
EI+ pin						
Input bias current	IB (CTL)		-1		1	μA
Common-mode input voltage range	VICM		0		VREG-1.7	V
Input voltage 1	VCTL1	Output duty 100%		3.0		V
Input voltage 2	VCTL2	Output duty 0%		1.35		V
Input voltage 1L	VCTL1L	Design target value. When VREG = 4.7V, 100%		2.82		V
Input voltage 2L	VCTL2L	Design target value. When VREG = 4.7V, 0%		1.29		V
Input voltage 1H	VCTL1H	Design target value. When VREG = 5.3V, 100%		3.18		V
Input voltage 2H	VCTL2H	Design target value. When VREG = 5.3V, 0%		1.44		V
HP pin						
Output saturation voltage	VHPL	I _O = 10mA		0.2	0.5	V
Output leakage current	IHPleak	V _O = 18V			10	μA
CSD oscillator (CSD pin)						
High-level output voltage	V _{OH} (CSD)		2.7	3.0	3.3	V
Low-level output voltage	V _{OL} (CSD)		0.7	1.0	1.3	V
External capacitor charge current	ICHG1	VCSD = 2V	-3.15	-2.5	-1.85	μA
External capacitor discharge current	ICHG2	VCSD = 2V	0.1	0.14	0.18	μA
Charge/discharge current ratio	RCSD	Charge current /discharge current	15	18	21	Times
RD pin						
Low-level output voltage	VRDL	I _O = 10mA		0.2	0.5	V
Output leakage current	IL (RD)	V _O = 18V			10	μA
Current limiter circuit (RF pin)						
Limiter voltage	VRF	RF-GND	0.225	0.25	0.275	V
PWMIN pin						
Input frequency	f (PI)				60	kHz
High-level input voltage	V _{IH} (PI)		2.0		VREG	V
Low-level input voltage	V _{IL} (PI)		0		1.0	V
Input open voltage	V _{IO} (PI)		VREG-0.5		VREG	V
Hysteresis	V _{IS} (PI)		0.2	0.25	0.4	V
High-level input current	I _{IH} (PI)	VPWMIN = VREG	-10	0	10	μA
Low-level input current	I _{IL} (PI)	VPWMIN = 0V	-130	-90		μA

Continued on next page

LB11620GP

Continued from preceding page.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
F/R pin						
High-level input voltage	V_{IH} (FR)		2.0		VREG	V
Low-level input voltage	V_{IL} (FR)		0		1.0	V
Input open voltage	V_{IO} (FR)		VREG-0.5		VREG	V
Hysteresis	V_{IS} (FR)		0.2	0.25	0.4	V
High-level input current	I_{IH} (FR)		-10	0	10	μ A
Low-level input current	I_{IL} (FR)		-130	-90		μ A
N1 pin						
High-level input voltage	V_{IH} (N1)		2.0		VREG	V
Low-level input voltage	V_{IL} (N1)		0		1.0	V
Input open voltage	V_{IO} (N1)		VREG-0.5		VREG	V
High-level input current	I_{IH} (N1)	VN1 = VREG	-10	0	10	μ A
Low-level input current	I_{IL} (N1)	VN1 = 0V	-130	-100		μ A

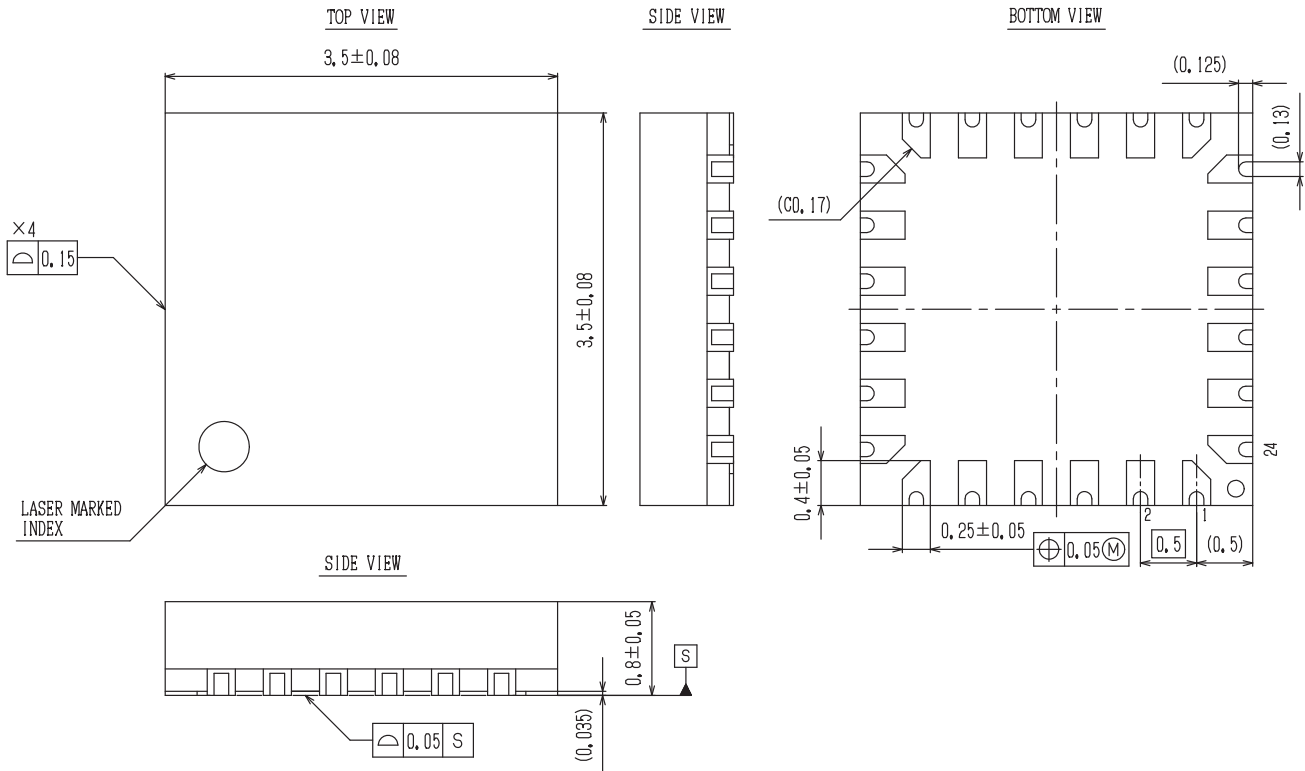
4. Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

LB11620GP

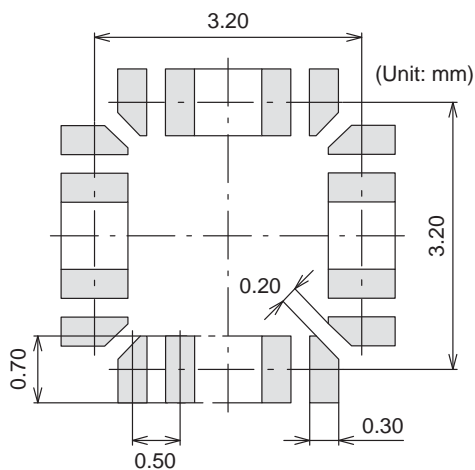
Package Dimensions

unit : mm (typ)

VCT24 3.5x3.5, 0.5P
CASE 601AD
ISSUE A



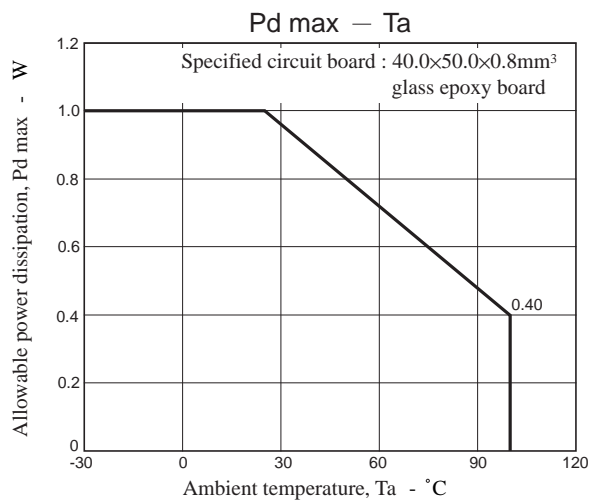
SOLDERING FOOTPRINT*



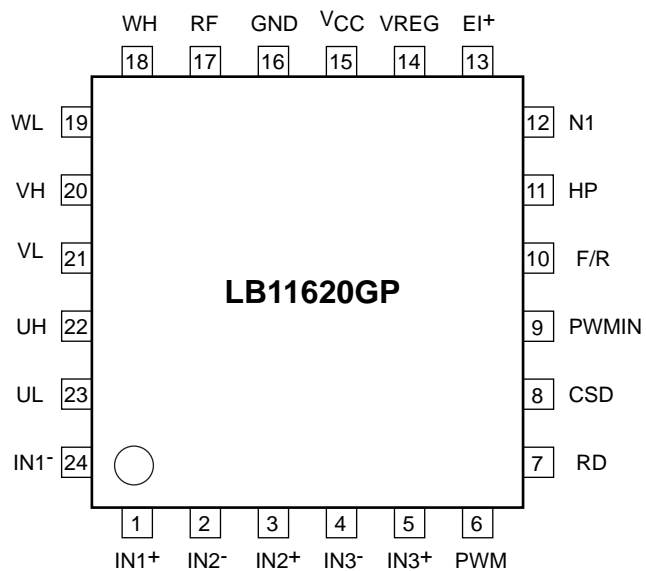
NOTE: The measurements are not to guarantee but for reference only.

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

LB11620GP



Pin Assignment



LB11620GP

- Three-Phase Logic Truth Table (IN = “H” indicates the state where $IN^+ > IN^-$)

	F/R = “L”			F/R=“H”			Output	
	IN1	IN2	IN3	IN1	IN2	IN3	PWM	
1	H	L	H	L	H	L	VH	UL
2	H	L	L	L	H	H	WH	UL
3	H	H	L	L	L	H	WH	VL
4	L	H	L	H	L	H	UH	VL
5	L	H	H	H	L	L	UH	WL
6	L	L	H	H	H	L	VH	WL

- PWMIN pin

Input state	State
High or open	Output off
Low	Output on

If the PWM pin is not used, the input must be held at the low level.

- N1 pin

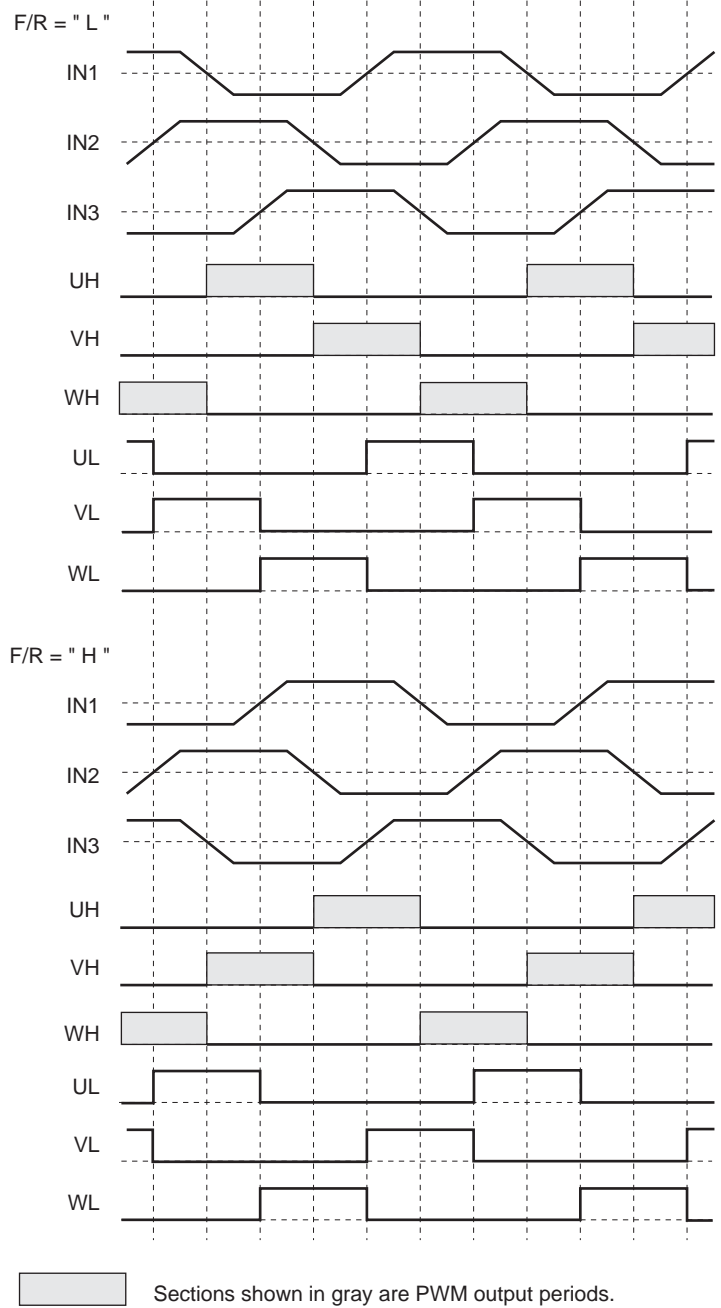
Input state	HP output
High or open	Three Hall sensor synthesized output
Low	Single Hall sensor output

Explanation of Pin Functions

Pin No.	Pin	Description
1, 24 3, 2 5, 4	IN1 ⁺ , IN1 ⁻ IN2 ⁺ , IN2 ⁻ IN3 ⁺ , IN3 ⁻	Hall sensor inputs from each motor phase. The logic high state indicates that $IN^+ > IN^-$. If inputs are provided by a Hall effect sensor IC, the common-mode input range is expanded by biasing either the + or - input.
6	PWM	Functions as both the PWM oscillator frequency setting pin and the initial reset pulse setting pin. Connect a capacitor between this pin and ground.
7	RD	Lock (motor constrained) detection state output. This output is turned on when the motor is turning and off when the lock protection function detects that the motor has been stopped. This is an open collector output.
8	CSD	Sets the operating time for the lock protection circuit. Connect a capacitor between this pin and ground. Connect this pin to ground if the lock protection function is not used.
9	PWMIN	PWM pulse signal input. The output goes to the drive state when this pin is low and to the off state when this pin is high or open. To use this pin for control, a CTL amplifier input such that the TOC pin voltage goes to the 100% duty state must be provided.
10	F/R	Forward/reverse control input
11	HP	Hall signal output (HP output). This provides either a single Hall sensor output or a synthesized 3-sensor output.
12	N1	Hall signal output (HP output) selection
13	EI+	CTL amplifier + (no inverting) input. The PWMIN pin must be held at the low level to use this input for motor control
14	VREG	5V regulator output (Used as the control circuit power supply. A low-voltage protection circuit is built in.) Connect a capacitor between this pin and ground for stabilization.
15	V _{CC}	Power supply. Connect a capacitor between this pin and ground to prevent noise and other disturbances from affecting this IC.
16	GND	Ground
17	RF	Output current detection. The current detection resistor (R _f) voltage is sensed by the RF pin to implement current detection. The maximum output current is set by RF to be $I_{OUT} = 0.25/R_f$.
22 20 18	UH VH WH	Outputs (PWM outputs). These are push-pull outputs.
23 21 19	UL VL WL	Outputs These are push-pull outputs.

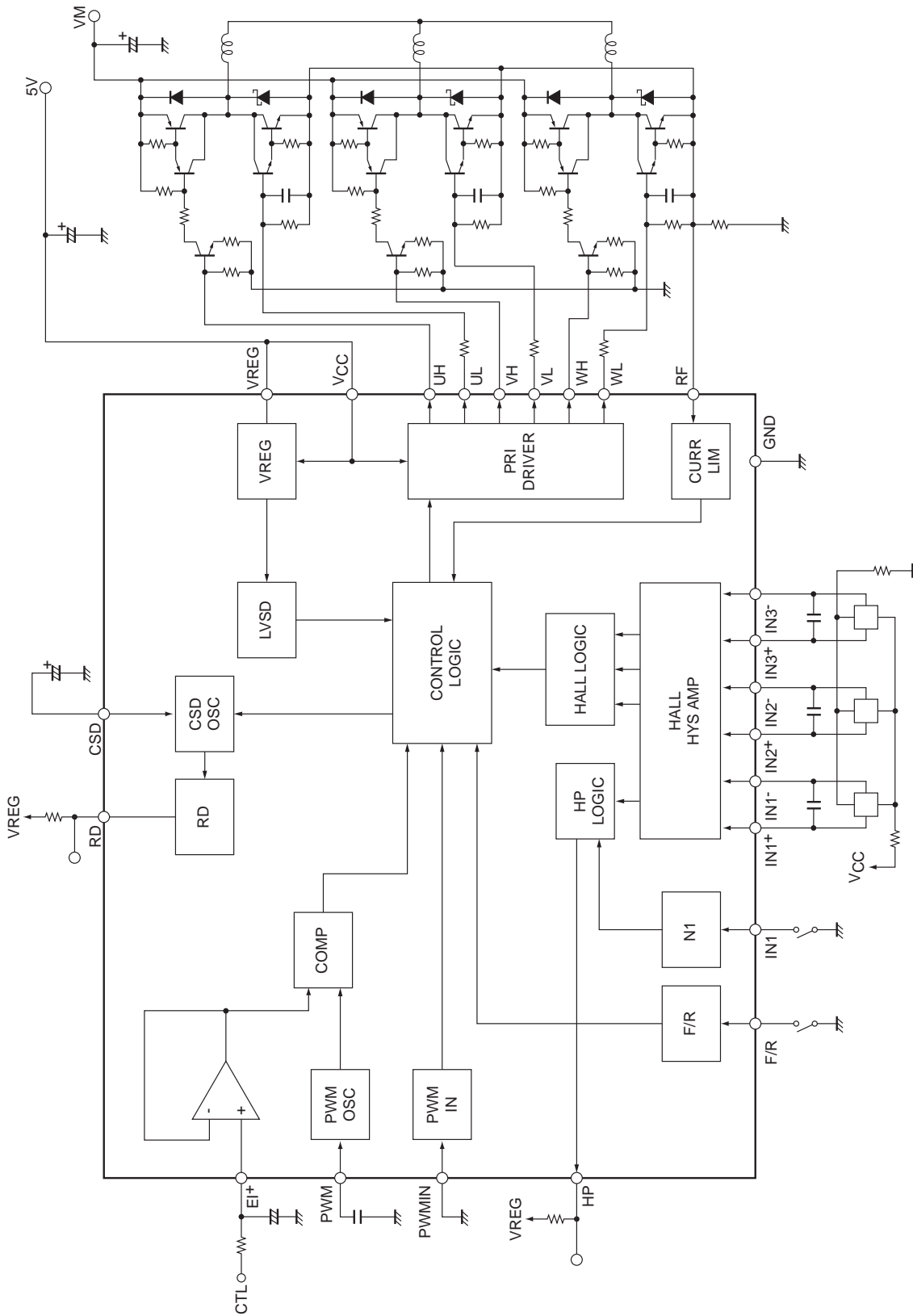
LB11620GP

Hall Sensor Signal Input/Output Timing Chart



Block Diagram and Application Example 1

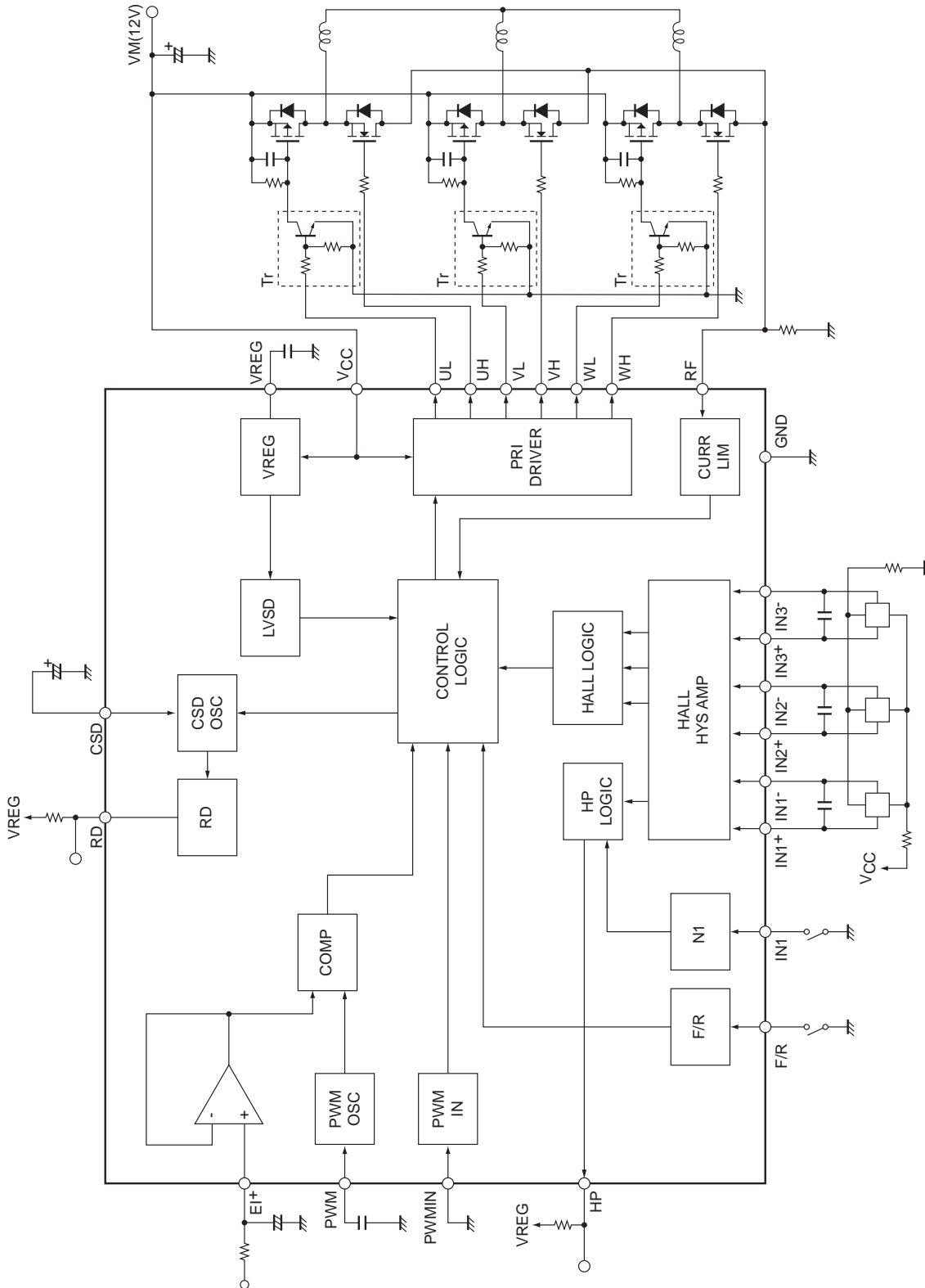
Bipolar transistor drive (high side PWM)
Using a 5V power supply



LB11620GP

Application Example 2

54 MOS transistor drive (low side PWM)
Using a 12V single-voltage power supply

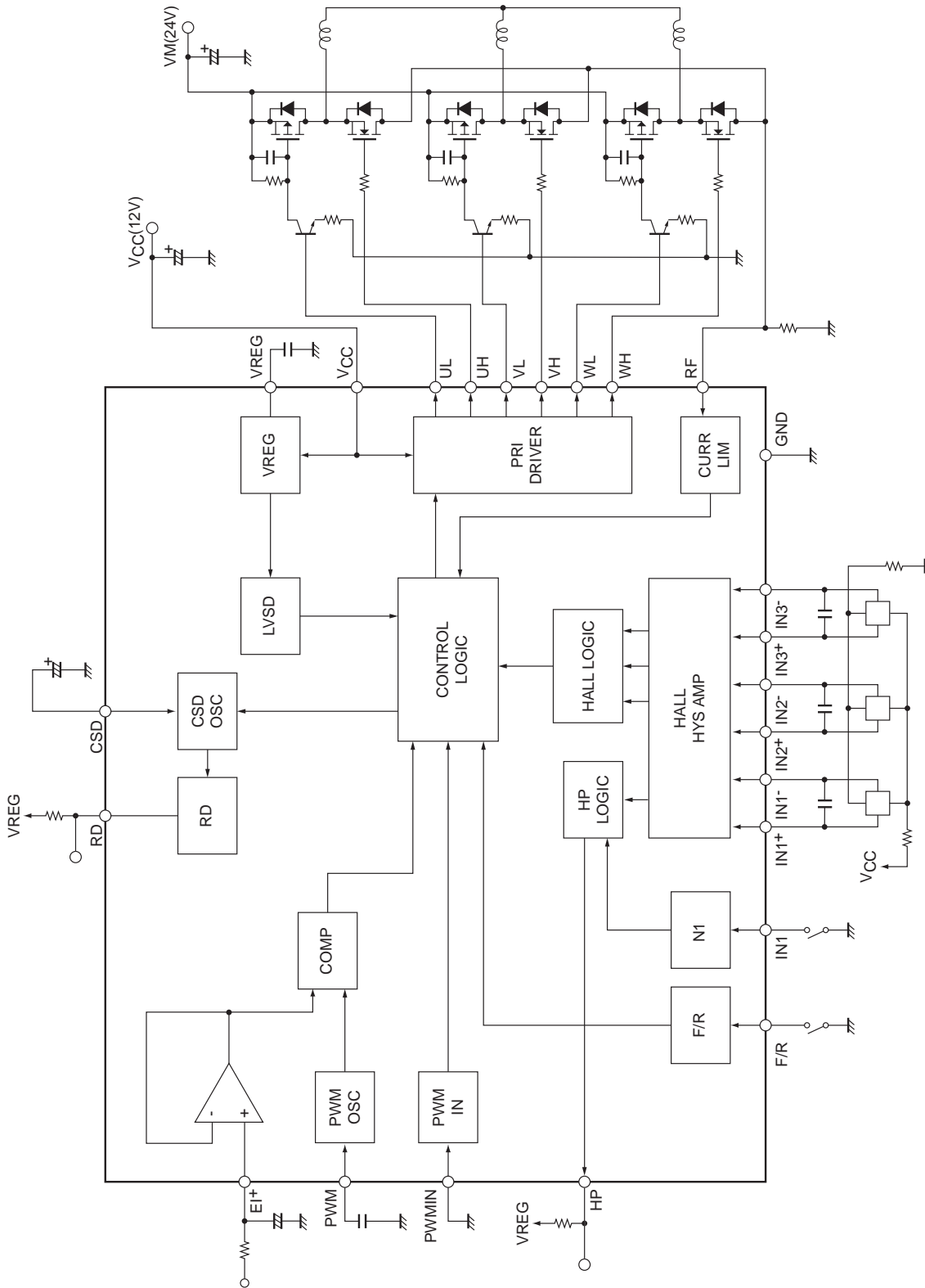


LB11620GP

Application Example 3

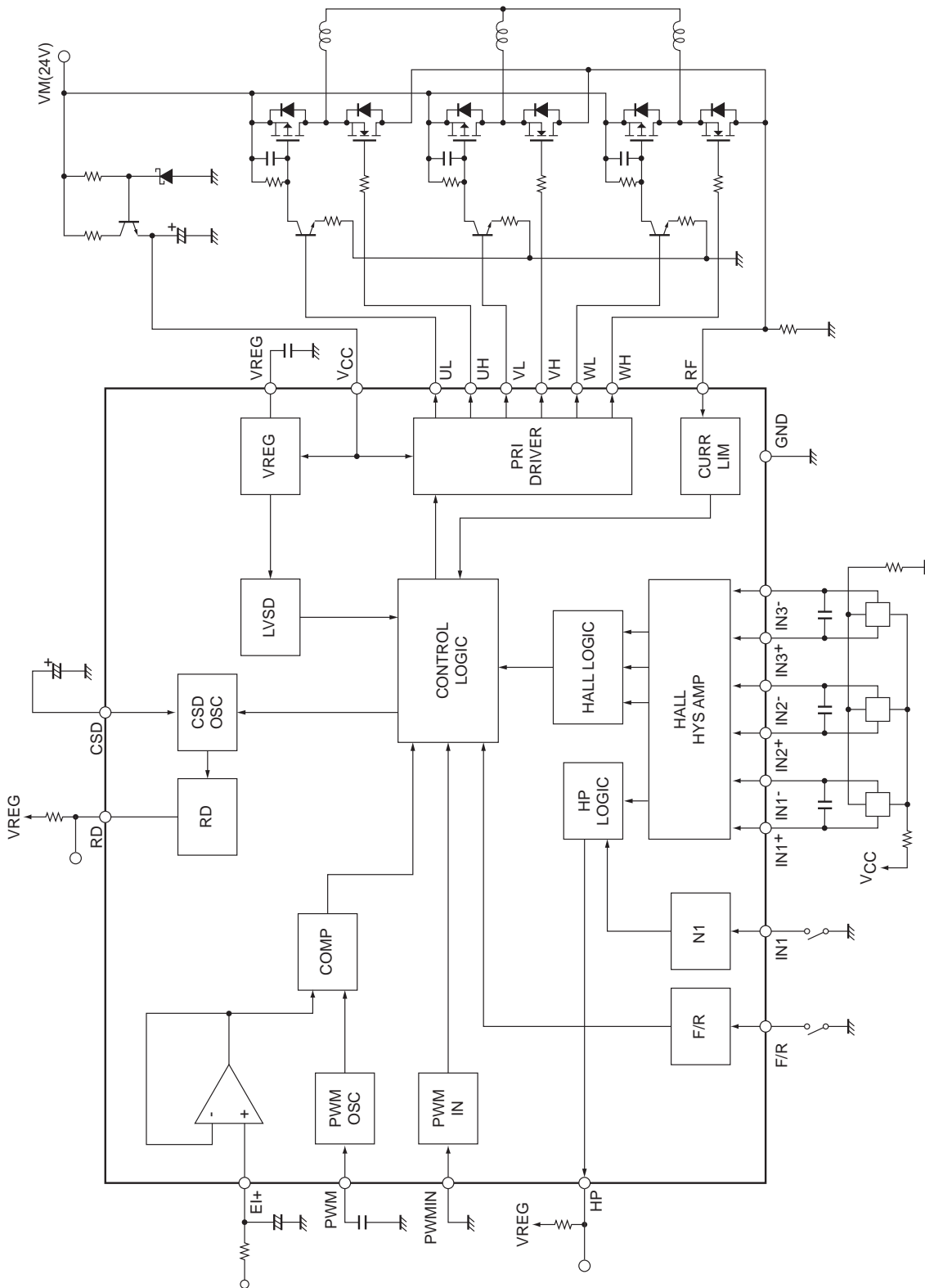
MOS transistor drive (low side PWM)

Using a $V_{CC} = 12V$, $V_M = 24V$ power supply system



Application Example 4

MOS transistor drive (low side PWM)
Using a 24V single-voltage power supply



LB11620GP

Pin Functions

PIN No.	PIN name	Function	Equivalent circuit
24 1 2 3 4 5	IN1- IN1+ IN2- IN2+ IN3- IN3+	Hall input pin. IN+ > IN- to "H", IN+ < IN- to "L". Connect the capacitor between IN+ and IN- when the noise of the hall signal becomes a problem.	
6	PWM	Functions as both the PWM oscillator frequency setting pin and the initial reset pulse setting pin. Connect a capacitor between this pin and ground. It is possible to set it to about 22kHz with C=2000pF.	
7	RD	Lock (motor constrained) detection state output. This output is turned on when the motor is turning and off when the lock protection function detects that the motor has been stopped.	
11	HP	Hall signal output pin. Two kinds of outputs can be selected by setting the N1 pin.	
8	CSD	Sets the operating time for the lock protection circuit. Connect a capacitor between this pin and ground. Connect this pin to ground if the lock protection function is not used.	
9	PWMIN	PWM pulse signal input. The output goes to the drive state when this pin is low and to the off state when this pin is high or open. To use this pin for control, a CTL amplifier input such that the TOC pin voltage goes to the 100% duty state must be provided.	
10	F/R	Forward/reverse control input.	

Continued on next page

LB11620GP

Continued from preceding page.

PIN No.	PIN name	Function	Equivalent circuit
10	F/R	Forward/reverse control input.	
12	N1	Hall signal output (HP output) selection.	
13	EI+	CTL amplifier + (no inverting) input. The PWMIN pin must be held at the low level to use this input for motor control.	
14	VREG	Stabilizing supply output pin. (5V output) Connect a capacitor between this pin and ground for stabilization. (about 0.1μF level)	
15	VCC	Power supply. Connect a capacitor between this pin and ground to prevent noise and other disturbances from affecting this IC.	
16	GND	Ground	
17	RF	Output current sensing pin. The low resistance is connected between RF and GND. It sets it by output maximum current $I_{OUT}=0.25/R_f$.	
18 19 20 21 22 23	WH WL VH VL UH UL	Output pin. (Driving external TR output) The duty is controlled on UH, VH, and WH side.	

ON Semiconductor and the ON logo are registered trademarks of Semiconductor Components Industries, LLC (SCILLC) or its subsidiaries in the United States and/or other countries. SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.