



SANYO Semiconductors

# DATA SHEET

## LB11995H — Monolithic Digital IC For CD-ROM Spindle Motor Driver Three-Phase Brushless Motor Driver

### Overview

LB11995H is a 3-phase brushless motor driver especially suited for CD-ROM spindle motor drivers.

### Features

- Current linear drive
- Separate power supply for output upper side bias circuit allows low output saturation by boosting this power supply only (useful for 5V power supply types).
- Upper side current detection technique loses loss voltage of current detection resistor. Voltage drop caused by this resistor reduces internal power dissipation of IC.
- Built-in short braking circuit
- Hall FG output
- Built-in current limiter circuit (selectable, 2 steps)
- Built-in thermal shutdown circuit
- Control V type amplifier
- Built-in reverse blocking circuit
- Built-in S/S function
- Built-in Hall power supply
- Supports 3.3V DSP

### Specifications

Maximum Ratings at  $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage	$V_{CC1 \text{ max}}$		7.0	V
	$V_{CC2 \text{ max}}$		14.4	V
	$V_{CC3 \text{ max}}$		14.4	V
Maximum applied output voltage	$V_O \text{ max}$		14.4	V
Maximum applied input voltage	$V_I \text{ max}$		$V_{CC1}$	V
Maximum output current	$I_O \text{ max}$		1.3	A
Allowable power dissipation	$P_d \text{ max}$	Independent IC	0.8	W
		*With specified substrate	1.9	W
Operating temperature	$T_{opr}$		-20 to +75	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-55 to +150	$^\circ\text{C}$

\* When mounted on the specified printed circuit board : 114.3mm × 76.1mm × 1.6mm, glass epoxy

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## Operating Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage	V <sub>CC1</sub>		4 to 6	V
	V <sub>CC2</sub>	≥ V <sub>CC1</sub>	4 to 13.6	V
	V <sub>CC3</sub>		4 to 13.6	V

## Application Example at Ta = 25°C

Parameter	Power supply pin	Conditions	Ratings	Unit
12V type	V <sub>CC1</sub>	Regulated voltage	4 to 6	V
	V <sub>CC2</sub> = V <sub>CC3</sub>	Unregulated voltage	4 to 13.6	V
5V type	V <sub>CC1</sub> = V <sub>CC3</sub>	Regulated voltage	4 to 6	V
	V <sub>CC2</sub>	Boost-up voltage or regulated voltage (Note)	4 to 13.6	V

Note : When boost-up voltage is used at V<sub>CC2</sub>, output can be set to low-saturation.

## Electrical Characteristics at Ta = 25°C, V<sub>CC1</sub> = 5V, V<sub>CC2</sub> = V<sub>CC3</sub> = 12V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Power supply current</b>						
Power supply current	I <sub>CC1</sub>	V <sub>C</sub> = V <sub>CREF</sub>		8		mA
	I <sub>CC2</sub>	V <sub>C</sub> = V <sub>CREF</sub>		0		mA
	I <sub>CC3</sub>	V <sub>C</sub> = V <sub>CREF</sub>		150	250	μA
Output idle current	I <sub>CC10Q</sub>	V <sub>S/S</sub> = 0V			200	μA
	I <sub>CC20Q</sub>	V <sub>S/S</sub> = 0V			30	μA
	I <sub>CC30Q</sub>	V <sub>S/S</sub> = 0V			30	μA
<b>Output</b>						
Saturation voltage, upper side 1	V <sub>OU1</sub>	I <sub>O</sub> = -0.5A, V <sub>CC1</sub> = 5V, V <sub>CC2</sub> = V <sub>CC3</sub> = 12V		1.0		V
Saturation voltage, lower side 1	V <sub>OD1</sub>	I <sub>O</sub> = 0.5A, V <sub>CC1</sub> = 5V, V <sub>CC2</sub> = V <sub>CC3</sub> = 12V		0.3		V
Saturation voltage, upper side 2	V <sub>OU2</sub>	I <sub>O</sub> = -0.5A, V <sub>CC1</sub> = V <sub>CC3</sub> = 5V, V <sub>CC2</sub> = 12V		0.3		V
Saturation voltage, lower side 2	V <sub>OD2</sub>	I <sub>O</sub> = 0.5A, V <sub>CC1</sub> = V <sub>CC3</sub> = 5V, V <sub>CC2</sub> = 12V		0.3		V
Current limiter setting voltage	V <sub>CL1</sub>	R <sub>RF</sub> = 0.33Ω, LMC : OPEN		0.24		V
	V <sub>CL2</sub>	R <sub>RF</sub> = 0.33Ω, LMC : GND		0.37		V
<b>Hall amplifier</b>						
Common mode input voltage range	V <sub>HCOM</sub>		1.2		V <sub>CC</sub> -1.0	V
Input bias current	V <sub>HIB</sub>			1		μA
Minimum Hall input level	V <sub>HIN</sub>		60			mVp-p
<b>S/S pin</b>						
High level voltage	V <sub>S/SH</sub>		2.0		V <sub>CC1</sub>	V
Low level voltage	V <sub>S/SL</sub>				0.7	V
Input current	I <sub>S/SI</sub>	V <sub>S/S</sub> = 5V			200	μA
Leak current	I <sub>S/SL</sub>	V <sub>S/S</sub> = 0V	-30			μA
<b>Control</b>						
V <sub>C</sub> pin input current	I <sub>VC</sub>	V <sub>C</sub> = V <sub>CREF</sub> = 1.65V			1	μA
V <sub>CREF</sub> pin input current	I <sub>VCREF</sub>	V <sub>C</sub> = V <sub>CREF</sub> = 1.65V			1	μA
Voltage gain	G <sub>VCO</sub>	ΔV <sub>RE</sub> /ΔV <sub>C</sub>		0.35		times
Startup voltage	V <sub>CTH</sub>	V <sub>CREF</sub> = 1.65V	1.5		1.8	V
Startup voltage width	ΔV <sub>CTH</sub>	V <sub>CREF</sub> = 1.65V	50		150	mV
<b>Hall power supply</b>						
Hall power supply voltage	V <sub>H</sub>	I <sub>H</sub> = 5mA		0.8		V
Allowable current	I <sub>H</sub>		20			mA
<b>Thermal shutdown</b>						
Operating temperature	T <sub>TSD</sub>	Design target value *	150	180	210	°C
Hysteresis	ΔT <sub>TSD</sub>	Design target value *		15		°C

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Short braking</b>						
Brake pin at High level	$V_{BRH}$		4		5	V
Brake pin at Low level	$V_{BRL}$		0		1	V

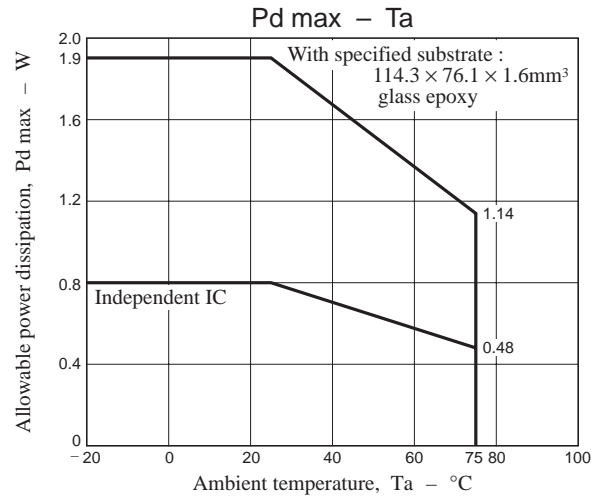
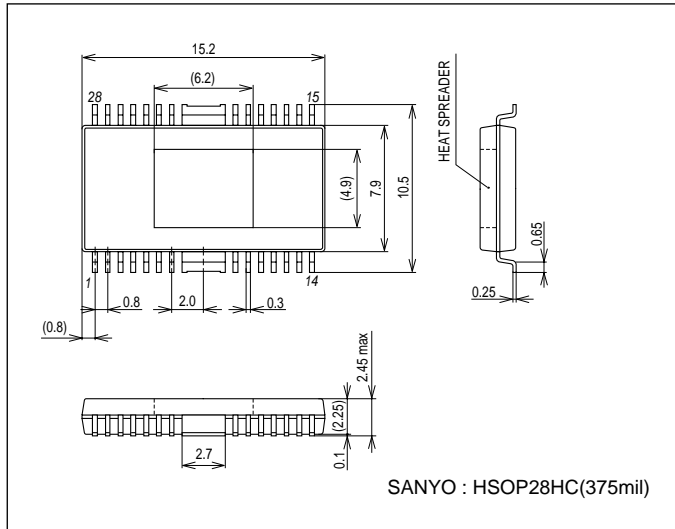
Note : During S/S OFF (standby), the Hall comparator is at High.

\* Design target values are not tested.

## Package Dimensions

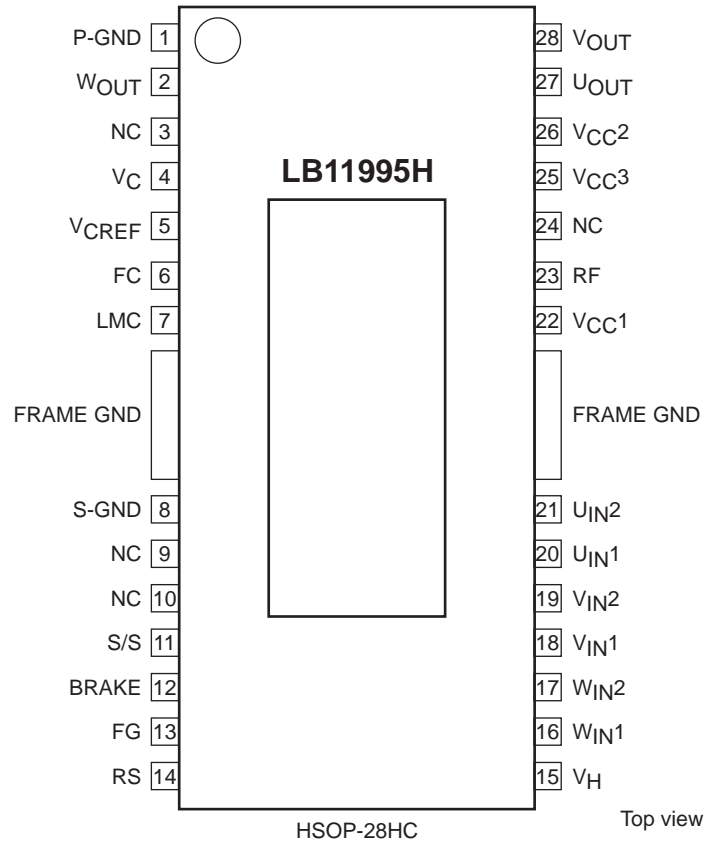
unit : mm (typ)

3234B



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## Pin Assignment



## Truth Table

	Source Sink	Hall input			Control V <sub>C</sub>
		U	V	W	
1	Phase W → Phase V	H	H	L	H
	Phase V → Phase W				L
2	Phase W → Phase U	H	L	L	H
	Phase U → Phase W				L
3	Phase V → Phase W	L	L	H	H
	Phase W → Phase V				L
4	Phase U → Phase V	L	H	L	H
	Phase V → Phase U				L
5	Phase V → Phase U	H	L	H	H
	Phase U → Phase V				L
6	Phase U → Phase W	L	H	H	H
	Phase W → Phase U				L

Input :

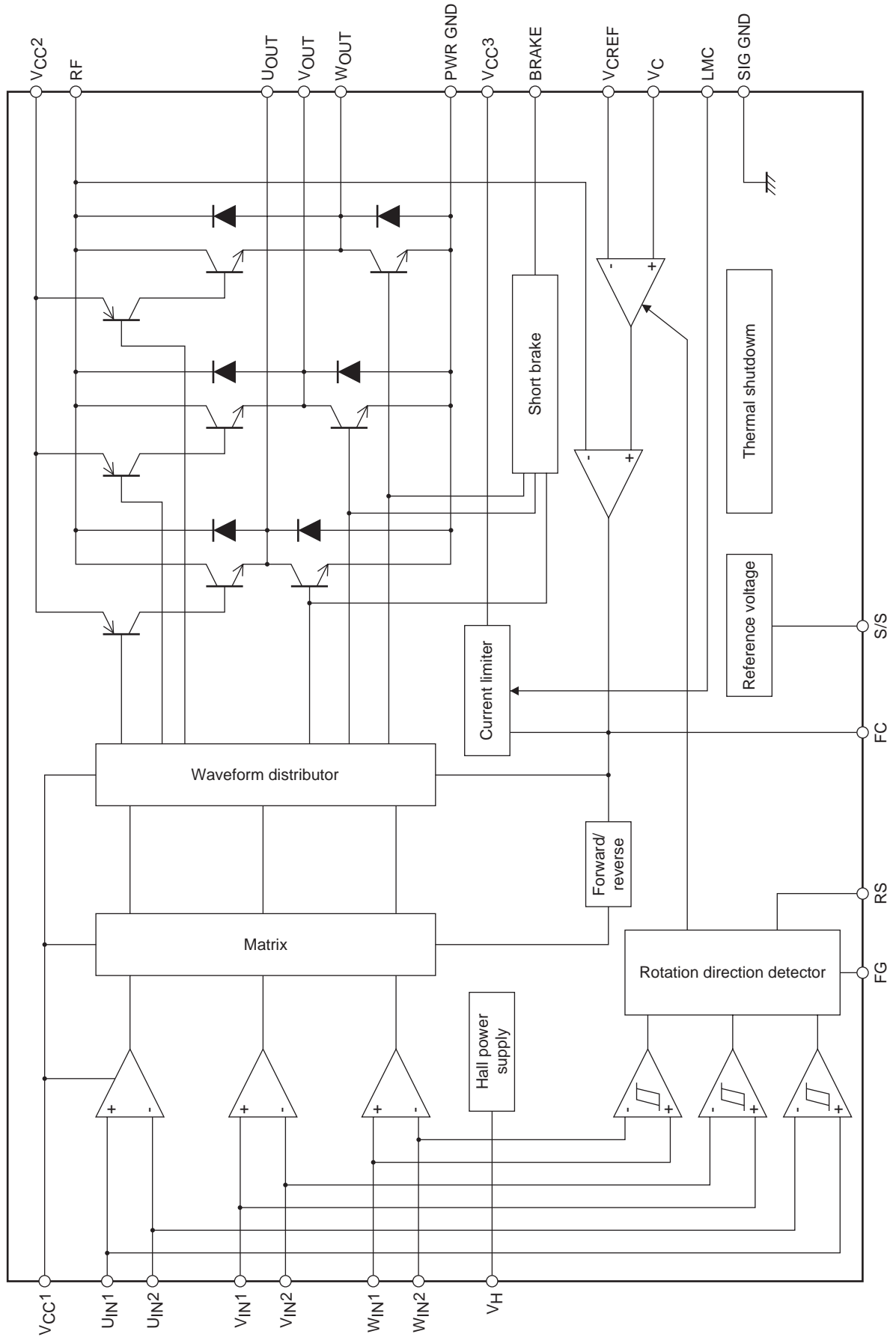
H : Input 1 is higher in potential than input 2 by at least 0.2V.

L : Input 1 is lower in potential than input 2 by at least 0.2V.

## Brake Operation Truth Table

BRAKE pin	Operation
H	Short brake
Low or open	Normal rotation

Block Diagram



Pin Functions

Pin No.	Pin name	Pin function	Pin voltage	Equivalent circuit
26	V <sub>CC2</sub>	Source side predrive voltage supply pin.	4V to 13.6V	
25	V <sub>CC3</sub>	Constant current control amplifier voltage supply pin.	4V to 13.6V	
22	V <sub>CC1</sub>	Power supply pin for all circuits except output transistors, source predrive, and low current control amplifier.	4V to 6V	
14	RS	Reverse detector pin. Forward rotation : High Reverse rotation : Low		
13	FG	1 Hall element waveform Schmitt comparator composite output.		
20	U <sub>IN1</sub>	U phase Hall element input and reverse detector U phase Schmitt comparator input pin.	1.2V to V <sub>CC1</sub> -1V	
21	U <sub>IN2</sub>	U phase Hall element input and reverse detector U phase Schmitt comparator input pin. Logic High indicates U <sub>IN1</sub> > U <sub>IN2</sub> .		
18	V <sub>IN1</sub>	V phase Hall element input and reverse detector V phase Schmitt comparator input pin.		
19	V <sub>IN2</sub>	V phase Hall element input and reverse detector V phase Schmitt comparator input pin. Logic High indicates V <sub>IN1</sub> > V <sub>IN2</sub> .		
16	W <sub>IN1</sub>	W phase Hall element input and reverse detector W phase Schmitt comparator input pin.		
17	W <sub>IN2</sub>	W phase Hall element input and reverse detector W phase Schmitt comparator input pin. Logic High indicates W <sub>IN1</sub> > W <sub>IN2</sub> .		
15	V <sub>H</sub>	Hall element lower side bias voltage supply pin.		
11	S/S	When this pin is at 0.7V or lower, or when it is open, all circuits are inactive. When driving motor, set this pin to 2V or higher.	0V to V <sub>CC1</sub>	
8	SIG GND	GND pin for all circuits except output.		
6	FC	Control loop frequency compensator pin. Connecting a capacitor between this pin and GND prevents closed loop oscillation in current limiting circuitry.		

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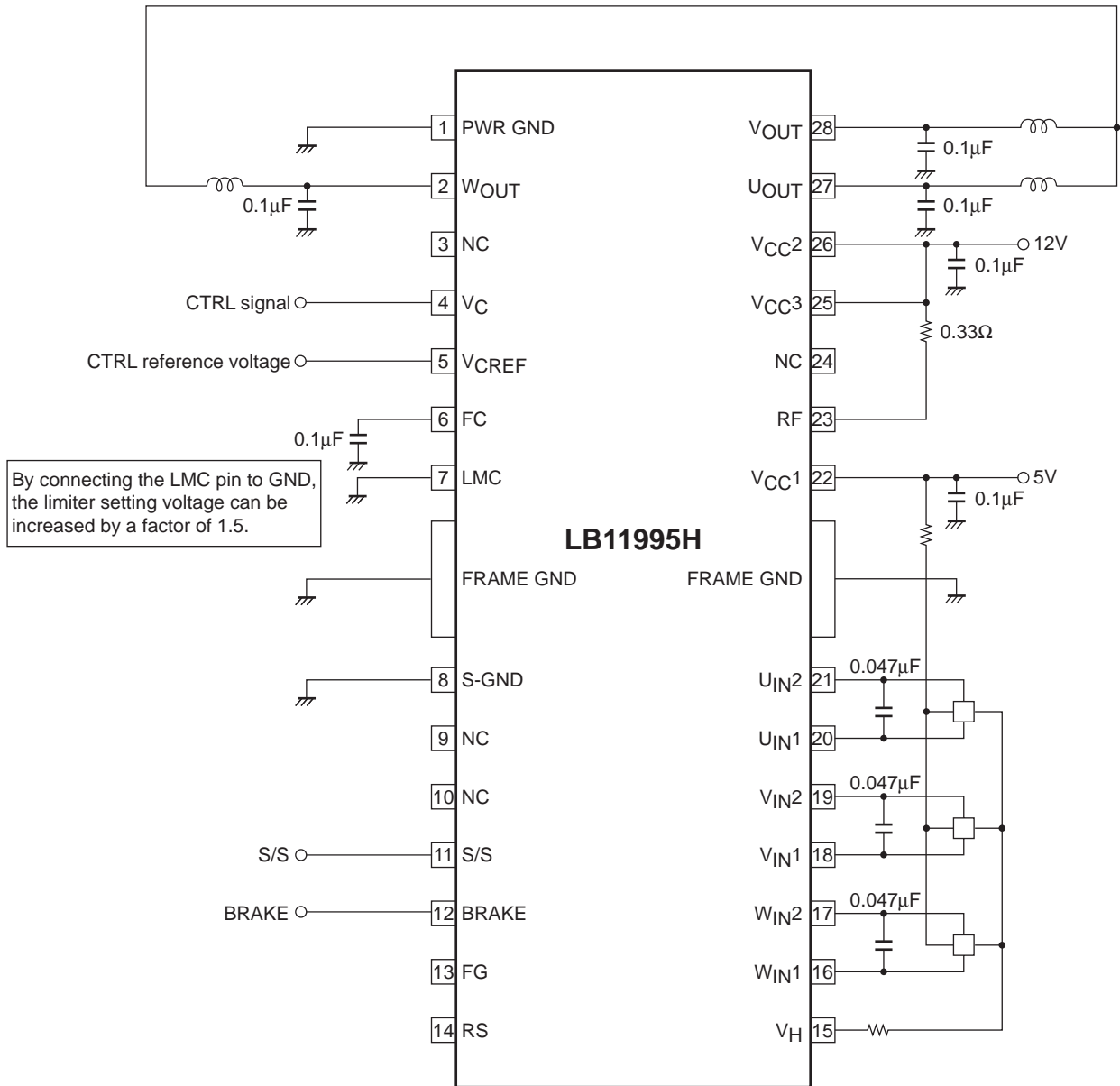
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Pin No.	Pin name	Pin function	Pin voltage	Equivalent circuit
5	V <sub>CREF</sub>	Control reference voltage applied pin. Determines control start voltage.	0V to V <sub>CC1</sub> -1.5V	
4	V <sub>C</sub>	Speed control voltage applied pin. V type control technique V <sub>C</sub> > V <sub>CREF</sub> : Forward V <sub>C</sub> < V <sub>CREF</sub> : Slowdown (Reverse-blocking circuit prevents reverse rotation.)	0V to V <sub>CC1</sub>	
2	W <sub>OUT</sub>	W-phase output.		
1	PWR GND	Output transistor GND.		
28	V <sub>OUT</sub>	V-phase output.		
27	U <sub>OUT</sub>	U-phase output.		
23	RF	Upper side output NPN transistor collector pin (common for all 3 phases). For current detection, connect resistor between V <sub>CC3</sub> pin and RF pin. Constant current control and current limiter works by detecting this voltage.		
7	LMC	When this pin is connected to GND, the limiter setting current is increased by a factor of 1.5.		
12	BRAKE	Short brake pin. BRAKE : High → Brake Low/Open → Drive		

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## Sample Application Circuit (12V Version)

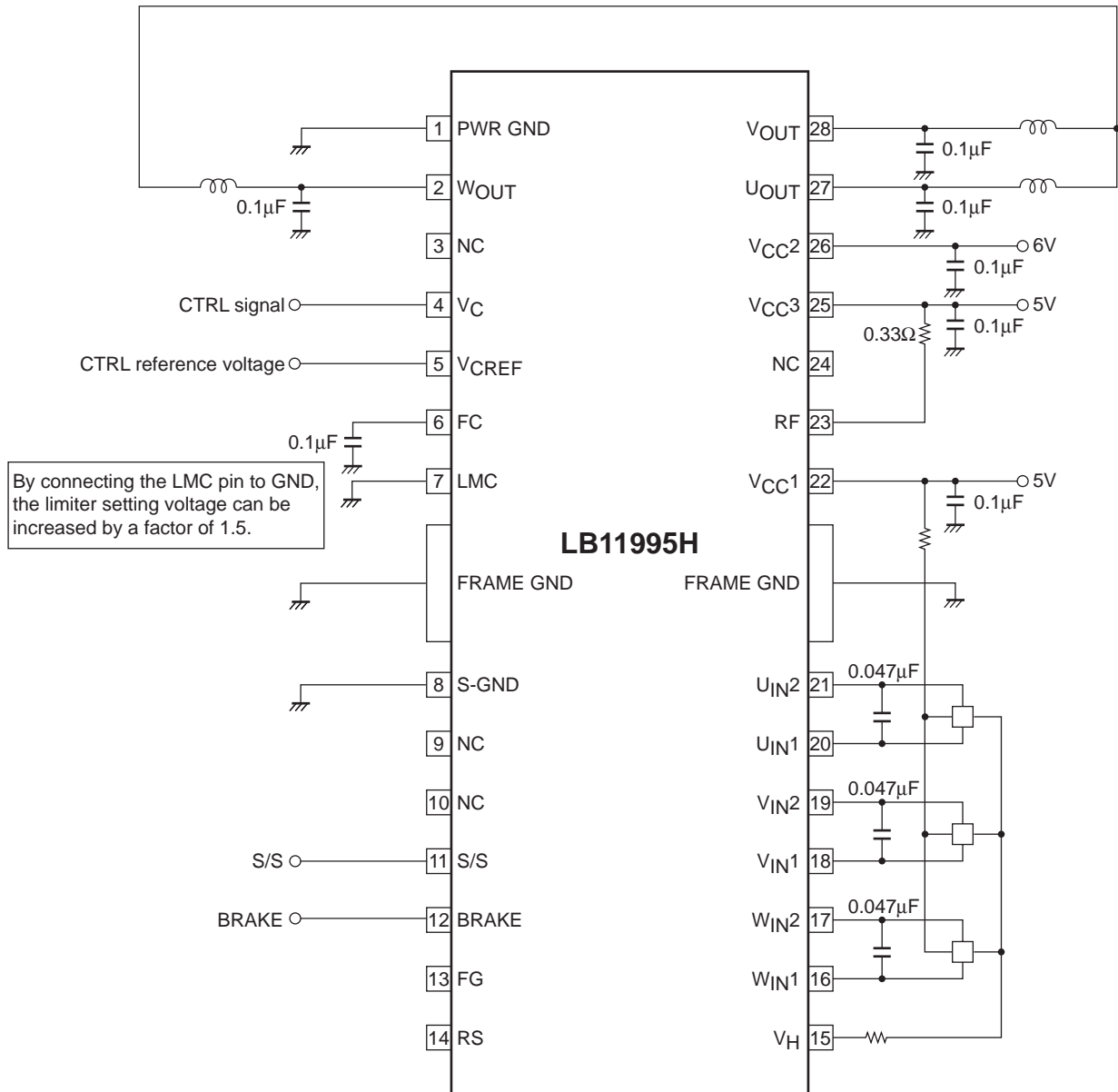


Power supply-GND  
Output-GND  
Between Hall input

Capacitor requirements may change depending on motor.  
For some motors, capacitor between Hall input may not be needed.

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## Sample Application Circuit (5V Version)



Power supply-GND  
Output-GND  
Between Hall input

Capacitor requirements may change depending on motor.  
For some motors, capacitor between Hall input may not be needed.

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