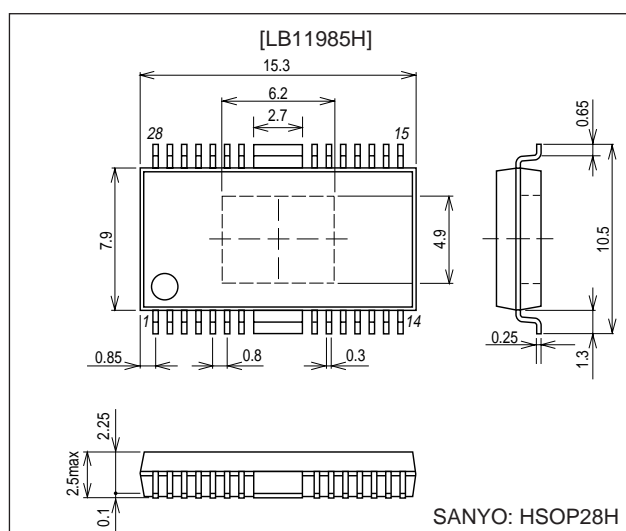


**LB11985H****VCR Capstan Motor Brushless Motor Driver****Functions**

- Three-phase current linear drive with switching between full-wave and half-wave operations
- Torque ripple correction circuit
- Current limiter circuit
- Upper and lower sides output stage saturation prevention circuits
- Short brake circuit
- FG amplifier
- Thermal shutdown circuit

**Package Dimensions**

unit: mm

**3233-HSOP28H****Specifications****Absolute Maximum Ratings at Ta = 25°C**

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V <sub>CCmax</sub>		6	V
	V <sub>Smax</sub>		15.5	V
Maximum output current	I <sub>Omax</sub>		1.5	A
Maximum output voltage	V <sub>Omax</sub>		30	V
Allowable power dissipation	P <sub>dmax</sub>	Independent IC	0.8	W
		76.1 × 114.3 × 1.6 mm <sup>3</sup> : With glass epoxy	2.0	W
Operating temperature	T <sub>opr</sub>		-20 to +75	°C
Storage temperature	T <sub>stg</sub>		-55 to +150	°C

**Allowable Operating Ranges at Ta = 25°C**

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V <sub>S</sub>		8 to 15	V
	V <sub>CC</sub>		4.5 to 5.5	
Hall input amplitude	V <sub>HALL</sub>	Between Hall inputs	±20 to ±100	mV 0-P
GSENSE input range	V <sub>GSENSE</sub>	With respect to the control system ground	-0.20 to +0.20	V

Note : Forward/reverse switching is not possible in half-wave operation mode.

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# LB11985H

## Electrical Characteristics at Ta = 25°C, VCC = 5 V, VS = 15 V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
VCC current drain	ICC	RL = ∞, VCTL = 0 V (quiescent mode)		10	15	mA
[Output]						
Output saturation voltage	VOsat1	IO = 500 mA, Rf = 0.5 Ω, Sink + Source VCTL = VLIM = 5 V (with saturation prevention)		2.2	2.7	V
	VOsat2	IO = 1.0 A, Rf = 0.5 Ω, Sink + Source VCTL = VLIM = 5 V (with saturation prevention)		2.8	3.7	V
Output leakage current	Ioleak				1.0	mA
[FR]						
FR pin input Threshold voltage	VFR		1		4	V
FR pin input Input bias current	Ib (FR)	VFR = 5 V		100	150	μA
[BR]						
BR pin input Threshold voltage	VBRTH		1		4	V
BR pin input Input bias current	Ib (BR)	VBR = 5 V		100	150	μA
[Control]						
CTLREF pin voltage	VCREF		2.0	2.15	2.3	V
CTLREF pin input range	VCREFIN		1		4	V
CTL pin input bias current	Ib (CTL)	VCTL = 5 V, with CTLREF open			5	μA
CTL pin control start voltage	VCTL (ST)	Rf = 0.5 Ω, VLIM = 5 V, IO ≥ 40 mA With the Hall input logic states fixed (U, V, W = high, high, low)	2.0	2.2	2.4	V
CTL pin control Gm	Gm (CTL)	Rf = 0.5 Ω, ΔIO = 200 mA With the Hall input logic states fixed (U, V, W = high, high, low)	1.8	2.25	2.7	V
[Current Limiter]						
LIM current limit offset voltage	Voff (LIM)	Rf = 0.5 Ω, VCTL = 5 V, IO ≥ 40 mA With the Hall input logic states fixed (U, V, W = high, high, low)	80	200	320	mV
LIM pin input bias current	Ib (LIM)	VCTL = 5 V, VREF: OPEN, VLIM = 0 V	-2	-1		μA
LIM pin current limit level	Gm (LIM)	Rf = 0.5 Ω, VCTL = 5 V With the Hall input logic states fixed (U, V, W = high, high, low)	0.37	0.47	0.57	mA
[Hall Amplifier]						
Input offset voltage	Voff (HALL)		-6		+6	mV
Input bias current	Ib (HALL)			1.0	3.0	μA
Common-mode input voltage	Vcm (HALL)		1.3		3.3	V
Torque ripple correction ratio	TRC	At the bottom and peak that occur in the Rf waveform at 200 mA (Rf = 0.5 Ω)		14.5		%
[FG Amplifier]						
FG amplifier input offset voltage	Voff (FG)		-8		+8	mV
FG amplifier input bias current	Ib (FG)		-100			nA
FG amplifier output saturation voltage	VOsat (FG)	For the sink side, at the internal pull-up resistor		0.4	0.55	V
FG amplifier common-mode input voltage	VCM (FG)		1.0		4.0	V
[Saturation]						
Saturation prevention circuit lower side set voltage	VOsat (DET)	IO = 10 mA, Rf = 0.5 Ω, VCTL = VLIM = 5 V The voltages between the OUT-Rf pairs at full wave.	0.13	0.25	0.42	V
[Schmitt Amplifier]						
Duty	DUTY	60 mVp-p, 1 kHz input *1	49	50	51	%
Upper side output saturation voltage	Vsatu (SH)		4.8			V
Lower side output saturation voltage	Vsatd (SH)				0.2	V
Hysteresis	Vhys	Design target values *2		45		mV
TSD operating temperature	T-TSD	Design target values *2		180		°C
TSD hysteresis	ΔT-TSD	Design target values *2		15		°C

Note \*1 : The ratings are just the measured value with no margin afforded.

\*2 : Items shown to be design target values in the conditions column are not measured.

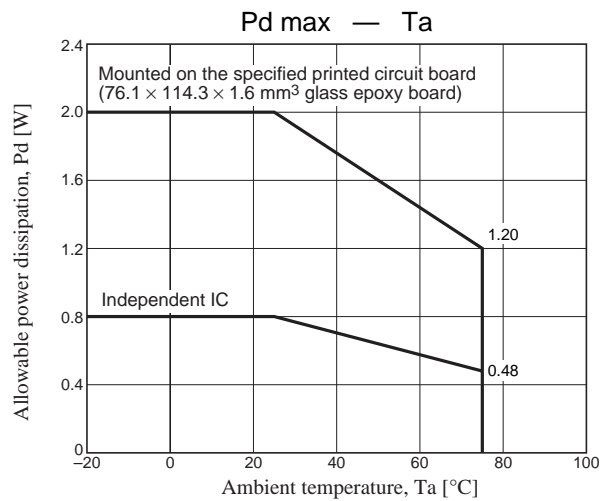
### Truth Table and Control Functions

	Source → Sink	Hall input			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

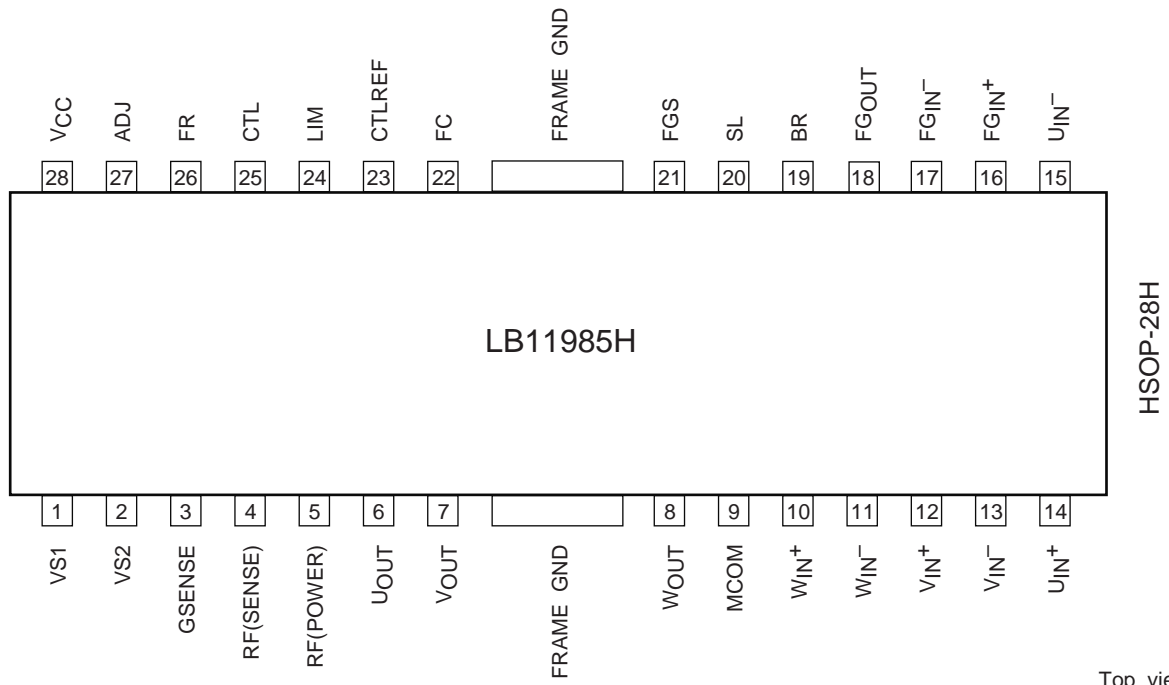
Note: 1. In the FR column, "H" indicates a voltage of 2.75 V or higher, and "L" indicates a voltage of 2.25 V or lower. (When  $V_{CC}$  is 5 V.)

2. For the Hall inputs, the input high state is defined to be the state where the (+) input is higher than the corresponding (–) input by at least 0.02 V, and the input low state is defined to be the state where the (+) input is lower than the corresponding (–) input by at least 0.02 V.

### Allowable Power Dissipation

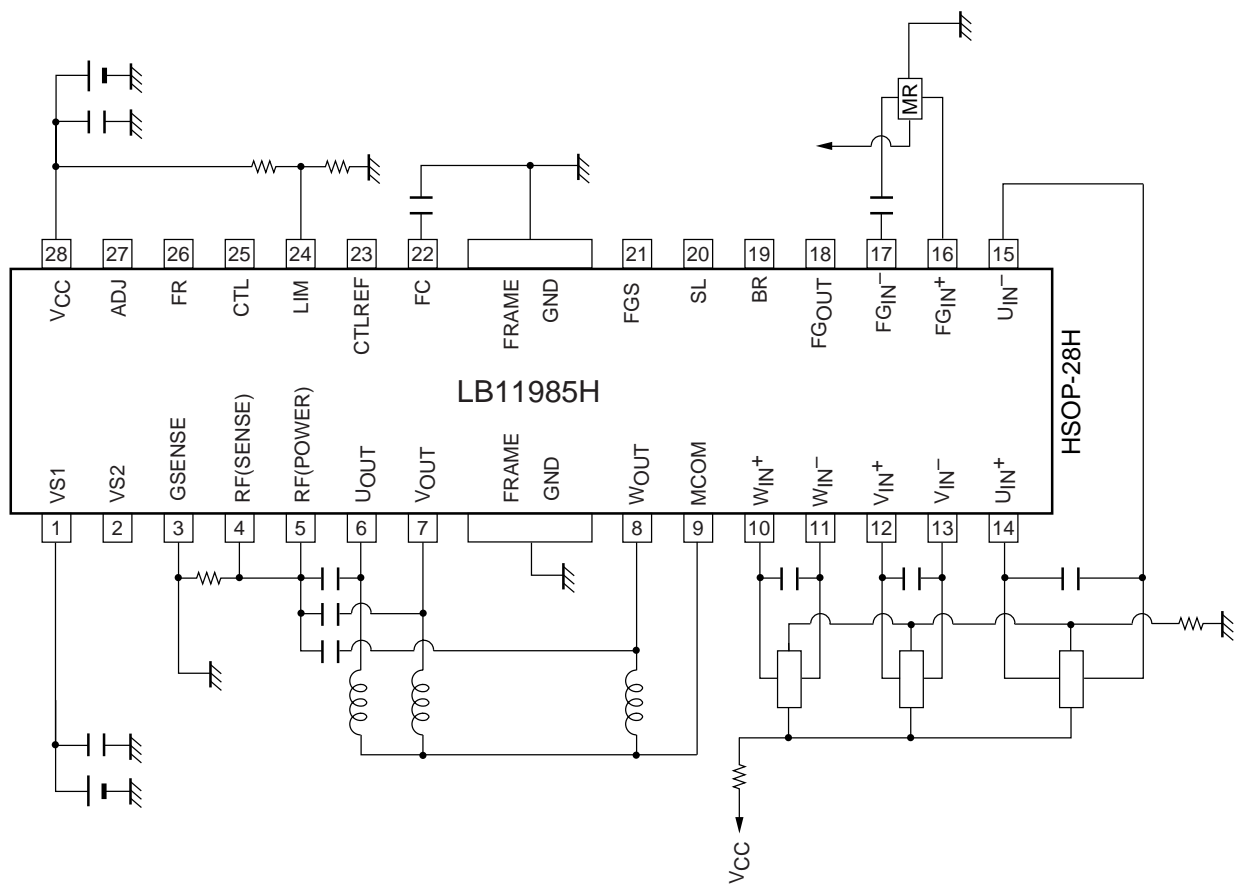


## Pin Assignment



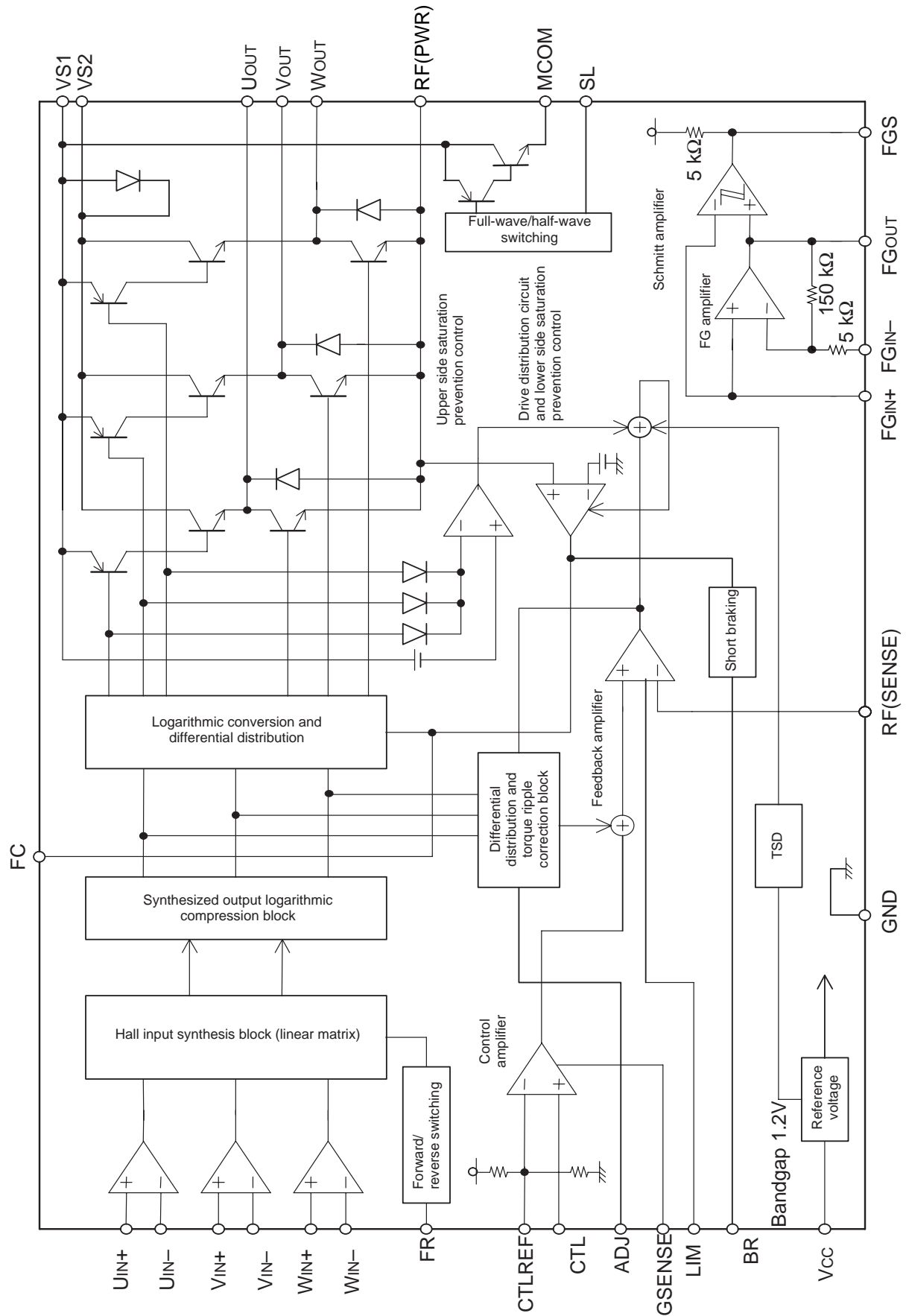
Top view

## Sample Application Circuit



A12221

## Block Diagram



## Pin Functions

Unit (resistance :  $\Omega$ )

Pin No.	Symbol	Pin Voltage	Description	Equivalent circuit
	FRAME GND		Ground for circuits other than the output transistors. The lowest potential of the output transistors will be the that of the RF pin.	
1	VS1	8 V to 15 V	Output block power supply	
2	VS2		A diode is internally connected between VS1 and this pin to prevent reverse current flow in half-wave operating mode.	
3	GSENSE		Ground sensing. The influence of the common ground impedance on Rf can be excluded by connecting this pin to the ground near the Rf resistor in the motor ground lines that include RF. (This pin must not be left open.)	
4 5	RF(SENSE) RF(POWER)		Output current detection. Current feedback is applied to the control block by inserting the resistor Rf between these pins and ground. Also, both the lower side saturation prevention circuit and the torque ripple correction circuit operate according to the voltage on this pin. In particular, since this voltage sets the oversaturation prevention level, the lower side oversaturation prevention operation can be degraded if the value of this resistor is set too low. Note that the POWER pin and the SENSE pin must be connected together.	
6 7 8	U <sub>OUT</sub> V <sub>OUT</sub> W <sub>OUT</sub>		Coil output	
9	MCOM		Motor midpoint connection. Half-wave drive is implemented by connecting the motor midpoint to this pin.	

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# LB11985H

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Unit (resistance :  $\Omega$ , current : A )

Pin No.	Symbol	Pin Voltage	Description	Equivalent circuit
10	$W_{IN+}$	1.3 V to 3.3 V ( $V_{CC} = 5\text{ V}$ )	W phase Hall element input. Logic "H" is defined as the state where $W_{IN+} > W_{IN-}$ .	 A13017
11	$W_{IN-}$			
12	$V_{IN+}$		V phase Hall element input. Logic "H" is defined as the state where $V_{IN+} > V_{IN-}$ .	
13	$V_{IN-}$			
14	$U_{IN+}$		U phase Hall element input. Logic "H" is defined as the state where $U_{IN+} > U_{IN-}$ .	
15	$U_{IN-}$			
16	$FG_{IN+}$		FG amplifier + input. This is the + input to the Schmitt amplifier. There is no bias applied internally.	 A13018
17	$FG_{IN-}$		FG amplifier – input. The input resistance is 5 kΩ and a 150 kΩ feedback resistor is built in. (The gain is 30×.)	
18	$FG_{OUT}$		FG amplifier linear output.	 A13019
19	BR	0 V to $V_{CC}$	Short braking control input. High: Short braking Low: Normal motor drive	 A13020
20	SL		Full-wave/half-wave control input. High: Half-wave drive Low: Full-wave drive	
21	FGS		FG Schmitt amplifier output.	 A13021

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# LB11985H

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Unit (resistance :  $\Omega$ , current : A )

Pin No.	Symbol	Pin Voltage	Description	Equivalent circuit
22	FC		Frequency characteristics correction. Oscillation in the current control system closed loop can be prevented by inserting a capacitor between this pin and ground.	<p>A13022</p>
23	CTLREF	1 V to 4 V ( $V_{CC} = 5\text{ V}$ )	Control reference voltage. Although this voltage is set to $V_{CC} \times (15/35)$ internally, it can be modified by applying a voltage from a low-impedance circuit.	<p>A13023</p>
25	CTL	0 V to $V_{CC}$	Speed control. Control consists of a constant current drive scheme implemented by applying current feedback from RF.	<p>A13023</p>
24	LIM	0 V to $V_{CC}$	Current limiter function control. The voltage applied to this pin modifies the output current linearly.	<p>A13024</p>
26	FR	0 V to $V_{CC}$	Forward/reverse control. The voltage applied to this pin selects forward or reverse operation.	<p>A13025</p>
27	ADJ		External torque ripple correction ratio adjustment. To adjust the correction ratio, apply the stipulated voltage to the ADJ pin from a low-impedance external circuit. If the applied voltage is increased, the correction ratio rises, and if the applied voltage is lowered, the correction ratio falls.	<p>A13026</p>
28	$V_{CC}$	4.5 V to 5.5 V	Power supply for all circuits other than the IC internal output block. This voltage must be stabilized so that ripple and noise do not enter the IC.	



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