



SANYO Semiconductors

# DATA SHEET

## LB11980H — Monolithic Digital IC For VCR Capstan Three-Phase Brushless Motor Driver

### Overview

LB11980H is a 3-phase brushless motor driver optimal for driving the VCR capstan motors.

### Features

- 3-Phase full-wave current-linear drive system.
- Torque ripple correction circuit built-in.(correction factor variable)
- Current limiter circuit built in.
- Output stage upper/lower over-saturation prevention circuit built in. (No external capacitor required)
- FG amplifier built in.
- Thermal shutdown circuit built in.

### Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V <sub>CC</sub> max		7	V
	V <sub>S</sub> max		25	V
Maximum output current	I <sub>O</sub> max		1.3	A
Allowable power dissipation	Pd max	Mounted on a specified board *	1.81	W
		Independent IC	0.77	W
Operating temperature	T <sub>opr</sub>		-20 to +75	°C
Storage temperature	T <sub>stg</sub>		-55 to +150	°C

\* Mounted on a specified board: 114mm×71.1mm×1.6mm, glass epoxy board

### Allowable Operating Range at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V <sub>S</sub>		5 to 24	V
	V <sub>CC</sub>		4.5 to 5.5	V
Hall input amplitude	V <sub>HALL</sub>	Between hall inputs	±30 to ±80	mVo-p
GSENSE input range	V <sub>GSENSE</sub>	With respect to the control system ground	-0.20 to +0.20	V

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# LB11980H

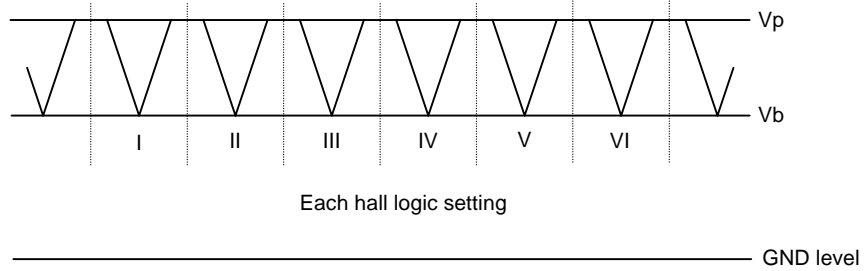
**Electrical Characteristics** at  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ ,  $V_S = 15\text{V}$

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
$V_{CC}$ supply current	$I_{CC}$	$R_L = \infty$ , $V_{CTL} = 0$ , $V_{LIM} = 0\text{V}$ (Quiescent)		12	18	mA
<b>Output</b>						
Output saturation voltage	$V_{O\text{sat}1}$	$I_O = 500\text{mA}$ , $R_f = 0.5\Omega$ , sink+source $V_{CTL} = V_{LIM} = 5\text{V}$ (With saturation prevention)		2.1	2.6	V
	$V_{O\text{sat}2}$	$I_O = 1.0\text{A}$ , $R_f = 0.5\Omega$ , sink+source $V_{CTL} = V_{LIM} = 5\text{V}$ (With saturation prevention)		2.6	3.5	V
Output leakage current	$I_{O\text{leak}}$				1.0	mA
<b>FR</b>						
FR pin input threshold voltage	VFSR		1.0	1.25	2	V
FR pin input bias current	$I_b$ (FSR)	$V_{FR} = 3\text{V}$	100	150	200	$\mu\text{A}$
<b>Control</b>						
CTL pin input bias current	$I_b$ (CTL)	$V_{CTL} = 5\text{V}$		1.5	3	$\mu\text{A}$
CTL pin input motor current	$I_{m\text{ctl}}$	$V_{CTL} = 0\text{V}$			5	mA
CTL pin control start voltage	$V_{CTL}$ (ST)	$R_f = 0.5\Omega$ , $V_{LIM} = 5\text{V}$ , $I_O \geq 10\text{mA}$ Hall input logic fixed (U, V, W = H, H, L)	2.25	2.50	2.75	V
CTL pin control Gm	Gm (CTL)	$R_f = 0.5\Omega$ , $\Delta I_O = 200\text{mA}$ Hall input logic fixed (U, V, W = H, H, L)	0.86	1.06	1.26	A/V
<b>Current limit</b>						
LIM pin input current	$I_{lim}$	$V_{LIM} = 3\text{V}$		1.5	3	$\mu\text{A}$
LIM pin motor current	$I_{lim}$	$V_{LIM} = 0\text{V}$			5	mA
LIM current limit offset voltage	$V_{off}$ (LIM)	$R_f = 0.5\Omega$ , $V_{CTL} = 5\text{V}$ , $I_O \geq 10\text{mA}$ Hall input logic fixed (U, V, W = H, H, L)	1.0	1.25	1.5	V
LIM pin control Gm	Gm (lim)	$R_f = 0.5\Omega$ , $V_{CTL} = 5\text{V}$ Hall input logic fixed (U, V, W = H, H, L)	0.59	0.71	0.83	A/V
<b>Hall amplifier</b>						
Hall amplifier input offset voltage	$V_{OFF}$ (HALL)		-6		+6	mV
Hall amplifier input bias current	$I_b$ (HALL)			1.0	3.0	$\mu\text{A}$
Hall amplifier common-mode input voltage	$V_{CM}$ (HALL)		1.3		3.3	V
<b>TRC</b>						
Torque ripple correction ratio	TRC	For the high and low peaks in the $R_f$ waveform when $I_O = 200\text{mA}$ ( $R_f = 0.5\Omega$ , ADJ-OPEN) Note.2		13		%
ADJ pin voltage	VADJ		2.37	2.50	2.63	V
<b>FG Amplifier</b>						
FG amplifier input offset voltage	$V_{OFF}$ (FG)		-8		+8	mV
FG amplifier input bias current	$I_b$ (FG)		-100			nA
FG amplifier output saturation voltage	$V_{O\text{sat}}$ (FG)	Sink side; With internal pull-up resistance load		0.5	0.6	V
FG amplifier voltage gain	VG (FG)	For open loop at $f = 10\text{kHz}$	41.5	44.5	47.5	dB
FG amplifier common-mode input voltage	$V_{CM}$ (FG)		0.5		4.0	V
<b>Schmitt amplifier</b>						
Duty ratio	DUTY	Under specified conditions ( $R_F = 39\text{k}\Omega$ ) Note 3	49.0	50	51.0	%
Upper side output saturation voltage	$V_{\text{sat}u}$ (SH)	$I_O = -20\mu\text{A}$	4.8			V
Lower side output saturation voltage	$V_{\text{sat}d}$ (SH)	$I_O = 100\mu\text{A}$			0.2	V
Hysteresis width	$V_{\text{hys}}$		32	46	60	mV
FGS output pin pull-up resistance	$R_{FG\text{out}}$			4.7		$\text{k}\Omega$
<b>Saturation</b>						
Saturation prevention circuit lower set voltage	$V_{O\text{ sat}}$ (DET)	Voltage between each OUT and $R_f$ with $I_O = 10\text{mA}$ , $R_f = 0.5\Omega$ , $V_{CTL} = V_{LIM} = 5\text{V}$	0.175	0.25	0.325	V
<b>TSD</b>						
TSD operating temperature	T-TSD	(Design target) Note.1		180		$^\circ\text{C}$

Note 1. No measurements are made on the parameters with Note (Design target).

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Note 2. The torque ripple compensation ratio is determined as follows from the Rf voltage waveform.



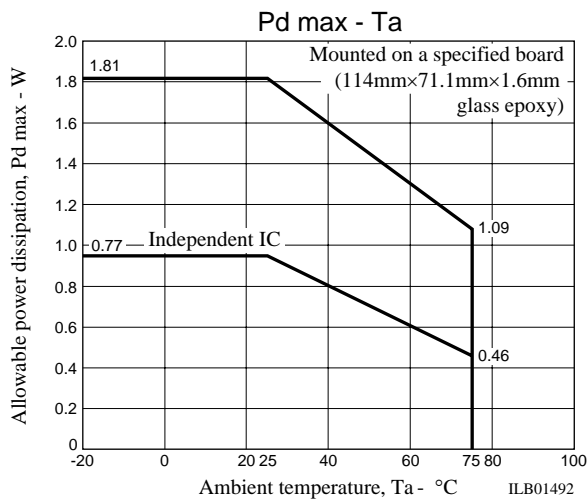
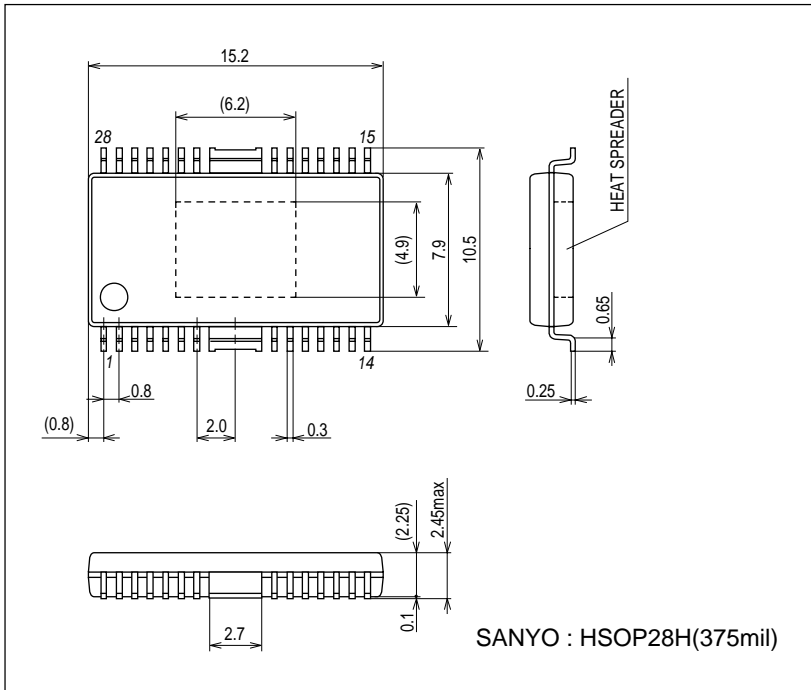
$$\text{Correnction ratio} = \frac{2 * (Vp - Vb)}{Vp + Vb} \cdot 100 * (\%)$$

Note 3. Apply the sine wave of 1kHz, 20mVP-P under conditions with a sample circuit installed externally as shown above.

## Package Dimensions

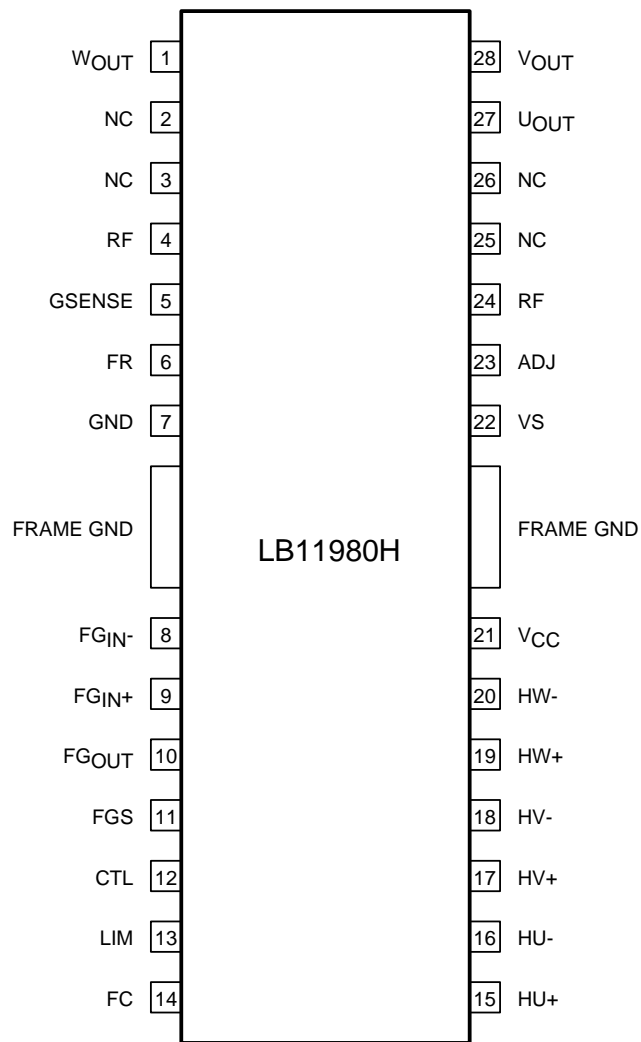
unit : mm (typ)

3233B



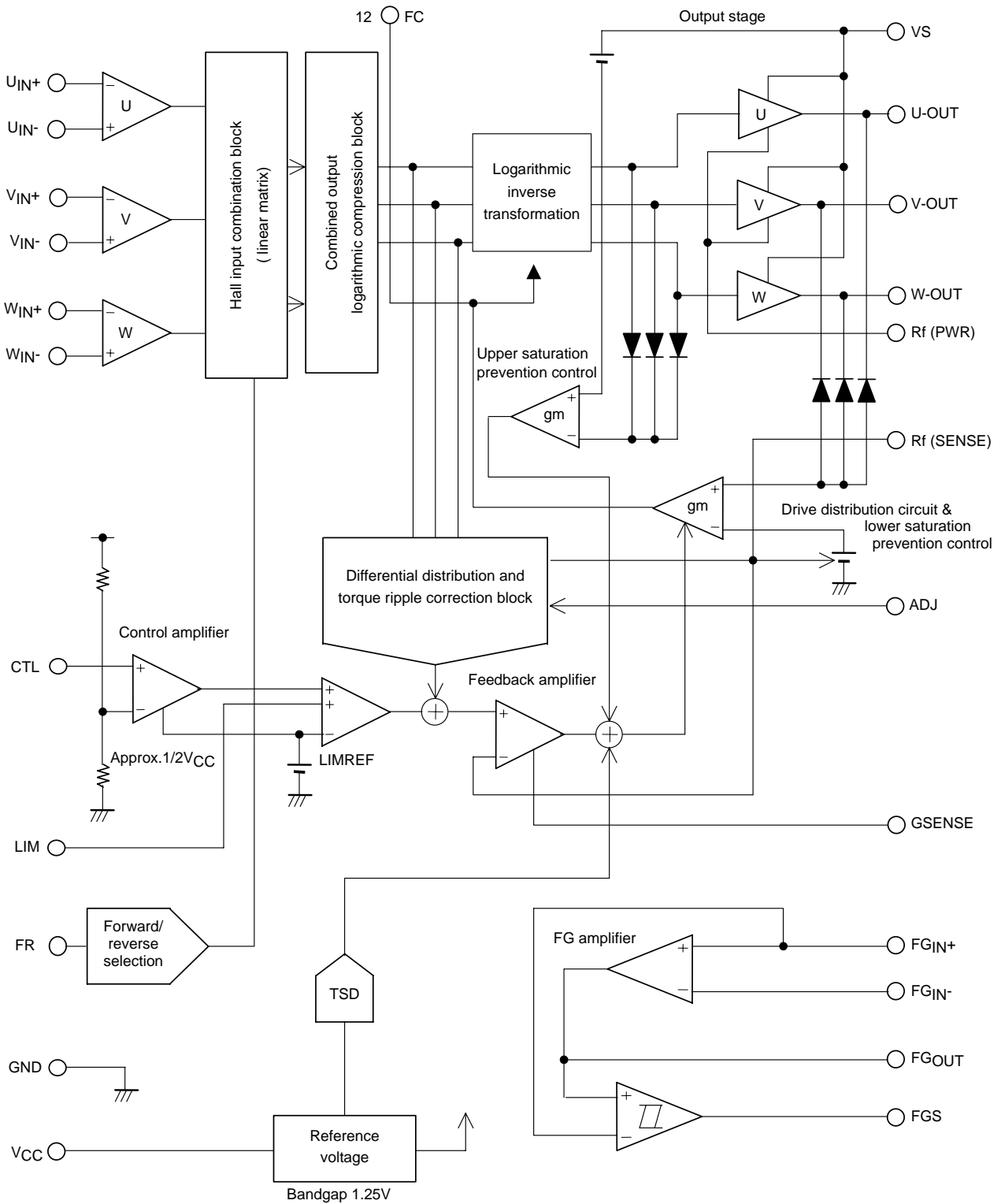
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## Pin Assignment



Top view

Block Diagram



**Truth Table and Control Function**

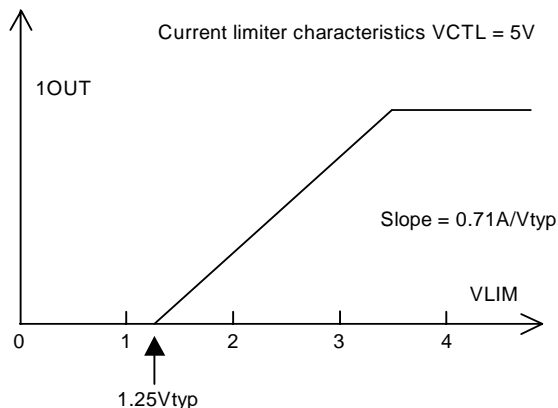
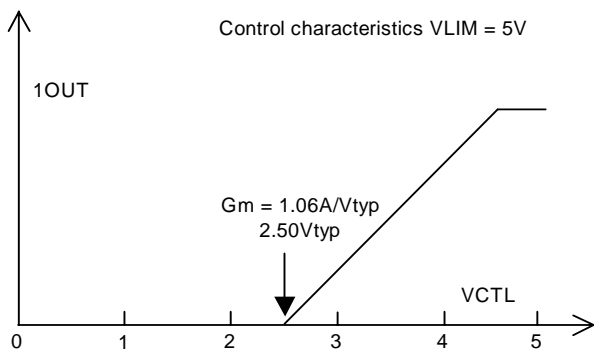
	Source → Sink	Hall input			FR
		U	V	W	
1	V → W	H	H	L	H
	W → V				L
2	U → W	H	L	L	H
	W → U				L
3	U → V	H	L	H	H
	V → U				L
4	W → V	L	L	H	H
	V → W				L
5	W → U	L	H	H	H
	U → W				L
6	V → U	L	H	L	H
	U → V				L

Note: “H” in the FR column represents a voltage of 2.75V or more. “L” represents a voltage of 2.25V or less.  
(At  $V_{CC} = 5V$ )

Note: “H” under the Hall Input columns represents a state in which “+” has a potential which is higher by 0.01V or more than that of the “-” phase inputs. Conversely “L” represents a state in which “+” has a potential which is lower by 0.01V or more than that of the “-” phase inputs.

Note: Since a 180° energized system is used as a drive system, other phases than the sink and source are not OFF.

[Control Function & Current Limiter Function]



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## Pin Functions

Pin name	Pin no	Functions
FR	6	Forward/reverse select pin. This pin voltage determines forward/reverse. ( $V_{th} = 1.25V$ TYP at $V_{CC} = 5V$ )
GND	7	GND for others than the output transistor. Minimum potential of output transistor is at Rf pin.
FG <sub>IN</sub> (-)	8	Input pin for the FG amplifier to be used with inverted input. A feedback resistor is connected between this pin and FG OUT.
FG <sub>IN</sub> (+)	9	Non-inverted input pin for the FG amplifier to be used as differential input. No bias is applied internally.
FG-OUT	10	FG amplifier output pin. Resistive load provided internally.
CTL	12	Speed control pin. Control is performed by means of constant current drive which is applied by current feedback from Rf. $G_m = 1.06A/VTYP$ at $R_f = 0.5\Omega$
LIM	13	Current limiter function control pin. This pin voltage is capable of varying the output current linearly. Slope = $0.71A/VTYP$ at $R_f = 0.5\Omega$
FC	14	Speed control loop's frequency characteristics correction pin.
U <sub>IN+</sub> , U <sub>IN-</sub> V <sub>IN+</sub> , V <sub>IN-</sub> W <sub>IN+</sub> , W <sub>IN-</sub>	15, 16 17, 18 19, 20	U-phase Hall device input pin; logic "H" presents IN+>IN- V-phase Hall device input pin; logic "H" presents IN+>IN- W-phase Hall device input pin; logic "H" presents IN+>IN-
V <sub>CC</sub>	21	Power supply pin for supplying power to all circuits except output section in IC; this voltage must be stabilized so as to eliminate ripple and noise.
VS	22	Power supply pin for supplying power to output section in IC.
ADJ	23	Pin to be used to adjust the torque ripple correction factor externally. When adjusting the correction factor, apply voltage externally to the ADJ pin through a low impedance. Increasing the applied voltage decreases the correction factor; lowering the applied voltage increases the correction factor. The rate of change, when left open, ranges approximately from 0 to 2 times. (Approximately $V_{CC}/2$ is set internally and the input impedance is approximately $5k\Omega$ .)
Rf (PWR) Rf (SNS)	24 4	Output current detection pins. Current feedback is provided to the control blocks by connecting Rf between the pins and GND. The operation of the lower over-saturation prevention circuit and torque ripple correction circuit depends on the pin voltage. In particular, since the oversaturation prevention level is set by the pin voltage, decreasing the Rf value externally may cause the lower over-saturation prevention to work less efficiently in the large current region. The PWR pin and SENSE pin must be connected.
FGS	11	FG Schmidt amp output pin, that is pulled up with $4.7k\Omega$ .
U <sub>OUT</sub> V <sub>OUT</sub> W <sub>OUT</sub>	27 28 1	U-phase output pin. } V-phase output pin. } (Built-in spark killer diode) W-phase output pin. }
GSENSE	5	GND sensing pin. By connecting this pin to GND in the vicinity of the Rf resistor side of the Rf included motor GND wiring, the influence that the GND common impedance exerts on Rf can be excluded. (Must not be left open.)

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## Each Input/Output Equivalent Circuit

Pin No.	Pin name	Input/Output equivalent circuit
15 16 17 18 19 20	$U_{IN} (+)$ $U_{IN} (-)$ $V_{IN} (+)$ $V_{IN} (-)$ $W_{IN} (+)$ $W_{IN} (-)$	<p style="text-align: center;">Each (+) input                      Each (-) input</p>
27 28 1 22 24 4	$U_{OUT}$ $V_{OUT}$ $W_{OUT}$ $V_S$ $R_f$ (POWER) $R_f$ (SENSE)	<p style="text-align: center;">Each OUT</p> <p style="text-align: center;">Lower oversaturation prevention circuit block</p>
12 13	CTL LIM	
6 23	FR ADJ	

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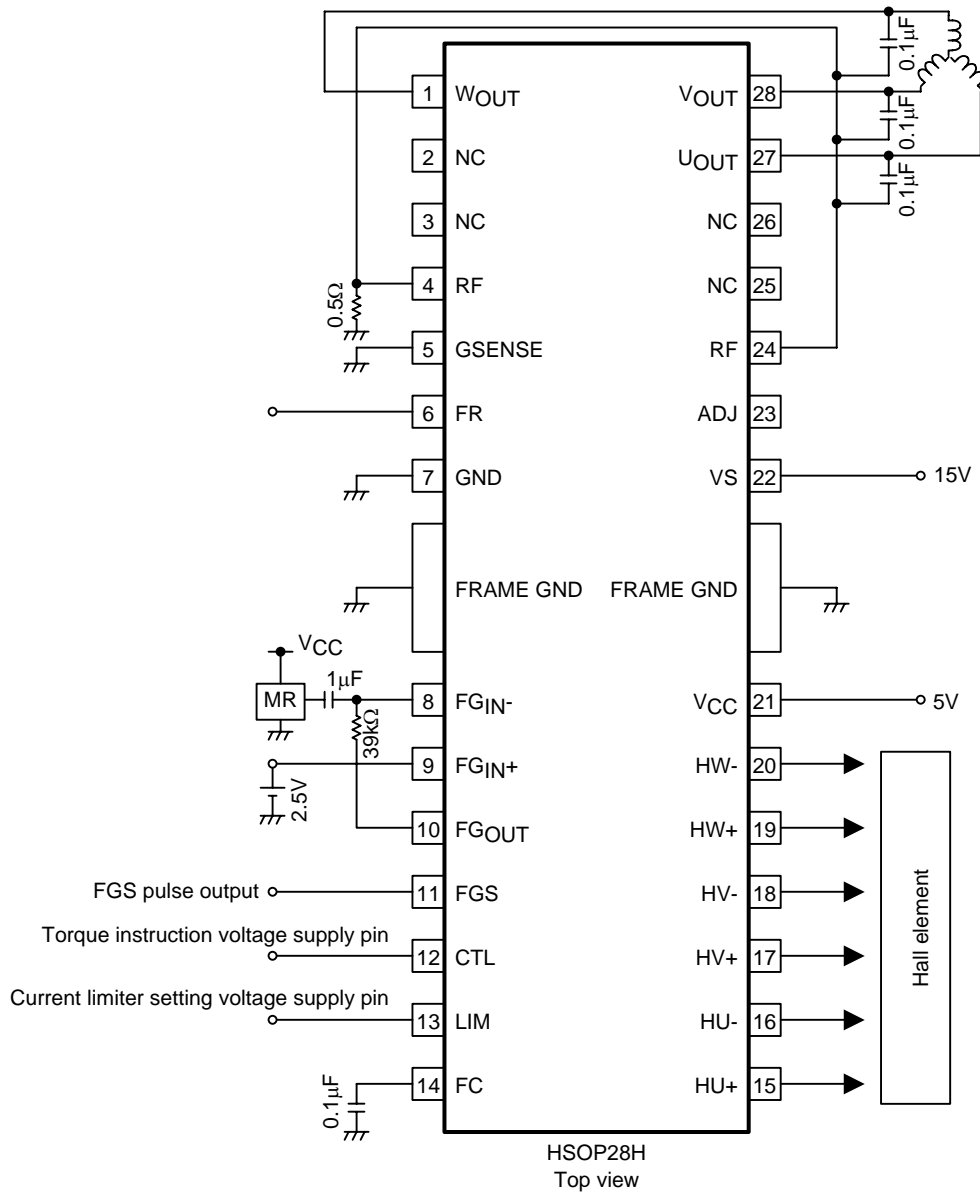


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Pin No.	Pin name	Input/output equivalent circuit
8 9	FG <sub>IN</sub> (-) FG <sub>IN</sub> (+)	
10 14	FG <sub>OUT</sub> FC	
11	FG <sub>S</sub>	

Sample Application Circuit



Note) The constant shown in this example is only for reference and does not guarantee the characteristics.  
 Connect a capacitor between power supply and GND and between Hall inputs as required.

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