

Monolithic Digital IC

**SANYO**

## LB11996,11996H

### Three-Phase Brushless Motor Driver for CD-ROM Spindle Motor Driver

#### Preliminary

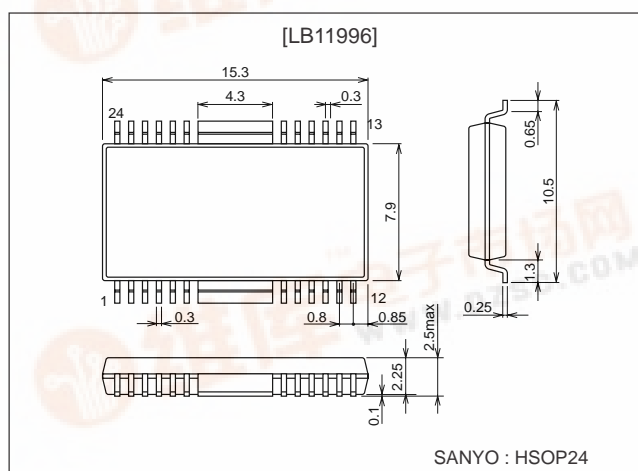
#### Features

- Current linear drive
- Control V type amplifier
- 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
- Built-in reverse blocking circuit
- Hall FG output
- Built-in S/S function
- Built-in current limiter circuit
- Built-in Hall power supply
- Built-in thermal shutdown circuit
- 1 Hall FG/3 Hall FG switchable
- Supports 3.3V DSP

#### Package Dimensions

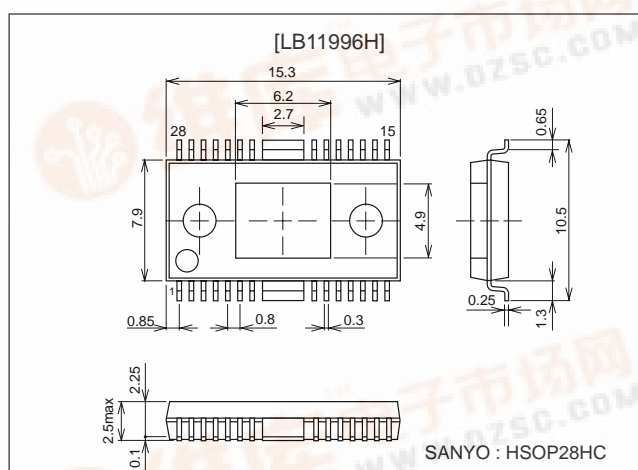
unit: mm

#### 3227-HSOP24



unit: mm

#### 3234-HSOP28HC



- Any and all SANYO products described or contained herein do not have specifications that can handle applications that require extremely high levels of reliability, such as life-support systems, aircraft's control systems, or other applications whose failure can be reasonably expected to result in serious physical and/or material damage. Consult with your SANYO representative nearest you before using any SANYO products described or contained herein in such applications.
- SANYO assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO products described or contained herein.

## LB11996,11996H

### Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Maximum power supply voltage 1	$V_{CC1\text{ max}}$		7.0	V
Maximum power supply voltage 2	$V_{CC2\text{ max}}$		14.4	V
Maximum power supply voltage 3	$V_{CC3\text{ max}}$		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	$P_d\text{ max}$	[LB11996] IC only	0.79	W
		*With specified substrate	*1.8	
		[LB11996H] IC only	0.8	
		*With specified substrate	*1.9	
Operating temperature	$T_{opr}$		-20 to +75	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$		-55 to +150	$^{\circ}\text{C}$

\* Specified substrate:  $114.3 \times 76.1 \times 1.6\text{ mm}^3$  glass epoxy

#### Allowable Operating Ranges at $T_a = 25^{\circ}\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Power supply voltage 1	$V_{CC1}$		4 to 6	V
Power supply voltage 2	$V_{CC2}$	$\geq V_{CC1}$	4 to 13.6	V
Power supply voltage 3	$V_{CC3}$		4 to 13.6	V

#### Sample Application at $T_a = 25^{\circ}\text{C}$

##### (1) 12V type

Power supply pin	Conditions	Ratings	Unit
$V_{CC1}$	Regulated voltage	4 to 6	V
$V_{CC2} = V_{CC3}$	Unregulated voltage	4 to 13.6	V

##### (2) 5V type

Power supply pin	Conditions	Ratings	Unit
$V_{CC1} = V_{CC3}$	Regulated voltage	4 to 6	V
$V_{CC2}$	Boost-up voltage or regulated voltage (Note)	4 to 13.6	V

Note: When boost-up voltage is used at  $V_{CC2}$ , output can be set to low-saturation.

## LB11996,11996H

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

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
[Power supply current]						
Power supply current 1	V <sub>CC1</sub>	V <sub>C</sub> = V <sub>CREF</sub>		8		mA
Power supply current 2	V <sub>CC2</sub>	V <sub>C</sub> = V <sub>CREF</sub>		0		mA
Power supply current 3	V <sub>CC3</sub>	V <sub>C</sub> = V <sub>CREF</sub>		150	250	μA
Output idle current 1	I <sub>CC1OQ</sub>	V <sub>S/S</sub> = 0V			200	μA
Output idle current 2	I <sub>CC2OQ</sub>	V <sub>S/S</sub> = 0V			30	μA
Output idle current 3	I <sub>CC3OQ</sub>	V <sub>S/S</sub> = 0V			30	μA
[Output]						
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>CL</sub>	R <sub>RF</sub> = 0.33Ω		0.37		V
[Hall amplifier]						
Common mode input voltage range	V <sub>HCOM</sub>		1.2		V <sub>CC1</sub> −1.0	V
Input bias current	V <sub>HIB</sub>			1		μA
Minimum Hall input level	V <sub>HIN</sub>		60			mVp-p
[S/S pin]						
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
Leakage current	I <sub>S/SL</sub>	V <sub>S/S</sub> = 0V	−30			μA
[Control]						
VC pin input current	I <sub>VC</sub>	V <sub>C</sub> = V <sub>CREF</sub> = 1.65V			1	μA
VCREF pin input current	I <sub>VCREF</sub>	V <sub>C</sub> = V <sub>CREF</sub> = 1.65V			1	μA
Voltage gain	GV <sub>CC</sub>	ΔV <sub>RF</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
[Hall power supply]						
Hall power supply voltage	V <sub>H</sub>	I <sub>H</sub> = 5 mA		0.8		V
Allowable current	I <sub>H</sub>		20			mA
[Thermal shutdown]						
Operating temperature	T <sub>TSD</sub>	(Target)	150	180	210	°C
Hysteresis	ΔT <sub>TSD</sub>	(Target)		15		°C
[Short braking]						
Brake pin at High level	V <sub>BRH</sub>		4		5	V
Brake pin at Low level	V <sub>BRL</sub>		0		1	V
[1 Hall FG/3 Hall FG select]						
FGSEL pin at High level	V <sub>FSH</sub>		4		5	V
FGSEL pin at Low level	V <sub>FSL</sub>		0		1	V

Note:

- During S/S OFF (standby), the Hall comparator is at High.
- Items shown to be “Target” are not measured.

## LB11996,11996H

### Truth Table

	Source	Input			Control
	Sink	U	V	W	V <sub>C</sub>
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.

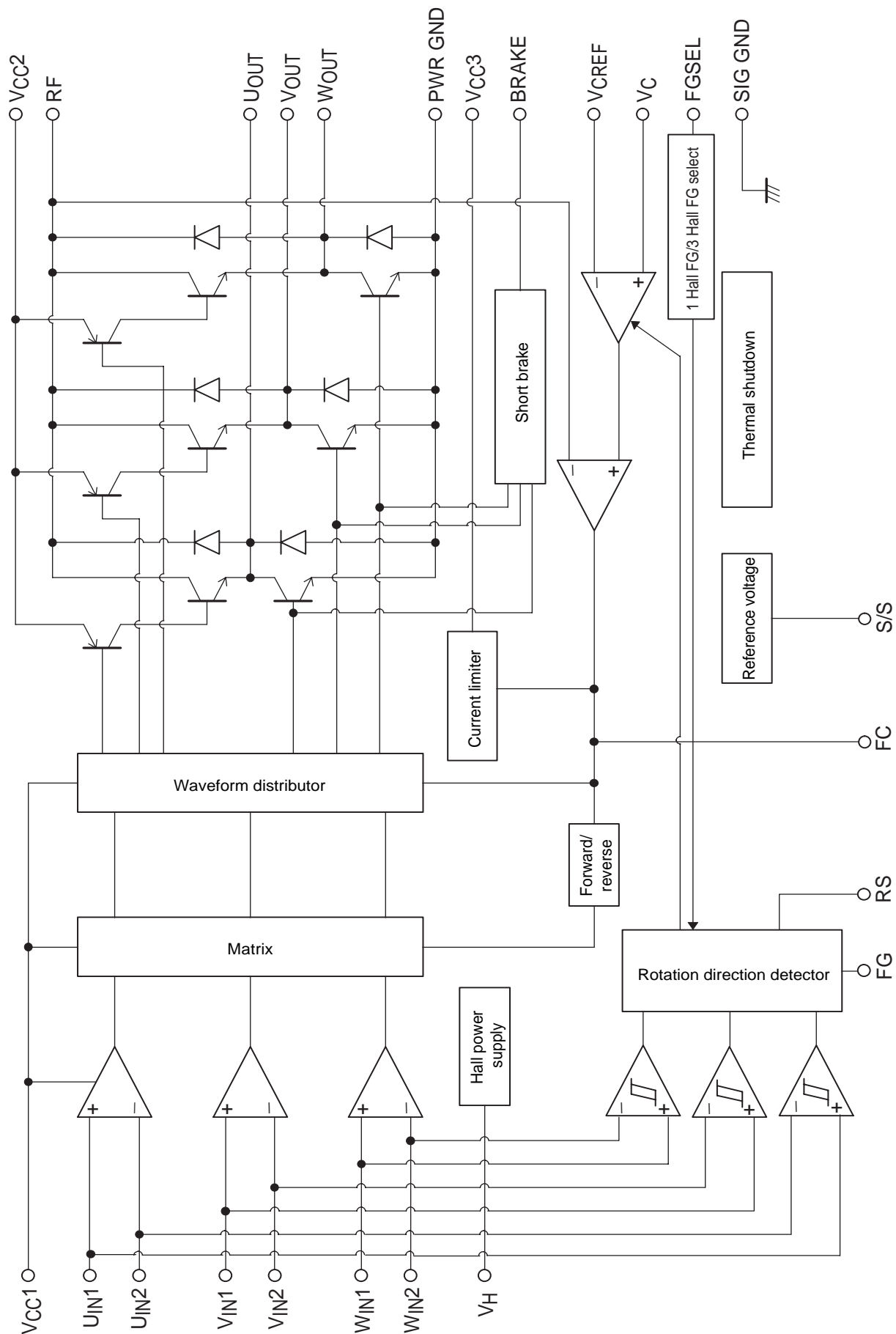
### Brake Operation

Brake pin	Operation
H	Brake operation
L	Normal rotation

### FGSEL (1 Hall /3 Hall select)

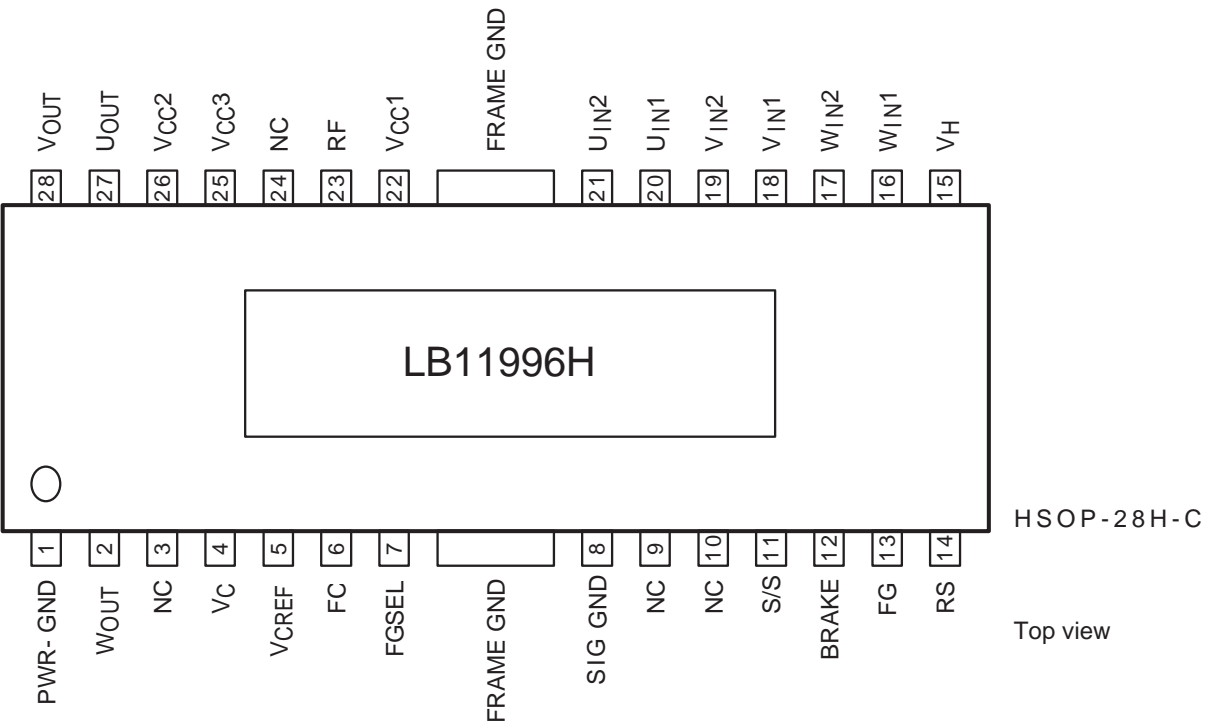
FGSEL	FG output principle
H	3 Hall FG output
L	1 Hall FG output

Block Diagram



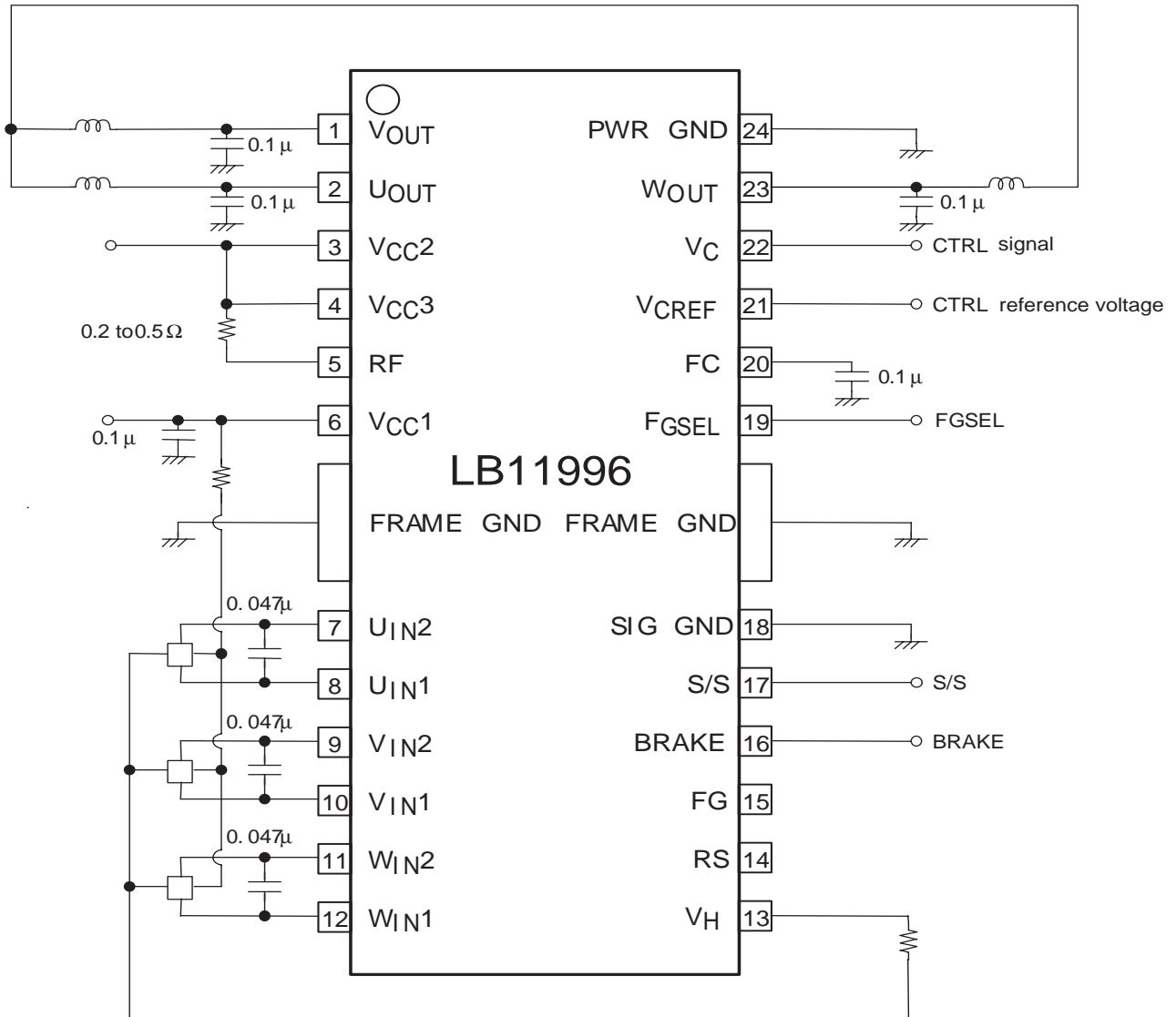
LB11996,11996H

Pin Assignments



## LB11996,11996H

### Sample Application Circuit



Unit (capacitance: F)

Power supply - GND  
Output - GND  
Between Hall inputs

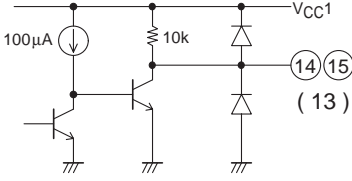
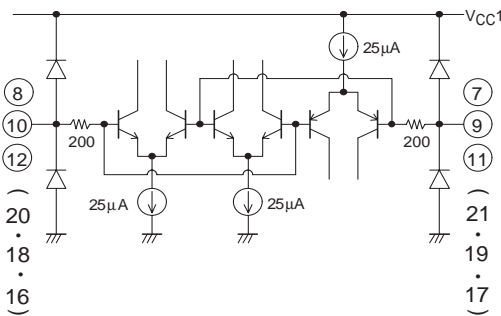
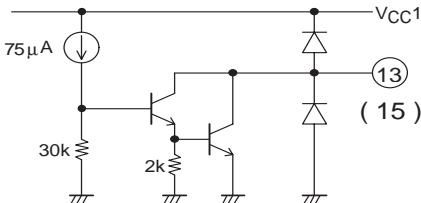
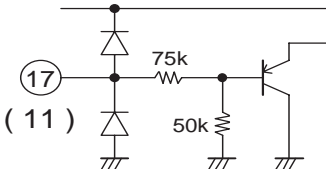
Capacitor requirements may change depending on motor.  
For some motors, capacitor between Hall inputs may not be needed.

# LB11996,11996H

## Pin Description

( ): LB11996H, other pins: identical

Unit (resistance:  $\Omega$ )

Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
3 (26)	$V_{CC2}$	4V to 13.6V		Source side predrive voltage supply pin.
4 (25)	$V_{CC3}$	4V to 13.6V		Constant current control amplifier voltage supply pin.
6 (22)	$V_{CC1}$	4V to 6V		Power supply pin for all voltage except output transistors, source predrive, and constant current control amplifier.
14	RS			Reverse detector pin Forward rotation: High Reverse rotation: Low
15 (13)	FG			1 Hall element waveform Schmitt comparator composite output
8 (20)	$U_{IN1}$	1.2V to $V_{CC1}-1V$		U phase Hall element input and reverse detector U phase Schmitt comparator input pin. Logic High indicates $U_{IN1} > U_{IN2}$ .
7 (21)	$U_{IN2}$			V phase Hall element input and reverse detector V phase Schmitt comparator input pin. Logic High indicates $V_{IN1} > V_{IN2}$ .
10 (18)	$V_{IN1}$			W phase Hall element input and reverse detector W phase Schmitt comparator input pin. Logic High indicates $W_{IN1} > W_{IN2}$ .
9 (19)	$V_{IN2}$			
12 (16)	$W_{IN1}$			
11 (17)	$W_{IN2}$			
13 (15)	$V_H$			Hall element lower side bias voltage supply pin.
17 (11)	S/S	0V to $V_{CC1}$		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.

Continued on next page



# LB11996,11996H

Continued from preceding page

Unit (resistance:  $\Omega$ )

Pin number	Pin name	Pin voltage	Equivalent circuit	Pin function
18 (8)	SIG GND			GND pin for all circuits except output.
20 (6)	FC			Control loop frequency compensator pin. Connecting a capacitor between this pin and GND prevents closed loop oscillation in current limiting circuitry.
21 (5)	$V_{CREF}$	0V to 3.5V		Control reference voltage applied pin. Determines control start voltage.
22 (4)	$V_C$	0V to $V_{CC1}$		Speed control voltage applied pin. V type control technique $V_C > V_{CREF}$ : Forward $V_C < V_{CREF}$ : Slowdown (Reverse-blocking circuit prevents reverse rotation.)
23 (2)	$W_{OUT}$			W-phase output.
24 (1)	PWR GND			Output transistor GND.
1 (28)	$V_{OUT}$			V-phase output.
2 (27)	$U_{OUT}$			U-phase output.
5 (23)	RF			Upper side output NPN transistor collector pin (common for all 3 phases). For current detection, connect resistor between $V_{CC3}$ pin and RF pin. Constant current control and current limiter works by detecting this voltage.
19 (7)	FGSEL			3 Hall FG/1 Hall FG select pin. FGSEL: High $\rightarrow$ 3 Hall FG Low/Open $\rightarrow$ 1 Hall FG
16 (12)	BRAKE			Short brake pin. BRAKE: High $\rightarrow$ Brake Low/Open $\rightarrow$ Drive

- Specifications of any and all SANYO products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.
- SANYO Electric Co., Ltd. strives to supply high-quality high-reliability products. However, any and all semiconductor products fail with some probability. It is possible that these probabilistic failures could give rise to accidents or events that could endanger human lives, that could give rise to smoke or fire, or that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO products(including technical data,services) described or contained herein are controlled under any of applicable local export control laws and regulations, such products must not be exported without obtaining the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written permission of SANYO Electric Co., Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only ; it is not guaranteed for volume production. SANYO believes information herein is accurate and reliable, but no guarantees are made or implied regarding its use or any infringements of intellectual property rights or other rights of third parties.