



Monolithic Digital IC

LB11996,11996H

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

Preliminary

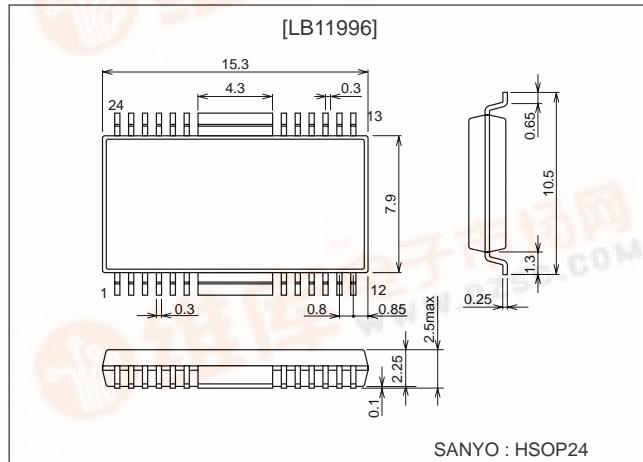
Features

- 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

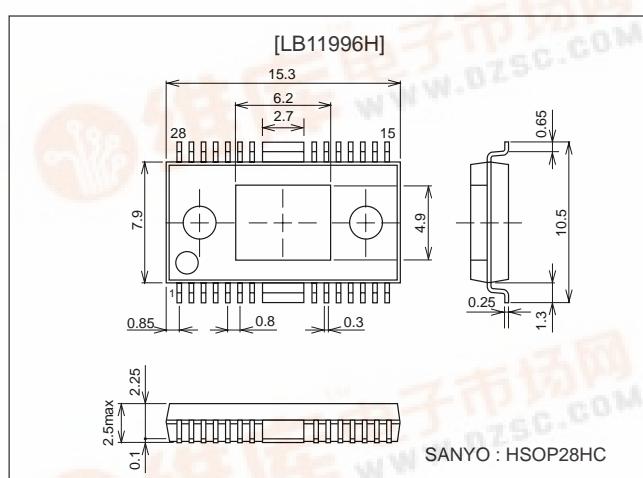
unit: mm

3227-HSOP24



unit: mm

3234-HSOP28HC



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Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|--------------------------------|---------------|---|--------------|------------------|
| Maximum power supply voltage 1 | V_{CC1} max | | 7.0 | V |
| Maximum power supply voltage 2 | V_{CC2} max | | 14.4 | V |
| Maximum power supply voltage 3 | V_{CC3} max | | 14.4 | V |
| Maximum applied output voltage | V_o max | | 14.4 | V |
| Maximum applied input voltage | V_i max | | V_{CC1} | V |
| Maximum output current | I_o max | | 1.3 | A |
| Allowable power dissipation | P_d max | [LB11996] IC only *With specified substrate | 0.79 *1.8 | W |
| | | [LB11996H] IC only *With specified substrate | 0.8 *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.

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Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC1} = 5\text{V}$, $V_{CC2} = V_{CC3} = 12\text{V}$ (unless otherwise specified)

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|-------------------------------------|------------------|---|---------|------|---------------|--------------------------|
| | | | min | typ | max | |
| [Power supply current] | | | | | | |
| Power supply current 1 | V_{CC1} | $V_C = V_{CREF}$ | | 8 | | mA |
| Power supply current 2 | V_{CC2} | $V_C = V_{CREF}$ | | 0 | | mA |
| Power supply current 3 | V_{CC3} | $V_C = V_{CREF}$ | | 150 | 250 | μA |
| Output idle current 1 | I_{CC10Q} | $V_{S/S} = 0\text{V}$ | | | 200 | μA |
| Output idle current 2 | I_{CC20Q} | $V_{S/S} = 0\text{V}$ | | | 30 | μA |
| Output idle current 3 | I_{CC30Q} | $V_{S/S} = 0\text{V}$ | | | 30 | μA |
| [Output] | | | | | | |
| Saturation voltage, upper side 1 | V_{OU1} | $I_O = -0.5\text{A}$, $V_{CC1} = 5\text{V}$, $V_{CC2} = V_{CC3} = 12\text{V}$ | | 1.0 | | V |
| Saturation voltage, lower side 1 | V_{OD1} | $I_O = 0.5\text{A}$, $V_{CC1} = 5\text{V}$, $V_{CC2} = V_{CC3} = 12\text{V}$ | | 0.3 | | V |
| Saturation voltage, upper side 2 | V_{OU2} | $I_O = -0.5\text{A}$, $V_{CC1} = V_{CC3} = 5\text{V}$, $V_{CC2} = 12\text{V}$ | | 0.3 | | V |
| Saturation voltage, lower side 2 | V_{OD2} | $I_O = 0.5\text{A}$, $V_{CC1} = V_{CC3} = 5\text{V}$, $V_{CC2} = 12\text{V}$ | | 0.3 | | V |
| Current limiter setting voltage | V_{CL} | $R_{RF} = 0.33\Omega$ | | 0.37 | | V |
| [Hall amplifier] | | | | | | |
| Common mode input voltage range | V_{HCOM} | | 1.2 | | $V_{CC1-1.0}$ | V |
| Input bias current | V_{HIB} | | | 1 | | μA |
| Minimum Hall input level | V_{HIN} | | 60 | | | $\text{mV}_{\text{p-p}}$ |
| [S/S pin] | | | | | | |
| High level voltage | $V_{S/SH}$ | | 2.0 | | V_{CC1} | V |
| Low level voltage | $V_{S/SL}$ | | | | 0.7 | V |
| Input current | $I_{S/SI}$ | $V_{S/S} = 5\text{V}$ | | | 200 | μA |
| Leakage current | $I_{S/SL}$ | $V_{S/S} = 0\text{V}$ | -30 | | | μA |
| [Control] | | | | | | |
| VC pin input current | I_{VC} | $V_C = V_{CREF} = 1.65\text{V}$ | | | 1 | μA |
| VCREF pin input current | $I_{V_{CREF}}$ | $V_C = V_{CREF} = 1.65\text{V}$ | | | 1 | μA |
| Voltage gain | GV_{CC} | $\Delta V_{RF}/\Delta V_C$ | | 0.35 | | times |
| Startup voltage | V_{CTH} | $V_{CREF} = 1.65\text{V}$ | 1.5 | | 1.8 | V |
| Startup voltage width | ΔV_{CTH} | $V_{CREF} = 1.65\text{V}$ | 50 | | 150 | mV |
| [Hall power supply] | | | | | | |
| Hall power supply voltage | V_H | $I_H = 5\text{ mA}$ | | 0.8 | | V |
| Allowable current | I_H | | 20 | | | mA |
| [Thermal shutdown] | | | | | | |
| Operating temperature | T_{TSD} | (Target) | 150 | 180 | 210 | °C |
| Hysteresis | ΔT_{TSD} | (Target) | | 15 | | °C |
| [Short braking] | | | | | | |
| Brake pin at High level | V_{BRH} | | 4 | | 5 | V |
| Brake pin at Low level | V_{BRL} | | 0 | | 1 | V |
| [1 Hall FG/3 Hall FG select] | | | | | | |
| FGSEL pin at High level | V_{FSH} | | 4 | | 5 | V |
| FGSEL pin at Low level | V_{FSL} | | 0 | | 1 | V |

Note:

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

Truth Table

| Source Sink | Input | | | Control V_C |
|----------------|-------------------|---|---|------------------|
| | U | V | W | |
| 1 | Phase W → Phase V | H | H | H |
| | Phase V → Phase W | | | L |
| 2 | Phase W → Phase U | H | L | H |
| | Phase U → Phase W | | | L |
| 3 | Phase V → Phase W | L | L | H |
| | Phase W → Phase V | | | L |
| 4 | Phase U → Phase V | L | H | H |
| | Phase V → Phase U | | | L |
| 5 | Phase V → Phase U | H | L | H |
| | Phase U → Phase V | | | L |
| 6 | Phase U → Phase W | L | 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.

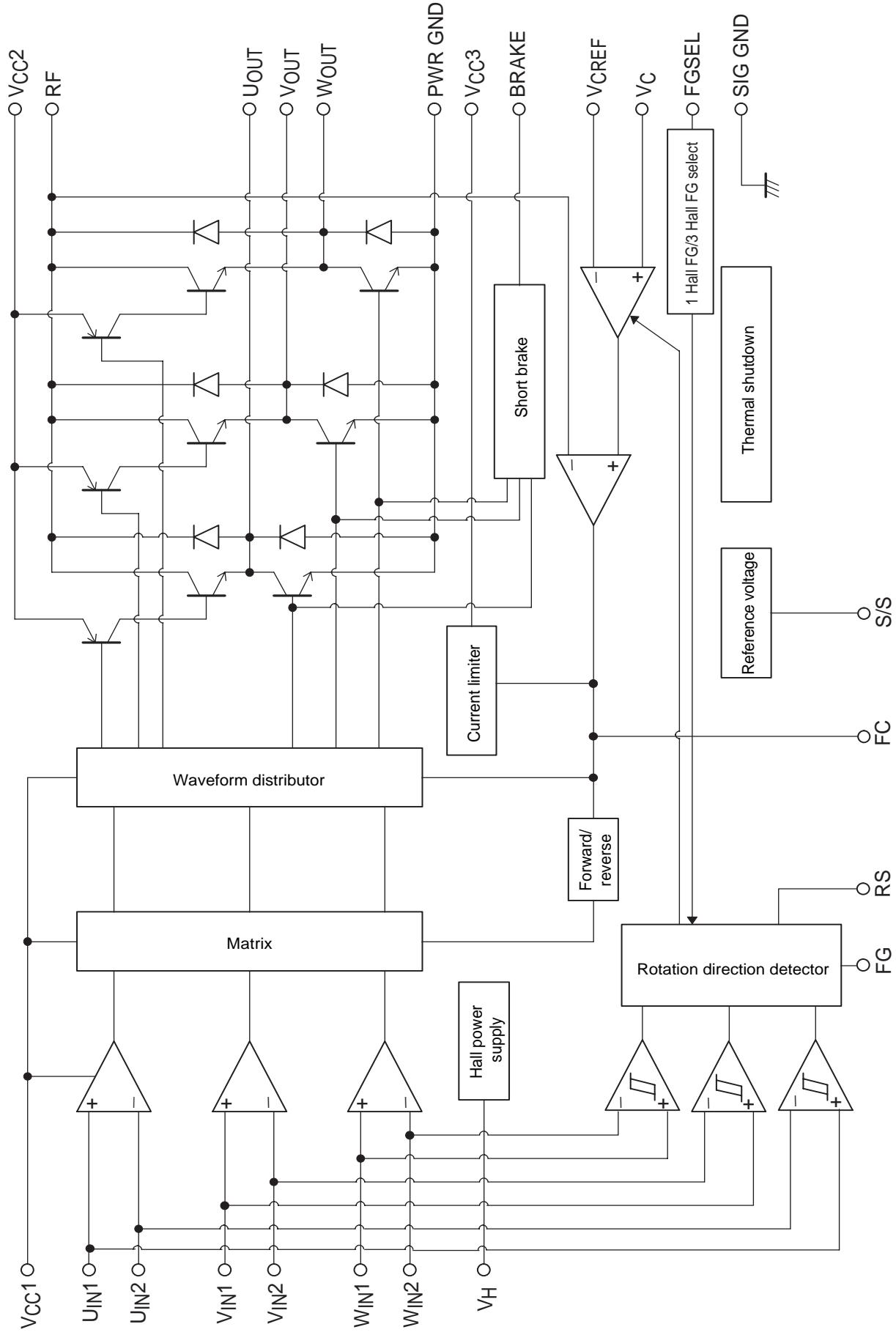
Brake Operation

| Brake pin | Operation |
|-----------|-----------------|
| H | Brake operation |
| L | Normal rotation |

FGSEL (1 Hall /3 Hall select)

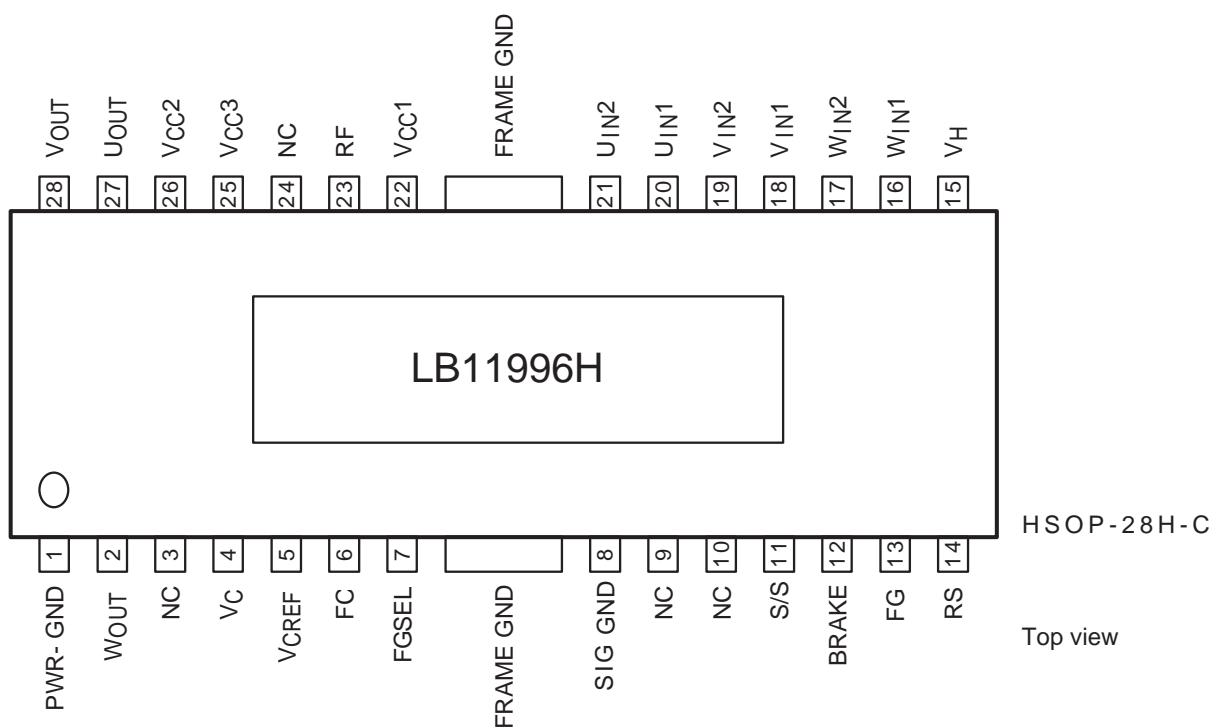
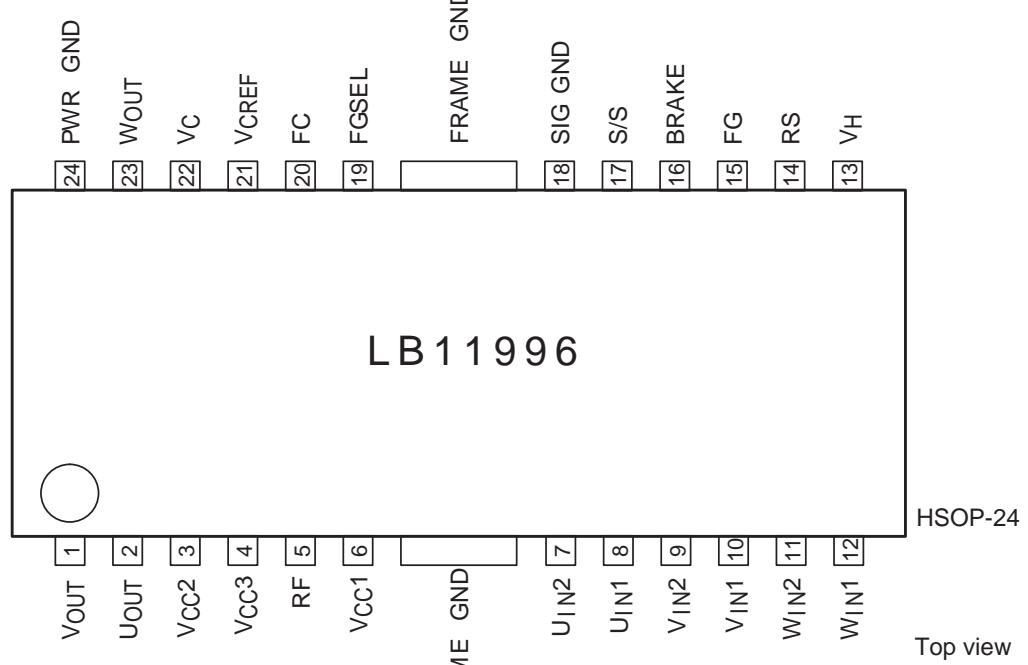
| FGSEL | FG output principle |
|-------|---------------------|
| H | 3 Hall FG output |
| L | 1 Hall FG output |

Block Diagram



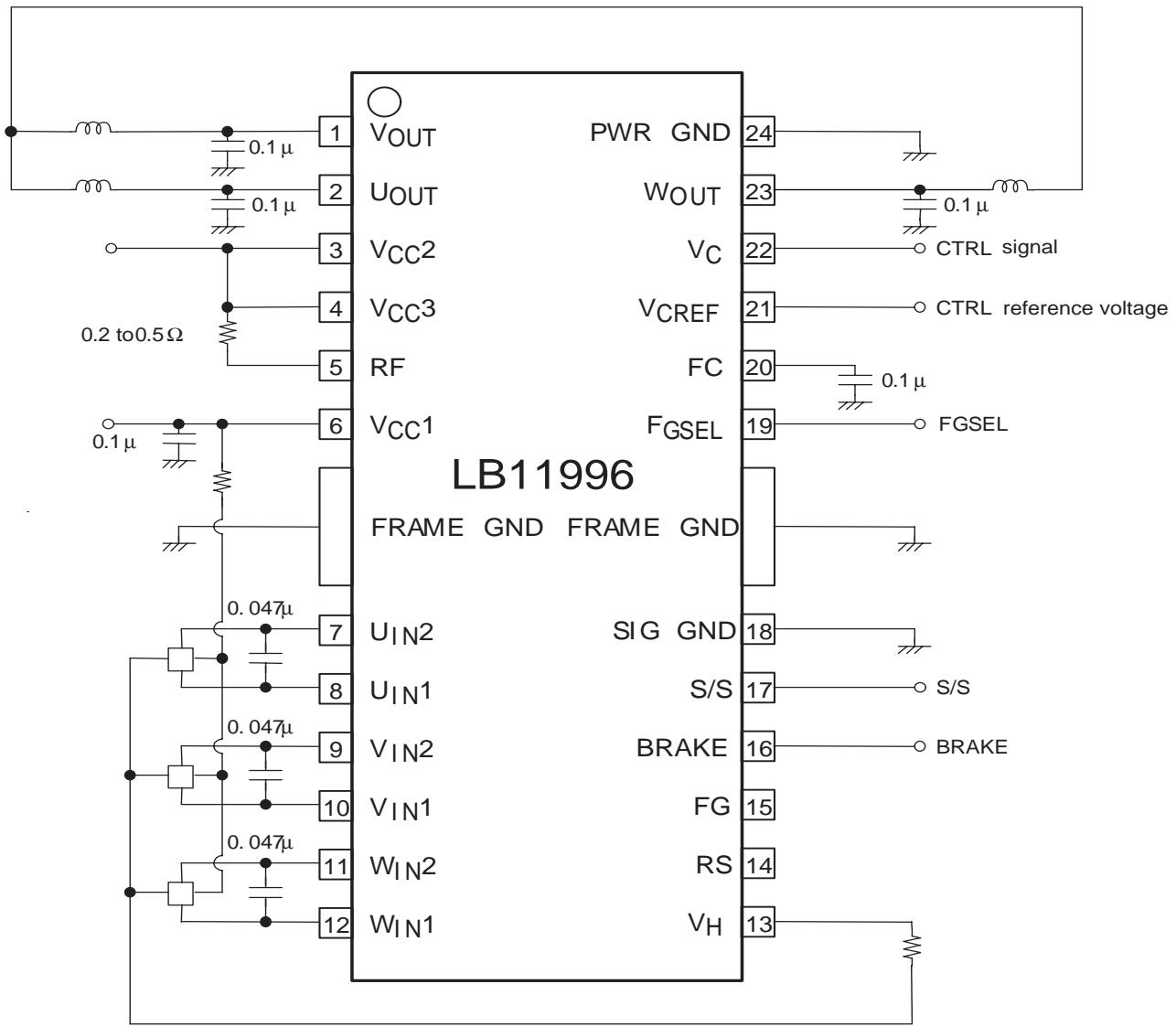
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Pin Assignments



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Sample Application Circuit



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Pin Description

(): LB11996H, other pins: identical

Unit (resistance: Ω)

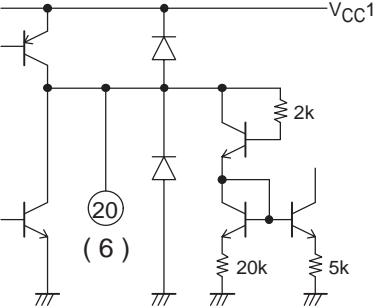
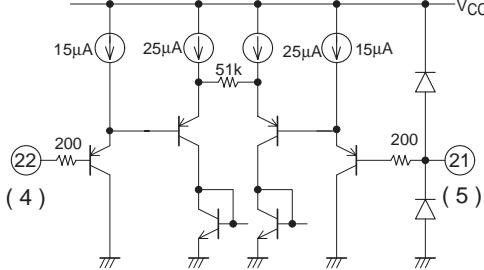
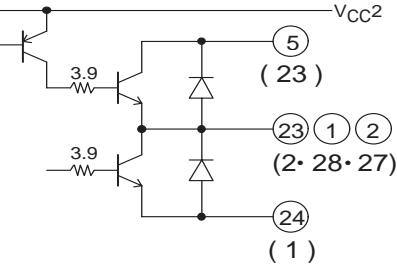
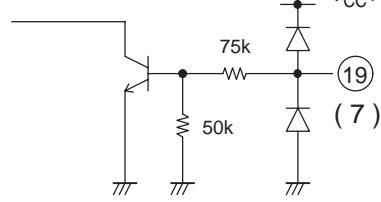
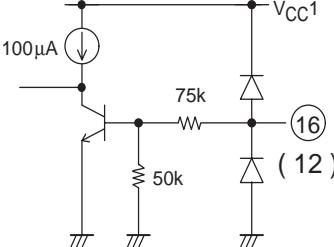
| Pin number | Pin name | Pin voltage | Equivalent circuit | Pin function |
|------------|------------------|------------------------------|--------------------|---|
| 3 (26) | V _{CC2} | 4V to 13.6V | | Source side predrive voltage supply pin. |
| 4 (25) | V _{CC3} | 4V to 13.6V | | Constant current 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

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Unit (resistance: Ω)

| 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 | |  | BRAKE: High \rightarrow Brake Low/Open \rightarrow Drive |

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