Ordering number : ENN6470

Monolithic Digital IC

# LB11880

## Three-Phase Sensorless Motor Driver with Loading Motor Driver

## Overview

The LB11880 is a sensorless motor driver that also includes a loading motor driver. It is ideal for drum motor drive in VCR products.

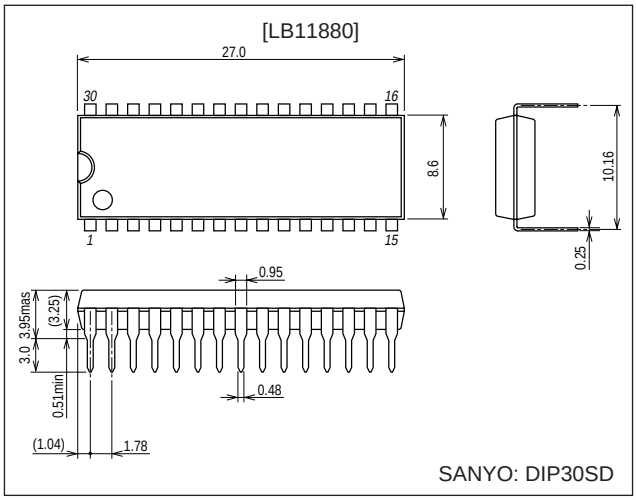
## Functions and Features

- Soft switching drive
- No Hall sensors required
- No FG sensors required
- Built-in PG amplifier
- Built-in thermal shutdown circuit
- Current limiter circuit
- On-chip loading motor driver

## Package Dimensions

unit: mm

**3196A-DIP30SD**




## Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Maximum supply voltage 1 | $V_{CC}$ max | | 14.5 | V |
| Maximum supply voltage 2 | $V_{CC}$L max | | 14.5 | V |
| Maximum supply voltage 3 | VREG max | | 7.0 | V |
| Output voltage | Vomax | | 14.5 | V |
| Input voltage | VI1max | | –0.3 to VREG + 0.3 | V |
| Cylinder current | Iomax | | 1.0 | A |
| Loading current | Iomax (AVE) | | 0.4 | A |
| | Iomax (peak) | | 1.2 | A |
| Allowable power dissipation | Pdmax | When mounted on the specified printed circuit board* | 2.8 | W |
| Operating temperature | Topr | | –20 to +75 | °C |
| Storage temperature | Tstg | | –55 to +150 | °C |

Note: * Specified printed circuit board: 114.3 × 76.1 × 1.6 mm glass-epoxy board

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## Allowable Operating Ranges at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Supply voltage 1 | $V_{CC}$ | | 8 to 13.8 | V |
| Supply voltage 2 | $V_{CC}L$ | | 8 to 13.8 | V |
| Supply voltage 3 | VREG | | 4 to 6 | V |

## Electrical Characteristics at Ta = 25°C, $V_{CC}$ = $V_{CC}L$ = 12 V, VREG = 5 V

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Supply current 1 | $I_{CC}$ | VC = 0 V, XIN = YIN = 0 V | | 3.5 | 5.0 | mA |
| Supply current 2 | $I_{CC}L$ | VC = 0 V, XIN = YIN = 0 V | | | 1 | mA |
| Supply current 3 | $I_{REG}$ | VC = 0 V, XIN = YIN = 0 V | | 10 | 15 | mA |
| Output saturation voltage 1 | $V_O$sat1 | IO = 0.4 A, source + sink | | 1.4 | 2.0 | V |
| Output saturation voltage 2 | $V_O$sat2 | IO = 0.8 A, source + sink | | 1.8 | 2.6 | V |
| MC pin common-mode input voltage range | $V_{IC}$ | | 0 | | $V_{CC}$ – 2 | V |
| VC pin input bias current | $I_{VC}$ | VC = 0 V | –2 | –1 | | µA |
| Control start voltage | VTHVC | VRF = 10 mA | 2.4 | 2.5 | 2.6 | V |
| Closed-loop control gain | GMVC | RF = 0.5 Ω | 0.75 | 0.95 | 1.15 | A/V |
| PCOUT output current 1 | $I_{PCO}$U | Source side | | –90 | | µA |
| PCOUT output current 2 | $I_{PCO}$D | Sink side | | 90 | | µA |
| VCOIN input current | $I_{VCO}$IN | VCOIN = 5 V | | 0.1 | 0.2 | µA |
| Minimum VCO frequency | $f_{VCO}$MIN | CX = 0.022 µF, $V_{CO}$IN = open | | 400 | | Hz |
| Maximum VCO frequency | $f_{VCO}$MAX | CX = 0.022 µF, $V_{CO}$IN = 5 V | | 18.5 | | kHz |
| C1/C2 source current ratio | $R_{SOURCE}$ | $I_{C1SOURCE}/I_{C2SOURCE}$ | –12 | | +12 | % |
| C1/C2 sink current ratio | $R_{SINK}$ | $I_{C1SINK}/I_{C2SINK}$ | –12 | | +12 | % |
| C1 source/sink current ratio | RC1 | $I_{C1SOURCE}/I_{C1SINK}$ | –35 | | +15 | % |
| C2 source/sink current ratio | RC2 | $I_{C2SOURCE}/I_{C2SINK}$ | –35 | | +15 | % |
| Thermal shutdown operating temperature | T-TSD | * | 150 | 180 | 210 | °C |
| Thermal shutdown hysteresis | ΔTTSD | * | | 15 | | °C |

Note: * These values are design guarantee values, and are not tested.

## FG/PG Amplifier Block at Ta = 25°C, $V_{CC}$ = $V_{CC}L$ = 12 V, VREG = 5 V

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| [Back EMF FG] | | | | | | |
| Output on voltage | $V_O$L | | | | 0.4 | V |
| Output off voltage | $V_O$H | | 4.5 | | | V |
| [PG Amplifier] | | | | | | |
| Input offset voltage | $V_I$O | | –8 | | +8 | mV |
| Input bias current | $I_B$IN– | | –250 | | | nA |
| Common-mode input voltage range | $V_{ICOM}$ | * | 1 | | 3.5 | V |
| Open-loop gain | GVPG | f = 1 kHz | | 55 | | dB |
| Output on voltage | $V_O$L | | | | 0.4 | V |
| Output off voltage | $V_O$H | | 4.5 | | | V |
| Schmitt amplifier hysteresis | $V_S$hys | | 70 | 93 | 115 | mV |

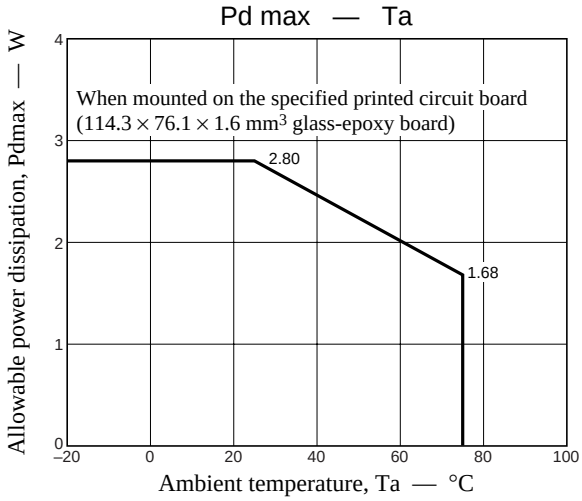
Note: * These values are design guarantee values, and are not tested.

## Loading Block at Ta = 25°C, $V_{CC}$ = $V_{CC}$L = 12 V, VREG = 5 V

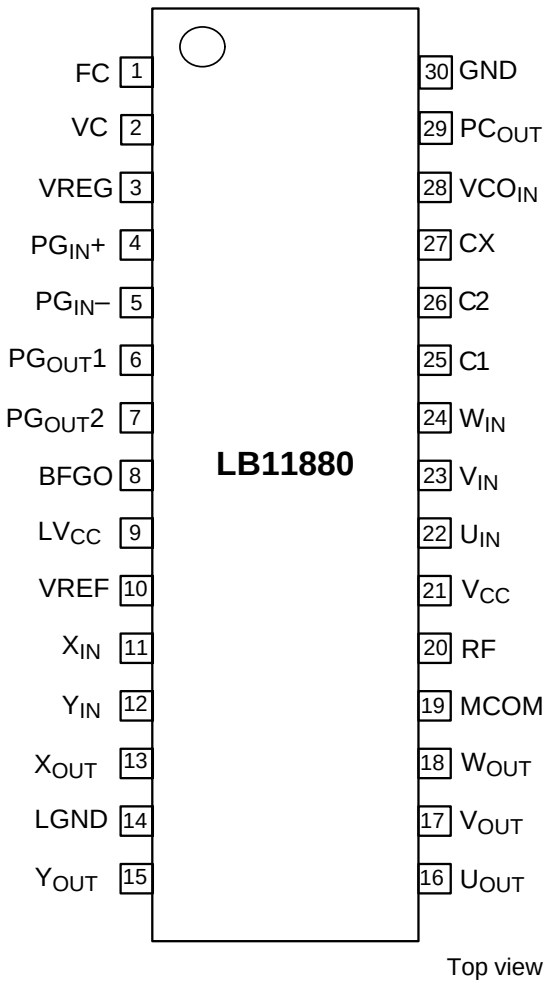
| Parameter | | Symbol | | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | min | typ | max | |
| Input voltage | 1 (high) | $V_{IN}1$ | | | 3.5 | | 5 | V |
| | 2 (low) | $V_{IN}2$ | | | 0 | | 0.8 | V |
| Input current | | $I_{IN}$ | | Sink $V_{IN}$ = 3.5 V | | 30 | 50 | µA |
| Input hysteresis | | ΔVT | | | | 0.7 | | V |
| Saturation voltage | | Vsat U-1 | | Vref = VS, between the output and VS<br>$I_O$ = 0.2 A, CW/CCW mode | | 1.5 | 2.1 | V |
| | | Vsat L-1 | | Vref = VS, between the output and ground<br>$I_O$ = 0.2 A, CW/CCW mode | | 0.2 | 0.3 | V |
| | | Vsat U-1' | | Vref = VS, between the output and VS<br>$I_O$ = 0.4 A, CW/CCW mode | | 1.6 | 2.2 | V |
| | | Vsat L-1' | | Vref = VS, between the output and ground<br>$I_O$ = 0.4 A, CW/CCW mode | | 0.3 | 0.5 | V |
| Upper side residual voltage | | VsatU-1'' | | Vref = 8 V, between the output and ground<br>$I_O$ = 0.2 A, CW/CCW mode | 7.2 | 8.0 | 8.8 | V |
| | | VsatL-1'' | | Vref = 8 V, between the output and ground<br>$I_O$ = 0.4 A, CW/CCW mode | 7.2 | 8.0 | 8.8 | V |
| Output transistor leakage current | | Upper | ILU | | | | 50 | µA |
| | | Lower | ILL | | | | 50 | µA |
| Diode forward voltage | | Uper | VFU | IF = 0.4 A | | 1.3 | | V |
| | | Lower | VFL | IF = 0.4 A | | 1.0 | | V |
| Control supply current | | Iref | | | –5 | –2 | | µA |

## Loading Motor Truth Table

| Input | | Output | | Mode |
|---|---|---|---|---|
| $X_{IN}$ | $Y_{IN}$ | $X_{OUT}$ | $Y_{OUT}$ | |
| L | L | Off | Off | Standby |
| H | L | H | L | Forward |
| L | H | L | H | Reverse |
| H | H | L | L | Brake |

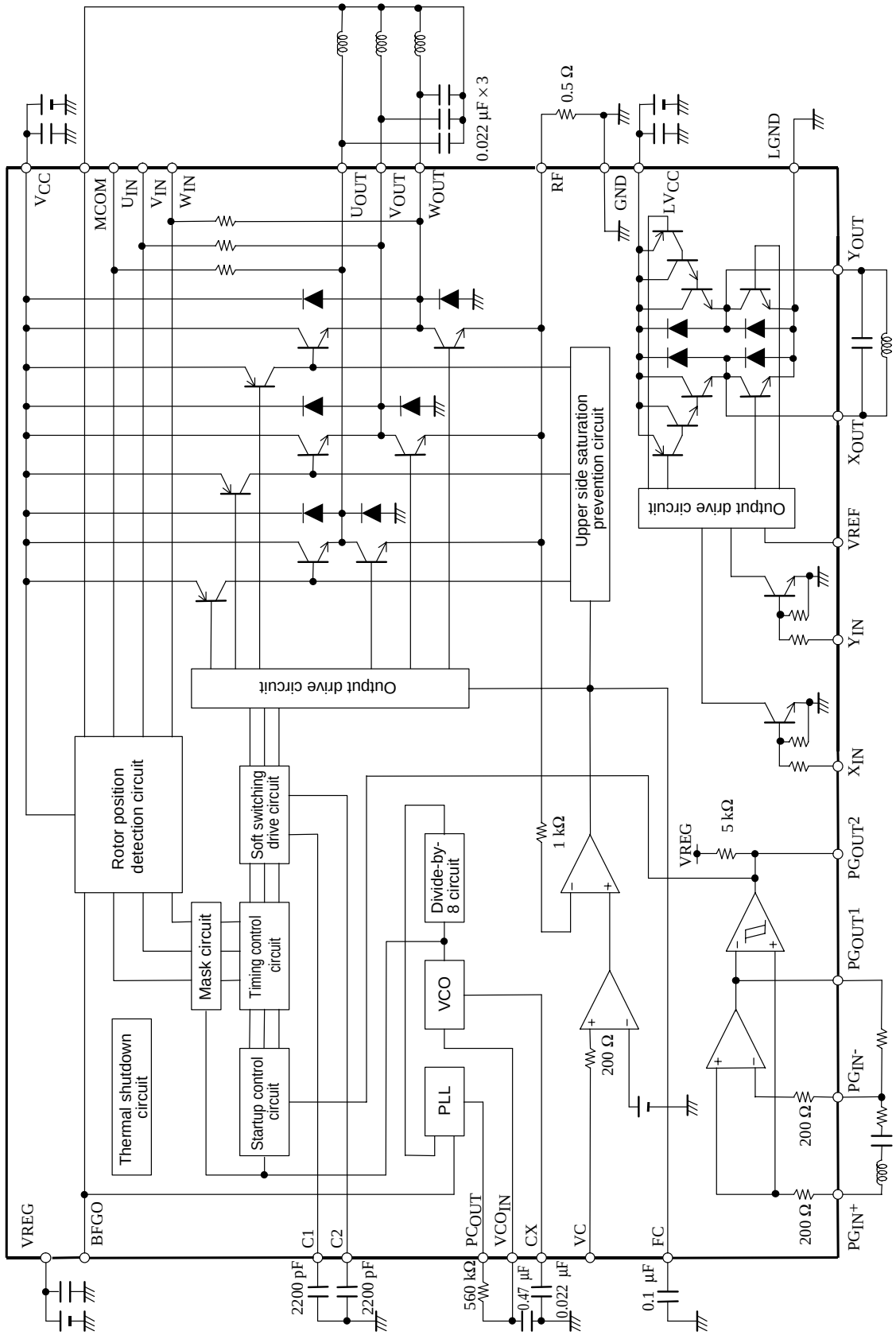



## Pin Assignment

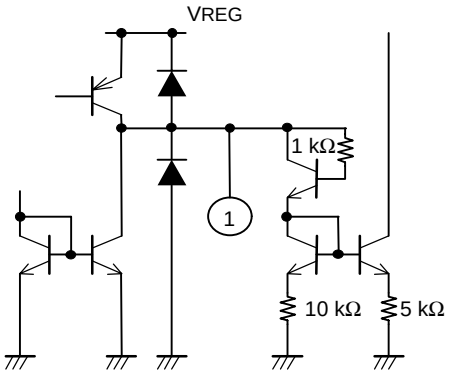
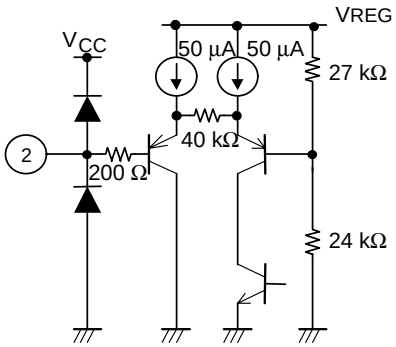
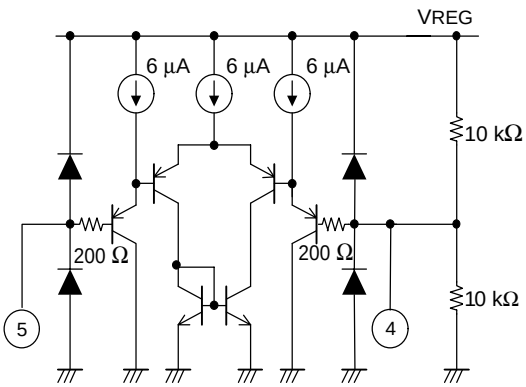
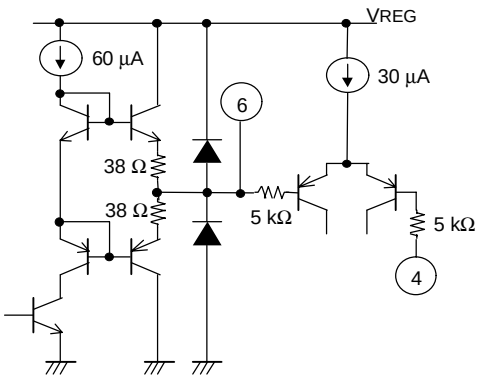



Top view

**Block Diagram** (Note that the values of the external components depend on the motor used.)



## Pin Description

| Pin No. | Pin | Pin voltage | Function | Equivalent circuit |
|---|---|---|---|---|
| 1 | FC | | Frequency characteristics compensation<br>Oscillation in the current control system closed loop can be prevented by connecting a capacitor between this pin and ground. |  |
| 2 | VC | 0 V to VREG | Speed control<br>This circuit implements constant-current control in which current feedback is applied from the RF system. |  |
| 3 | VREG | 4 V to 6 V | Control system power supply<br>This power supply must be stabilized so that ripple and noise do not enter the IC. | |
| 4 | $PG_{IN}+$ | | PG amplifier plus side input<br>This pin is biased to 1/2 VREG internally. |  |
| 5 | $PG_{IN}-$ | | PG amplifier minus side input | |
| 6 | $PG_{OUT}1$ | | PG amplifier linear output |  |

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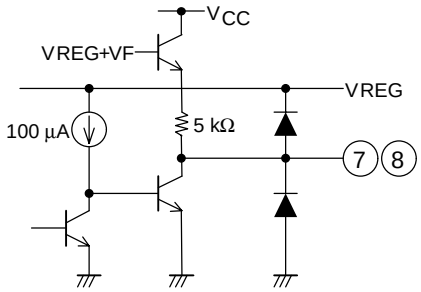
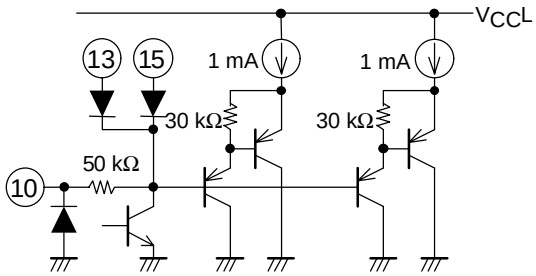
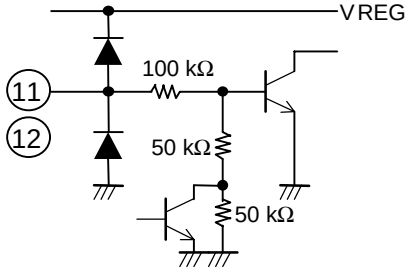
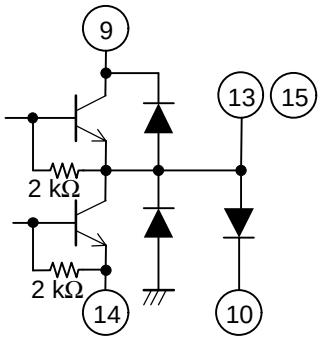
| Pin No. | Pin | Pin voltage | Function | Equivalent circuit |
|---|---|---|---|---|
| 7 | $PG_{OUT}2$ | | PG Schmitt amplifier output |  |
| 8 | BFGO | | Motor back EMF voltage detection FG output (synthesized from three phases) | |
| 9 | $LV_{CC}$ | 8 to 13.8 V | Loading motor driver output transistor power supply | |
| 10 | VREF | 0 to $V_{CC}L$ | Loading motor driver output voltage setting |  |
| 11 | $X_{IN}$ | 0 V to VREG | Loading motor driver logic input |  |
| 12 | $Y_{IN}$ | | | |
| 13 | $X_{OUT}$ | | Loading motor driver output |  |
| 15 | $Y_{OUT}$ | | | |
| 14 | LGND | | Loading motor driver output transistor ground | |

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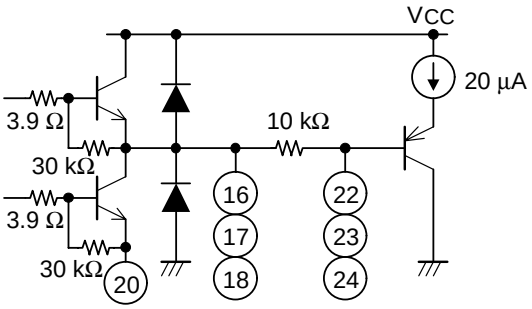
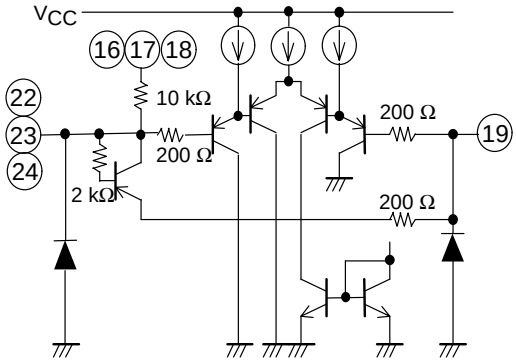
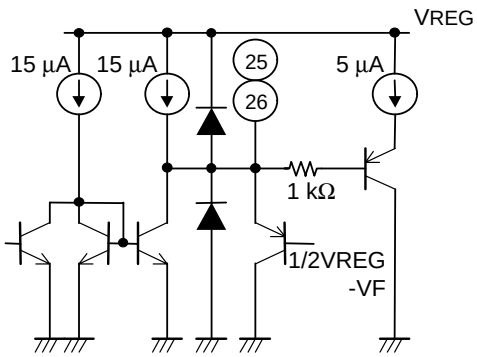
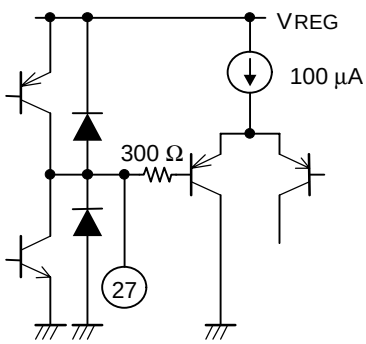
| Pin No. | Pin | Pin voltage | Function | Equivalent circuit |
|---|---|---|---|---|
| 16 | $U_{OUT}$ | | Drum motor driver output |  |
| 17 | $V_{OUT}$ | | | |
| 18 | $W_{OUT}$ | | | |
| 20 | RF | | Lowest potential of the drum motor driver output transistor<br>This IC implements constant-current control by detecting this voltage.<br>The current limiter also operates by detecting this voltage. | |
| 21 | $V_{CC}$ | 8 to 13.8 V | Internal reference voltage and power supply for both the drum motor driver output block and the coil waveform detection circuit. | |
| 19 | MCOM | | Motor coil center input<br>The coil voltage waveform is detected with this voltage as the reference. |  |
| 22 | $U_{IN}$ | | Coil waveform detection comparator input<br>Each phase output is connected by an internal 10 kΩ resistor. | |
| 23 | $V_{IN}$ | | | |
| 24 | $W_{IN}$ | | | |
| 25 | C1 | | Triangular wave generating capacitor connection<br>This triangular wave is used to implement soft switching in the coil output waveform. |  |
| 26 | C2 | | | |
| 27 | CX | | The value of the capacitor connected between this pin and ground determines the operating frequency range and the minimum operating frequency of the VCO circuit. |  |

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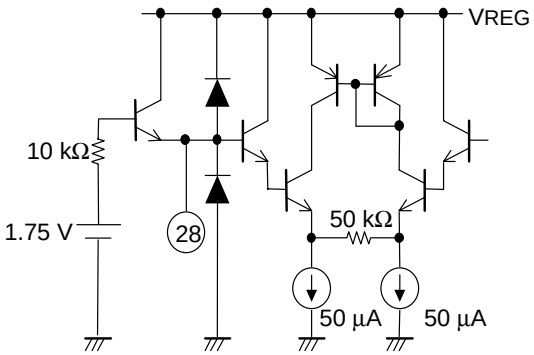
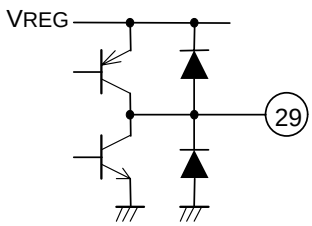
| Pin No. | Pin | Pin voltage | Function | Equivalent circuit |
|---|---|---|---|---|
| 28 | $VCO_{IN}$ | | VCO circuit voltage input<br>The PCOUT pin voltage is filtered by an RC circuit and input to this pin. |  |
| 29 | $PC_{OUT}$ | | VCO circuit PLL output |  |
| 30 | GND | | Ground for all circuits other than the drum and loading driver output transistors. | |