



SANYO Semiconductors

DATA SHEET

An ON Semiconductor Company

LV8771VH — Bi-CMOS LSI PWM Constant-Current Control Stepping Motor Driver

Overview

The LV8771VH is a PWM current control stepping motor driver. It is ideally suited for driving stepping motors used in office equipment and amusement applications.

Features

- 1 channel PWM current control stepping motor driver.
- I_O max = 1.5A
- Output on-resistance (High side : 0.6 Ω ; Low side : 0.4 Ω ; total : 1.0 Ω ; $T_a = 25^\circ\text{C}$, $I_O = 1.5\text{A}$).
- Micro step mode can be set to full-step, half-step (full torque), half-step, and quarter-step mode.
- Built-in thermal shutdown circuit.
- No control power supply necessary.

Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|-----------------------------|--------------|--|-------------|------------------|
| Supply voltage | V_M max | | 36 | V |
| Output peak current | I_O peak | $t \leq 10\text{ms}$, ON-duty $\leq 20\%$ | 1.75 | A |
| Output current | I_O max | | 1.5 | A |
| Allowable power dissipation | P_d max | * | 3.0 | W |
| Logic input voltage | V_{IN} max | | -0.3 to +6 | V |
| VREF input voltage | VREF max | | -0.3 to +6 | V |
| Operating temperature | T_{opr} | | -20 to +85 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -55 to +150 | $^\circ\text{C}$ |

* Specified circuit board : 90.0mm \times 90.0mm \times 1.6mm, glass epoxy board.

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.

Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

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Recommendation Operating Conditions at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|--------------------------|-----------------|------------|----------|------|
| Supply voltage range | VM | | 9 to 32 | V |
| Logic input voltage | V _{IN} | | 0 to 5.5 | V |
| VREF input voltage range | VREF | | 0 to 3 | V |

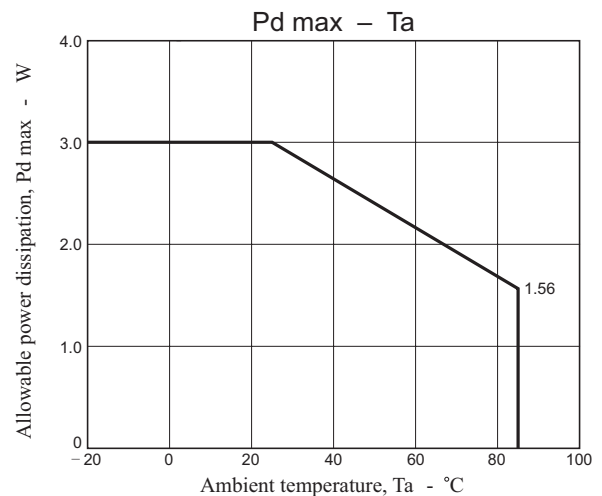
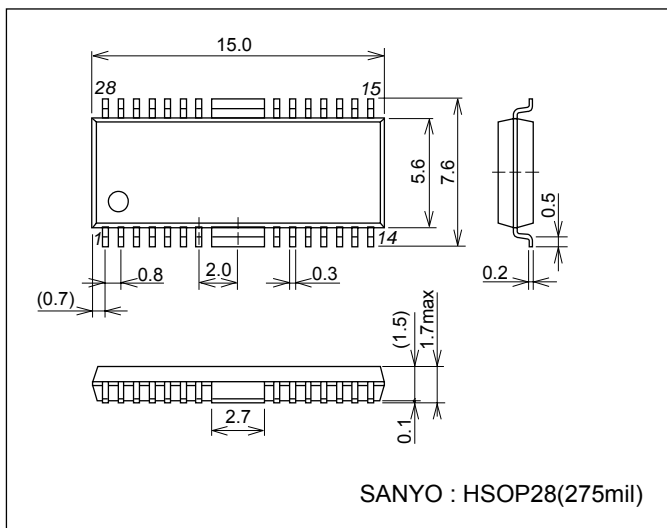
Electrical Characteristics at Ta = 25°C, VM = 24V, VREF = 1.5V

| Parameter | Symbol | Conditions | Ratings | | | Unit |
|--|---------------------|---|---------|------|------|------|
| | | | min | typ | max | |
| Standby mode current drain | IMstn | ST = "L" | | 100 | 150 | μA |
| Current drain | IM | ST = "H", I01 = I11 = I02 = I12 = "L", with no load | | 2 | 3 | mA |
| VREG5 output voltage | Vreg5 | Ireg5 = -1mA | 4.7 | 5 | 5.3 | V |
| Thermal shutdown temperature | TSD | Design guarantee | 150 | 180 | 210 | °C |
| Thermal hysteresis width | ΔTSD | Design guarantee | | 40 | | °C |
| Motor driver | | | | | | |
| Output on resistance | Ron _u | I _O = 1.5A, Upper-side on resistance | | 0.6 | 0.78 | Ω |
| | Ron _d | I _O = 1.5A, Lower-side on resistance | | 0.4 | 0.52 | Ω |
| Output leakage current | I _O leak | V _M = 36V | | | 50 | μA |
| Diode forward voltage | VD | | | 1.1 | 1.4 | V |
| Logic high-level input voltage | V _{INH} | | 2.0 | | | V |
| Logic low-level input voltage | V _{INL} | | | | 0.8 | V |
| Logic pin input current | I _{INL} | V _{IN} = 0.8V | 4 | 8 | 12 | μA |
| | I _{INH} | V _{IN} = 5V | 30 | 50 | 70 | μA |
| Current setting comparator threshold voltage | Vtdac11 | I01(02) = "H", I11(12) = "H" | 0.29 | 0.30 | 0.31 | V |
| | Vtdac01 | I01(02) = "L", I11(12) = "H" | 0.20 | 0.21 | 0.22 | V |
| | Vtdac10 | I01(02) = "H", I11(12) = "L" | 0.11 | 0.12 | 0.13 | V |
| Chopping frequency | Fchop1 | FC = "L" | 24.8 | 31.0 | 37.2 | kHz |
| | Fchop2 | FC = "H" | 49.6 | 62.0 | 74.4 | kHz |
| VREF pin input current | Iref | VREF = 1.5V | -0.5 | | | μA |
| Charge pump | | | | | | |
| VG output voltage | VG | | 28 | 28.7 | 29.8 | V |
| Rise time | t _{ONG} | VG = 0.1μF | | 200 | 500 | μS |
| Oscillator frequency | Fosc | | 100 | 125 | 150 | kHz |

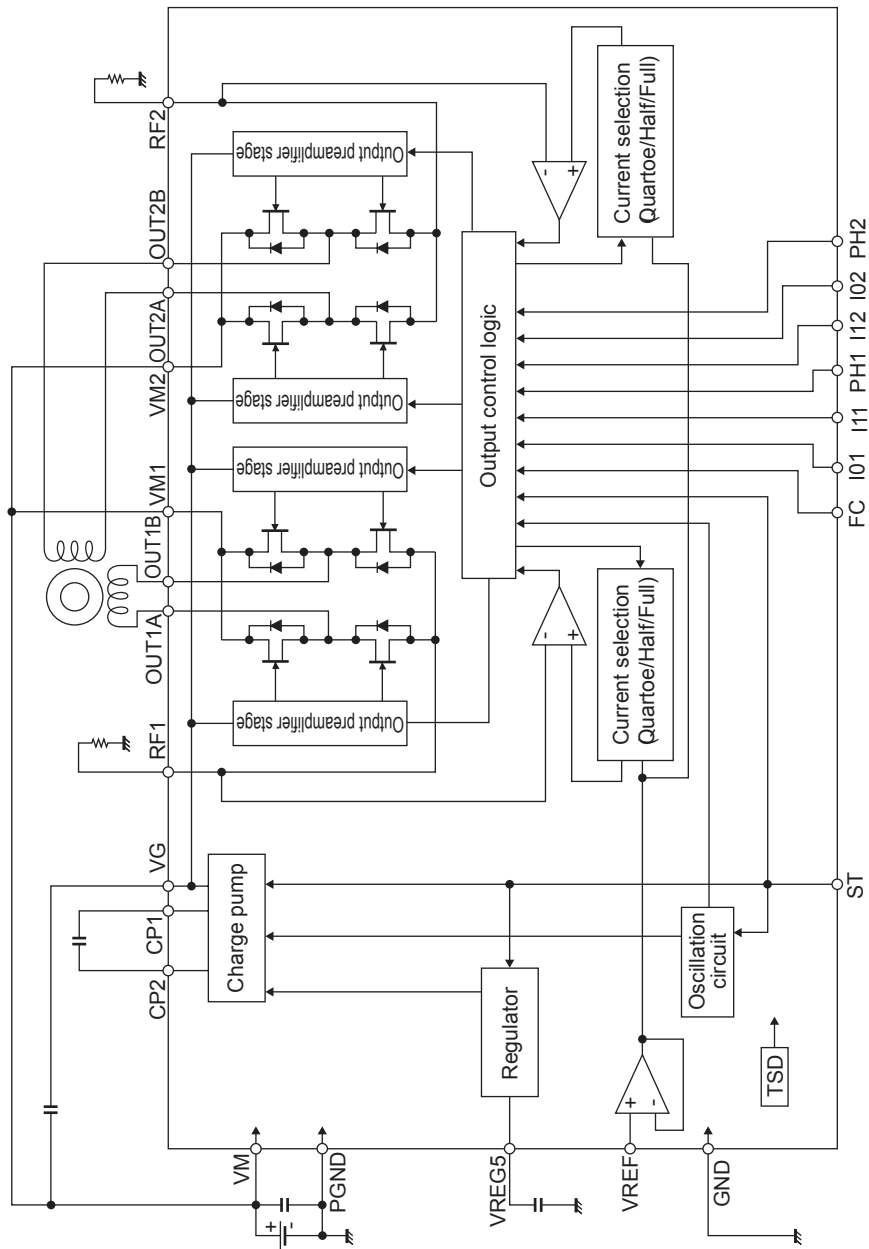
Package Dimensions

unit : mm (typ)

3222A

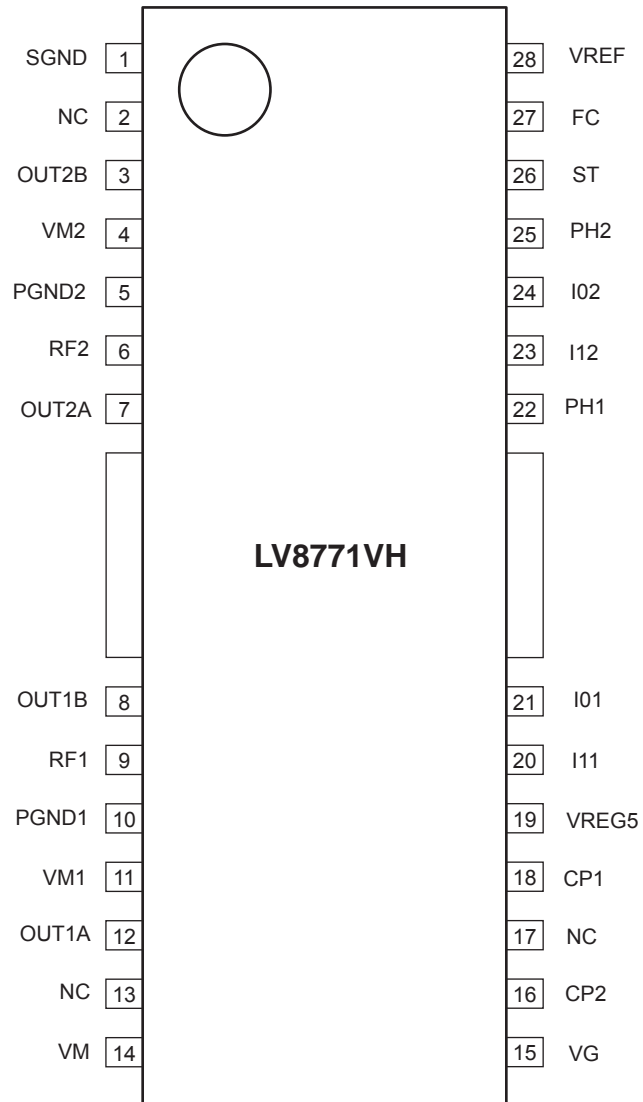


Block Diagram



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Pin Assignment



Top view

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Pin Functions

| Pin No. | Pin Name | Pin Function | Equivalent Circuit |
|---|--|--|--------------------|
| 22 21 20 25 24 23 27 | PH1 I01 I11 PH2 I02 I12 FC | Channel 1 forward/reverse rotation pin. Channel 1 output control input pin . Channel 1 output control input pin . Channel 2 forward/reverse rotation pin. Channel 2 output control input pin . Channel 2 output control input pin . Chopping frequency switching pin. | |
| 26 | ST | Chip enable pin. | |
| 8 9 10 11 12 3 4 5 6 7 | OUT1B RF1 PGND1 VM1 OUT1A OUT2B VM2 PGND2 RF2 OUT2A | Channel 1 OUTB output pin. Channel 1 current-sense resistor connection pin. Power system ground pin 1. Channel 1 motor power supply connection pin. Channel 1 OUTA output pin. Channel 2 OUTB output pin. Channel 2 current-sense resistor connection pin. Power system ground pin 2. Channel 2 motor power supply connection pin. Channel 2 OUTA output pin. | |
| 2, 13 , 17 | NC | No Connection (No internal connection to the IC) | |

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| Pin No. | Pin Name | Pin Function | Equivalent Circuit |
|----------------------|------------------------|---|--------------------|
| 15 14 16 18 | VG VM CP2 CP1 | Charge pump capacitor connection pin. Motor power supply connection pin. Charge pump capacitor connection pin. Charge pump capacitor connection pin. | |
| 19 | VREG5 | Internal power supply capacitor connection pin. | |
| 28 | VREF | Constant current control reference voltage input pin. | |

Description of operation

Input Pin Function

The function to prevent including the turn from the input to the power supply is built into each logic pin. Therefore, the current turns to the power supply even if power supply (VM) is turned off with the voltage impressed to the input pin and there is not crowding.

(1) Chip enable function

This IC is switched between standby and operating mode by setting the ST pin. In standby mode, the IC is set to power-save mode and all logic is reset. In addition, the internal regulator circuit and charge pump circuit do not operate in standby mode.

| ST | Mode | Internal regulator | Charge pump |
|-------------|----------------|--------------------|-------------|
| Low or Open | Standby mode | Standby | Standby |
| High | Operating mode | Operating | Operating |

(2) Output control logic

| I01(02) | I11(12) | Output current (I _O) |
|---------|---------|---------------------------------------|
| Low | Low | 0 |
| High | Low | $I_O = ((VREF / 5) / RF) \times 40\%$ |
| Low | High | $I_O = ((VREF / 5) / RF) \times 70\%$ |
| High | High | $I_O = (VREF / 5) / RF$ |

| PH1(2) | Current direction |
|--------|-------------------|
| Low | OUTB → OUTA |
| High | OUTA → OUTB |

(3) Setting constant-current control reference current

This IC is designed to automatically exercise PWM constant-current chopping control for the motor current by setting the output current. Based on the voltage input to the VREF pin and the resistance connected between RF and GND, the output current that is subject to the constant-current control is set using the calculation formula below:

$$I_{OUT} = (VREF / 5) / RF \text{ resistance}$$

* The above setting is the output current at I01(02) = High, I11(12) = Low.

(Example) When VREF = 1.5V, I01(02) = High, I11(12) = Low and RF1(2) resistance is 0.5Ω, the setting current is shown below.

$$I_{OUT} = (1.5V / 5) / 0.5\Omega = 0.6A$$

(4) Chopping frequency control logic

| FC | Chopping frequency |
|------|--------------------|
| Low | 31kHz |
| High | 62kHz |

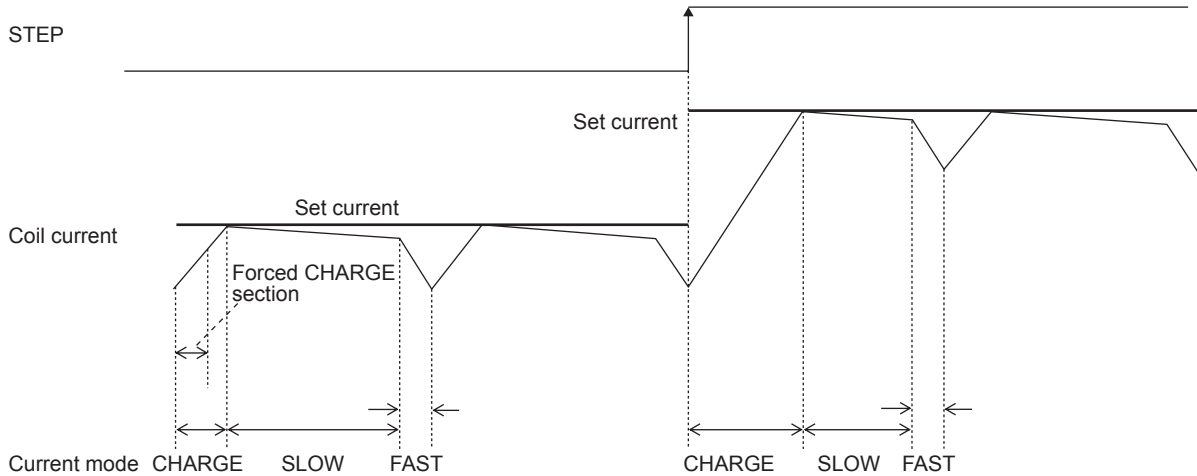
(5) Blanking period

If, when exercising PWM constant-current chopping control over the motor current, the mode is switched from decay to charge, the recovery current of the parasitic diode may flow to the current sensing resistance, causing noise to be carried on the current sensing resistance pin, and this may result in erroneous detection. To prevent this erroneous detection, a blanking period is provided to prevent the noise occurring during mode switching from being received. During this period, the mode is not switched from charge to decay even if noise is carried on the current sensing resistance pin.

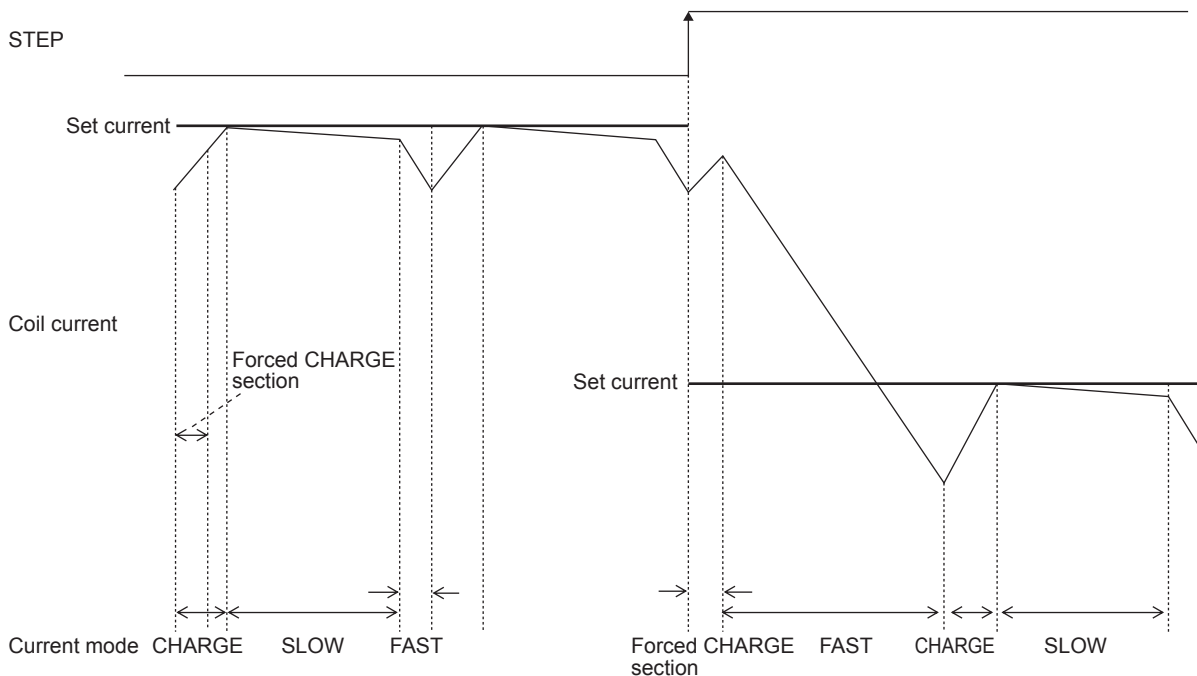
The blanking time is fixed at approximately 1μs.

(6) Current control operation specification

(Sine wave increasing direction)



(Sine wave decreasing direction)



In each current mode, the operation sequence is as described below :

- At rise of chopping frequency, the CHARGE mode begins. (In the time defined as the “blanking time,” the CHARGE mode is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF).)
- The coil current (ICOIL) and set current (IREF) are compared in this blanking time.

When $(ICOIL < IREF)$ state exists ;

The CHARGE mode up to $ICOIL \geq IREF$, then followed by changeover to the SLOW DECAy mode, and finally by the FAST DECAy mode for approximately $1\mu s$.

When $(ICOIL < IREF)$ state does not exist ;

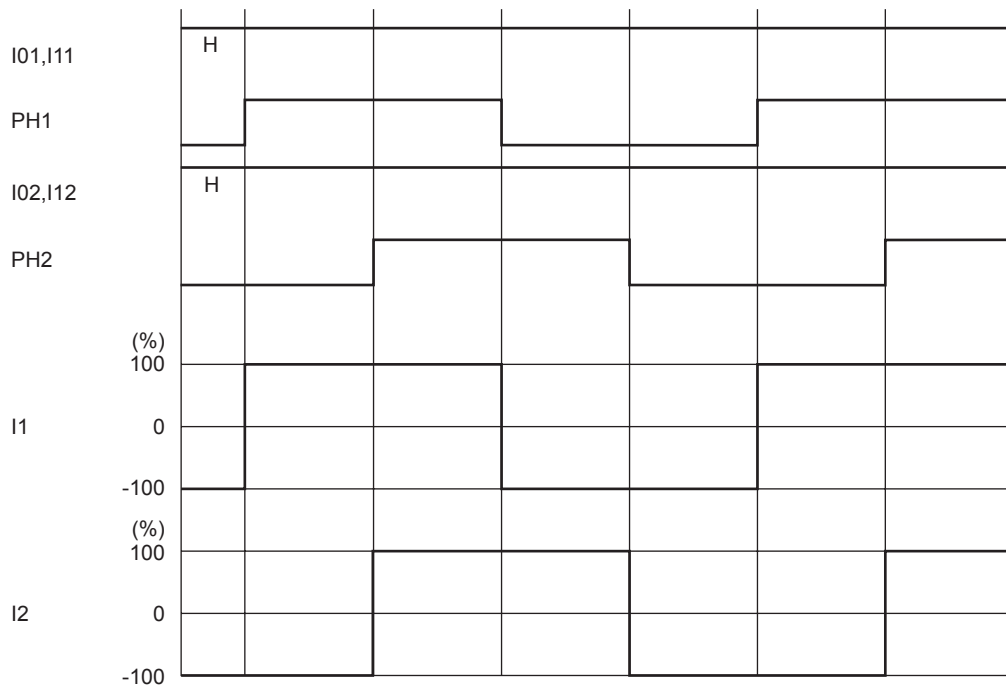
The FAST DECAy mode begins. The coil current is attenuated in the FAST DECAy mode till one cycle of chopping is over.

Above operations are repeated. Normally, the SLOW (+FAST) DECAy mode continues in the sine wave increasing direction, then entering the FAST DECAy mode till the current is attenuated to the set level and followed by the SLOW DECAy mode.

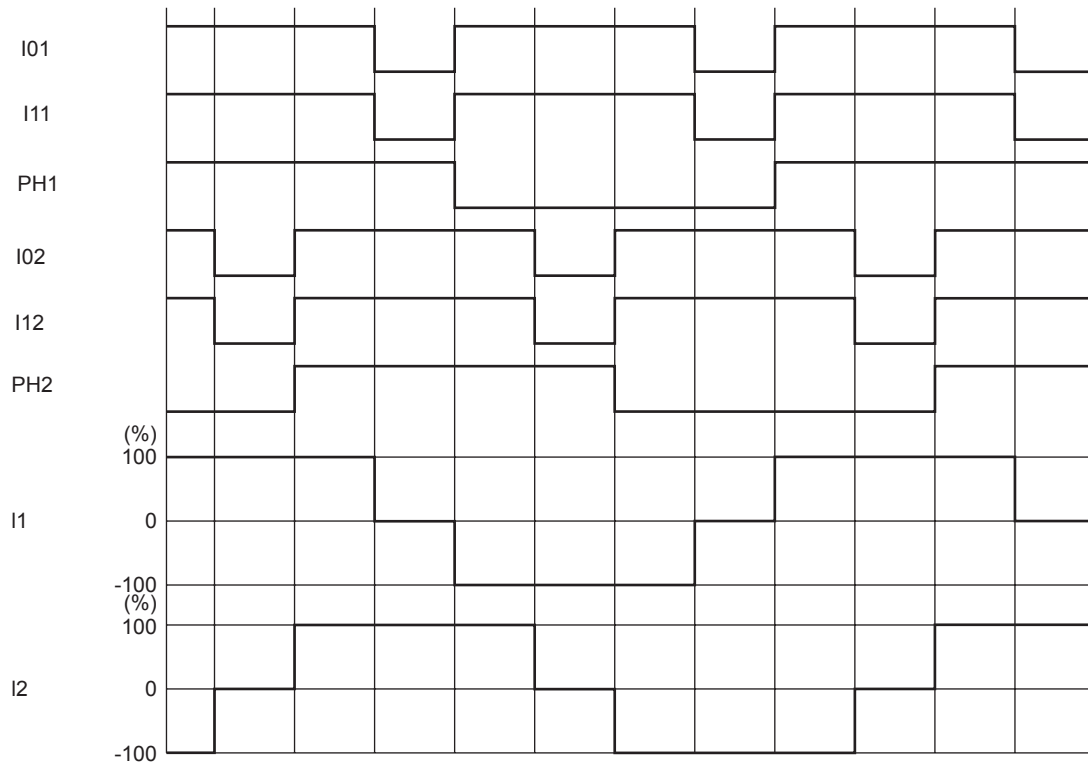
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(7) Typical current waveform in each excitation mode

Full step (CW mode)

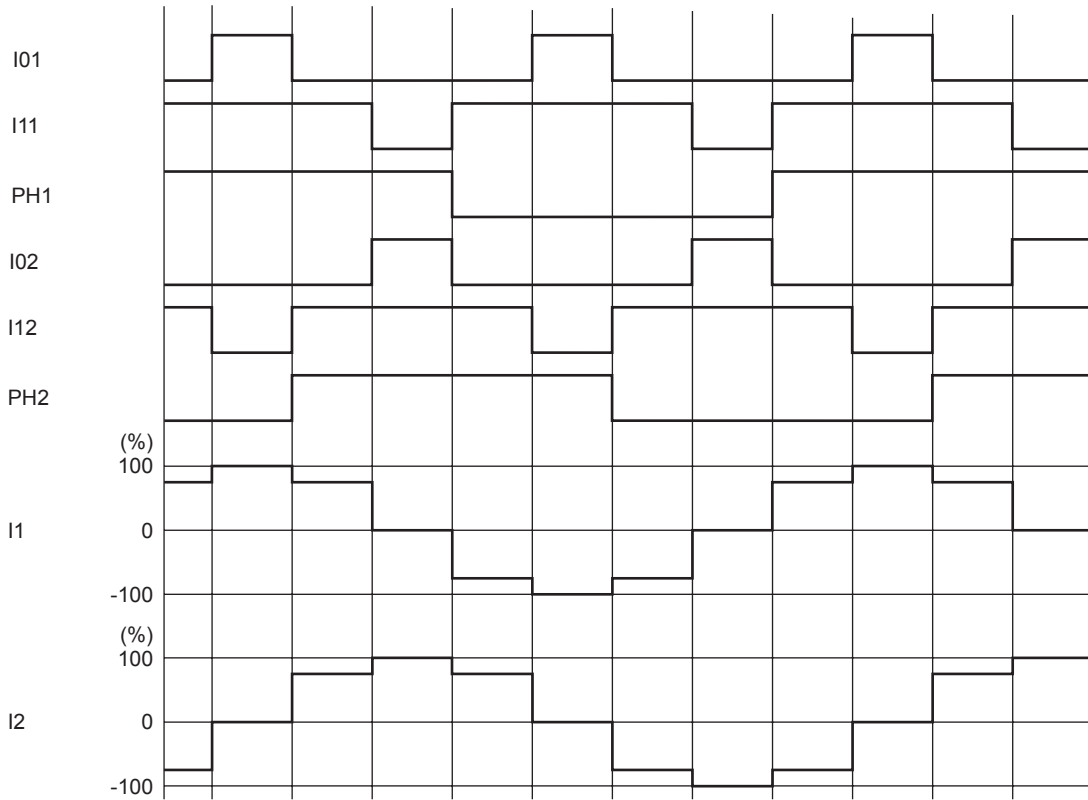


Half step full torque (CW mode)

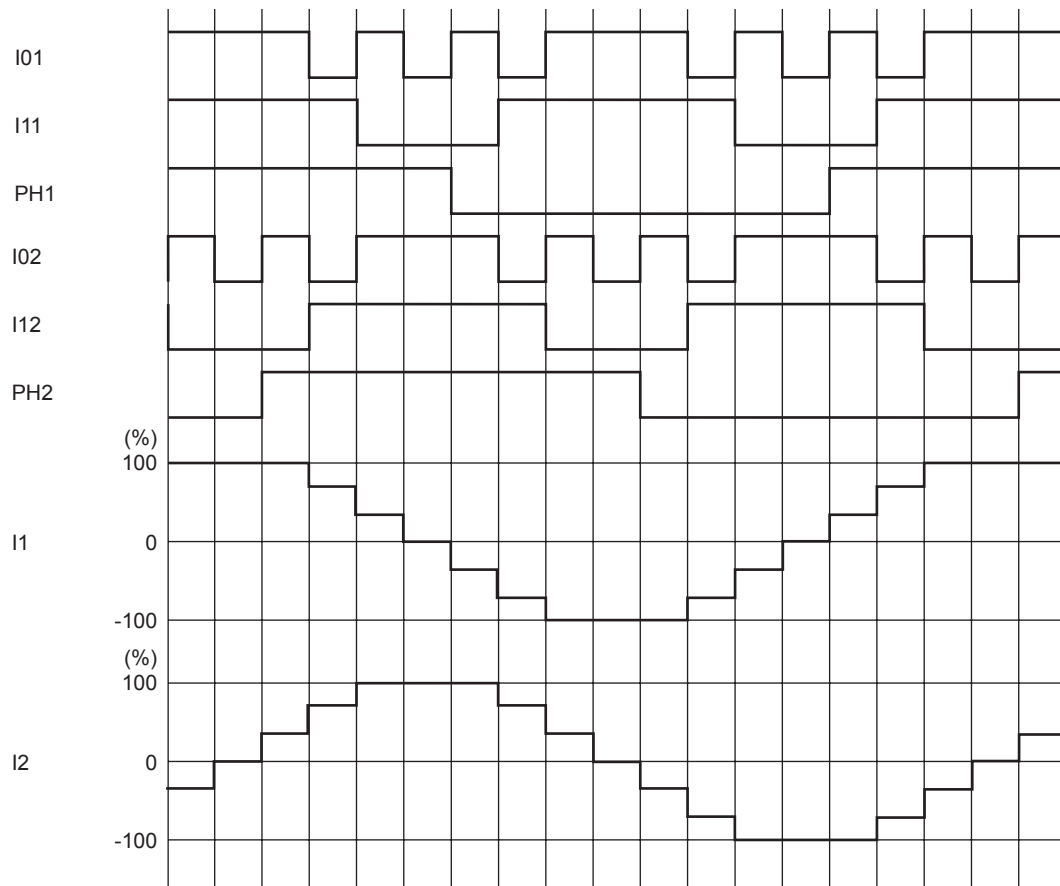


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Half step (CW mode)



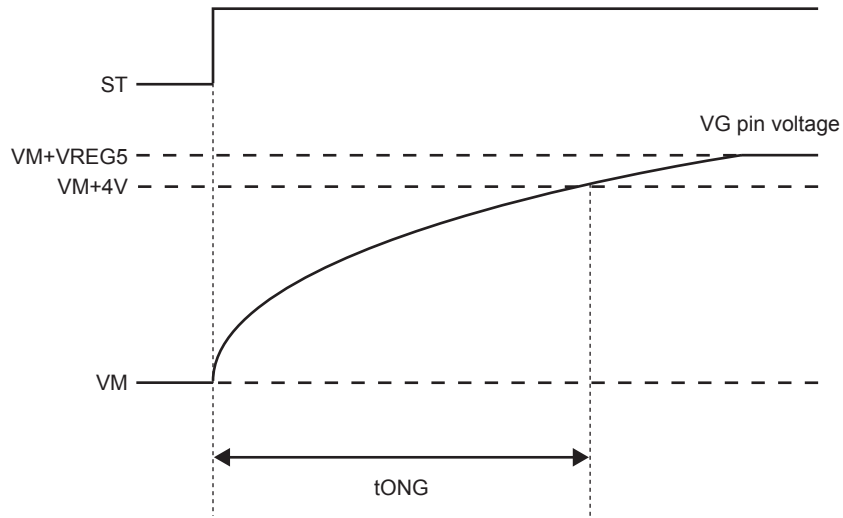
Quarter step (CW mode)



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(8) Charge Pump Circuit

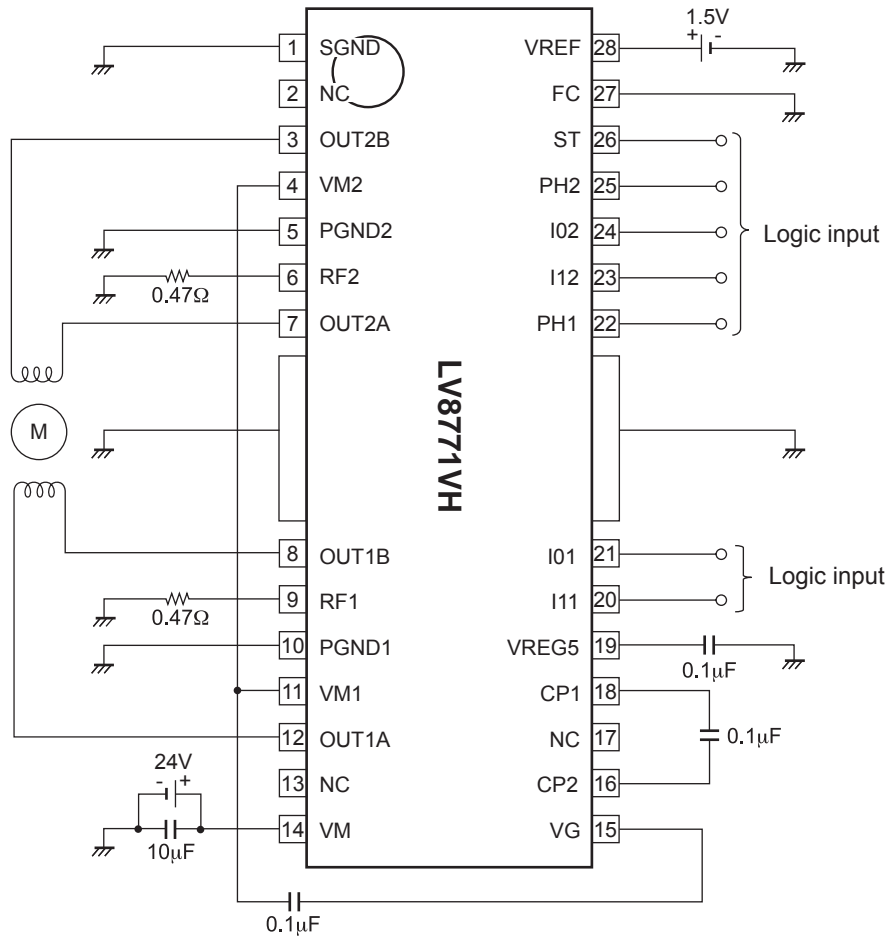
When the ST pin is set High, the charge pump circuit operates and the V_G pin voltage is boosted from the V_M voltage to the $V_M + V_{REG5}$ voltage. Because the output is not turned on if $V_M + 4V$ or more is not pressured, the voltage of the V_G pin recommends the drive of the motor to put the time of t_{ONG} or more, and to begin.



VG Pin Voltage Schematic View

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Application Circuit Example



Each constant setting formula of above circuit example is as below.

Setting of chopping frequency: 31kHz (FC = Low)

The setting constant-current level becomes like a list.

(Example) I01(02) = High, I11(12) = High

When VREF = 1.5V, RF = 0.47Ω

$$I_{OUT} = VREF / 5 / RF \text{ resistance}$$

$$= (1.5V / 5) / 0.47\Omega = 0.64A$$

| I01(02) | I11(12) | Output current (I _O) |
|---------|---------|---------------------------------------|
| Low | Low | 0 |
| High | Low | $I_O = ((VREF / 5) / RF) \times 40\%$ |
| Low | High | $I_O = ((VREF / 5) / RF) \times 70\%$ |
| High | High | $I_O = (VREF / 5) / RF$ |

| PH1(2) | Current direction |
|--------|-------------------|
| Low | OUTB → OUTA |
| High | OUTA → OUTB |

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