Ordering number : ENA2121

SANYO Semiconductors
DATA SHEET

An ON Semiconductor Company

Bi-CMOS LSI

# LV8702V — PWM Current Control High-efficient Stepping Motor Driver

## Overview

The LV8702V is a 2-channel Full-bridge driver IC that can drive a stepping motor driver, which is capable of micro-step drive and supports quarter step. Current is controlled according to motor load and rotational speed at half step, half step full-torque and quarter step excitation, thereby highly efficient drive is realized. Consequently, the reduction of power consumption, heat generation, vibration and noise is achieved.

## Features

- Built-in 1ch PWM current control stepping motor driver (bipolar type)
- BiCDMOS process IC
- Ron (High-side Ron: 0.3Ω, Low-side Ron: 0.25Ω, total: 0.55Ω, Ta = 25ºC, $I_O$ = 2.5A)
- Excitation mode is configurable as follows: full step/half step full-torque/half step/quarter step
- Excitation step moves forward only with step signal input
- $I_O$ max=2.5A
- Built-in output short protection circuit (latch method)
- Built-in thermal shut down circuit
- Control power supply is unnecessary
- Built-in high-efficient drive function (supports half step full-torque/half step/quarter step excitation mode)
- Built-in step-out detection function (Step-out detection may not be accurate during high speed rotation)

## Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Power supply voltage | $V_M$ max | | 36 | V |
| Output peak current | $I_O$ peak | tw ≤ 10ms, duty 20% | 3 | A |
| Output current | $I_O$ max | | 2.5 | A |
| Logic input voltage | $V_{IN}$ | | -0.3 to +6 | V |
| DST1, DST2, MONI, SST pin input voltage | Vdst1, Vdst2, Vmoni, Vsst | | -0.3 to +6 | V |
| Allowable power dissipation | Pd max | Ta ≤ 25°C * | 5.5 | W |
| Operating temperature | Topr | | -40 to +85 | °C |
| Storage temperature | Tstg | | -55 to +150 | °C |

* Specified board : 90.0mm × 90.0mm × 1.6mm, glass epoxy 4-layer board, with backside mounting.

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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.

## Recommended Operating Range at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Range of power supply voltage | $V_M$ | | 9 to 32 | V |
| Logic input voltage | $V_{IN}$ | | 0 to 5.5 | V |
| Range of VREF input voltage | VREF | | 0 to 3 | V |

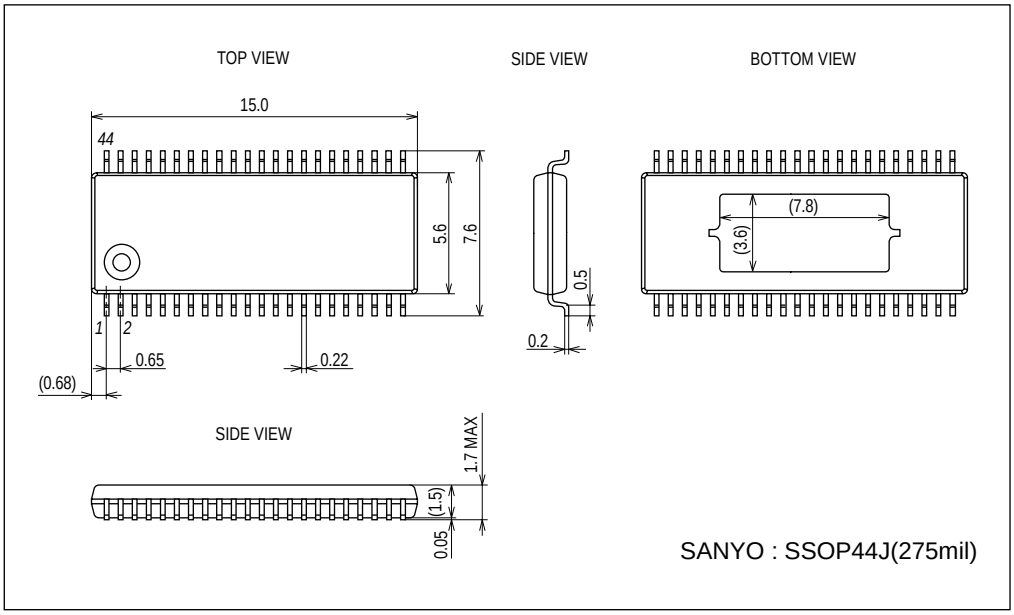
## Electrical Characteristics at Ta = 25°C, $V_M$ = 24V, VREF = 1.5V

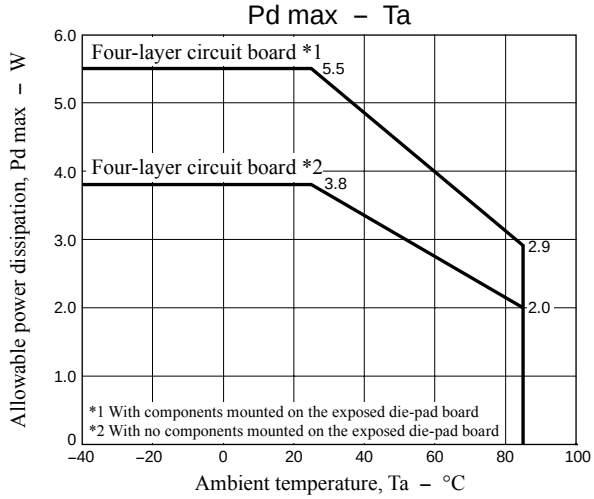
| Parameter | | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | min | typ | max | |
| Consumption current during standby | | IMstn | ST = "L" | | 110 | 400 | μA |
| Consumption current | | IM | ST = "H", OE = "L", STEP = "L", non-load | | 4.5 | 6.5 | mA |
| VREG5 output voltage | | VREG5 | $I_O$ = -1mA | 4.5 | 5 | 5.5 | V |
| Thermal shutdown temperature | | TSD | Design certification | 150 | 180 | 210 | °C |
| Thermal hysteresis width | | ΔTSD | Design certification | | 40 | | °C |
| **Motor driver** | | | | | | | |
| Output on resistor | | Ronu | $I_O$ = 2.5A, Source-side Ron | | 0.3 | 0.4 | Ω |
| | | Rond | $I_O$ = 2.5A, Sink-side Ron | | 0.25 | 0.33 | Ω |
| Output leak current | | $I_O$leak | VM = 32V | | | 50 | μA |
| Forward diode voltage | | VD | ID = -2.5A | | 1.2 | 1.4 | V |
| logic pin input current | | $I_{IN}$L | $V_{IN}$ = 0.8V | 4 | 8 | 12 | μA |
| | | $I_{IN}$H | $V_{IN}$ = 5V | 30 | 50 | 70 | μA |
| ADIN pin input voltage | | Vadin | Ra2 = 100kΩ: refer to 15-4) | 0 | | 12 | V |
| Logic input "H" level voltage | | $V_{IN}$H | | 2.0 | | | V |
| Logic input "L" level voltage | | $V_{IN}$L | | | | 0.8 | V |
| Current selection reference voltage level | quarter step | Vtdac0_W | Step0 (initial status, 1ch comparator level) | 290 | 300 | 310 | mV |
| | | Vtdac1_W | Step1 (initial + 1) | 264 | 276 | 288 | mV |
| | | Vtdac2_W | Step2 (initial + 2) | 199 | 210 | 221 | mV |
| | | Vtdac3_W | Step3 (initial + 3) | 106 | 114 | 122 | mV |
| | half step | Vtdac0_H | Step0 (initial status, 1ch comparator level) | 290 | 300 | 310 | mV |
| | | Vtdac2_H | Step2 (initial + 1) | 199 | 210 | 221 | mV |
| | half step (full-torque) | Vtdac0_HF | Step0 (initial status, 1ch comparator level) | 290 | 300 | 310 | mV |
| | | Vtdac2'_HF | Step2' (initial + 1) | 290 | 300 | 310 | mV |
| | full step | Vtdac2'_F | Step2' (initial status, 1ch comparator level) | 290 | 300 | 310 | mV |
| Chopping frequency | | Fchop | Cchop = 200pF | 35 | 50 | 65 | kHz |
| CHOP pin charge/discharge current | | Ichop | | 7 | 10 | 13 | μA |
| Chopping oscillator circuit threshold voltage | | Vtup | | 0.8 | 1 | 1.2 | V |
| VREF pin input current | | Iref | VREF = 1.5V | -0.5 | | | μA |
| DST1, DST2, MONI, SST pin saturation voltage | | | Idst1 = Idst2 = Imoni = Isst = 1mA | | | 400 | mV |
| **Charge pump** | | | | | | | |
| VG output voltage | | VG | | 28 | 28.7 | 29.8 | V |
| Rise time | | tONG | VG = 0.1μF | | | 0.5 | mS |
| Oscillator frequency | | Fosc | | 90 | 125 | 160 | kHz |

## Package Dimensions

unit : mm (typ)

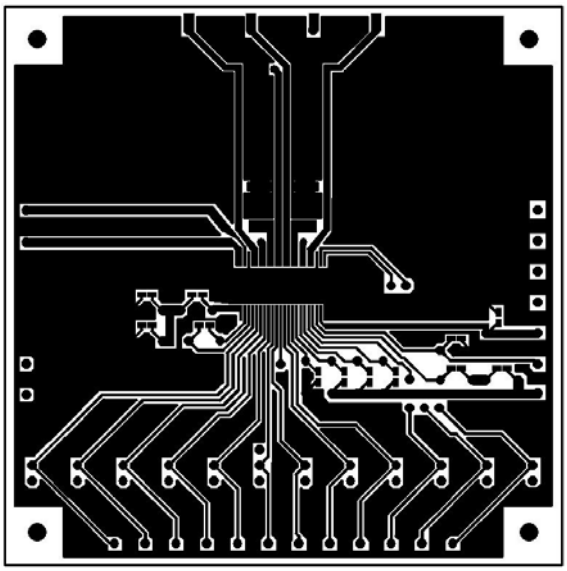
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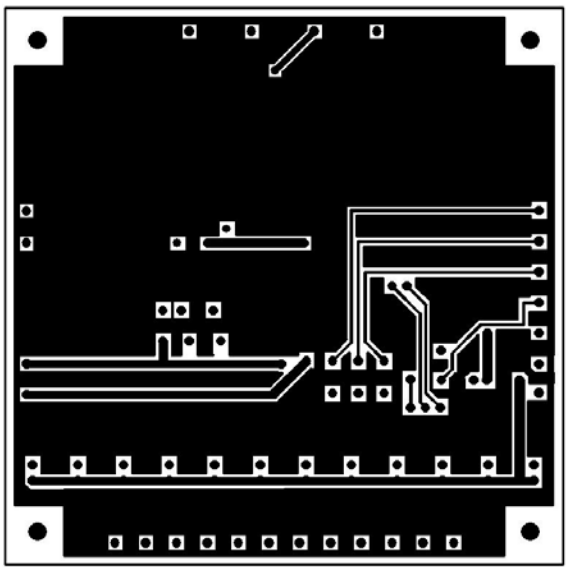



**Substrate specifications** (Substrate recommended for operation of LV8702V)

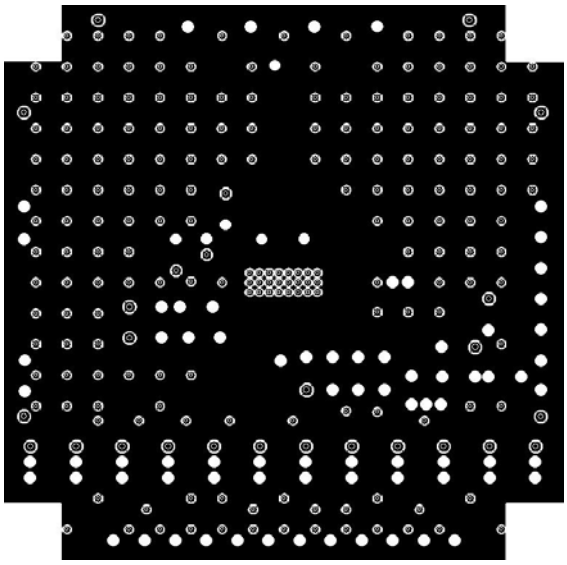
Size : 90mm × 90mm × 1.6mm (Four-layer substrate)
Material : Glass epoxy
Copper wiring density : L1 = 85%, L2 = 90%



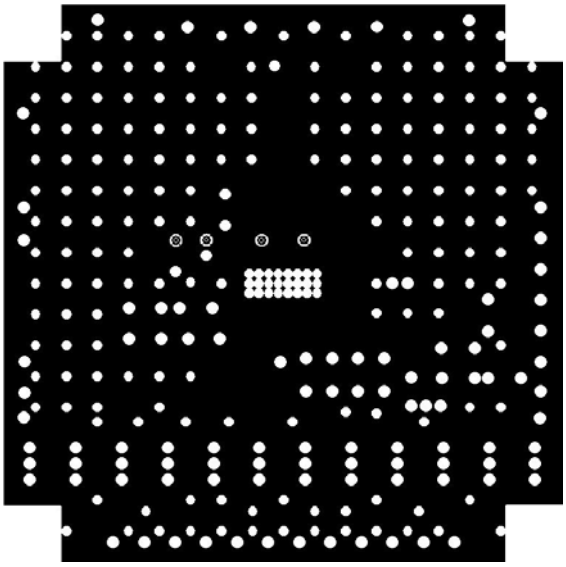
L1: Copper wiring pattern diagram



L2: Copper wiring pattern diagram



L3: GND layer



L4: Power supply layer

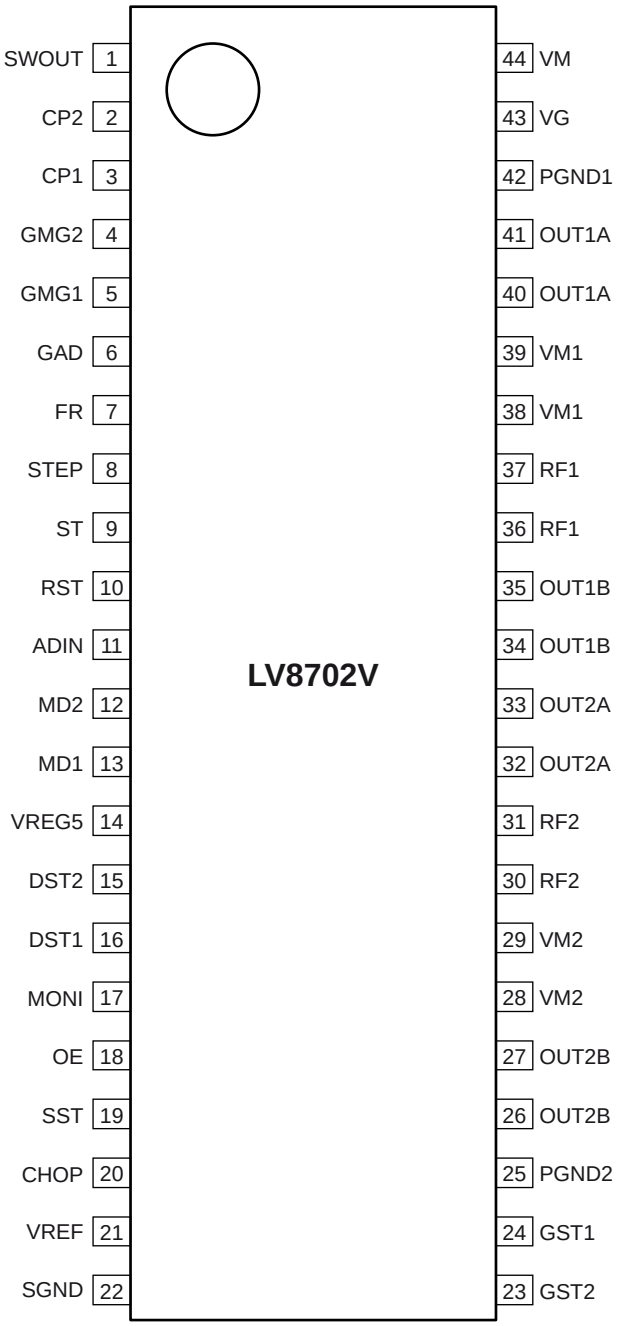
**Cautions**

1) The data for the case with the Exposed Die-Pad substrate mounted shows the values when 90% or more of the Exposed Die-Pad is wet.

2) For the set design, employ the derating design with sufficient margin.
Stresses to be derated include the voltage, current, junction temperature, power loss, and mechanical stress such as vibration, impact, and tension.
Accordingly, the design must ensure these stresses to be as low or small as possible.
The guideline for ordinary derating is shown below:
(1)Maximum value 80% or less for the voltage rating
(2)Maximum value 80% or less for the current rating
(However this does not apply to high efficiency drive because operating current is lower than the setting current.)
(3)Maximum value 80% or less for the temperature rating

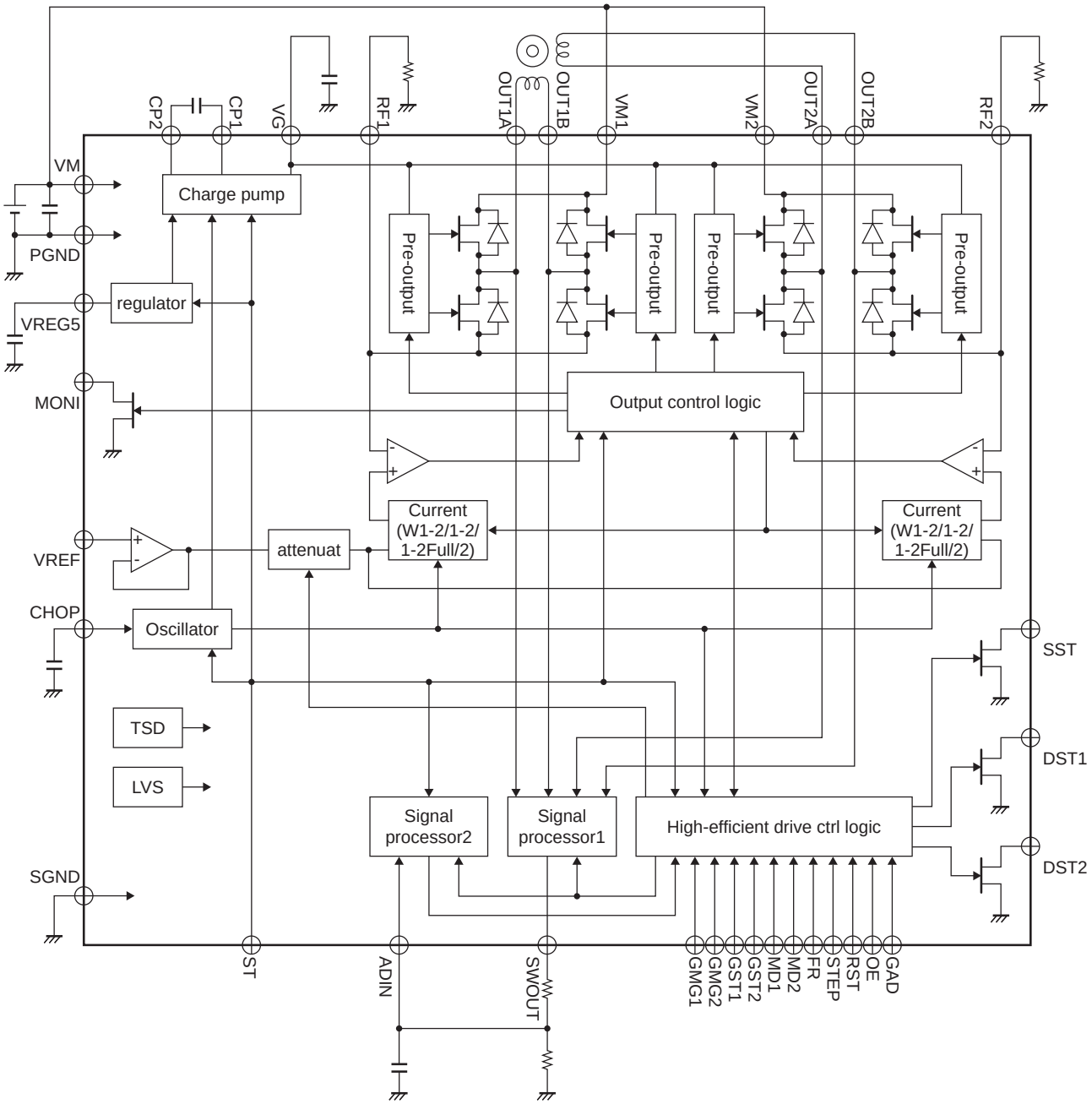
3) After the set design, be sure to verify the design with the actual product.
Confirm the solder joint state and verify also the reliability of solder joint for the Exposed Die-Pad, etc.
Any void or deterioration, if observed in the solder joint of these parts, causes deteriorated thermal conduction, possibly resulting in thermal destruction of IC.

## Pin Assignment




Top view

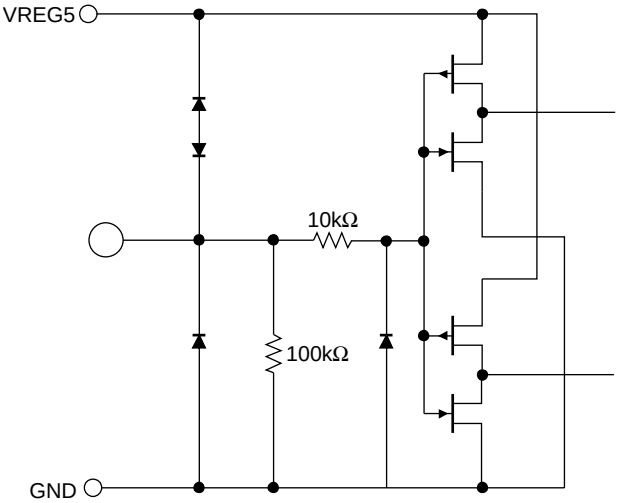
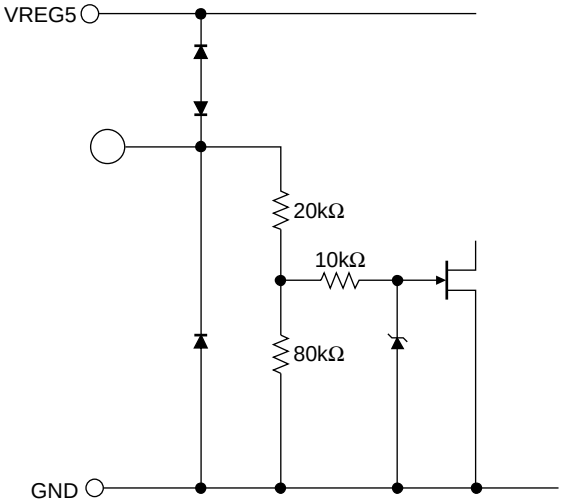
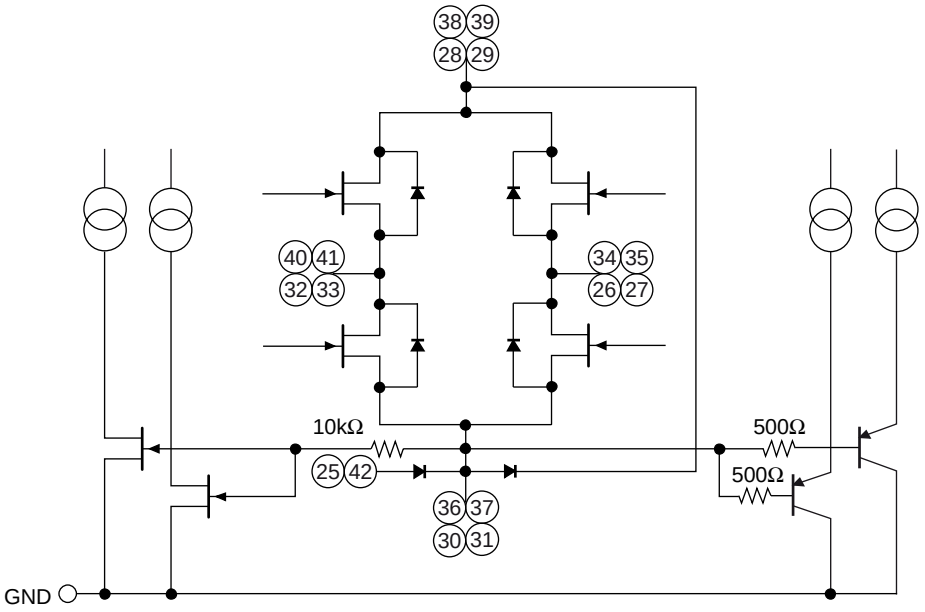
## Block Diagram



## Pin Functions

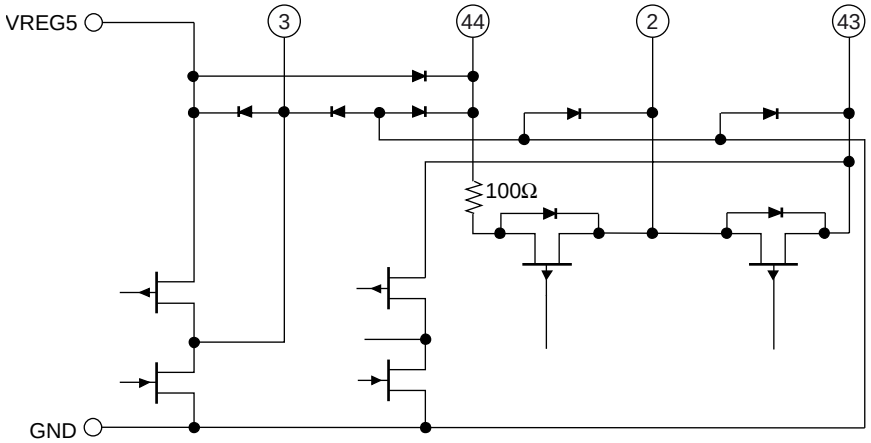
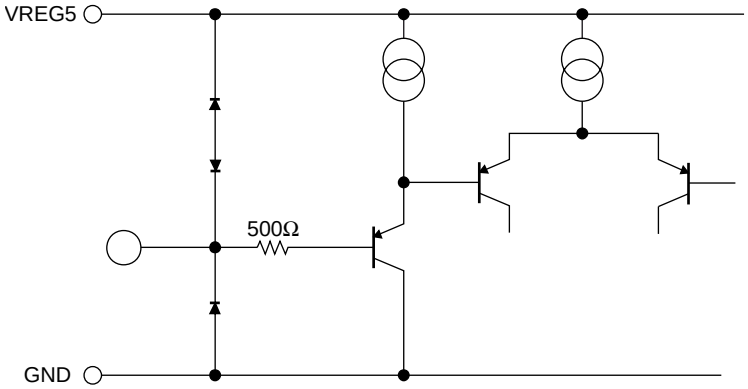
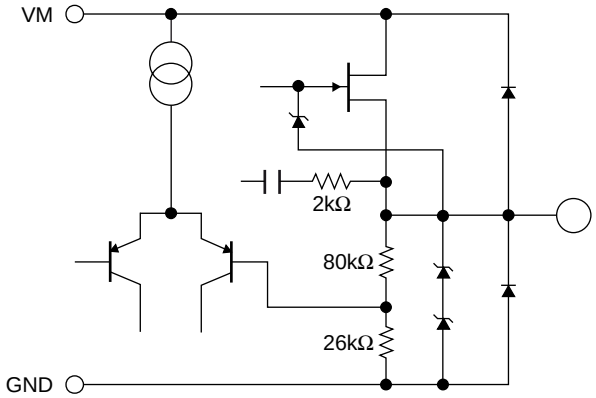
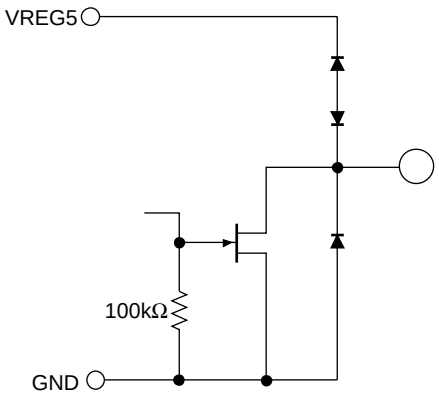
| Pin No. | Pin name | Description |
|---|---|---|
| 1 | SWOUT | Control signal output pin |
| 2 | CP2 | Capacitor connection pin for charge pump |
| 3 | CP1 | Capacitor connection pin for charge pump |
| 4 | GMG2 | Driving capability margin adjuster pin |
| 5 | GMG1 | Driving capability margin adjuster pin |
| 6 | GAD | High-efficient drive switching pin |
| 7 | FR | Forward/ reverse signal input pin |
| 8 | STEP | STEP signal input pin |
| 9 | ST | Chip enable pin |
| 10 | RST | RESET signal input pin |
| 11 | ADIN | Control signal input pin |
| 12 | MD2 | Excitation mode switching pin |
| 13 | MD1 | Excitation mode switching pin |
| 14 | VREG5 | Capacitor connection pin for internal power supply |
| 15 | DST2 | Drive status warning output pin |
| 16 | DST1 | Drive status warning output pin |
| 17 | MONI | Position detection monitor pin |
| 18 | OE | Output enable signal input pin |
| 19 | SST | Motor stop detection output pin |
| 20 | CHOP | Capacitor connection pin for chopping frequency setting |
| 21 | VREF | Constant current control reference voltage input pin |
| 22 | SGND | Signal GND |
| 23 | GST2 | Boost-up adjuster pin |
| 24 | GST1 | Boost-up adjuster pin |
| 25 | PGND2 | 2ch power GND |
| 26, 27 | OUT2B | 2ch OUTB output pin |
| 28, 29 | VM2 | 2ch motor power supply connection pin |
| 30, 31 | RF2 | 2ch current sense resistor connection pin |
| 32, 33 | OUT2A | 2ch OUTA output pin |
| 34, 35 | OUT1B | 1ch OUTB output pin |
| 36, 37 | RF1 | 1ch current sense resistor connection pin |
| 38, 39 | VM1 | 1ch motor power supply connection pin |
| 40, 41 | OUT1A | 1ch OUTA output pin |
| 42 | PGND1 | 1ch power GND |
| 43 | VG | Capacitor connection pin for charge pump |
| 44 | VM | Motor power supply connection pin |

## Pin Description

| Pin No. | Pin name | Equivalent Circuit |
|---|---|---|
| 4<br>5<br>6<br>7<br>8<br>10<br>12<br>13<br>18<br>23<br>24 | GMG2<br>GMG1<br>GAD<br>FR<br>STEP<br>RST<br>MD2<br>MD1<br>OE<br>GST2<br>GST1 |  |
| 9 | ST |  |
| 25<br>26, 27<br>28, 29<br>30, 31<br>32, 33<br>34, 35<br>36, 37<br>38, 39<br>40, 41<br>42 | PGND2<br>OUT2B<br>VM2<br>RF2<br>OUT2A<br>OUT1B<br>RF1<br>VM1<br>OUT1A<br>PGND1 |  |

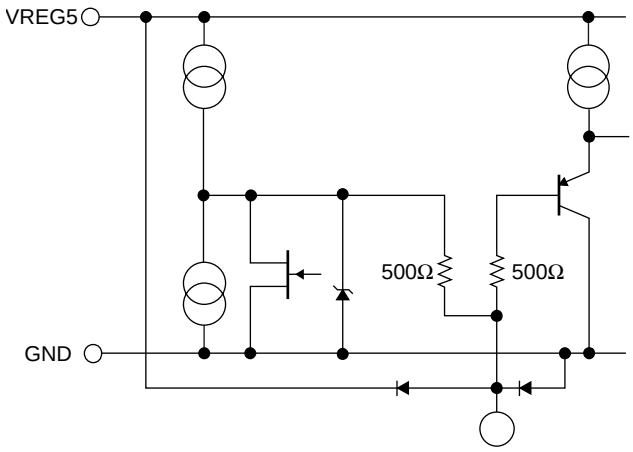
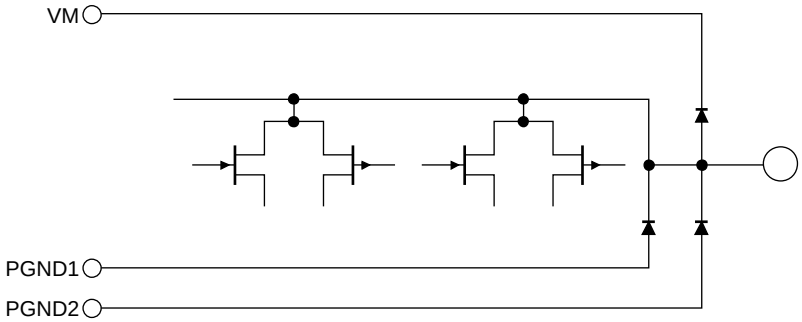
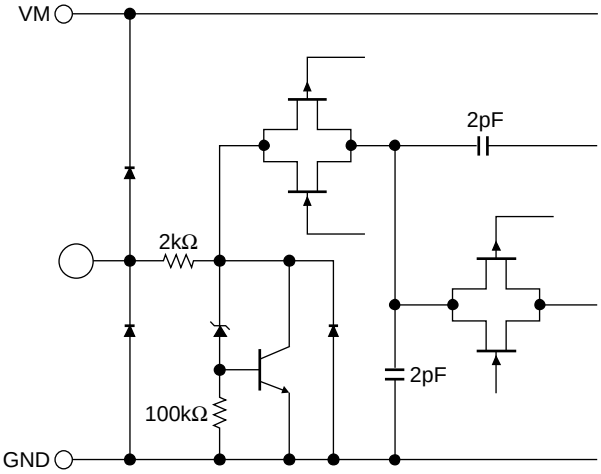
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| Pin No. | Pin name | Equivalent Circuit |
|---|---|---|
| 2<br>3<br>43<br>44 | CP2<br>CP1<br>VG<br>VM |  |
| 21 | VREF |  |
| 14 | VREG5 |  |
| 15<br>16<br>17<br>19 | DST2<br>DST1<br>MONI<br>SST |  |

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| Pin No. | Pin name | Equivalent Circuit |
|---|---|---|
| 20 | CHOP |  |
| 1 | SWOUT |  |
| 11 | ADIN |  |
| 22 | SGND | |

## Operation description

1. Chip enable function

The mode of the IC is switched with ST pin between standby and operation mode. In standby mode, the IC is set to power saving mode and all the logics are reset. During standby mode, the operation of the internal regulator circuit and the charge pump circuit are stopped.

| ST | Status | Internal regulator | Charge pump |
|---|---|---|---|
| L or Open | Standby mode | Standby | Standby |
| H | Operating mode | Operation | Operation |

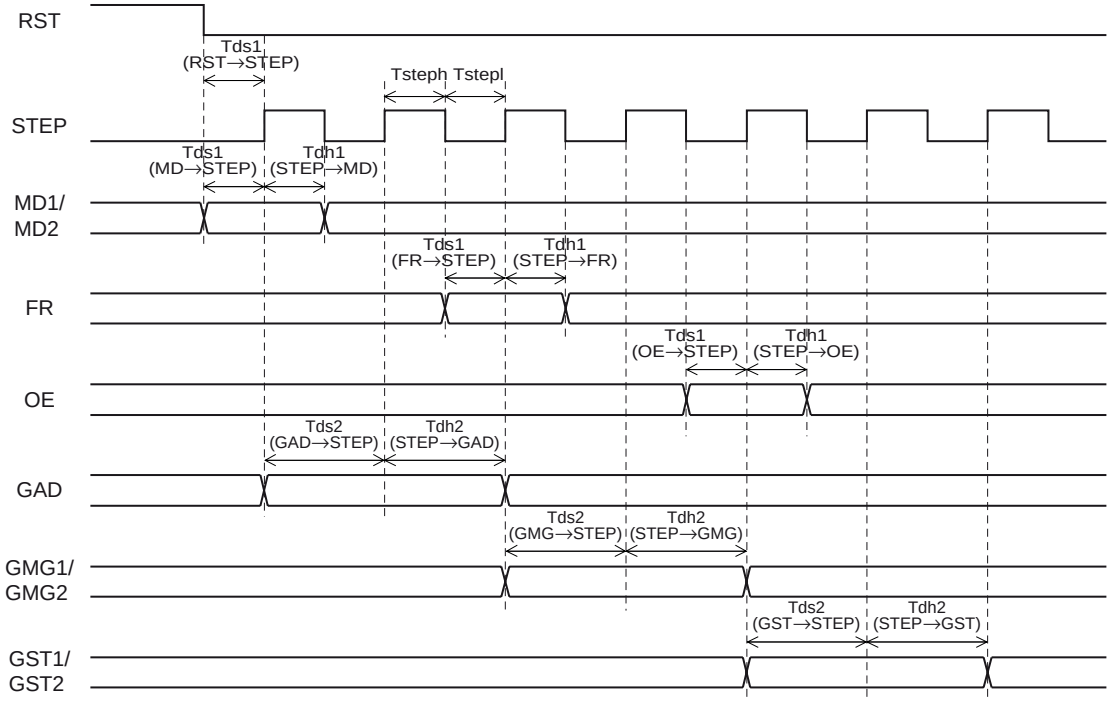
2. STEP pin function

The excitation step progresses by inputting the step signal to the STP pin.

| Input | | Operation mode |
|---|---|---|
| ST | STEP | |
| L or OPEN | X* | Standby mode |
| H |  | Excitation step forward |
| H |  | Excitation step keep |

* Don't care

3. Input timing




TstepH/TstepL : Clock H/L pulse width (min 12.5µs)
Tds1 : Data set-up time (min 12.5µs)
Tdh1 : Data hold time (min 12.5µs)
Tds2 : Data set-up time (min 25µs)
Tdh2 : Data hold time (min 25µs)

4. Position detection monitor function

The MONI position detection monitoring pin is of an open drain type.
When the excitation position is in the initial position, the MONI output is placed in the ON state.
(Refer to "Examples of current waveforms in each of the excitation modes.")

5. 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 resistance

The above setting is the output current at 100% of each excitation mode.

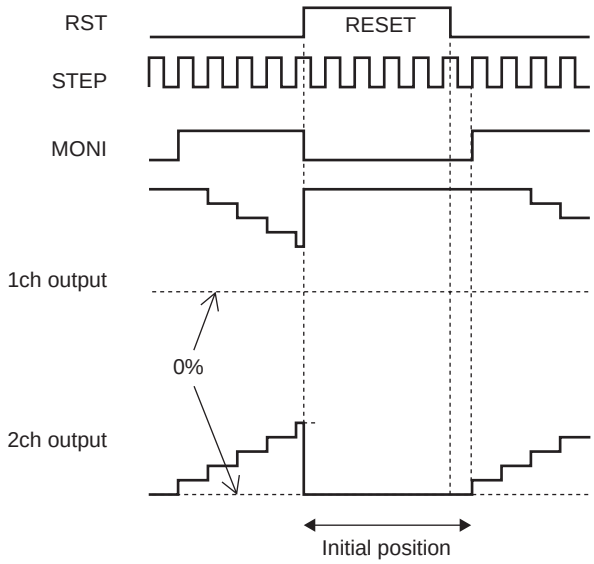
For example, where VREF=1.5V and RF resistance 0.2Ω, we obtain output current as follows.

$I_{OUT}$ = 1.5V/5/0.2Ω = 1.5A

When high-efficient drive function is on, $I_{OUT}$ is adjusted automatically within the range of the current value set by VREF.

6. Reset function

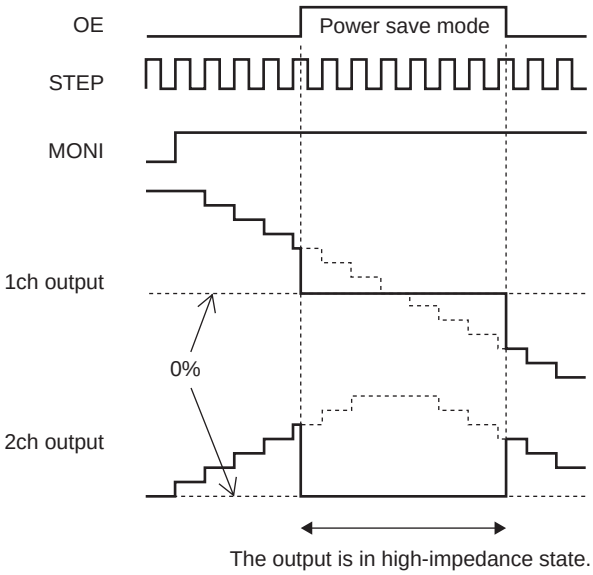
| RST | Operation mode |
|---|---|
| L or OPEN | Normal operation |
| H | RESET status |




When RST pin = “H”, the excitation position of the output is set to the initial position forcibly and MONI output is turned on. And then by setting RST = “L”, the excitation position moves forward with the next step signal.

7. Output enable function

| OE | Operation mode |
|---|---|
| H | Output OFF |
| L or OPEN | Output ON |




When OE pin = “H”, the output is turned off forcibly and becomes a high-impedance output.
However, since the internal logic circuit is in operation, an excitation position moves forward if step signal is input to STEP pin. Therefore, by setting back to OE = “L”, the output pin outputs signal based on the excitation position by step signal.

8. Excitation mode setting function

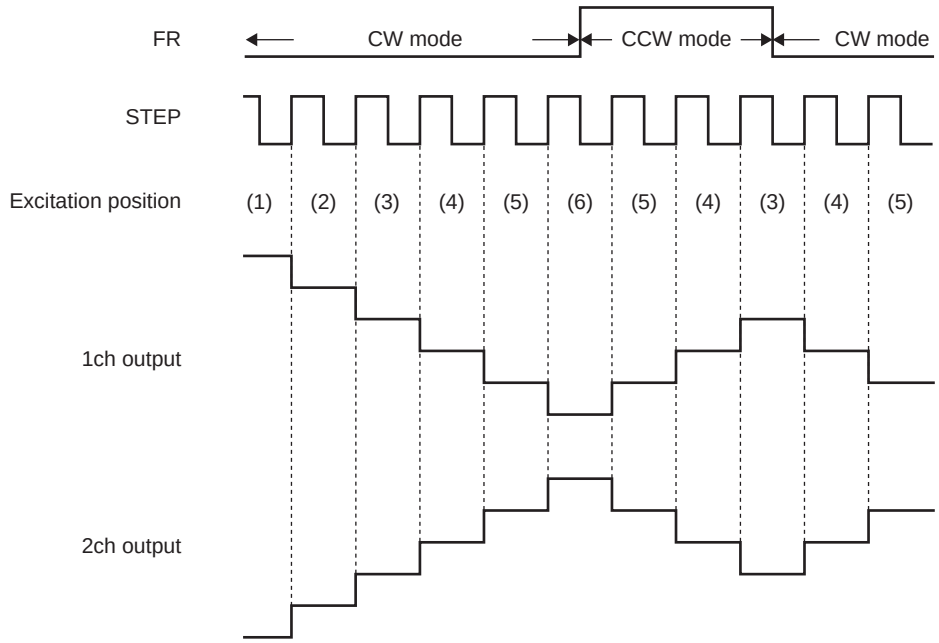
MD1 and MD2 pin set excitation mode of the stepping motor as follows.

| MD1 | MD2 | Excitation mode | Initial position | |
|---|---|---|---|---|
| | | | 1ch | 2ch |
| L or OPEN | L or OPEN | full step excitation | 100% | -100% |
| H | L or OPEN | half step excitation | 100% | 0% |
| L or OPEN | H | quarter step excitation | 100% | 0% |
| H | H | half step excitation (full-torque) | 100% | 0% |

The position of excitation mode is set to the initial position when: 1) a power is supplied and 2) counter is reset in each excitation mode.
During full step excitation mode, high-efficient drive function is turned off even when GAD = “H”.

9. Forward/reverse switching function

| FR | Operation mode |
|---|---|
| L or OPEN | CW |
| H | CCW |




The built-in DA converter moves forward by 1bit with the rise of step signal that is input to STEP pin.
Also a mode is switched between CW and CCW by setting FR pin.
In CW mode, the phase of 2ch current delays by 90° compared to that of 1ch current.
In CCW mode the phase of 2ch current moves forward by 90° compared to 1ch current.

10. Chopping frequency setting

When you control constant current of this IC, chopping is performed using the frequency defined in the capacitor (Cchop) connected between CHOP pin and GND.
The calculation for the value of chopping frequency is:

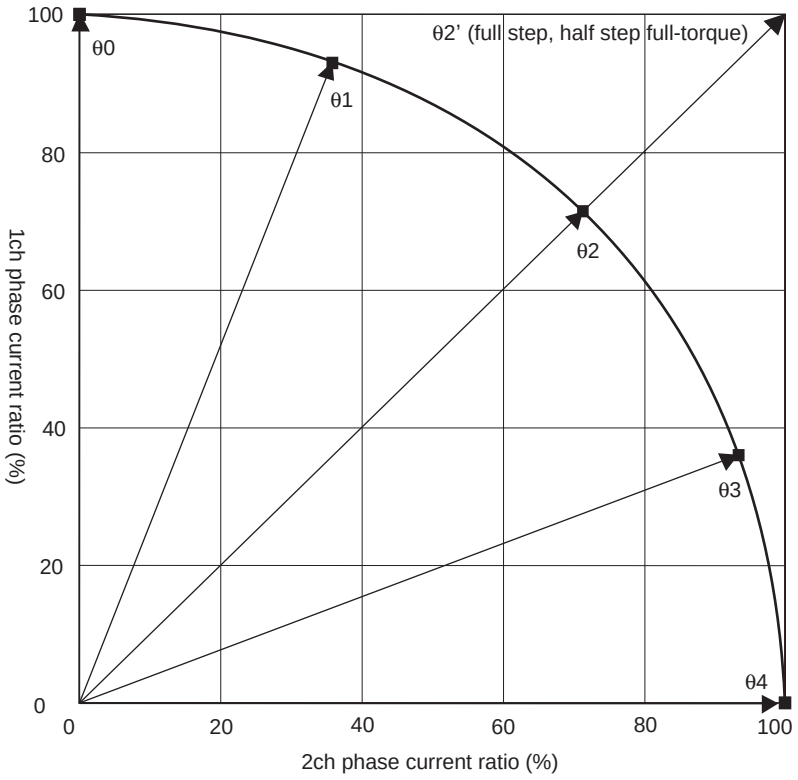
Fchop = Ichop/ (Cchop×Vtchop×2) (Hz)
Ichop: Capacitor charge and discharge current typ: 10μA
Vtchop: Charge and discharge hysteresis voltage (Vtup-Vtdown) typ: 0.5V

For example, where Cchop = 200pF, we obtain Fchop as follows:
Fchop = 10μA/ (200pF×0.5V×2) = 50kHz

11. Blanking time

If you attempt to control PWM constant current chopping of the motor current, when the mode shifts from DECAY to CHARGE, noise is generated in sense resistor pin due to the recovery current of parasitic diode flowing into current sense resistor, and this may cause error detection. The blanking time avoids noise at mode switch. During the blanking time, even if noise is generated in sense resistor, a mode does not switch from CHARGE to DECAY. In this IC, the blanking time is fixed to approximately 1μs.

12. Output current vector locus (1step is normalized to 90°)

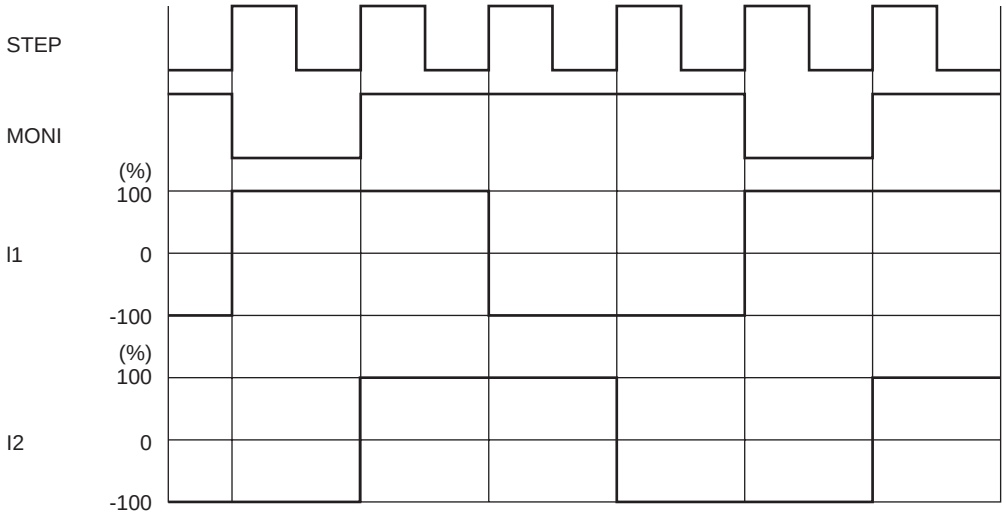



Setting current ration in each excitation mode

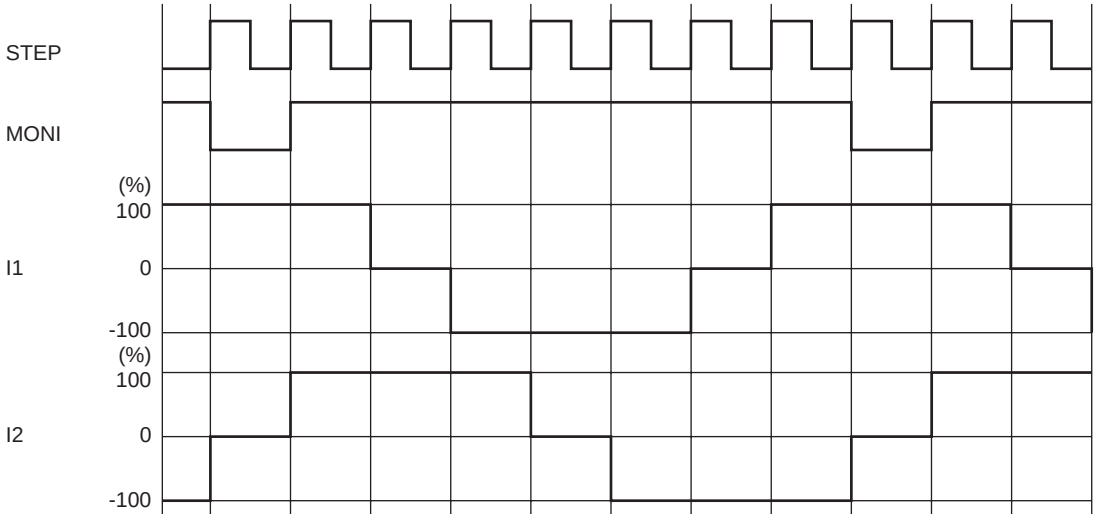
| STEP | quarter step (%) | | half step (%) | | half step full-torque (%) | | full step (%) | |
|---|---|---|---|---|---|---|---|---|
| | 1ch | 2ch | 1ch | 2ch | 1ch | 2ch | 1ch | 2ch |
| θ0 | 100 | 0 | 100 | 0 | 100 | 0 | | |
| θ1 | 92 | 38 | | | | | | |
| θ2 | 70 | 70 | 70 | 70 | 100 | 100 | 100 | 100 |
| θ3 | 38 | 92 | | | | | | |
| θ4 | 0 | 100 | 0 | 100 | 0 | 100 | | |

13. The example of current waveform in each excitation mode

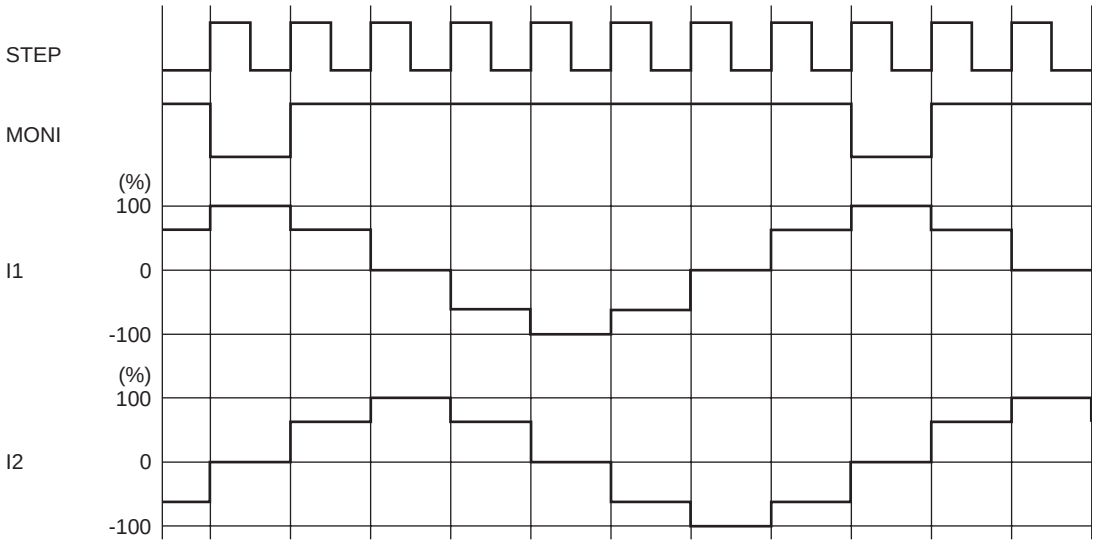
full step excitation (CW mode)



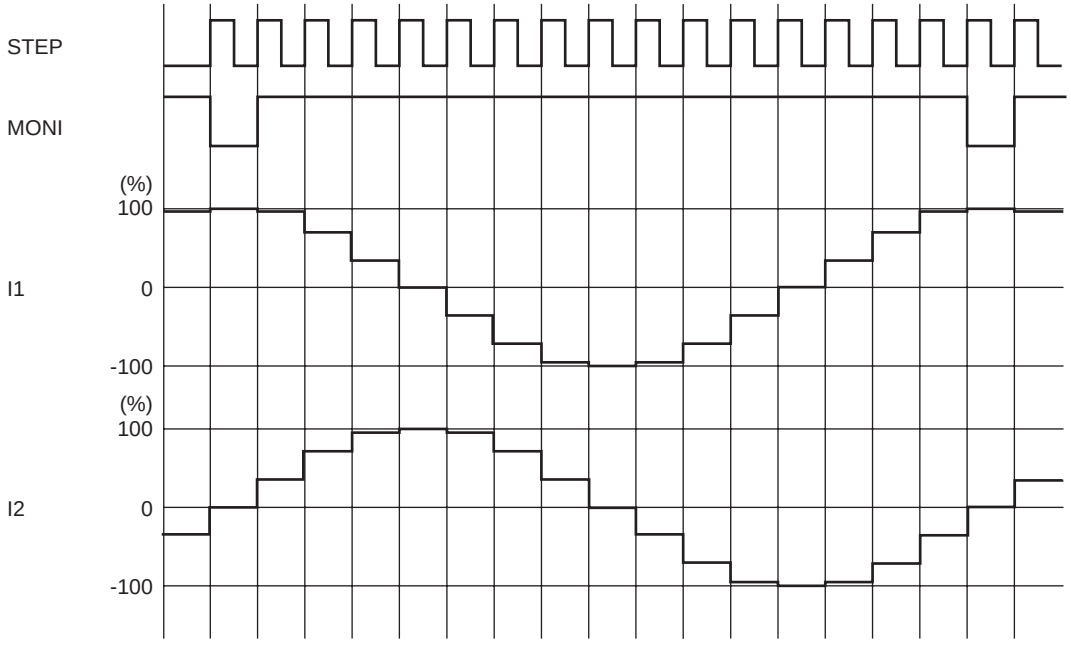

half step excitation full-torque (CW mode)



half step excitation (CW mode)

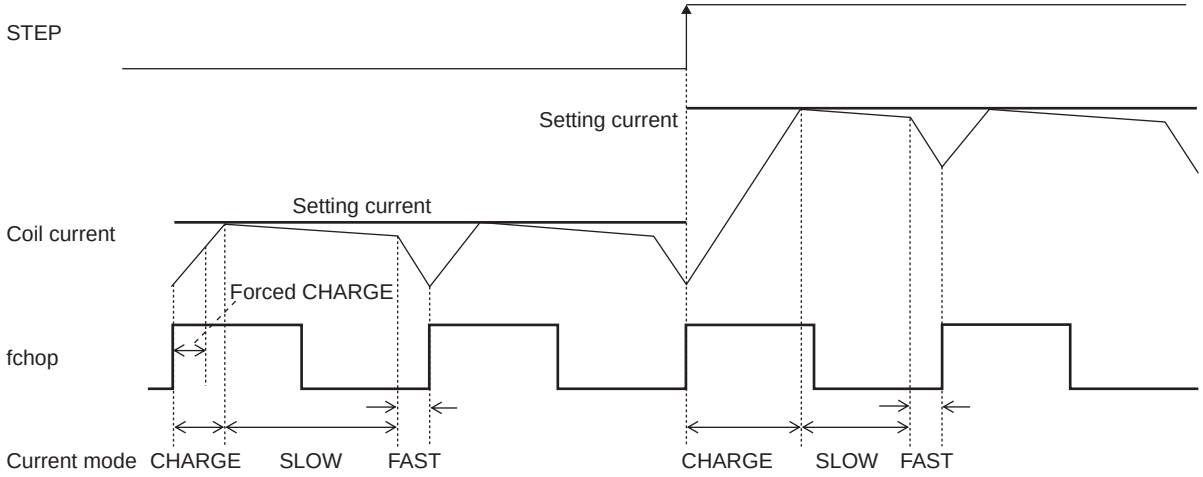



quarter step excitation (CW mode)

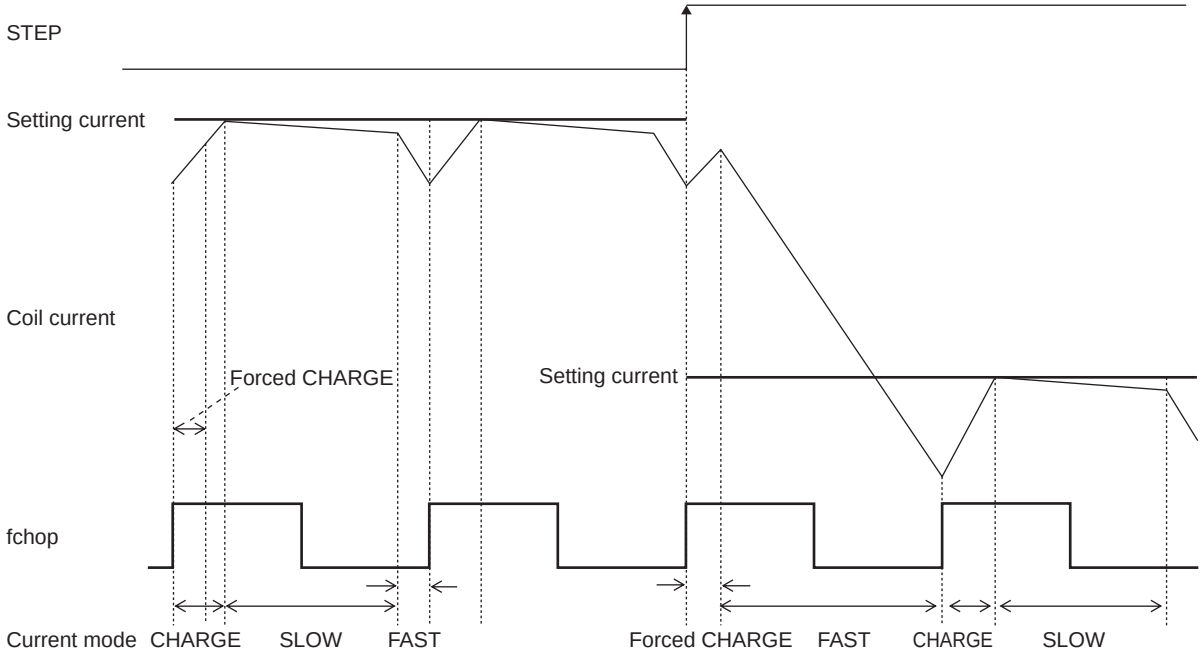


14. Current control operation specification

(Sine wave increase)




(Sine wave decrease)




Each current mode is operated according to the following sequence.

- 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 ≥ IREF, then followed by changeover to the SLOW DECAY mode, and finally by the FAST DECAY mode for approximately 1μs.

  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 Triangle 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.

## 15. High-efficient drive function

This IC includes high-efficient drive function. When high-efficient drive function is turned on, $I_{OUT}$ is adjusted automatically within the current value set with VREF pin. When high-efficient drive function is turned off, the current value of $I_{OUT}$ becomes the maximum value set by REF pin.

1) High-efficient drive enable function

High-efficient drive function is switched on and off with GAD pin.

However, in the case of full step excitation mode (MD1 = MD2 = "L"), even when GAD = "H", high-efficient drive function is turned off.

Even if you adjust the GMG1, GMG2 of 15-2) and GST1, GST2 of 15-3), in the case of abrupt motor acceleration or load variation to the extent that auto adjuster cannot follow up and eventually leads to the rotation stepping-out, it is recommended that you turn off the high-efficient drive function temporally. As high-efficient control may become unstable due to the control signal from the motor is unstable during low speed rotation, it is also recommended to turn off this function as well.

| GAD | Operation mode |
|---|---|
| L or OPEN | Normal mode |
| H | High-efficient mode<br>(except for full step excitation mode) |

Recommended speed of high-efficient drive

| excitation | Operating conditions | Speed |
|---|---|---|
| half step<br>half step full-torque | HB motor/no-load | over 1500pps |
| | PM motor/no-load | over 1000pps |
| quarter step | HB motor/no-load | over 3000pps |
| | PM motor/no-load | over 2500pps |

When there is a load, the high-efficient drive is enabled at slower speed.

2) High-efficient drive margin adjuster function

By setting GMG1 and GMG2 pin, margin for step-out is adjusted.

Where GMG1 = GMG2 = "L", $I_{OUT}$ and consumption current are at the lowest. In some case, as the $I_{OUT}$ becomes lower, the number of boost-up process* may increase triggered by slight change of load. With insufficient driving capability, you need to increase the margin setting. One way to set GMG1 and GMG2 is to minimize boost-up level, then lower the margin from high to low to optimize the margin where motor rotates stably.

In the application where load variation is excessive, you need to have a larger margin.

| GMG1 | GMG2 | Setting | Current consumption | Load following capability |
|---|---|---|---|---|
| L or OPEN | L or OPEN | Margin: small | Smallest | Ordinary |
| H | L or OPEN | Margin: middle | Smaller | Good |
| L or OPEN | H | Margin: large | Small | Better |
| H | H | Setting is inhibited | - | - |

*: This is a function to increase $I_{OUT}$ rapidly as soon as a possible stepping out is detected due to load variation during high efficiency drive.

3) Boost-up adjuster function

During high-efficient drive, boost-up adjuster function detects a possibility of step-out caused by such factors as abrupt load variation and then boosts up $I_{OUT}$ at once (Boost-up process). You can set a level of boost-up by setting GST1 and GST2 pins. One way to set GST1 and GST2 is to increase boost-up level from minimum to maximum within the maximum load condition and select the optimum boost-up setting where motor rotates without stepping out. Also, boost-up level varies depends on reference current defined by VREF. Therefore, you can increase load following capability by increasing VREF voltage.

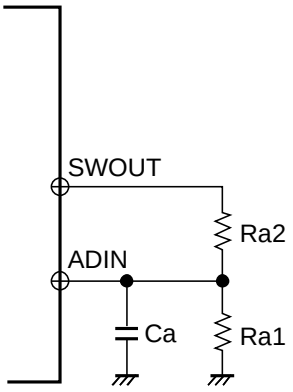
The higher the boost-up level is, the more the IC becomes tolerant for abrupt load variation. However, rotation stability may become poor (vibration and rotation fluctuation may occur) because excessively high boost-up level leads to rapid increase of $I_{OUT}$ at load variation. You may be able to improve poor rotation stability with high boost-up level by increasing high-efficient drive margin.

| GST1 | GST2 | Setting | Increase of Iout | load following capability | Rotation stability |
|---|---|---|---|---|---|
| L or OPEN | L or OPEN | Boost-up level minimum | {(VREF/5)/RF resistance} × 1/128 | Ordinary | Best |
| H | L or OPEN | Boost-up level low | {(VREF/5)/RF resistance} × 4/128 | Good | Better |
| L or OPEN | H | Boost-up level high | {(VREF/5)/RF resistance} × 16/128 | Better | Good |
| H | H | Boost-up level maximum | {(VREF/5)/RF resistance} × 64/128 | Best | Ordinary |

4) External component

The resistance value of Ra1, Ra2 (control signal resistors) is adjusted in such a way as to set the maximum SWOUT output voltage during motor rotation to 12V in ADIN pin. Preferably, resistance values of Ra1 and Ra2 are as high as possible to the extent that does not influence waveform. (Recommendation for Ra1: 15kΩ, Ra2: 100kΩ).

In some motor where boost-up process occurs at a high speed rotation of 7000pps to 8000pps or higher (HB motor: Half step excitation), you can suppress boost-up by lowering Ra1. Moreover, you can achieve high efficiency at lower speed of 1500pps or lower by increasing resistance for Ra1 (HB motor: Half step excitation). Although it depends on a usage motor, step-out is detectable at higher speed rotation by attaching smaller resistor for Ra1.



5) Drive status warning function

DST1 and DST2 are open-drain output. The driving status can be monitored through a status of DST1 and DST2 pins. When step-out status is detected, DST1 is on for a period of 1 step. Likewise, when small step-out margin status is detected, DST2 turns on for the period of 1 step. In the case of output short status or overheat status, DST1 and DST2 stay on until ST = "L".

Step-out status and small step-out margin status are detectable during high-efficient drive only. In some cases, step-out status may not be detected properly. Hence, make sure to verify the operation with the usage application. If step-out or small step-out margin status occur frequently, make sure to set a large high-efficient drive margin or higher boost-up level.

| DST1 | DST2 | Status |
|---|---|---|
| OFF | OFF | Normal status |
| ON | OFF | Step-out status *1(this function is enabled only in high-efficient drive) |
| OFF | ON | Small step-out margin status *2(this function is enabled only in high-efficient drive) |
| ON | ON | Output short status or overheat status |

*1: Although it depends on a usage motor, step-out is detectable at higher speed rotation by attaching smaller resistor for Ra1.

*2: If DST2 alone is turned on, boost-up processing is performed.

## 16. Output short protection circuit

Output short protection circuit is included in this IC which sets an output to standby mode and turns on warning output. This protection circuit prevents IC destruction when the output is short due to power short or ground short.

1) Operation overview

When output short is detected, short detection circuit operates. If the short status continues for the period of internal timer (≈2μs), the output of 1ch/ 2ch is turned off. If the short status exceeds the timer latch time (≈32μs) set in the internal timer, the output is turned on again and detects short status again. If short is detected again, all the output of 1ch/ 2ch are switched to standby mode and the status is kept. To cancel the standby status, set ST = "L".

2) Error status warning output pin (DST2, DST1)

When the IC detects error status and protection circuit operates, DST2 pin and DST1 pin outputs the error status to CPU side.

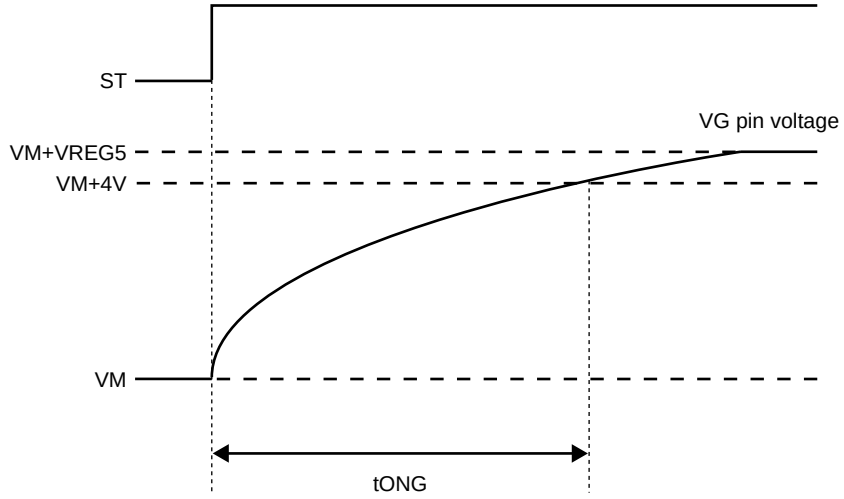
This pin is open-drain output. When error status is detected, DST2 and DST1 output turn on (DST2 = DST1 = "L").

DST2/DST1 pins are turned on in the following statuses:

| Error status | DST2 | DST1 |
|---|---|---|
| Short is detected in 1ch side. | ON | ON |
| Short is detected in 2ch side. | ON | ON |
| When overheat is detected. | ON | ON |

17. Charge pump circuit

When ST pin is set to “H”, charge pump circuit operates and VG pin voltage increases from VM voltage to VM + VREG5 voltage. Because the output is not turned on if VM+4V or more is not pressured, the voltage of the VG pin recommends the drive of the motor to put the time of tONG or more, and to begin.

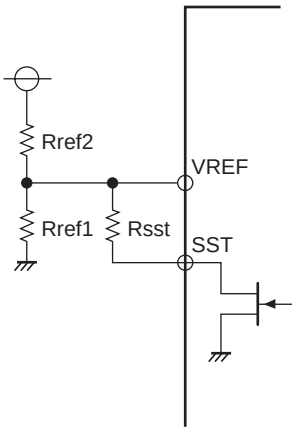


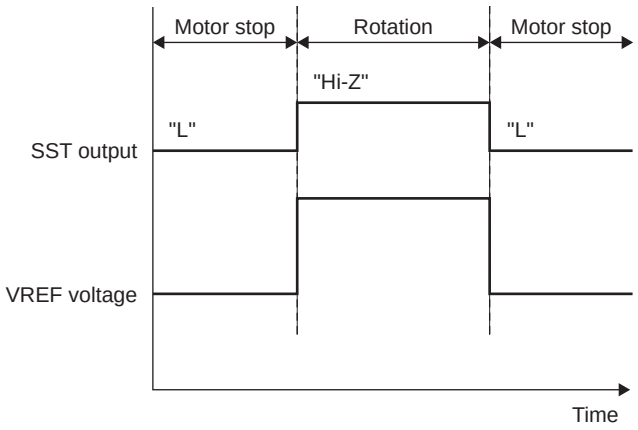

Fg. VG pin voltage

18. Current save function when motor is stopped

SST pin is the open-drain output. When STEP signal is not input for about 16mS, (min: 13mS, max: 23mS), SST pin detects that the rotation of the motor is stopped and SST pin is turned on. At this time, high-efficient drive function is turned off automatically and full current value is set for $I_{OUT}$ by VREF pin. And then after signal is input to STEP pin, SST pin is turned off and high-efficient control function is enabled.

In this driver, the circuit constituent is as follows. By decreasing VREF voltage when the motor is stopped, $I_{OUT}$ current can be saved. However, this function is unusable when you rotate motor at which input cycle of STEP pulse signal is 16mS or longer.

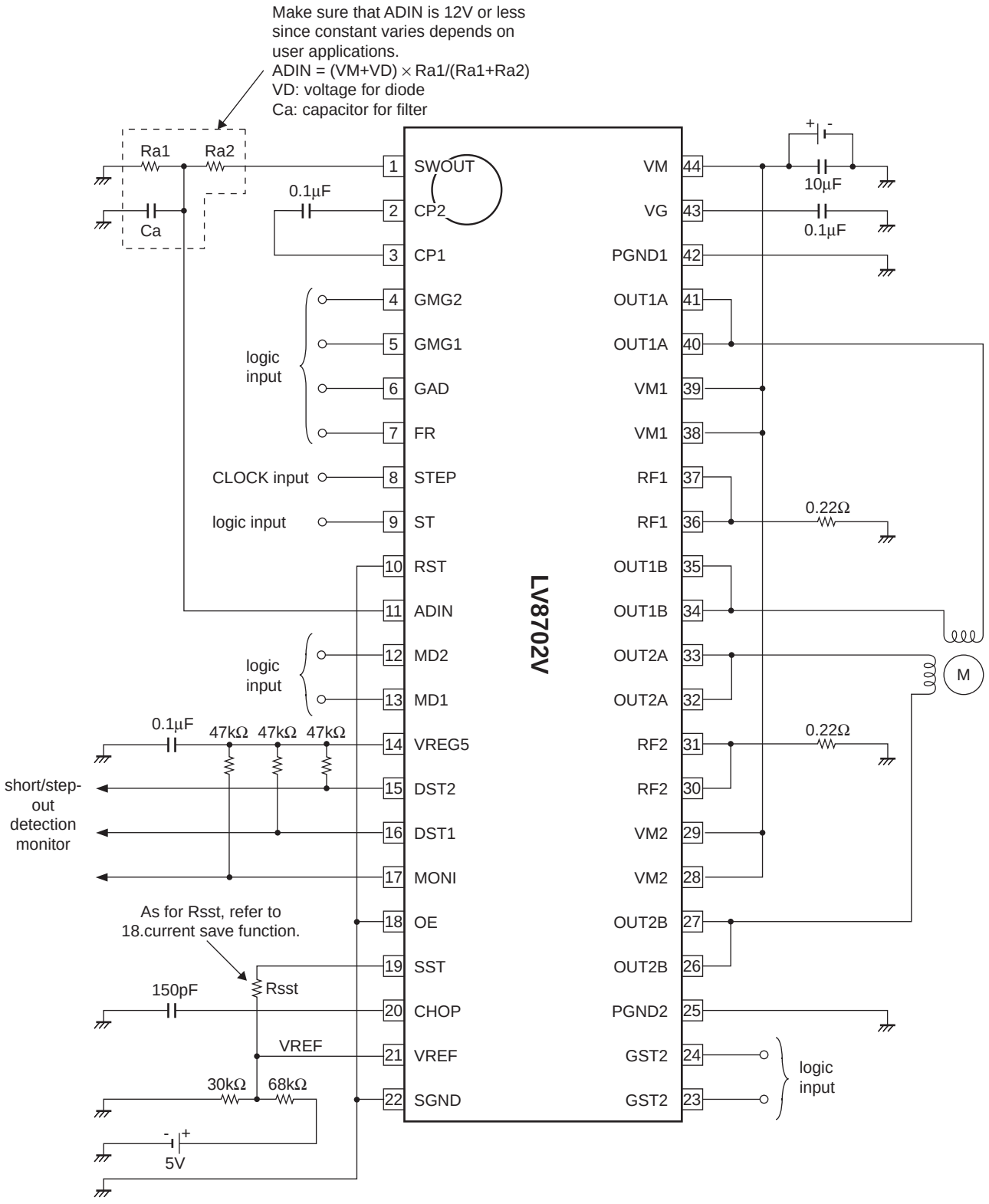



1) With STEP signal where Rref1 = 30kΩ, Rref2 = 68kΩ and Rsst = 5kΩ
VREF1 = 5V×30kΩ/(68k+30kΩ) ≈ 1.53V
Where VREF1 = 1.53V,
$I_{OUT}$ = VREF/5/0.22Ω ≈ 1.39A

2) Without STEP signal where Rref1 = 30kΩ, Rref2 = 68kΩ, and Rsst = 5kΩ
VREF2 = 5V×4.3kΩ/(68k+4.3kΩ) ≈ 0.3V
Where VREF2 = 0.3V
$I_{OUT}$ = VREF/5/0.22Ω ≈ 0.27A

## Example of application circuit




Calculation for each constant setting according to the above circuit diagram is as follows.

1) Constant current (100%) setting

VREF = 5V×30kΩ/(68kΩ + 30kΩ) ≈ 1.53V

When VREF = 1.53V :

$I_{OUT}$ = VREF/5/0.22Ω ≈ 1.39A

2) Chopping frequency setting

Fchop = Ichop/(Cchop×Vtchop×2)

=10µA/(150pF×0.5V×2)

≈ 66.7kHz

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