



ON Semiconductor®

<http://onsemi.com>

# LV8712T/LV8713T

Bi-CMOS LSI

## PWM Constant-Current Control Stepper Motor Driver Application Note

### Overview

The LV8712T and LV8713T are micro-stepping motor drivers with built-in translator for easy operation. The LV8712T supports full-step, half-step, quarter-step, and 1/8-step resolution. The LV8713T supports full-step, half-step, 1/16-step, and 1/32-step resolution. These ICs are optimal for driving stepping motor of scanner and small printer.

### Function

- Single-channel PWM constant-current control stepping motor driver incorporated.
- Microstepping is configurable to the following modes:
  - Full-step, half-step, quarter-step, or 1/8-step. (LV8712T)
  - Full-step, half-step, 1/16-step, or 1/32-step. (LV8713T)
- CLK-IN input facilitates the control of microstepping.
- Power-supply voltage of motor :  $V_M$  max = 18V
- Output current :  $I_O$  max = 0.8A
- Output ON resistance :  $R_{ON}$  = 1.1 $\Omega$  (upper and lower total, typical,  $T_a$  = 25°C)
- Thermal shutdown circuit and low voltage detecting circuit incorporated.

### Typical Applications

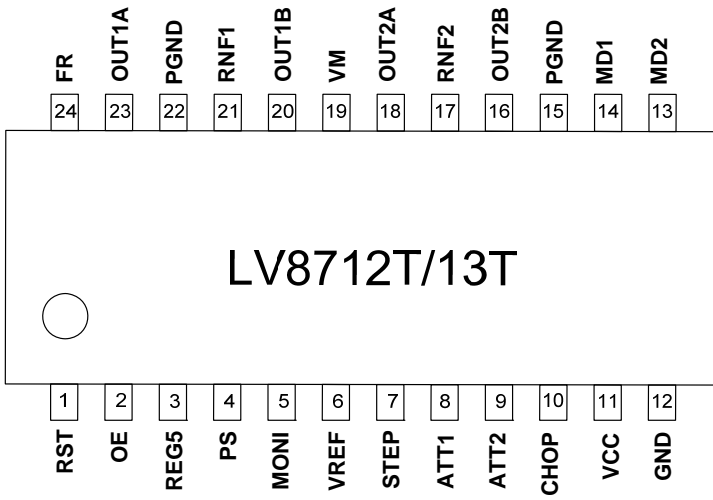
- POS Printer
- Scanner
- Thermal Printer Unit
- Security camera
- Air-conditioner

### Selection Guide

| Part Number | Microstepping mode            |
|-------------|-------------------------------|
| LV8712T     | Full-,half-,quarter-,1/8-step |
| LV8713T     | Full-,half-,1/16-,1/32-step   |

# LV8712T/LV8713T Application Note

## Pin Assignment

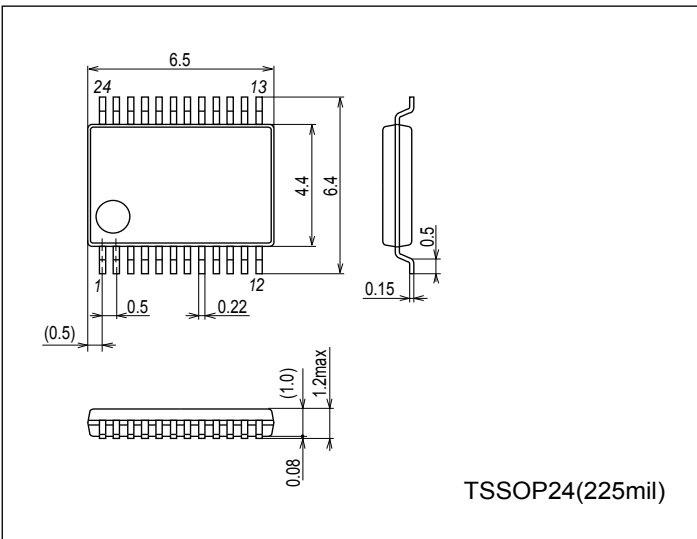


Top view

## Package Dimension

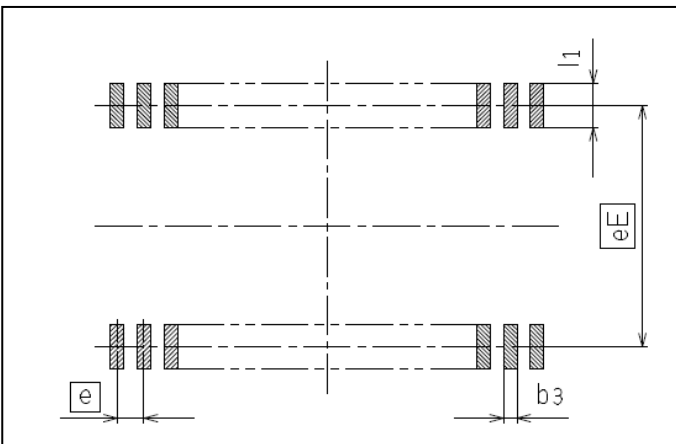
unit: mm (typ)

3260A



Caution: The package dimension is a reference value, which is not a guaranteed value.

## Recommended Soldering Footprint

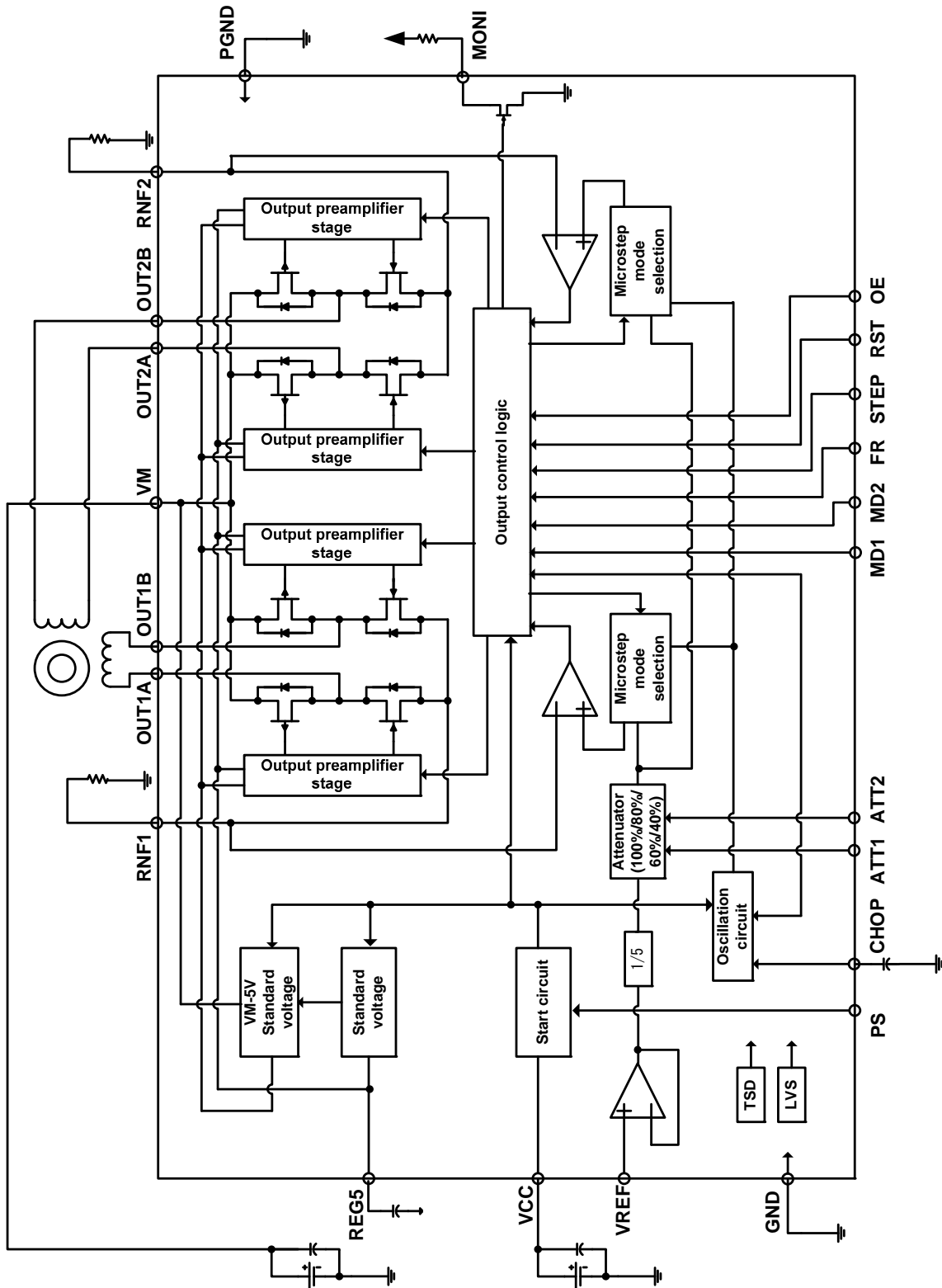


(Unit:mm)

| Reference symbol | TSSOP24 (225mil) |
|------------------|------------------|
| eE               | 5.80             |
| e                | 0.50             |
| b3               | 0.32             |
| l1               | 1.00             |

# LV8712T/LV8713T Application Note

## Block Diagram



# LV8712T/LV8713T Application Note

## Specifications

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

| Parameter                     | Symbol              | Conditions                    | Ratings                       | Unit |
|-------------------------------|---------------------|-------------------------------|-------------------------------|------|
| Motor supply voltage          | VM max              |                               | 18                            | V    |
| Logic supply voltage          | V <sub>CC</sub> max |                               | 6                             | V    |
| Output peak current           | I <sub>O</sub> peak | Each 1ch, tw ≤ 10ms, duty 20% | 1.0                           | A    |
| Output continuousness current | I <sub>O</sub> max  | Each 1ch                      | 800                           | mA   |
| Logic input voltage           | V <sub>IN</sub>     |                               | -0.3 to V <sub>CC</sub> + 0.3 | V    |
| Allowable power dissipation   | Pd max              | *                             | 1.35                          | W    |
| Operating temperature         | Topr                |                               | -20 to +85                    | °C   |
| Storage temperature           | Tstg                |                               | -55 to +150                   | °C   |

\* Specified circuit board: 57.0mm×57.0mm×1.7mm, glass epoxy 2-layer 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.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

### Recommended Operating Conditions at Ta = 25°C

| Parameter                  | Symbol          | Conditions | Ratings |     |                      | Unit |
|----------------------------|-----------------|------------|---------|-----|----------------------|------|
|                            |                 |            | min     | typ | max                  |      |
| Motor supply voltage range | VM              |            | 4       |     | 16                   | V    |
| Logic supply voltage range | V <sub>CC</sub> |            | 2.7     |     | 5.5                  | V    |
| Logic input voltage        | V <sub>IN</sub> |            | -0.3    |     | V <sub>CC</sub> +0.3 | V    |
| VREF input voltage range   | VREF            |            | 0       |     | V <sub>CC</sub> -1.8 | V    |

### Electrical Characteristics at Ta = 25°C, VM = 12V, V<sub>CC</sub> = 3.3V, VREF = 1.0V

| Parameter   | Symbol                          | Conditions   | Ratings |       |       | Unit |
|---|---------------------------------|--|---------|-------|-------|------|
|   |                                 |  | min     | typ   | max   |      |
| Standby mode current drain  | IMstn                           | PS = "L", no load                                  |         |       | 1     | μA   |
|   | I <sub>CC</sub> stn             | PS = "L", no load                                  |         |       | 1     | μA   |
| Operating mode current drain  | IM                              | PS = "H", no load                                  | 0.3     | 0.5   | 0.7   | mA   |
|   | I <sub>CC</sub>                 | PS = "H", no load                                  | 0.9     | 1.3   | 1.7   | mA   |
| Thermal shutdown temperature  | TSD                             | Design guarantee                                   |         | 180   |       | °C   |
| Thermal hysteresis width  | ΔTSD                            | Design guarantee                                   |         | 40    |       | °C   |
| V <sub>CC</sub> low voltage cutting voltage                                       | V <sub>th</sub> V <sub>CC</sub> |  | 2.1     | 2.4   | 2.7   | V    |
| Low voltage hysteresis voltage  | V <sub>th</sub> HIS             |  | 100     | 130   | 160   | mV   |
| REG5 output voltage   | Vreg5                           | I <sub>O</sub> = -1mA                              | 4.5     | 5     | 5.5   | V    |
| Output on resistance  | RonU                            | I <sub>O</sub> = -800mA, Source-side on resistance |         | 0.78  | 1.0   | Ω    |
|   | RonD                            | I <sub>O</sub> = 800mA, Sink-side on resistance    |         | 0.32  | 0.43  | Ω    |
| Output leakage current  | I <sub>O</sub> leak             | V <sub>O</sub> = 15V                               |         |       | 10    | μA   |
| Diode forward voltage   | VD                              | ID = -800mA  |         | 1.0   | 1.2   | V    |
| Logic pin input current   | I <sub>IN</sub> L               | V <sub>IN</sub> = 0.8V                             | 4       | 8     | 12    | μA   |
|   | I <sub>IN</sub> H               | V <sub>IN</sub> = 3.3V                             | 22      | 33    | 45    | μA   |
| Logic high-level input voltage  | V <sub>INH</sub>                |  | 2.0     |       |       | V    |
| Logic low-level input voltage   | V <sub>INL</sub>                |  |         |       | 0.8   | V    |
| VREF input current  | I <sub>REF</sub>                | VREF = 1.0V  | -0.5    |       |       | μA   |
| Current setting comparator threshold voltage (current attenuation rate switching) | Vtatt00                         | ATT1 = L, ATT2 = L                                 | 0.191   | 0.200 | 0.209 | V    |
|   | Vtatt01                         | ATT1 = H, ATT2 = L                                 | 0.152   | 0.160 | 0.168 | V    |
|   | Vtatt10                         | ATT1 = L, ATT2 = H                                 | 0.112   | 0.120 | 0.128 | V    |
|   | Vtatt11                         | ATT1 = H, ATT2 = H                                 | 0.072   | 0.080 | 0.088 | V    |
| Chopping frequency  | Fchop                           | Cchop = 220pF                                      | 36      | 45    | 54    | kHz  |
| CHOP pin threshold voltage  | V <sub>CHOP</sub> H             |  | 0.6     | 0.7   | 0.8   | V    |
|   | V <sub>CHOP</sub> L             |  | 0.17    | 0.2   | 0.23  | V    |
| CHOP pin charge/discharge current   | I <sub>chop</sub>               |  | 7       | 10    | 13    | μA   |
| MONI pin saturation voltage   | Vsatmon                         | I <sub>moni</sub> = 1mA                            |         | 250   | 400   | mV   |

Continued on next page

# LV8712T/LV8713T Application Note

Continued from preceding page.

| Parameter   |  | Symbol     | Conditions  | Ratings |       |       | Unit |
|---|--|------------|---|---------|-------|-------|------|
|   |  |            |   | min     | typ   | max   |      |
| Current setting comparator threshold voltage (current step switching) | 8W1-2-phase drive (1/32-step at LV8713T) | Vtdac0_2W  | Step 0 (When initialized: channel 1 comparator level) | 0.191   | 0.200 | 0.209 | V    |
|   |  | Vtdac1_8W  | Step 1 (Initial state+1)                              | 0.191   | 0.200 | 0.209 | V    |
|   |  | Vtdac2_8W  | Step 2 (Initial state+2)                              | 0.191   | 0.200 | 0.209 | V    |
|   |  | Vtdac3_8W  | Step 3 (Initial state+3)                              | 0.189   | 0.198 | 0.207 | V    |
|   |  | Vtdac4_8W  | Step 4 (Initial state+4)                              | 0.187   | 0.196 | 0.205 | V    |
|   |  | Vtdac5_8W  | Step 5 (Initial state+5)                              | 0.185   | 0.194 | 0.203 | V    |
|   |  | Vtdac6_8W  | Step 6 (Initial state+6)                              | 0.183   | 0.192 | 0.201 | V    |
|   |  | Vtdac7_8W  | Step 7 (Initial state+7)                              | 0.179   | 0.188 | 0.197 | V    |
|   |  | Vtdac8_8W  | Step 8 (Initial state+8)                              | 0.175   | 0.184 | 0.193 | V    |
|   |  | Vtdac9_8W  | Step 9 (Initial state+9)                              | 0.171   | 0.180 | 0.189 | V    |
|   |  | Vtdac10_8W | Step 10 (Initial state+10)                            | 0.167   | 0.176 | 0.185 | V    |
|   |  | Vtdac11_8W | Step 11 (Initial state+11)                            | 0.163   | 0.172 | 0.181 | V    |
|   |  | Vtdac12_8W | Step 12 (Initial state+12)                            | 0.158   | 0.166 | 0.174 | V    |
|   |  | Vtdac13_8W | Step 13 (Initial state+13)                            | 0.152   | 0.160 | 0.168 | V    |
|   |  | Vtdac14_8W | Step 14 (Initial state+14)                            | 0.146   | 0.154 | 0.162 | V    |
|   |  | Vtdac15_8W | Step 15 (Initial state+15)                            | 0.140   | 0.148 | 0.156 | V    |
|   |  | Vtdac16_8W | Step 16 (Initial state+16)                            | 0.132   | 0.140 | 0.148 | V    |
|   |  | Vtdac17_8W | Step 17 (Initial state+17)                            | 0.126   | 0.134 | 0.142 | V    |
|   |  | Vtdac18_8W | Step 18 (Initial state+18)                            | 0.118   | 0.126 | 0.134 | V    |
|   |  | Vtdac19_8W | Step 19 (Initial state+19)                            | 0.112   | 0.120 | 0.128 | V    |
|   |  | Vtdac20_8W | Step 20 (Initial state+20)                            | 0.102   | 0.110 | 0.118 | V    |
|   |  | Vtdac21_8W | Step 21 (Initial state+21)                            | 0.094   | 0.102 | 0.110 | V    |
|   |  | Vtdac22_8W | Step 22 (Initial state+22)                            | 0.086   | 0.094 | 0.102 | V    |
|   |  | Vtdac23_8W | Step 23 (Initial state+23)                            | 0.078   | 0.086 | 0.094 | V    |
|   |  | Vtdac24_8W | Step 24 (Initial state+24)                            | 0.068   | 0.076 | 0.084 | V    |
|   |  | Vtdac25_8W | Step 25 (Initial state+25)                            | 0.060   | 0.068 | 0.076 | V    |
|   |  | Vtdac26_8W | Step 26 (Initial state+26)                            | 0.050   | 0.058 | 0.066 | V    |
|   |  | Vtdac27_8W | Step 27 (Initial state+27)                            | 0.040   | 0.048 | 0.056 | V    |
|   |  | Vtdac28_8W | Step 28 (Initial state+28)                            | 0.032   | 0.040 | 0.048 | V    |
|   |  | Vtdac29_8W | Step 29 (Initial state+29)                            | 0.022   | 0.030 | 0.038 | V    |
|   |  | Vtdac30_8W | Step 30 (Initial state+30)                            | 0.012   | 0.020 | 0.028 | V    |
|   |  | Vtdac31_8W | Step 31 (Initial state+31)                            | 0.002   | 0.010 | 0.018 | V    |
|   | 4W1-2-phase drive (1/16-step at LV8713T) | Vtdac0_4W  | Step 0 (When initialized: channel 1 comparator level) | 0.191   | 0.200 | 0.209 | V    |
|   |  | Vtdac2_4W  | Step 2 (Initial state+1)                              | 0.191   | 0.200 | 0.209 | V    |
|   |  | Vtdac4_4W  | Step 4 (Initial state+2)                              | 0.187   | 0.196 | 0.205 | V    |
|   |  | Vtdac6_4W  | Step 6 (Initial state+3)                              | 0.183   | 0.192 | 0.201 | V    |
|   |  | Vtdac8_4W  | Step 8 (Initial state+4)                              | 0.175   | 0.184 | 0.193 | V    |
|   |  | Vtdac10_4W | Step 10 (Initial state+5)                             | 0.167   | 0.176 | 0.185 | V    |
|   |  | Vtdac12_4W | Step 12 (Initial state+6)                             | 0.158   | 0.166 | 0.174 | V    |
|   |  | Vtdac14_4W | Step 14 (Initial state+7)                             | 0.146   | 0.154 | 0.162 | V    |
|   |  | Vtdac16_4W | Step 16 (Initial state+8)                             | 0.132   | 0.140 | 0.148 | V    |
|   |  | Vtdac18_4W | Step 18 (Initial state+9)                             | 0.118   | 0.126 | 0.134 | V    |
|   |  | Vtdac20_4W | Step 20 (Initial state+10)                            | 0.102   | 0.110 | 0.118 | V    |
|   |  | Vtdac22_4W | Step 22 (Initial state+11)                            | 0.086   | 0.094 | 0.102 | V    |
|   |  | Vtdac24_4W | Step 24 (Initial state+12)                            | 0.068   | 0.076 | 0.084 | V    |
|   |  | Vtdac26_4W | Step 26 (Initial state+13)                            | 0.050   | 0.058 | 0.066 | V    |
| Vtdac28_4W  | Step 28 (Initial state+14)               | 0.032      | 0.040   | 0.048   | V     |       |      |
| Vtdac30_4W  | Step 30 (Initial state+15)               | 0.012      | 0.020   | 0.028   | V     |       |      |

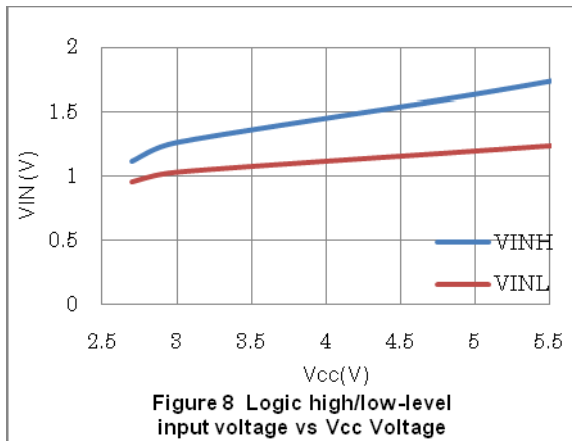
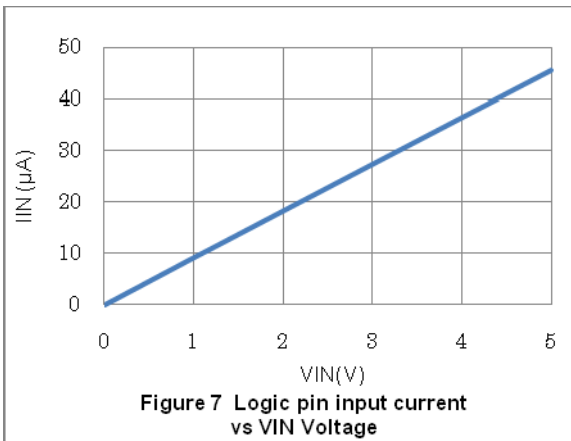
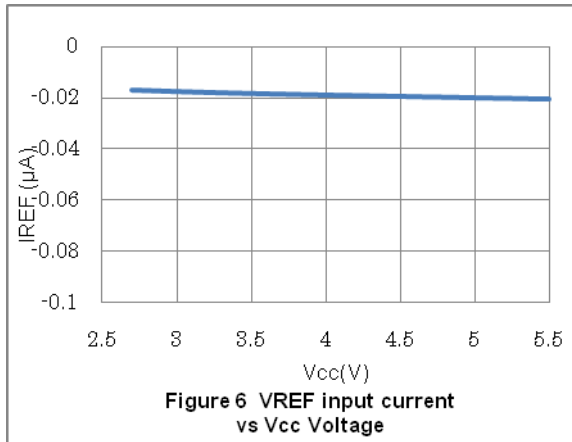
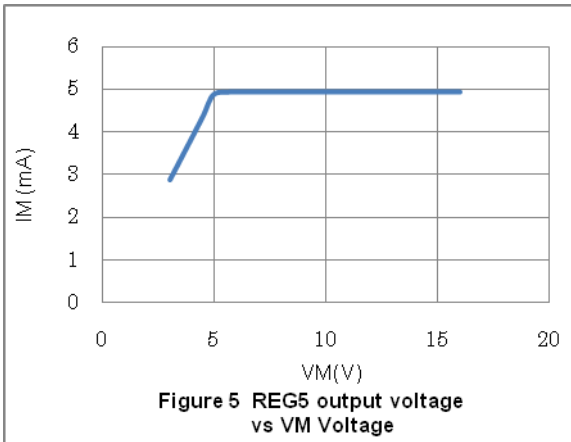
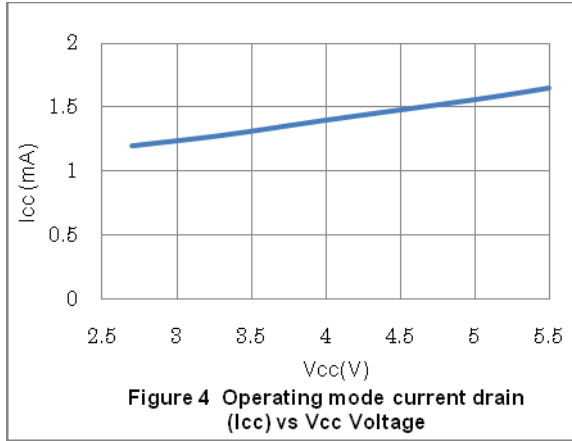
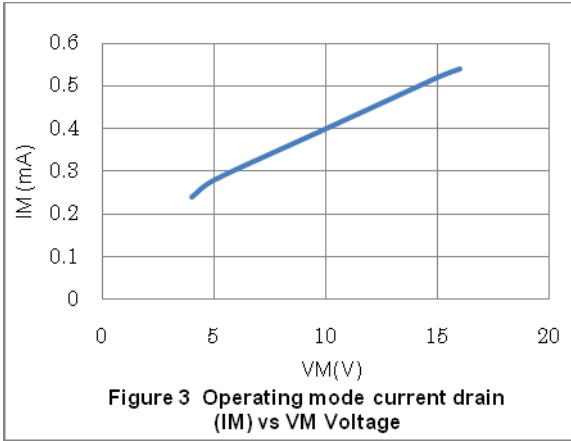
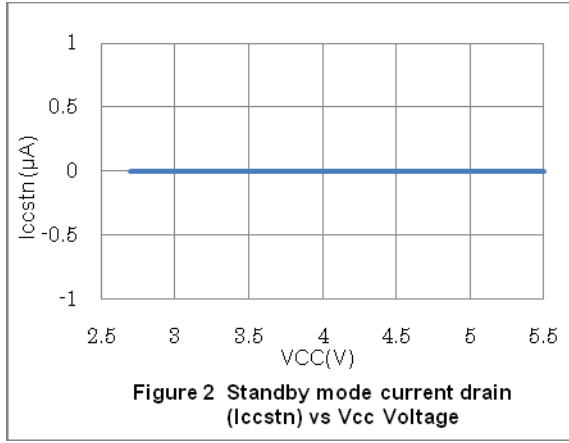
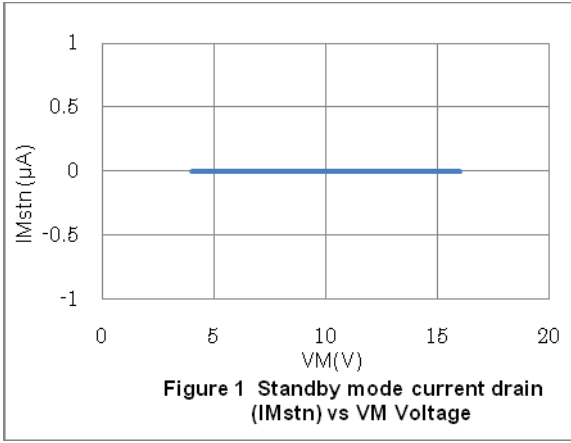
Continued on next page

## LV8712T/LV8713T Application Note

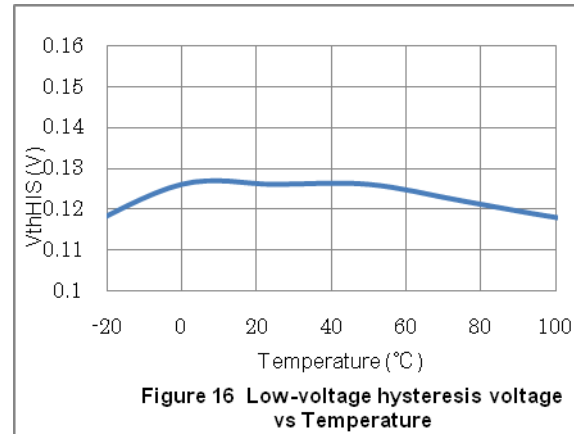
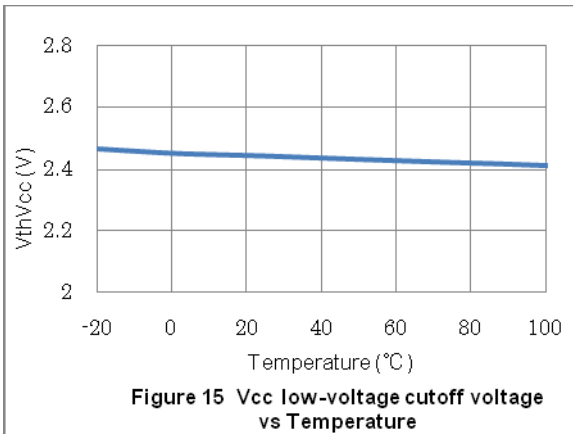
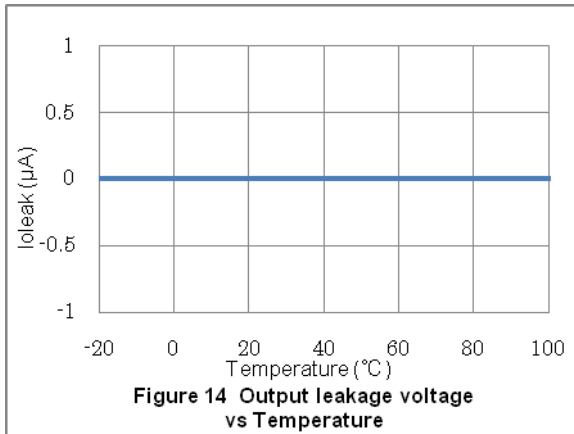
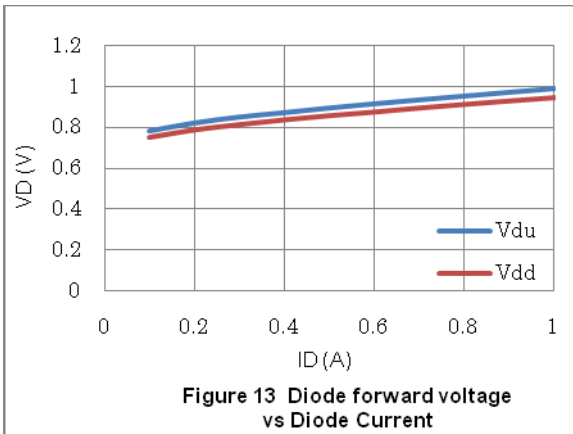
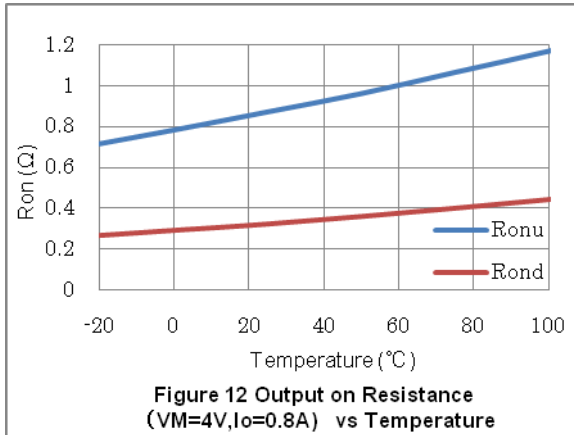
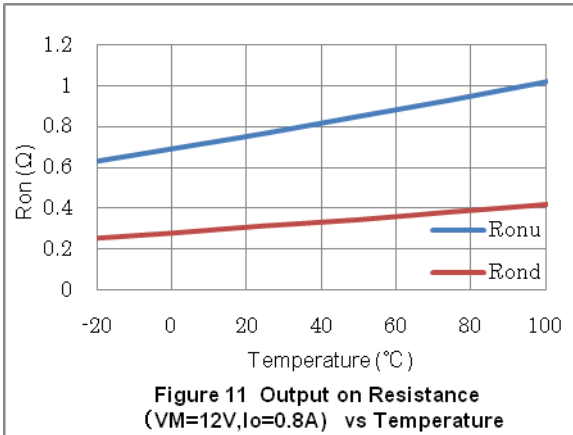
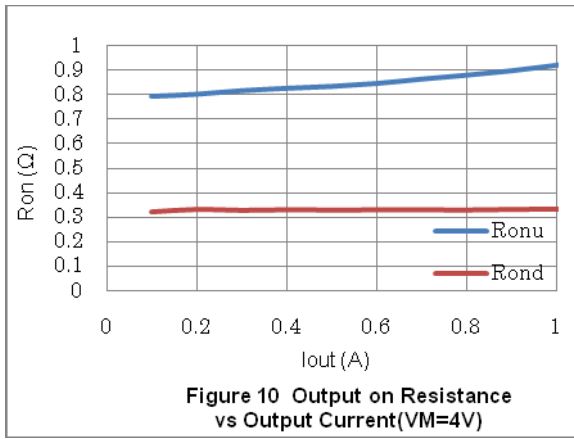
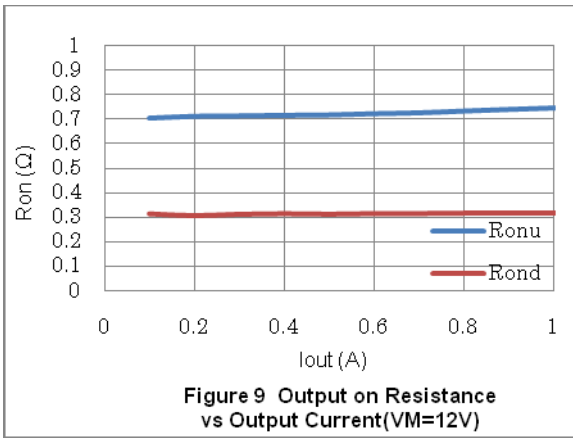
Continued from preceding page.

| Parameter   |  | Symbol  | Conditions  | Ratings |       |       | Unit |
|---|--|---|---|---------|-------|-------|------|
|   |  |   |   | min     | typ   | max   |      |
| Current setting comparator threshold voltage (current step switching) | 2W1-2-phase drive (1/8-step at LV8712T)    | Vtdac0_2W   | Step 0 (When initialized: channel 1 comparator level) | 0.191   | 0.2   | 0.209 | V    |
|   |  | Vtdac4_2W   | Step 4 (Initial state+1)                              | 0.187   | 0.196 | 0.205 | V    |
|   |  | Vtdac8_2W   | Step 8 (Initial state+2)                              | 0.175   | 0.184 | 0.193 | V    |
|   |  | Vtdac12_2W  | Step 12 (Initial state+3)                             | 0.158   | 0.166 | 0.174 | V    |
|   |  | Vtdac16_2W  | Step 16 (Initial state+4)                             | 0.132   | 0.140 | 0.148 | V    |
|   |  | Vtdac20_2W  | Step 20 (Initial state+5)                             | 0.102   | 0.110 | 0.118 | V    |
|   |  | Vtdac24_2W  | Step 24 (Initial state+6)                             | 0.068   | 0.076 | 0.084 | V    |
|   |  | Vtdac28_2W  | Step 28 (Initial state+7)                             | 0.032   | 0.040 | 0.048 | V    |
|   | W1-2-phase drive (quarter-step at LV8712T) | Vtdac0_W  | Step 0 (When initialized: channel 1 comparator level) | 0.191   | 0.200 | 0.209 | V    |
|   |  | Vtdac8_W  | Step 8 (Initial state+1)                              | 0.175   | 0.184 | 0.193 | V    |
|   |  | Vtdac16_W   | Step 16 (Initial state+2)                             | 0.132   | 0.140 | 0.148 | V    |
|   |  | Vtdac24_W   | Step 24 (Initial state+3)                             | 0.068   | 0.076 | 0.084 | V    |
|   | 1-2 phase drive (half-step at LV8712T/13T) | Vtdac0_H  | Step 0 (When initialized: channel 1 comparator level) | 0.191   | 0.200 | 0.209 | V    |
|   |  | Vtdac16_H   | Step 16 (Initial state+1)                             | 0.132   | 0.140 | 0.148 | V    |
| 2 phase drive (full-step at LV8712T/13T)                              | Vtdac16_F                                  | Step 16' (When initialized: channel 1 comparator level) | 0.191   | 0.200   | 0.209 | V     |      |

# LV8712T/LV8713T Application Note

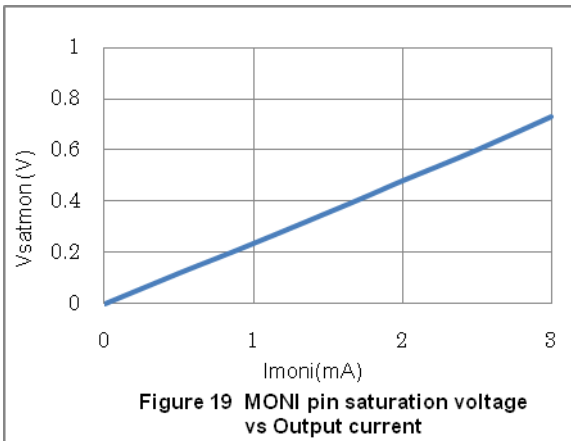
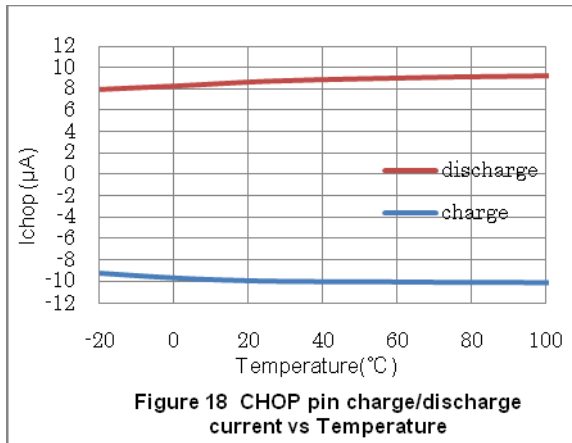
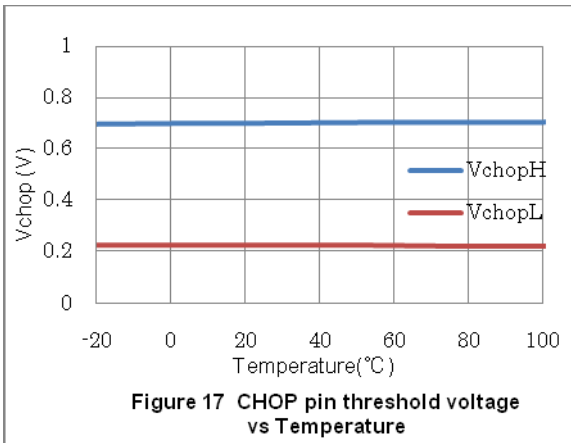


# LV8712T/LV8713T Application Note





# LV8712T/LV8713T Application Note



# LV8712T/LV8713T Application Note

## Pin Functions

| Pin No.                                 | Pin Name  | Pin Function  | Equivalent Circuit |
|---|---|---|--------------------|
| 1<br>2<br>7<br>8<br>9<br>13<br>14<br>24 | RST<br>OE<br>STEP<br>ATT1<br>ATT2<br>MD2<br>MD1<br>FR | Excitation reset signal input pin.<br>Output enable signal input pin.<br>STEP signal input pin.<br>Motor holding current switching pin.<br>Motor holding current switching pin.<br>Excitation mode switching pin 2.<br>Excitation mode switching pin 1.<br>CW / CCW switching signal input pin. |                    |
| 4                                       | PS  | Power save signal input pin.  |                    |
| 16<br>17<br>18<br>20<br>21<br>23        | OUT2B<br>RNF2<br>OUT2A<br>OUT1B<br>RNF1<br>OUT1A      | Channel 2 OUTB output pin.<br>Channel 2 current-sense resistor connection pin.<br>Channel 2 OUTA output pin.<br>Channel 1 OUTB output pin.<br>Channel 1 current-sense resistor connection pin.<br>Channel 1 OUTA output pin   |                    |
| 6                                       | VREF  | Constant current control reference voltage input pin.   |                    |

Continued on next page.

# LV8712T/LV8713T Application Note

Continued from preceding page.

| Pin No. | Pin Name | Pin Function   | Equivalent Circuit |
|---------|----------|--|--------------------|
| 3       | REG5     | Internal power supply capacitor connection pin.      |                    |
| 5       | MONI     | Position detection monitor pin.                      |                    |
| 10      | CHOP     | Chopping frequency setting capacitor connection pin. |                    |

## Operation description

### Stepping motor control

#### 1. Power save function

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

| PS          | Mode           | Internal regulator |
|-------------|----------------|--------------------|
| Low or Open | Standby mode   | Standby            |
| High        | Operating mode | Operating          |

#### 2. The recommended order of power supply



It is recommendable that the power supplies are turned on in the following order.

VCC power supply → VM power supply → PS pin = High

For turning off the power supplies, the order should be reversed.

However, the above-mentioned order is presented only as a recommendation, and noncompliance is not going to be the cause of over-current or IC destruction.

#### 3. STEP pin function

| Input |   | Operating mode           |
|-------|---|--------------------------|
| PS    | STP   |                          |
| Low   | *   | Standby mode             |
| High  |  | Excitation step proceeds |
| High  |  | Excitation step is kept  |

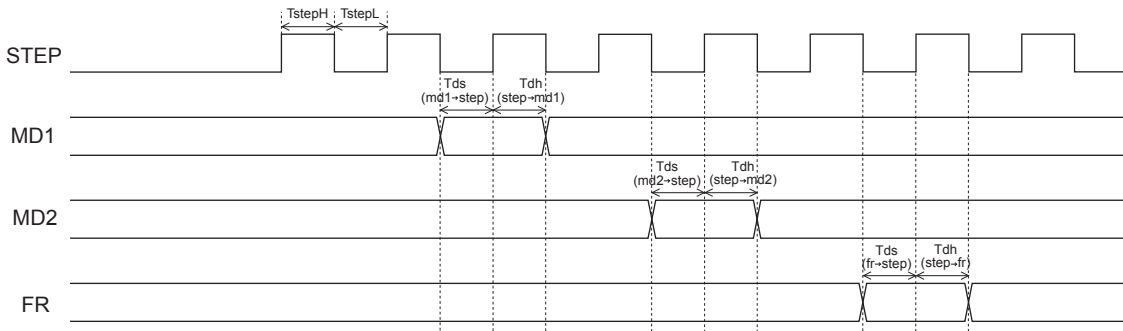
STEP input advances electrical angle at every rising edge (advances step by step).

STEP input MIN pulse width (common in H/L): 500ns (MAX input frequency: 1MHz)

However, constant current control is performed by PWM during chopping period, which is set by the capacitor connected between CHOP and GND. You need to perform chopping more than once per step. For this reason, for the actual STEP frequency, you need to take chopping frequency and chopping count into consideration.

For example, if chopping frequency is 50kHz (20μs) and chopping is performed twice per step, the maximum STEP frequency is obtained as follows:  $f=1/(20\mu s \times 2) = 25\text{kHz}$ .

#### 4. Input timing



$T_{stepH}/T_{stepL}$ : Clock H/L pulse width (min 500ns)

$T_{ds}$ : Data set-up time (min 500ns)

$T_{dh}$ : Data hold time (min 500ns)

Figure 20. Input timing chart

## 5. Microstepping mode setting function (initial position)

<LV8712T>

| MD1  | MD2  | Microstepping Resolution | Excitation mode | Initial position |           |
|------|------|--------------------------|-----------------|------------------|-----------|
|      |      |                          |                 | Channel 1        | Channel 2 |
| Low  | Low  | Full Step                | 2 Phase         | 100%             | -100%     |
| High | Low  | Half Step                | 1-2 Phase       | 100%             | 0%        |
| Low  | High | Quarter Step             | W1-2 Phase      | 100%             | 0%        |
| High | High | 1/8 Step                 | 2W1-2 Phase     | 100%             | 0%        |

<LV8713T>

| MD1  | MD2  | Microstepping Resolution | Excitation mode | Initial position |           |
|------|------|--------------------------|-----------------|------------------|-----------|
|      |      |                          |                 | Channel 1        | Channel 2 |
| Low  | Low  | Full Step                | 2 Phase         | 100%             | -100%     |
| High | Low  | Half Step                | 1-2 Phase       | 100%             | 0%        |
| Low  | High | 1/16 Step                | 4W1-2 Phase     | 100%             | 0%        |
| High | High | 1/32 Step                | 8W1-2 Phase     | 100%             | 0%        |

This is the initial position of each excitation mode in the initial state after power-on and when the counter is reset.

## 6. Initial Position monitoring function

MONI pin monitors the initial position which is open drain.

When the excitation is in the initial position, the MONI output is turned on.

(Refer to " (13) Examples of current waveforms in the respective excitation modes.")

## 7. Reset function

| RST  | Operating mode   |
|------|------------------|
| High | Normal operation |
| Low  | Reset state      |

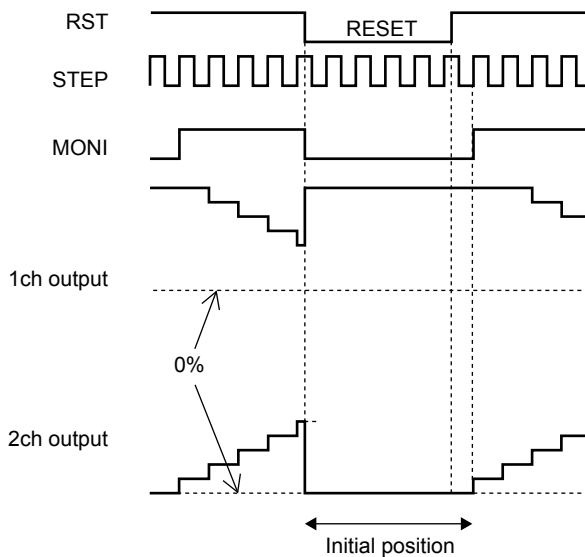


Figure 21. Reset function timing chart

When the RST pin is Low, the excitation position of the output is forcibly set to the initial position, and the MONI output is turned on. When RST turns High, the excitation position is advanced by the next STEP input.

## 8. Output enable function

| OE   | Operating mode |
|------|----------------|
| Low  | Output ON      |
| High | Output OFF     |

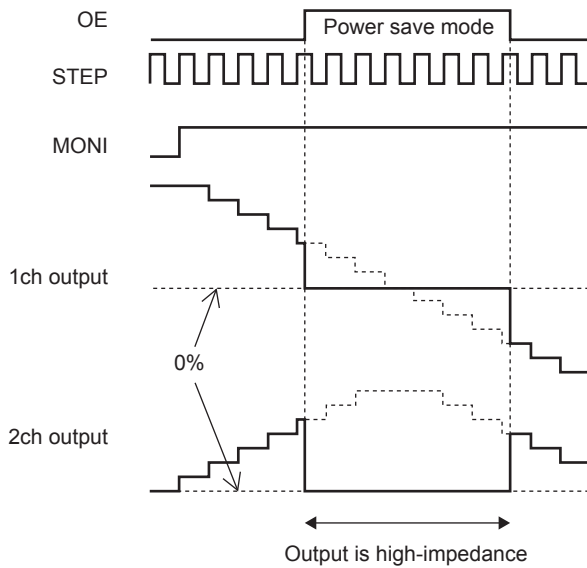


Figure 22. Output enable function timing chart

When the OE pin is High, the output turns OFF by force and turns to high impedance. However, since the internal logic circuits are under operation, the excitation position proceeds when the STEP signal is input. Therefore, when OE turns Low again, the output level follows the excitation position led by the STEP input.

## 9. Forward/reverse switching function

| FR   | Operating mode          |
|------|-------------------------|
| Low  | Clockwise (CW)          |
| High | Counter-clockwise (CCW) |

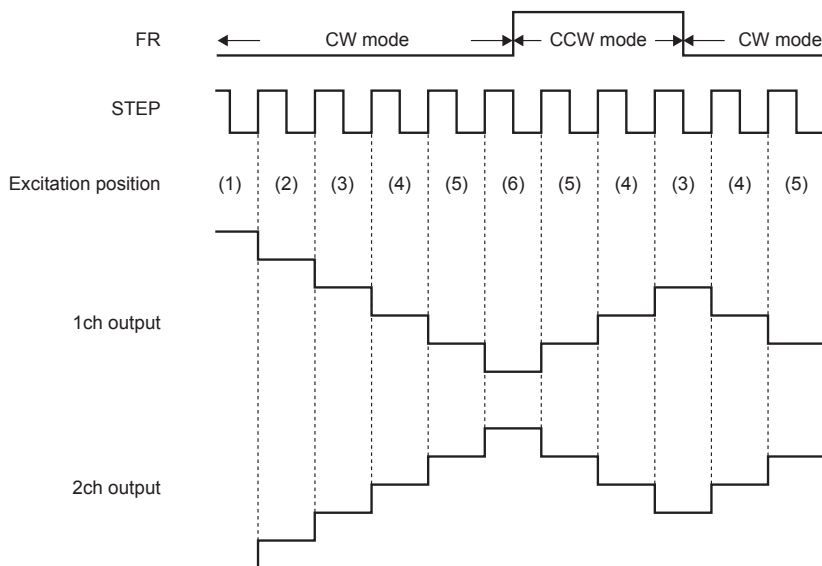


Figure 23. Forward/Reverse switching function timing chart

The internal D/A converter proceeds by one bit at the rising edge of the input STEP pulse. In addition, CW and CCW mode are switched by setting the FR pin. In CW mode, the channel 2 current phase is delayed by 90° relative to the channel 1 current. In CCW mode, the channel 2 current phase is advanced by 90° relative to the channel 1 current.

## LV8712T/LV8713T Application Note

### 10. Constant current control setting

The setting of STM driver's constant current control is determined by the following based on the VREF voltage and the resistor connected between RNF and GND.

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

\* The above formula gives setting value where the output current is 100% in each excitation mode.

If VREF is open or the setting is out of the recommendation operating range, output current will increase and you cannot set constant current under normal condition. Hence, make sure that VREF is set in accordance with the specification.

However, if current control is not performed (if the IC is used by saturation drive or used without current limit at DCM) make sure that the setting is as follows: VREF=5V or VREF=VREG5

Power dissipation of RF resistor is obtained as follows:  $Pd = I_{out}^2 \times R_F$ . Make sure to take allowable power dissipation into consideration when you select RF resistor.

The voltage input to the VREF pin can be switched to four-step settings depending on the statuses of the two inputs, ATT1 and ATT2. This is effective for reducing power consumption when motor holding current is supplied.

Attenuation function for VREF input voltage

| ATT1 | ATT2 | Current setting reference voltage attenuation ratio |
|------|------|---|
| Low  | Low  | 100%  |
| High | Low  | 80%   |
| Low  | High | 60%   |
| High | High | 40%   |

The formula is given below which is used to calculate the output current when using the function for attenuating the VREF input voltage.

$$I_{OUT} = (VREF/5) \times (\text{attenuation ratio}) / RNF \text{ resistance}$$

Example: At VREF of 1.0V and a reference voltage setting is 100% [(ATT1, ATT2) = (L, L)] and an RNF resistance of 0.5Ω, the output current is set as follows.

$$I_{OUT} = 1.0V/5 \times 100\%/0.5\Omega = 400mA$$

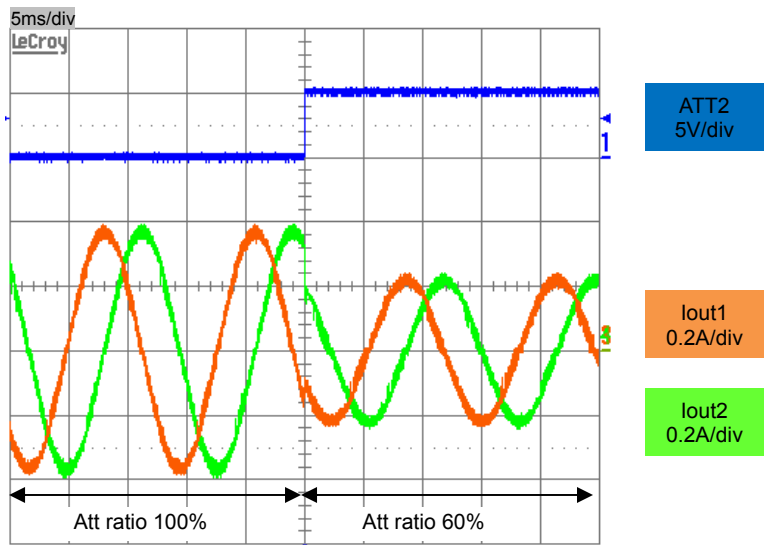
If (ATT1, ATT2) is set to (H, H) in this state, IOUT is obtained as follows:

$$I_{OUT} = 400mA \times 40\% = 160mA$$

In this way, the output current is attenuated when the motor holding current is supplied for power saving.

Figure 24. Constant current control (Attenuation function) waveform

[LV8713T]  
 Vcc=5V, VM=12V  
 VREF=1V, RNF=0.51Ω  
 PS=High, RST=High, ATT1=Low  
 MD1=MD2=High, fSTEP=10 kHz



## 11. Chopping frequency setting

For constant-current control, this IC performs chopping operations at the frequency determined by the capacitor (C<sub>chop</sub>) connected between the CHOP pin and GND.

The chopping frequency is set as shown below by the capacitor (C<sub>chop</sub>) connected between the CHOP pin and GND.

$$T_{chop} \approx C_{chop} \times V_{tchop} \times 2 / I_{chop} \text{ (s)}$$

V<sub>tchop</sub>: Width of threshold voltage (V<sub>chopH</sub>-V<sub>chopL</sub>), typ 0.5V

I<sub>chop</sub>: Charge/discharge current, typ 10μA

$$F_{chop} \approx 1 / T_{chop} \text{ (Hz)}$$

For instance, when C<sub>chop</sub> is 220pF, the chopping frequency will be as follows:

$$F_{chop} = 1/T_{chop} = 10\mu A / (220pF \times 0.5V \times 2) = 45 \text{ kHz}$$

The higher the chopping frequency is, the greater the output switching loss becomes. As a result, heat generation issue arises. The lower the chopping frequency is, the lesser the heat generation becomes. However, current ripple occurs. Since noise increases when switching of chopping takes place, you need to adjust frequency with the influence to the other devices into consideration. The frequency range should be between 40 kHz and 125 kHz.

## 12. Output current vector locus (one step is normalized to 90 degrees)

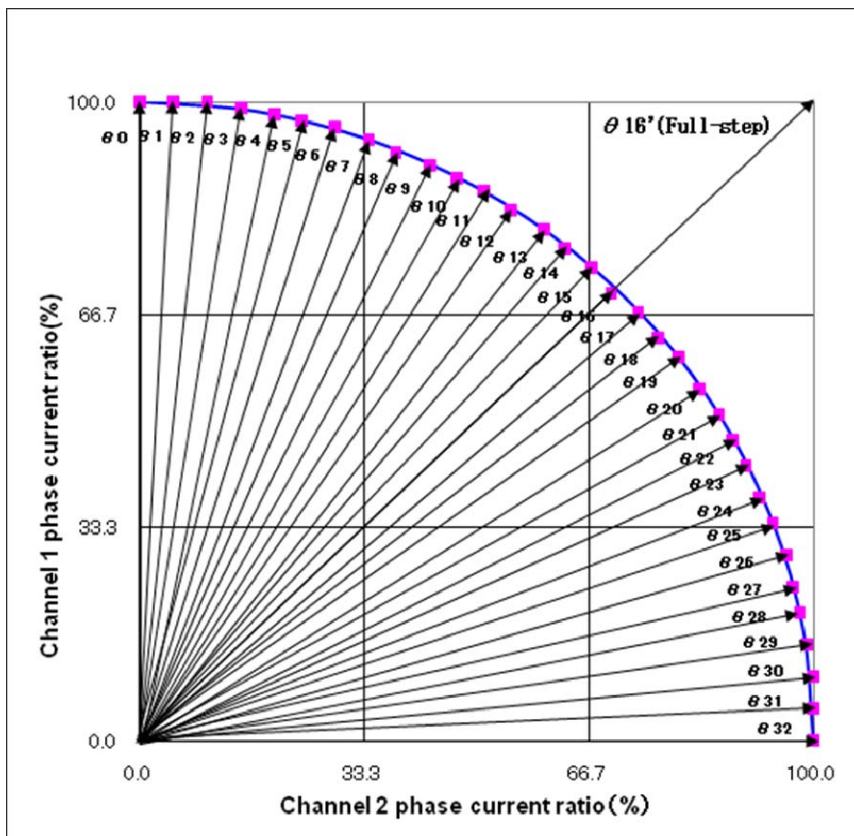


Figure 25. Output current vector



## LV8712T/LV8713T Application Note

Setting current ration in each Microstepping mode

| STEP | LV8713T selectable |           |           |           | LV8712T selectable |           |              |           | LV8712T/LV8713T selectable |           |           |           |
|------|--------------------|-----------|-----------|-----------|--------------------|-----------|--------------|-----------|----------------------------|-----------|-----------|-----------|
|      | 1/32 Step          |           | 1/16 Step |           | 1/8 Step           |           | Quarter Step |           | Half Step                  |           | Full Step |           |
|      | Ch- 1 (%)          | Ch- 2 (%) | Ch- 1 (%) | Ch- 2 (%) | Ch- 1 (%)          | Ch- 2 (%) | Ch- 1 (%)    | Ch- 2 (%) | Ch- 1 (%)                  | Ch- 2 (%) | Ch- 1 (%) | Ch- 2 (%) |
| 00   | 100                | 0         | 100       | 0         | 100                | 0         | 100          | 0         | 100                        | 0         |           |           |
| 01   | 100                | 5         |           |           |                    |           |              |           |                            |           |           |           |
| 02   | 100                | 10        | 100       | 10        |                    |           |              |           |                            |           |           |           |
| 03   | 99                 | 15        |           |           |                    |           |              |           |                            |           |           |           |
| 04   | 98                 | 20        | 98        | 20        | 98                 | 20        |              |           |                            |           |           |           |
| 05   | 97                 | 24        |           |           |                    |           |              |           |                            |           |           |           |
| 06   | 96                 | 29        | 96        | 29        |                    |           |              |           |                            |           |           |           |
| 07   | 94                 | 34        |           |           |                    |           |              |           |                            |           |           |           |
| 08   | 92                 | 38        | 92        | 38        | 92                 | 38        | 92           | 38        |                            |           |           |           |
| 09   | 90                 | 43        |           |           |                    |           |              |           |                            |           |           |           |
| 010  | 88                 | 47        | 88        | 47        |                    |           |              |           |                            |           |           |           |
| 011  | 86                 | 51        |           |           |                    |           |              |           |                            |           |           |           |
| 012  | 83                 | 55        | 83        | 55        | 83                 | 55        |              |           |                            |           |           |           |
| 013  | 80                 | 60        |           |           |                    |           |              |           |                            |           |           |           |
| 014  | 77                 | 63        | 77        | 63        |                    |           |              |           |                            |           |           |           |
| 015  | 74                 | 67        |           |           |                    |           |              |           |                            |           |           |           |
| 016  | 70                 | 70        | 70        | 70        | 70                 | 70        | 70           | 70        | 70                         | 70        | 100       | 100       |
| 017  | 67                 | 74        |           |           |                    |           |              |           |                            |           |           |           |
| 018  | 63                 | 77        | 63        | 77        |                    |           |              |           |                            |           |           |           |
| 019  | 60                 | 80        |           |           |                    |           |              |           |                            |           |           |           |
| 020  | 55                 | 83        | 55        | 83        | 55                 | 83        |              |           |                            |           |           |           |
| 021  | 51                 | 86        |           |           |                    |           |              |           |                            |           |           |           |
| 022  | 47                 | 88        | 47        | 88        |                    |           |              |           |                            |           |           |           |
| 023  | 43                 | 90        |           |           |                    |           |              |           |                            |           |           |           |
| 024  | 38                 | 92        | 38        | 92        | 38                 | 92        | 38           | 92        |                            |           |           |           |
| 025  | 34                 | 94        |           |           |                    |           |              |           |                            |           |           |           |
| 026  | 29                 | 96        | 29        | 96        |                    |           |              |           |                            |           |           |           |
| 027  | 24                 | 97        |           |           |                    |           |              |           |                            |           |           |           |
| 028  | 20                 | 98        | 20        | 98        | 20                 | 98        |              |           |                            |           |           |           |
| 029  | 15                 | 99        |           |           |                    |           |              |           |                            |           |           |           |
| 030  | 10                 | 100       | 10        | 100       |                    |           |              |           |                            |           |           |           |
| 031  | 5                  | 100       |           |           |                    |           |              |           |                            |           |           |           |
| 032  | 0                  | 100       | 0         | 100       | 0                  | 100       | 0            | 100       | 0                          | 100       |           |           |

## 13. Typical current waveform in each excitation mode

Figure 26. Full-Step resolution (FR="Low")

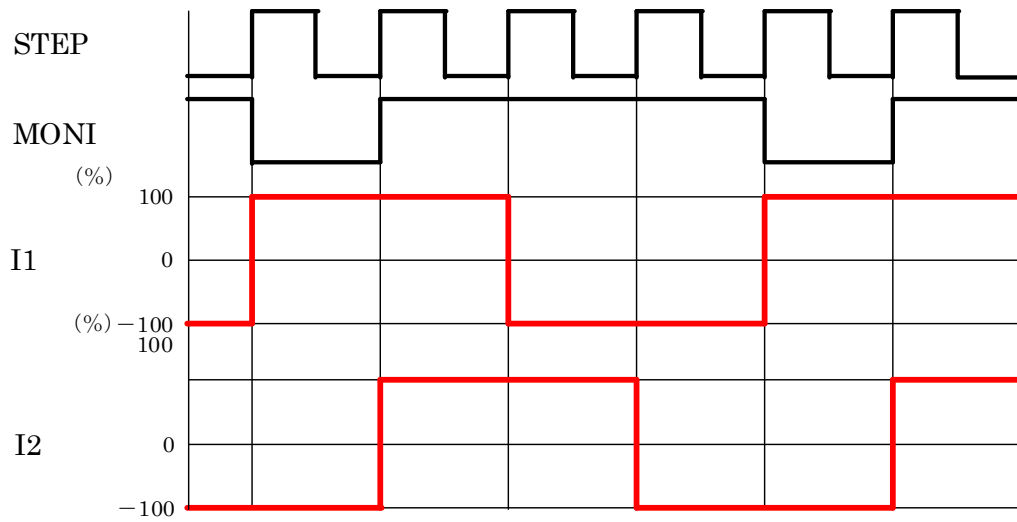
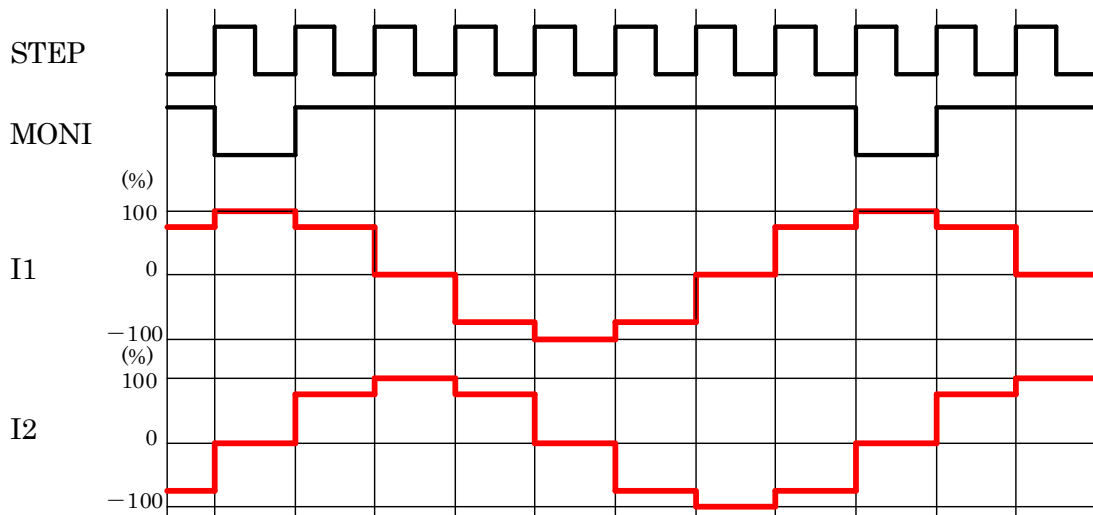


Figure 27. Half-Step resolution (FR="Low")



# LV8712T/LV8713T Application Note

Figure 28. Quarter-Step resolution (FR="Low") (LV8712T)

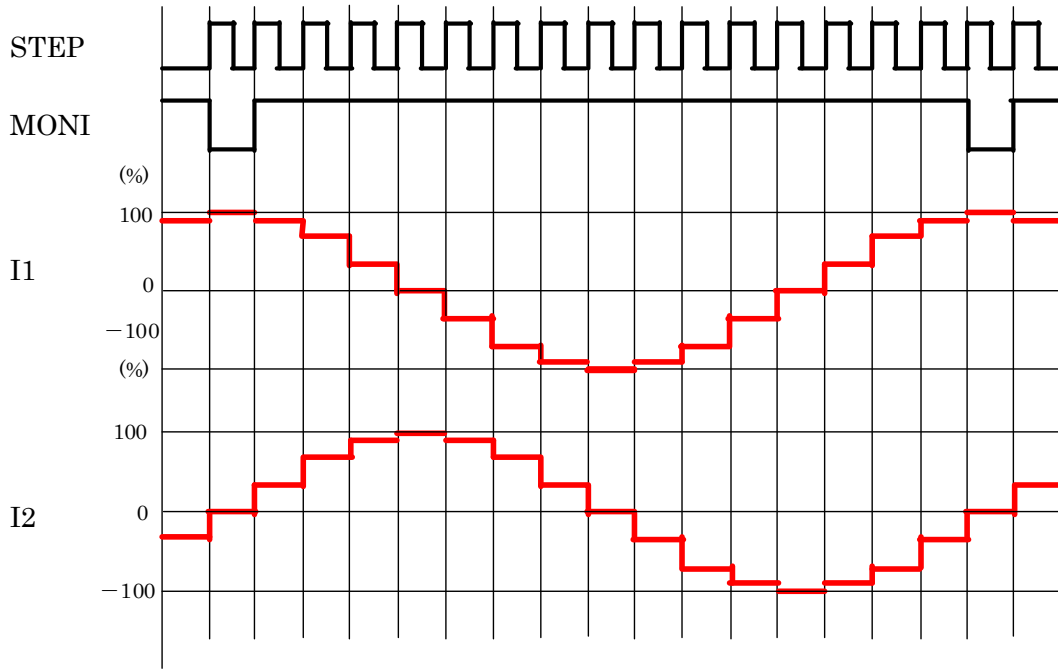
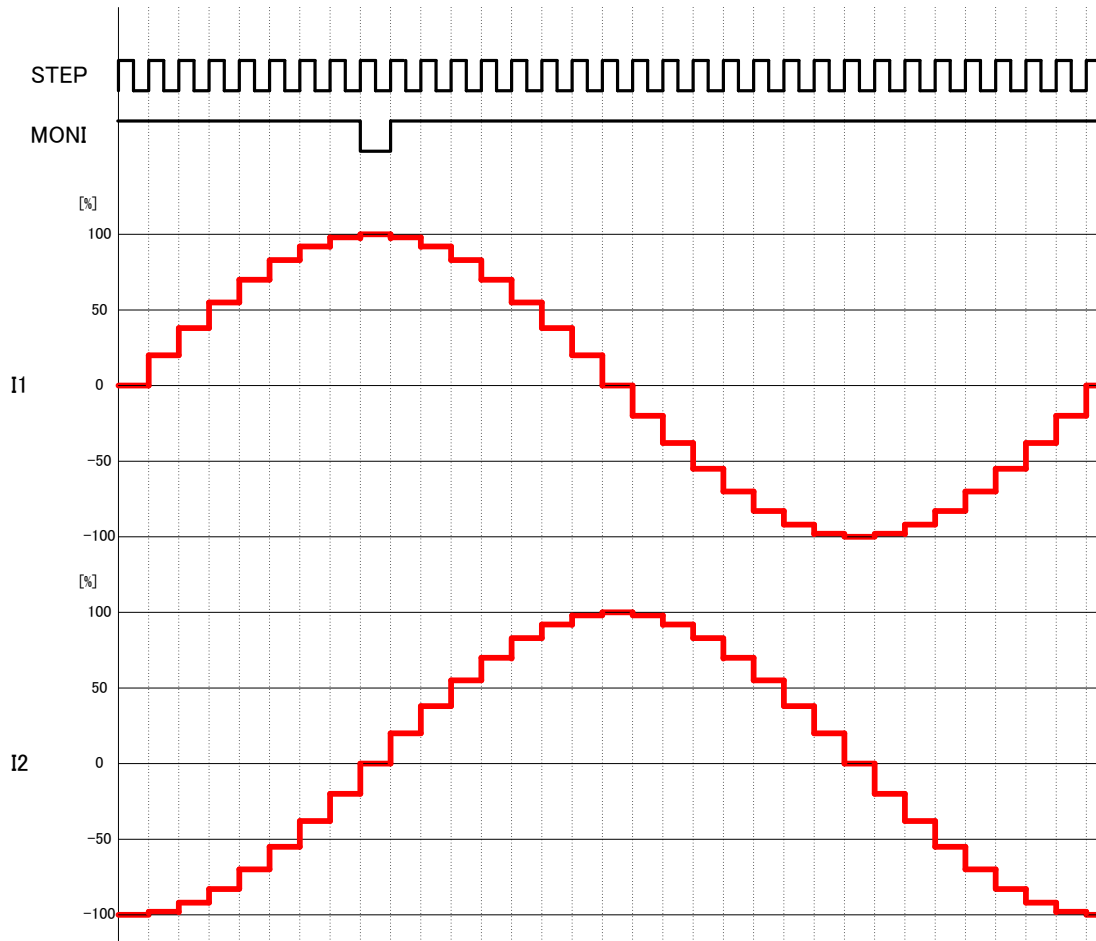


Figure 29. 1/8-Step resolution (FR="Low") (LV8712T)



# LV8712T/LV8713T Application Note

Figure 30. 1/16-Step resolution (FR="Low") (LV8713T)

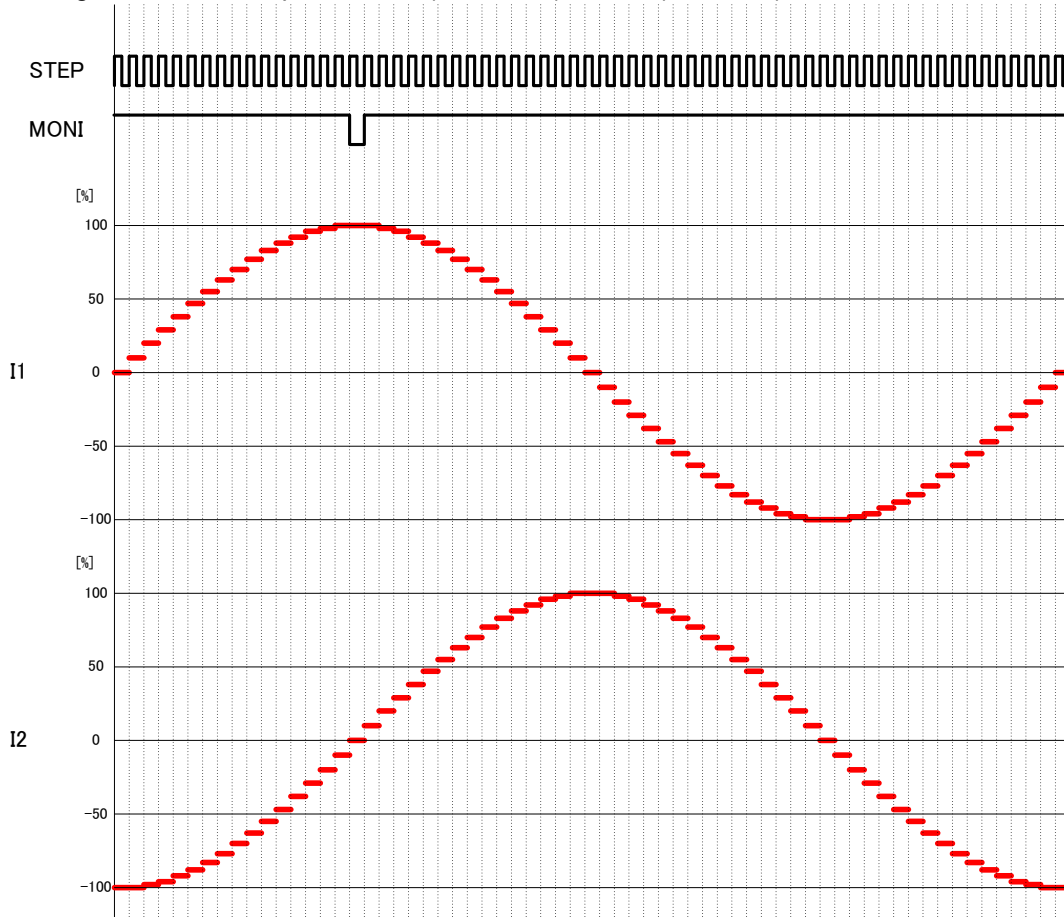
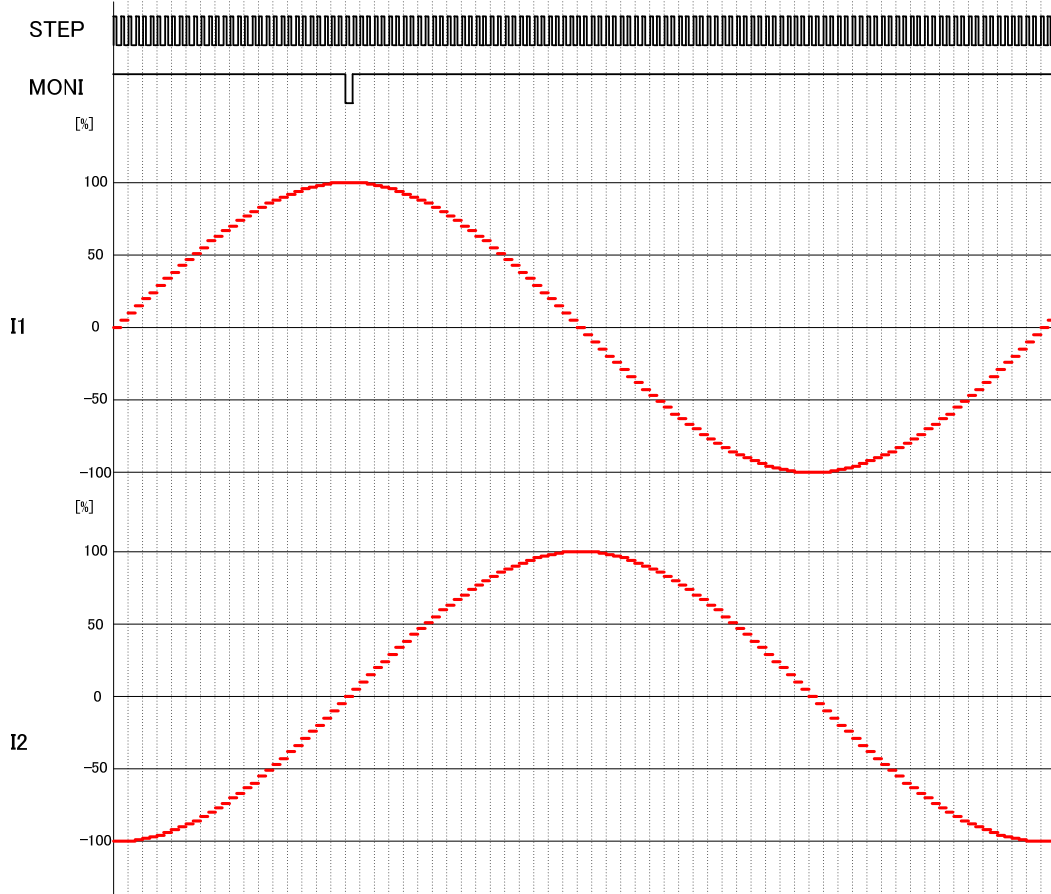
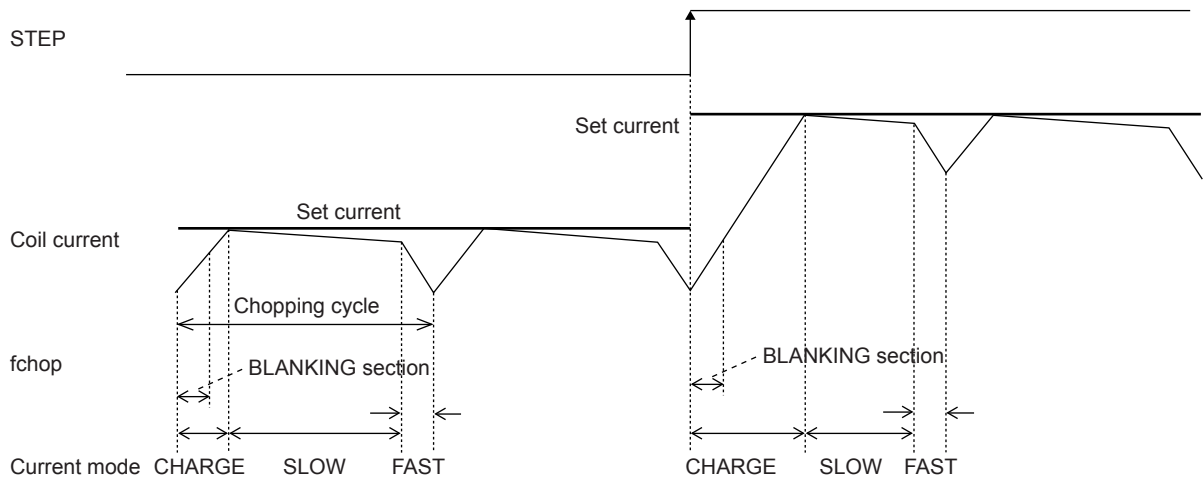


Figure 31. 1/32-Step resolution (FR="Low") (LV8713T)



## 14. Constant Current control (Chopping operation)

(Sine wave increasing direction)



(Sine wave decreasing direction)

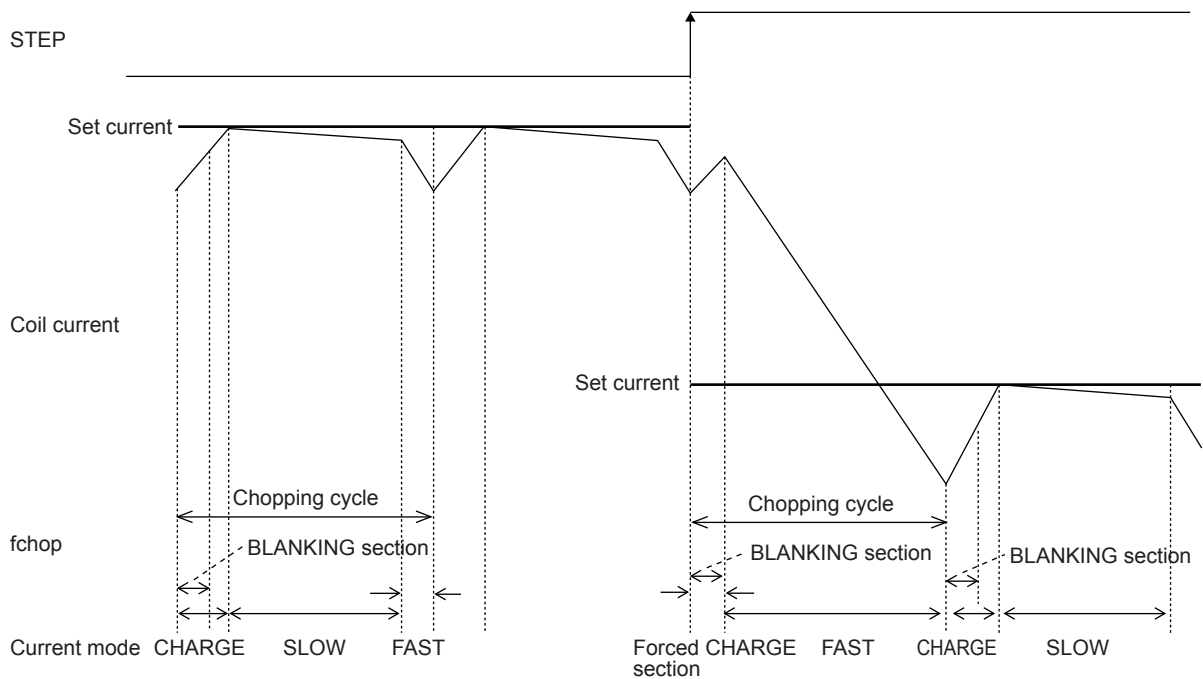


Figure 32. Constant current control timing chart

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

- At rise of chopping frequency, the CHARGE mode begins. (The Blanking section in which the CHARGE mode is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF) exists for 1 $\mu$ s.)
- 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.

# LV8712T/LV8713T Application Note

## 15. Output transistor operation

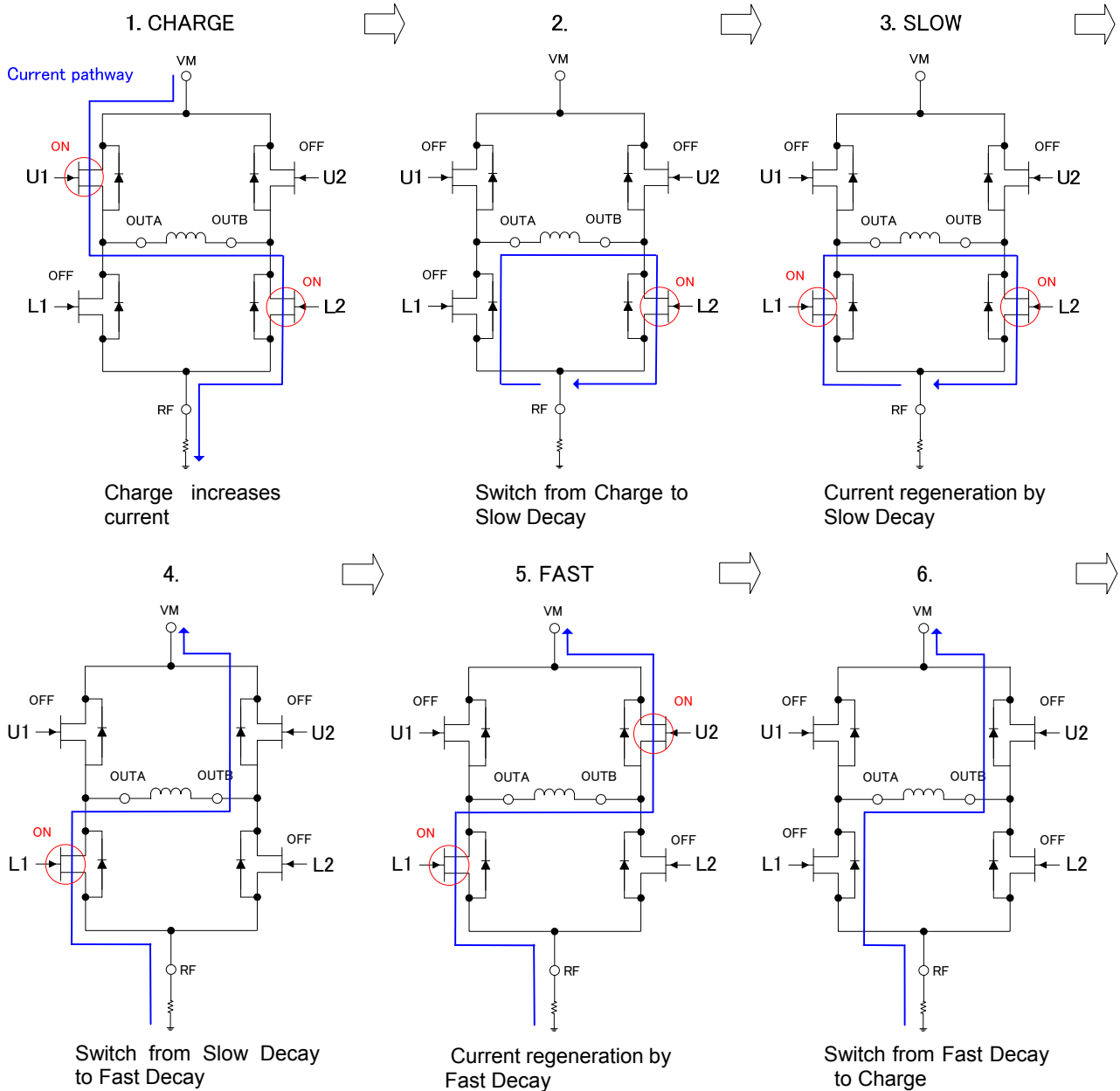


Figure 33 . Output transistor operation sequence

This IC controls constant current by performing chopping to output transistor.

As shown above, by repeating the process from 1 to 6, setting current is maintained.

Chopping consists of 3 modes: Charge/ Slow decay/ Fast decay. In this IC, for switching mode (No.2, 4, 6), there are "off period" in upper and lower transistor to prevent crossover current between the transistors. This off period is set to be constant ( $\approx 0.375\mu\text{s}$ ) which is controlled by the internal logic. The diagrams show parasitic diode generated due to structure of MOS transistor. When the transistor is off, output current is regenerated through this parasitic diode.

### Output FET control function

OUTA→OUTB (CHARGE)

| Output Tr | CHARGE | SLOW | FAST |
|-----------|--------|------|------|
| U1        | ON     | OFF  | OFF  |
| U2        | OFF    | OFF  | ON   |
| L1        | OFF    | ON   | ON   |
| L2        | ON     | ON   | OFF  |

OUTB→OUTA (CHARGE)

| Output Tr | CHARGE | SLOW | FAST |
|-----------|--------|------|------|
| U1        | OFF    | OFF  | ON   |
| U2        | ON     | OFF  | OFF  |
| L1        | ON     | ON   | OFF  |
| L2        | OFF    | ON   | ON   |

# LV8712T/LV8713T Application Note

Figure 34. Constant current control waveform [LV8713T]

Vcc=5V, VM=12V  
 VREF=1V, RNF=0.51Ω, Cchop=220pF  
 PS=High, RST=High, ATT1=ATT2=Low  
 MD1=High, MD2=Low, fSTEP=100Hz

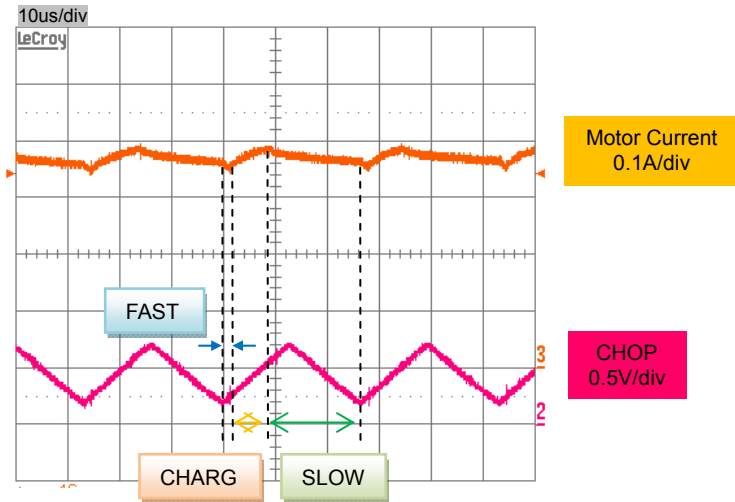
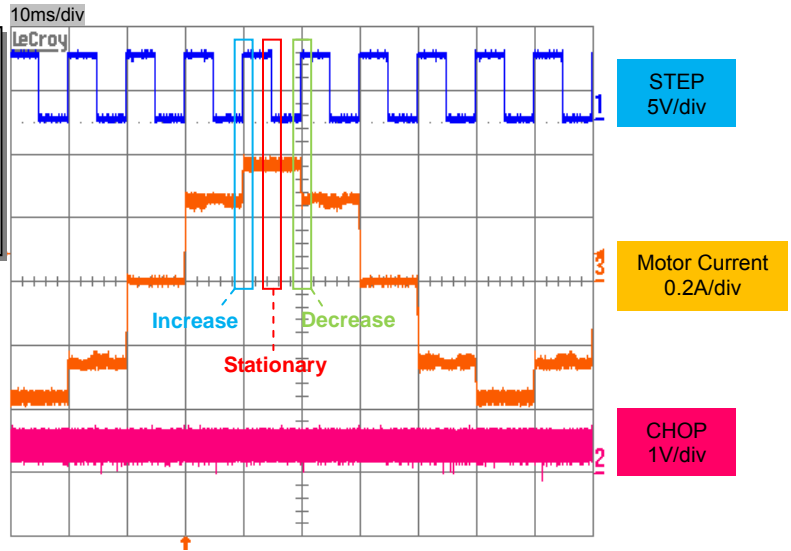


Figure 35. Constant current control waveform (Stationary state)

Motor current switches to Fast Decay mode when triangle wave (CHOP) switches from Discharge to Charge. Approximately after 1μs, the motor current switches to Charge mode. When the current reaches to the setting current, it is switched to Slow Decay mode which continues over the Discharge period of triangle wave.

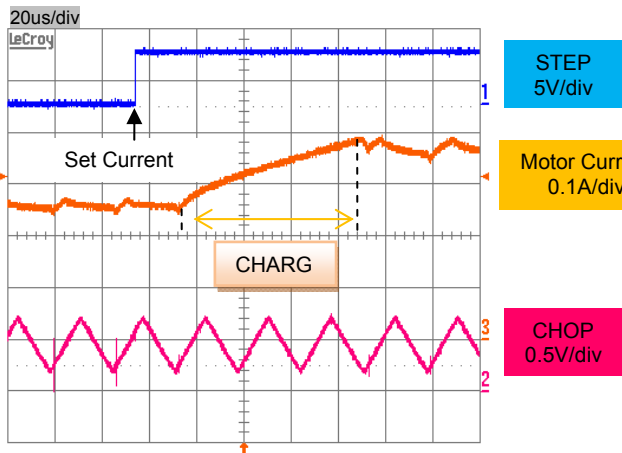


Figure 36. Constant current control waveform (Increasing direction)

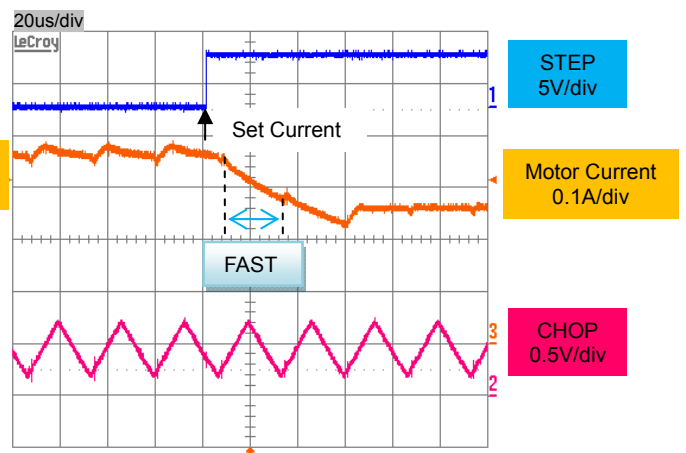


Figure 37. Constant current control waveform (Decreasing direction)

## 16. Blanking time

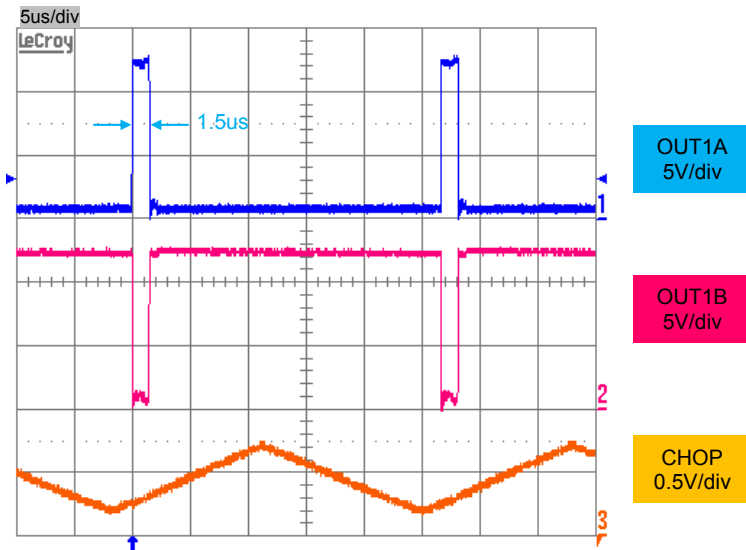
If, when exercising PWM constant-current chopping control over the motor current, the mode is switched from decay to charge, the recovery current of the parasitic diode may flow to the current sensing resistance, causing noise to be carried on the current sensing resistance pin, and this may result in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

The blanking time,  $t_{BLANK}$  ( $\mu s$ ), is approximately

$$t_{BLANK} \approx 1\mu s$$

Figure 38. Blanking time waveform [LV8713T]

$V_{CC}=5V$ ,  $V_M=12V$   
 $V_{REF}=5V$ ,  $R_{NF}=1V$ ,  $C_{CHOP}=220pF$   
 $PS=High$ ,



From the above Fig., the blanking time appears to be  $1.5\mu s$ . However, since the mode shifts from charge (blanking time), OFF, to DECAY, the actual blanking time is obtained as follows:

$$\text{Blanking time} = 1\mu s + \text{OFF zone} = 0.5\mu s$$



## LV8712T/LV8713T Application Note

### 17. Microstepping mode switching operation

When Microstepping mode is switched while the motor is rotating, each drive mode operates with the following sequence.

FR="Low"

| Before the Microstepping mode changes |            | Position after the Microstepping mode is changed |           |          |              |           |           |
|---------------------------------------|------------|--|-----------|----------|--------------|-----------|-----------|
| Microstepping mode                    | Step angle | 1/32 Step  | 1/16 Step | 1/8 Step | Quarter Step | Half Step | Full Step |
| 1/32 Step Resolution                  | 00-01      | /  | 02        | 04       | 08           | 016       | 016'      |
|                                       | 02-03      |  | 04        | 04       | 08           | 016       | 016'      |
|                                       | 04-05      |  | 06        | 08       | 08           | 016       | 016'      |
|                                       | 06-07      |  | 08        | 08       | 08           | 016       | 016'      |
|                                       | 08-09      |  | 010       | 012      | 016          | 016       | 016'      |
|                                       | 010-011    |  | 012       | 012      | 016          | 016       | 016'      |
|                                       | 012-013    |  | 014       | 016      | 016          | 016       | 016'      |
|                                       | 014-015    |  | 016       | 016      | 016          | 016       | 016'      |
|                                       | 016-017    |  | 018       | 020      | 024          | 032       | 016'      |
|                                       | 018-019    |  | 020       | 020      | 024          | 032       | 016'      |
|                                       | 020-021    |  | 022       | 024      | 024          | 032       | 016'      |
|                                       | 022-023    |  | 024       | 024      | 024          | 032       | 016'      |
|                                       | 024-025    |  | 026       | 028      | 032          | 032       | 016'      |
|                                       | 026-027    |  | 028       | 028      | 032          | 032       | 016'      |
|                                       | 028-029    |  | 030       | 032      | 032          | 032       | 016'      |
|                                       | 030-031    |  | 032       | 032      | 032          | 032       | 016'      |
|                                       | 032        |  | -030      | -028     | -024         | -016      | -016'     |
| 1/16 Step Resolution                  | 00         | 01   | /         | 04       | 08           | 016       | 016'      |
|                                       | 02         | 03   |           | 04       | 08           | 016       | 016'      |
|                                       | 04         | 05   |           | 08       | 08           | 016       | 016'      |
|                                       | 06         | 07   |           | 08       | 08           | 016       | 016'      |
|                                       | 08         | 09   |           | 012      | 016          | 016       | 016'      |
|                                       | 010        | 011  |           | 012      | 016          | 016       | 016'      |
|                                       | 012        | 013  |           | 016      | 016          | 016       | 016'      |
|                                       | 014        | 015  |           | 016      | 016          | 016       | 016'      |
|                                       | 016        | 017  |           | 020      | 024          | 032       | 016'      |
|                                       | 018        | 019  |           | 020      | 024          | 032       | 016'      |
|                                       | 020        | 021  |           | 024      | 024          | 032       | 016'      |
|                                       | 022        | 023  |           | 024      | 024          | 032       | 016'      |
|                                       | 024        | 025  |           | 028      | 032          | 032       | 016'      |
|                                       | 026        | 027  |           | 028      | 032          | 032       | 016'      |
|                                       | 028        | 029  |           | 032      | 032          | 032       | 016'      |
|                                       | 030        | 031  |           | 032      | 032          | 032       | 016'      |
|                                       | 032        | -031   |           | -028     | -024         | -016      | -016'     |
| 1/8 Step Resolution                   | 00         | 01   | 02        | /        | 08           | 016       | 016'      |
|                                       | 04         | 05   | 06        |          | 08           | 016       | 016'      |
|                                       | 08         | 09   | 010       |          | 016          | 016       | 016'      |
|                                       | 012        | 013  | 014       |          | 016          | 016       | 016'      |
|                                       | 016        | 017  | 018       |          | 024          | 032       | 016'      |
|                                       | 020        | 021  | 022       |          | 024          | 032       | 016'      |
|                                       | 024        | 025  | 026       |          | 032          | 032       | 016'      |
|                                       | 028        | 029  | 030       |          | 032          | 032       | 016'      |
|                                       | 032        | -031   | -030      |          |              | -024      | -016      |
| Quarter Step Resolution               | 00         | 01   | 02        | 04       | /            | 016       | 016'      |
|                                       | 08         | 09   | 010       | 012      |              | 016       | 016'      |
|                                       | 016        | 017  | 018       | 020      |              | 032       | 016'      |
|                                       | 024        | 025  | 026       | 028      |              | 032       | 016'      |
|                                       | 032        | -031   | -030      | -028     |              |           | -016      |
| Half Step Resolution                  | 00         | 01   | 02        | 04       | 08           | /         | 016'      |
|                                       | 016        | 017  | 018       | 020      | 024          |           | 016'      |
|                                       | 032        | -031   | -030      | -028     | -024         |           | -016'     |
| Full Step Resolution                  | 016'       | 017  | 018       | 020      | 024          | 032       | /         |

\*As for 00 to 032, please refer to the step position of current ratio setting.

# LV8712T/LV8713T Application Note

If you switch Microstepping mode while the motor is driving, the mode setting will be reflected from the next STEP and the motor advances to the position shown in the following.

(a) Microstepping (1/32-,1/16-,1/8-,Quarter-.Half-step) → Microstepping (1/32-,1/16-,1/8-,Quarter-.Half-step)

When a microstepping switches to the next microstepping, the excitation position is switched to the next corresponding step angle of the next microstepping mode.

- e.g.) When the rotation direction is forward at 1/16-step ( $\theta_6$ ) and if you switch to 1/8 step, the step angle is set to  $\theta_8$  at the next step.
- When the rotation direction is forward at 1/16-step ( $\theta_{20}$ ) and if you switch to 1/8 step, the step angle is set to  $\theta_{24}$  at the next step.

(b) Microstepping (1/32-,1/16-,1/8-,Quarter-.Half-step) → Full-step

When a microstepping switches to the full-step, the excitation position is switched to full-step angle of the present quadrant. Caution is required when switching from  $\theta_{16}$  or higher step angle of microstepping position to full-step.

- e.g.) When the rotation direction is forward at 1/8 step ( $\theta_8$ ) and if you switch to full-step, the step angle is set to  $\theta_{16}$ ' at the next step.
- When the rotation direction is forward at 1/8 step ( $\theta_{16}$ ) and if you switch to full-step, the step angle is set to  $\theta_{16}$ ' at the next step. (the electric angle is the same but the absolute value changes)
- When the rotation direction is forward at 1/8 step ( $\theta_{24}$ ) (the electric angle returns and the absolute value changes)

(c) Full-step → Microstepping (1/32-,1/16-,1/8-,Quarter-.Half-step)

When full step switches to microstepping, the excitation position is switched to the next corresponding step angle.

- e.g.) When the rotation direction is forward at Full step ( $\theta_{16}$ ') and if you switch to 1/8 step, the step angle is set to  $\theta_{20}$  at the next step.

Microstep mode switching operation  
 [LV8712T]  
 Vcc=5V, VM=12V  
 VREF=1V, RNF=0.51  $\Omega$   
 PS=High, RST=High, fSTEP=100Hz

Figure 39  
 Microstepping (1/8step) → Microstepping (quarter step)  
 MD2=High

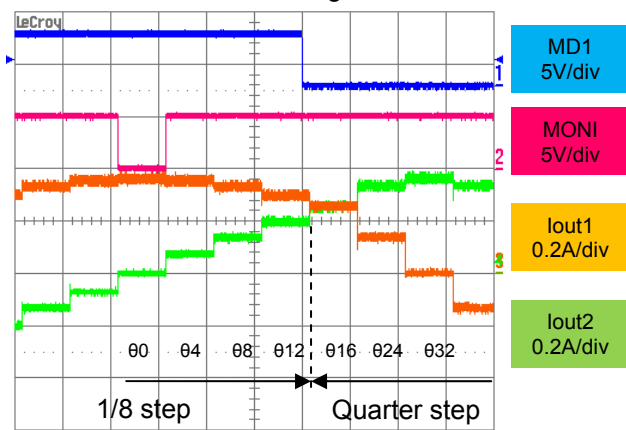


Figure 40.  
 Microstepping (Half-step) → Microstepping (1/8 step)  
 MD1=High

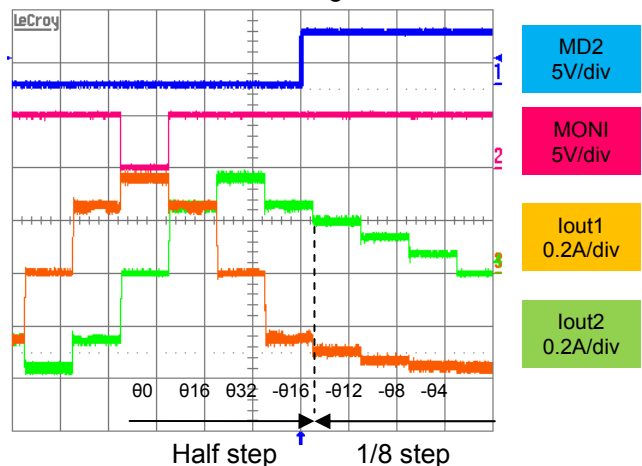


Figure 41  
Microstepping (quarter step) → Full step  
MD1=Low

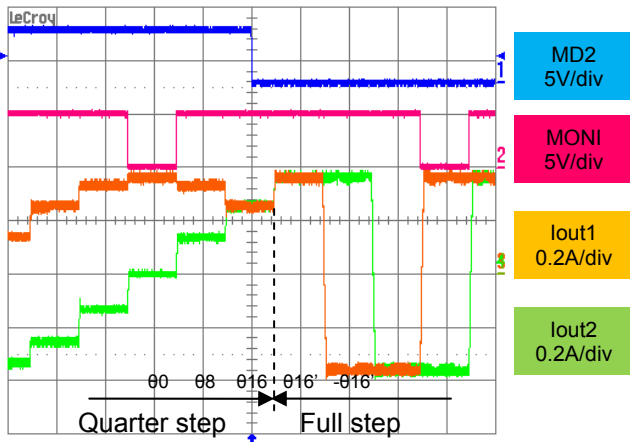
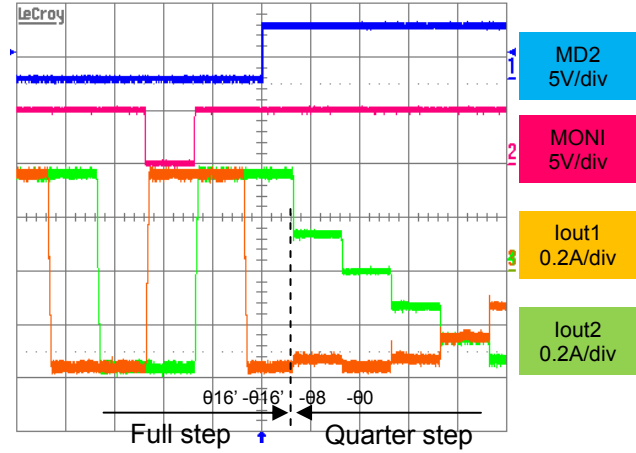


Figure 42.  
Full step → Microstepping (quarter step)  
MD1=Low



## Thermal shutdown function

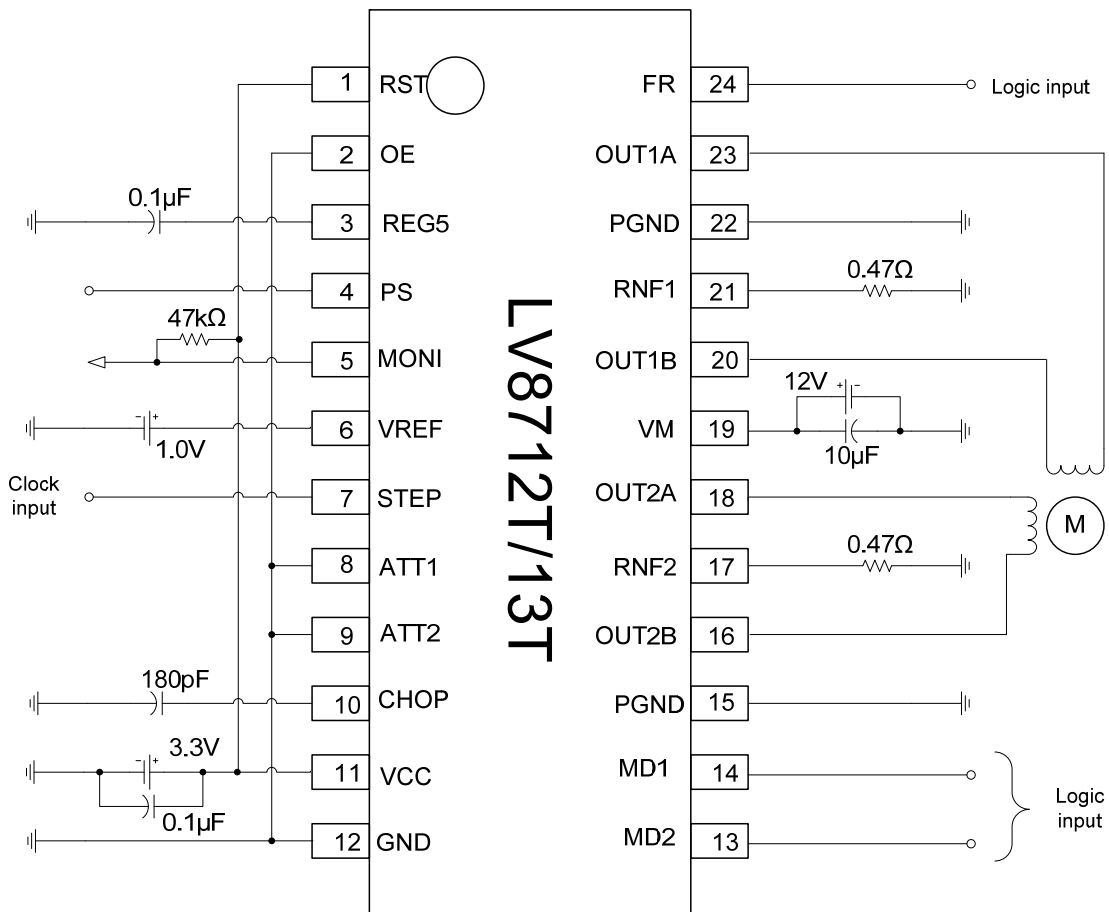
The thermal shutdown circuit is incorporated and the output is turned off when junction temperature  $T_j$  exceeds  $180^{\circ}\text{C}$ . As the temperature falls by hysteresis, the output turned on again (automatic restoration). The thermal shutdown circuit does not guarantee the protection of the final product because it operates when the temperature exceed the junction temperature of  $T_{j\text{max}}=150^{\circ}\text{C}$ .

$T_{SD} = 180^{\circ}\text{C}$  (typ)

$\Delta T_{SD} = 40^{\circ}\text{C}$  (typ)

# LV8712T/LV8713T Application Note

## Application Circuit Example



The formulae for setting the constants in the examples of the application circuits above are as follows:

Constant current (100%) setting

When  $V_{REF} = 1.0V$

$$I_{OUT} = V_{REF}/5/RNF \text{ resistance}$$

$$= 1.0V/5/0.47\Omega = 0.426A$$

Chopping frequency setting

$$F_{chop} = I_{chop}/(C_{chop} \times V_{tchop} \times 2)$$

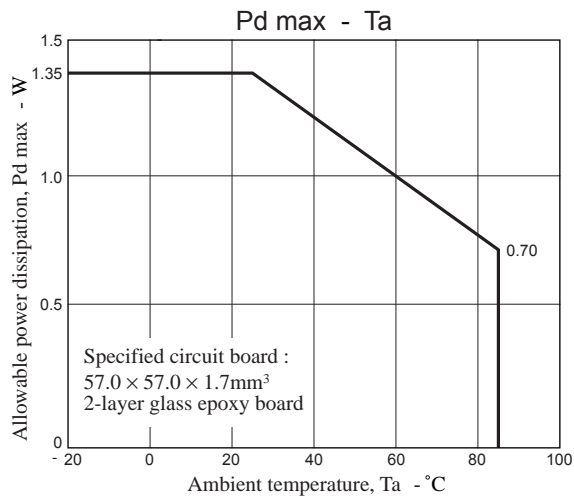
$$= 10\mu A/(180pF \times 0.5V \times 2) = 55 \text{ kHz}$$

# LV8712T/LV8713T Application Note

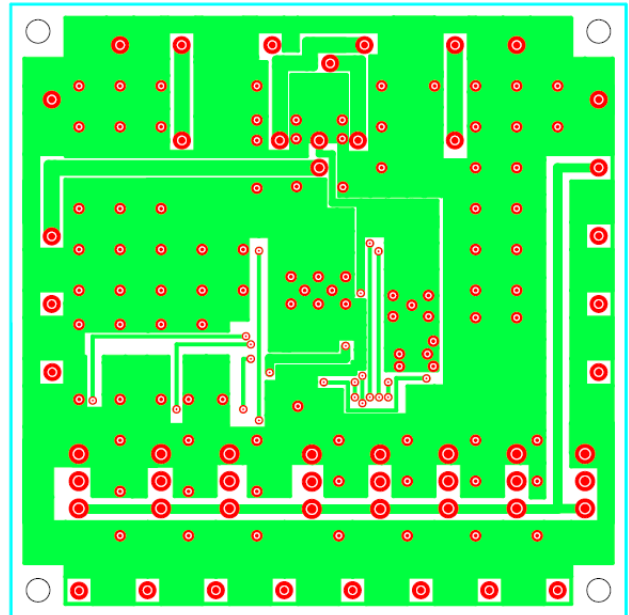
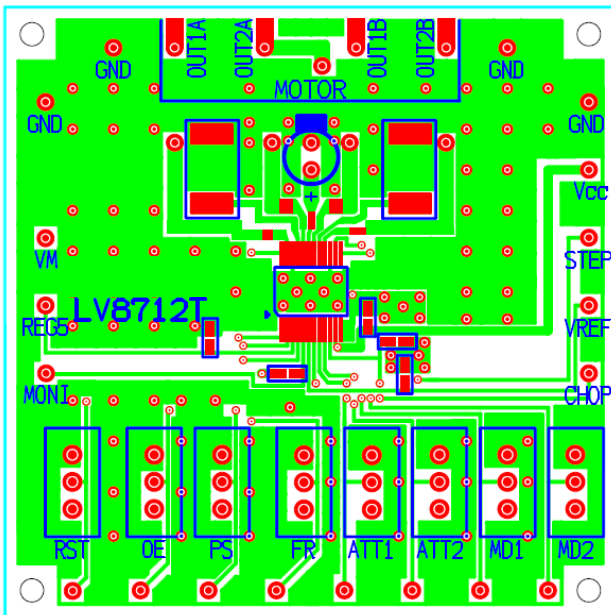
## Allowable power dissipation

Evaluation board

Size: 57mm x 57mm x 1.7mm, glass epoxy 2-layer board



## Evaluation board Design Diagram



TOP View

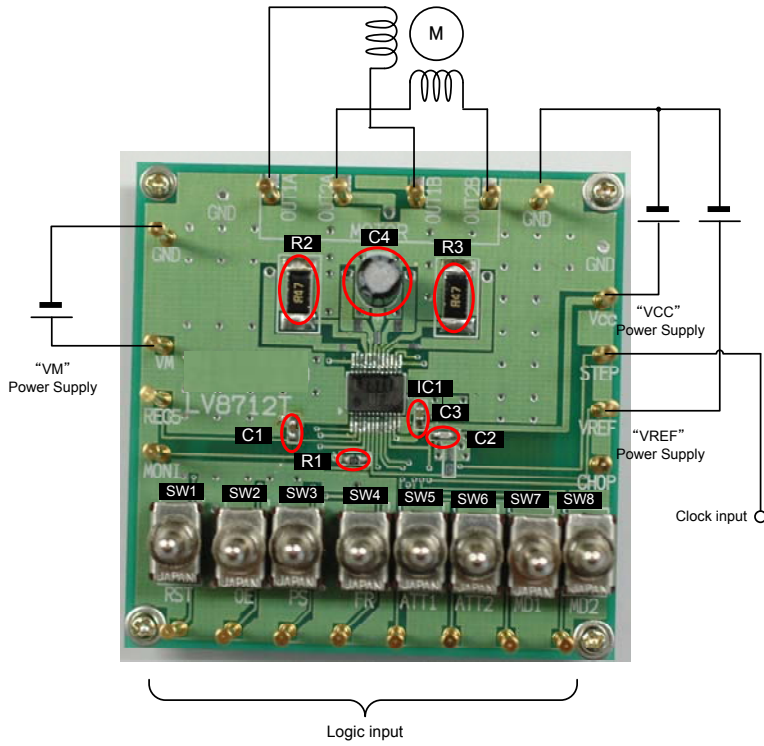
# LV8712T/LV8713T Application Note

## Evaluation board

### 1. Completed PCB with Devices

The evaluation board of LV8712T and LV8713T is common.

PCB size: 57mm×57mm×1.7mm, glass epoxy 2-layer board

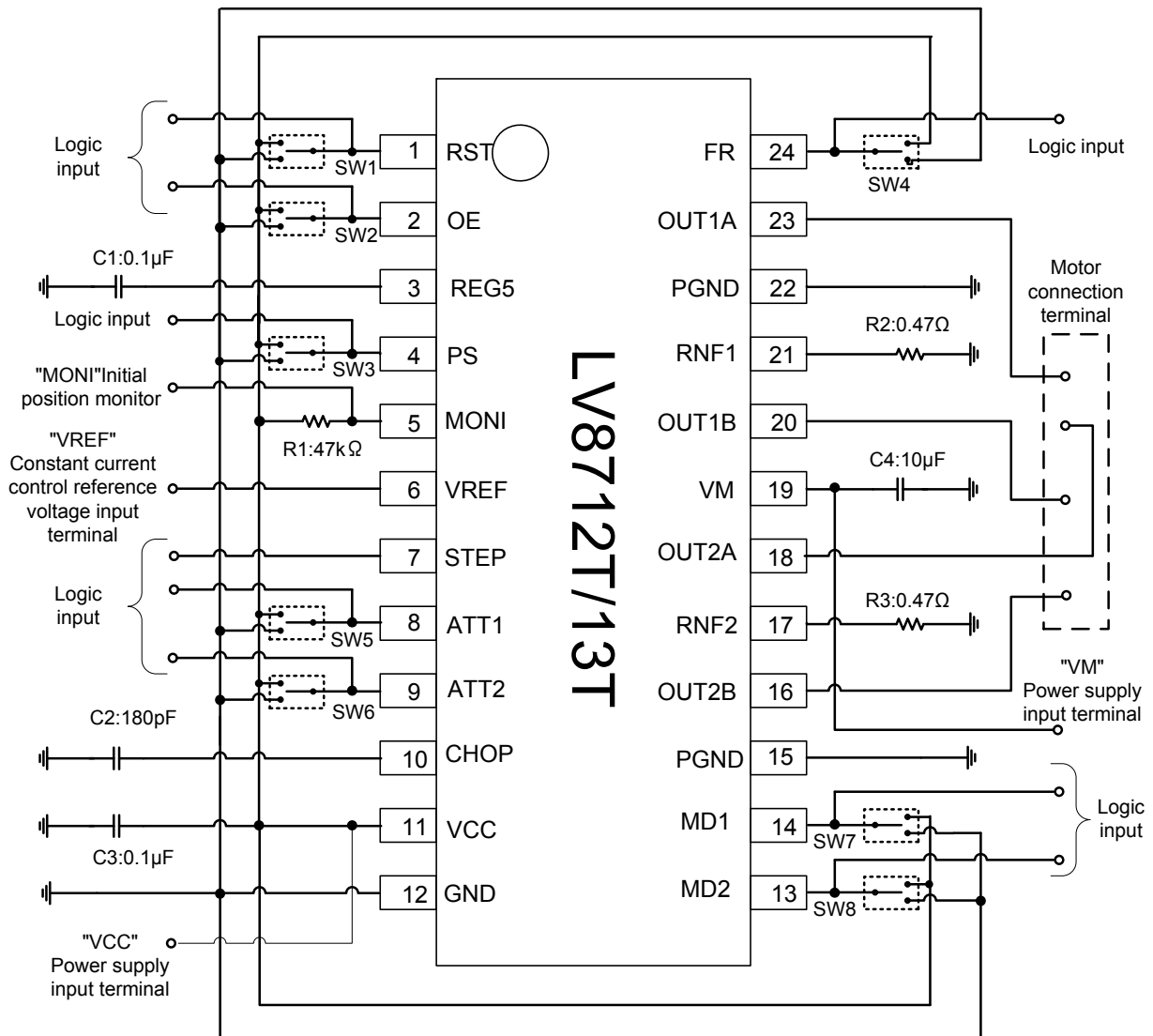


### 2. Bill of Materials for LV8712T/13T Evaluation Board

| Designator | Quantity | Description                              | Value       | Tolerance | Footprint        | Manufacturer              | Manufacturer Part Number | Substitution Allowed | Lead Free |
|------------|----------|--|-------------|-----------|------------------|---------------------------|--------------------------|----------------------|-----------|
| C1         | 1        | REG5 stabilization Capacitor             | 0.1μF, 100V | ±10%      |                  | Murata                    | GRM188R72A104KA35*       | Yes                  | Yes       |
| C2         | 1        | Capacitor to set chopping frequency      | 180pF, 50V  | ±5%       |                  | Murata                    | GRM1882C1H181JA01*       | Yes                  | Yes       |
| C3         | 1        | VCC Bypass Capacitor                     | 0.1μF, 100V | ±10%      |                  | Murata                    | GRM188R72A104KA35*       | Yes                  | Yes       |
| C4         | 1        | VM Bypass Capacitor                      | 10μF, 50V   | ±20%      |                  | SUN Electronic Industries | 50ME10HC                 | Yes                  | Yes       |
| R1         | 1        | Pull-up Resistor for pin MONI            | 47kΩ, 1/10W | ±5%       |                  | KOA                       | RK73B1JT**473J           | Yes                  | Yes       |
| R2         | 1        | Channel 1 output current detect Resistor | 0.47Ω, 1W   | ±5%       |                  | ROHM                      | MCR100JZHJLR47           | Yes                  | Yes       |
| R3         | 1        | Channel 2 output current detect Resistor | 0.47Ω, 1W   | ±5%       |                  | ROHM                      | MCR100JZHJLR47           | Yes                  | Yes       |
| IC1        | 1        | Motor Driver                             |             |           | TSSOP24 (225mil) | ON Semiconductor          | LV8712T<br>LV8713T       | No                   | Yes       |
| SW1-SW8    | 8        | Switch                                   |             |           |                  | MIYAMA ELECTRIC           | MS-621C-A01              | Yes                  | Yes       |
| TP1-TP21   | 21       | Test Point                               |             |           |                  | MAC8                      | ST-1-3                   | Yes                  | Yes       |

# LV8712T/LV8713T Application Note

## 3. Evaluation board circuit



# LV8712T/LV8713T Application Note

## 4. Evaluation Board Manual

[Supply Voltage] VM (4 to 16V): Motor Power Supply  
 VCC (2.7 to 5.5V): Control Power Supply  
 VREF (0 to VCC-1.8V): Const. Current Control for Reference Voltage

[Toggle Switch State] Upper Side: High (VCC)  
 Middle: Open, enable to external logic input  
 Lower Side: Low (GND)

### [Operation Guide]

1. **Initial Condition Setting:** Set "Open or Low" all switches
2. **Motor Connection:** Connect the Motors between OUT1A and OUT1B, between OUT2A and OUT2B.
3. **Power Supply:** Supply DC voltage to VCC, VM and VREF.
4. **Ready for Operation from Standby State:** Turn "High" the PS pin toggle switch. Channel 1 and 2 are into full-step excitement initial position (100%, -100%) .
5. **Motor Operation:** Turn "High" the RST pin toggle switch. Input the clock signal into the pin STEP.
6. **Other Setting** (See Application Note for detail)
  - i. ATT1, ATT2: Motor current attenuation.
  - ii. FR: Motor rotation direction (CW / CCW) setting.
  - iii. MD1, MD2: Microstepping Resolution.
  - iv. OE: Output Enable.

### [Setting for External Component Value]

1. Constant Current (100%)  
 At VREF=1.0V  

$$I_{out} = VREF [V] / 5 / RNF [ohm]$$

$$= 1.0 [V] / 5 / 0.47 [ohm]$$

$$= 0.426 [A]$$
2. Chopping Frequency  

$$f_{chop} = I_{chop} [\mu A] / (C_{chop} \times V_t \times 2)$$

$$= 10 [\mu A] / (180 [pF] \times 0.5 [V] \times 2)$$

$$= 55 [kHz]$$

## 5. Evaluation Board waveform (Stepping motor drive)

LV8712T  
 VM=12V, VCC=5V, VREF=1.0V  
 PS=High, RST=High  
 ATT1=ATT2=FR=OE=Low

Figure 43.  
 Full-step (MD1=MD2=Low, fSTEP=500Hz)

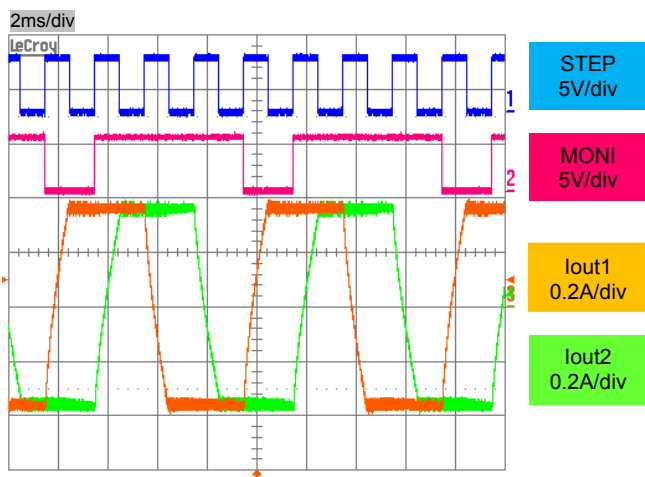
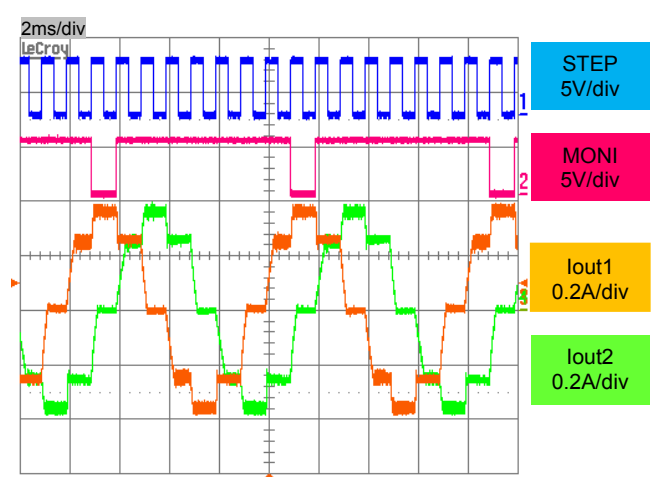


Figure 44.  
 Half-step (MD1=High, MD2=Low, fSTEP=1 kHz)





# LV8712T/LV8713T Application Note

Figure 45.  
Quarter-step (MD1=Low,MD2=High, fSTEP=2kHz)

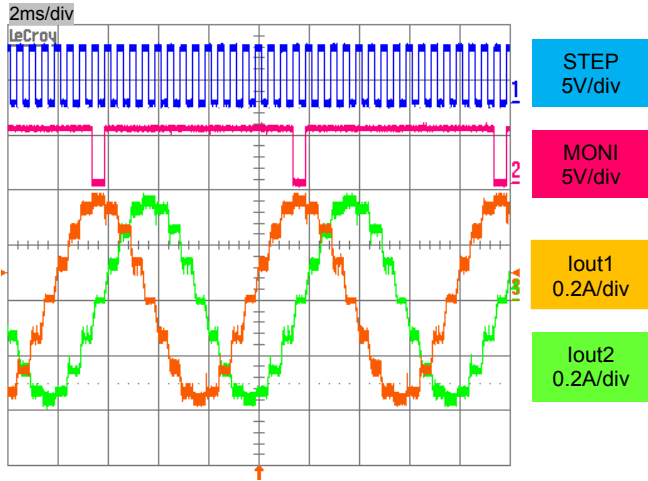
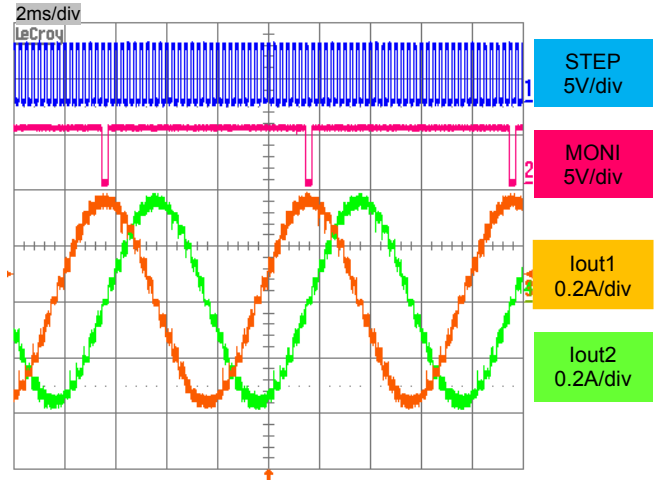


Figure 46.  
1/8-step (MD1=MD2=High, fSTEP=4kHz)



LV8713T  
VM=12V, VCC=5V, VREF=1.0V  
PS=High, RST=High  
ATT1=ATT2=FR=OE=Low

Figure 47.  
Full-step (MD1=MD2=Low, fSTEP=500Hz)

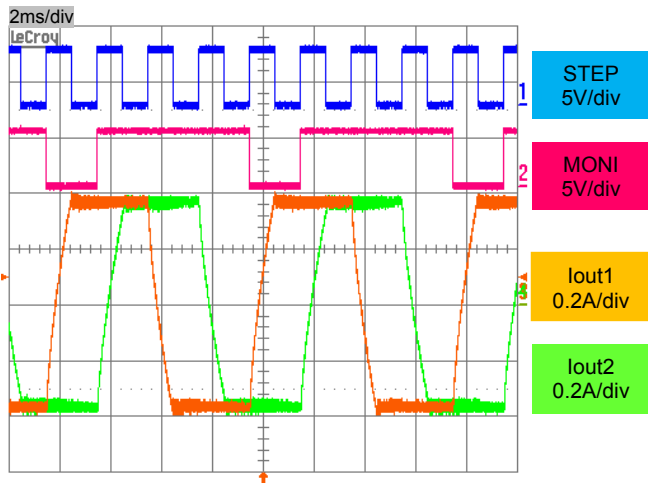


Figure 48  
Half-step (MD1=High, MD2=Low, fSTEP=1 kHz)

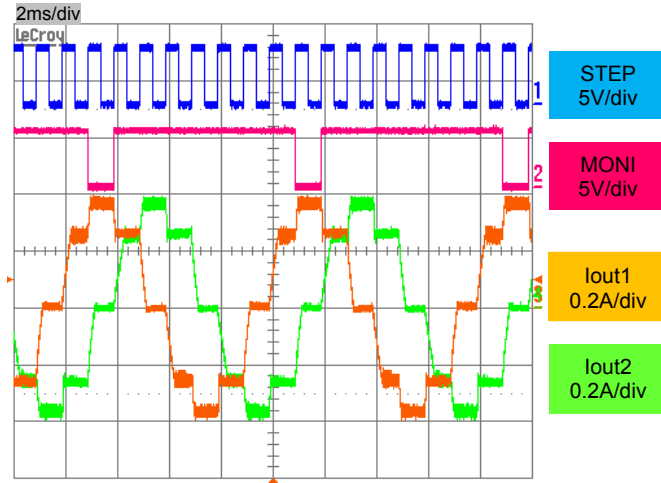


Figure 49.  
1/16-step (MD1=Low,MD2=High, fSTEP=8kHz)

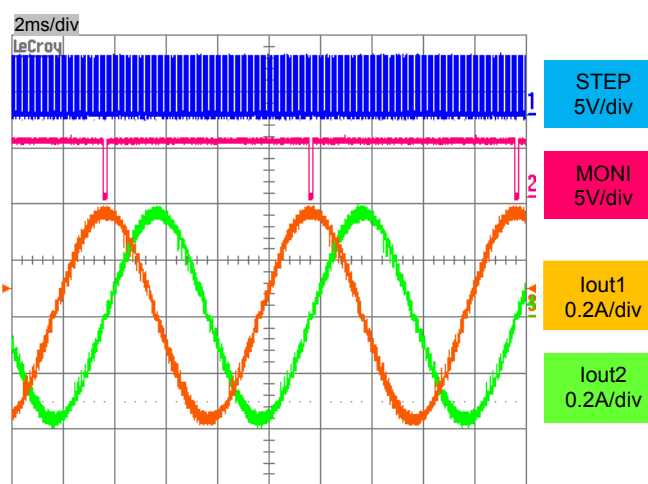
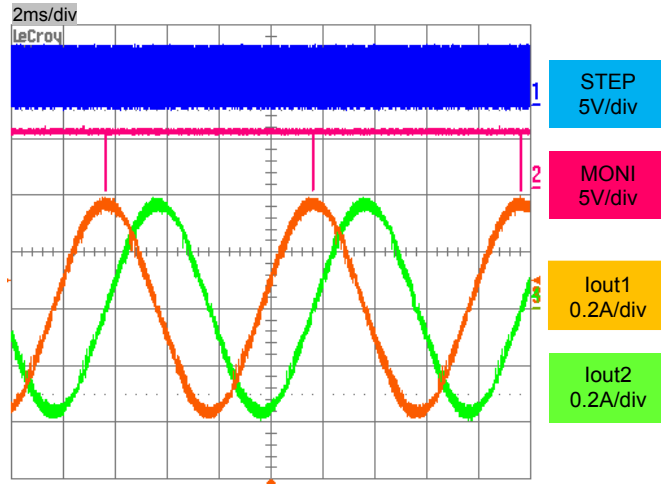


Figure 50.  
1/32-step (MD1=MD2=High, fSTEP=16kHz)



## LV8712T/LV8713T Application Note

---

### Cautions for layout:

#### ●Power supply connection pin [VM]

- ✓ VCC is a control power supply, and VM is a motor power supply.
- ✓ Make sure that supply voltage does not exceed the absolute MAX ratings under no circumstance. Noncompliance can be the cause of IC destruction and degradation.
- ✓ Caution is required for VM supply voltage because this IC performs switching.
- ✓ The bypass capacitor of the VM power supply should be close to the IC as much as possible to stabilize voltage. Also if you intend to use high current or back EMF is high, please augment enough capacitance.

#### ●GND pin [GND, PGND, RNF-resistor GND line]

- ✓ High current flows into the PGND and GND side of RNF resistor; therefore, connect PGND and RNF – GND independently.
- ✓ On the other hand, since PGND and GND are connected through silicon board, if the line of PGND is too long, difference of electric potential occurs between PGND and GND which creates gradient to the GND electric potential within the IC board. This can be the cause of the IC malfunction. Hence make sure to connect PGND and RNF – GND independently so that the pins do not share the common impedance with GND. And GND, PGND, and RNF should be single-point grounded to the low impedance GND area near the IC. Also the capacitor between VM and GND should be connected adjacent to the IC.

#### ●Internal power supply regulator pin [REG5]

- ✓ REG5 is a power supply to drive output FET (typ 5V).
- ✓ When VM supply is powered and PS is "High", REG5 operates.
- ✓ Please connect capacitor for stabilize REG5. The recommendation value is 0.1uF.
- ✓ Since the voltage of REG5 fluctuates ( $\pm 10\%$ ), do not use it as reference voltage that requires accuracy.

#### ●Input pin

- ✓ The logic input pin incorporates pull-down resistor (100k $\Omega$ ).
- ✓ When you set input pin to low voltage, please short it to GND because the input pin is vulnerable to noise.
- ✓ The input is TTL level (H: 2V or higher, L: 0.8V or lower).
- ✓ VREF pin is high impedance.

#### ●OUT pin [OUT1A, OUT1B, OUT2A, OUT2B]

- ✓ During chopping operation, the output voltage becomes equivalent to VM voltage, which can be the cause of noise. Caution is required for the pattern layout of output pin.
- ✓ The layout should be low impedance because driving current of motor flows into the output pin.
- ✓ Output voltage may boost due to back EMF. Make sure that the voltage does not exceed the absolute MAX ratings under no circumstance. Noncompliance can be the cause of IC destruction and degradation.

#### ●Current sense resistor connection pin [RNF1, RNF2]

- ✓ To perform constant current control, please connect resistor to RNF pin.
- ✓ To perform saturation drive (without constant current control) , please connect RNF pin to GND.
- ✓ If RNF pin is open, you cannot set constant current under normal condition. Therefore, please connect it to resistor or GND.
- ✓ The motor current flows into RNF – GND line. Therefore, please connect it to common GND line and low impedance line.

## LV8712T/LV8713T Application Note

---

ON Semiconductor and the ON logo are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.