



SANYO Semiconductors

## DATA SHEET

An ON Semiconductor Company

# LV8711T — Bi-CMOS LSI

## PWM Constant-Current Control Stepping Motor Driver

### Overview

The LV8711T is a PWM constant-current control stepping motor driver.

### Features

- Two circuits of PWM constant-current control H-bridge drivers incorporated
- Control of the stepping motor to 1-2 phase excitations possible
- Reference voltage output: 1.0V
- Short circuit protection circuit incorporated
- Abnormal condition warning output pin incorporated
- Upper and lower regenerative diodes incorporated
- Thermal shutdown circuit incorporated

### 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    |
| Logic input voltage         | V <sub>IN</sub>     |                             | 6           | V    |
| Output peak current         | I <sub>O</sub> peak | Per ch, tw ≤ 10ms, duty 20% | 1.0         | A    |
| Output continuous current   | I <sub>O</sub> max  | Per ch                      | 800         | mA   |
| Allowable power dissipation | Pd max              | *                           | 1.45        | W    |
| Operating temperature       | T <sub>opr</sub>    |                             | -20 to +85  | °C   |
| Storage temperature         | T <sub>stg</sub>    |                             | -55 to +150 | °C   |

\* Specified circuit board : 57.0mm×57.0mm×1.7mm, glass epoxy printed circuit board.

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# LV8711T

## Recommended Operating Ratings at $T_a = 25^\circ\text{C}$

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

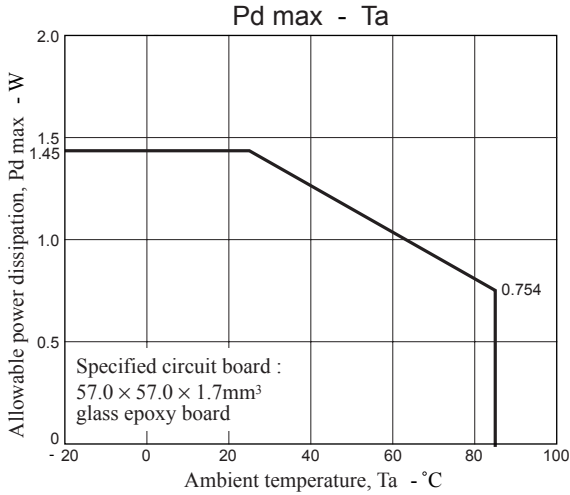
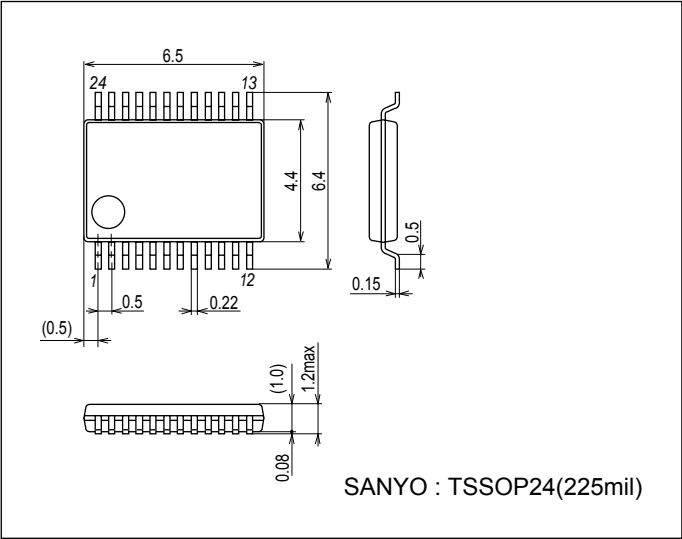
## Electrical Characteristics at $T_a = 25^\circ\text{C}$ , VM = 12V, V<sub>CC</sub> = 3.3, VREF = 1.0V

| Parameter                                   | Symbol                          | Conditions                           | Ratings |       |       | Unit |
|---|---------------------------------|--------------------------------------|---------|-------|-------|------|
|   |                                 |                                      | min     | typ   | max   |      |
| General                                     |                                 |                                      |         |       |       |      |
| Standby mode current drain                  | IMstn                           | PS = "L", no load                    |         |       | 1     | μA   |
|   | I <sub>CC</sub> stn             | PS = "L", no load                    |         |       | 1     | μA   |
| Current drain                               | IM                              | PS = "H", no load                    |         | 1.0   | 1.5   | mA   |
|   | I <sub>CC</sub>                 | PS = "H", no load                    |         | 1.7   | 3.0   | mA   |
| Thermal shutdown temperature                | TSD                             | Design guarantee                     | 150     | 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> HYS             |                                      | 100     | 130   | 160   | mV   |
| Reference voltage                           |                                 |                                      |         |       |       |      |
| REG5 output voltage                         | VREG5                           |                                      | 4.5     | 5     | 5.5   | V    |
| Output                                      |                                 |                                      |         |       |       |      |
| Output on resistance                        | R <sub>on</sub> U               | I <sub>O</sub> = -800mA, Source-side |         | 0.78  | 1.0   | Ω    |
|   | R <sub>on</sub> D               | I <sub>O</sub> = 800mA, Sink-side    |         | 0.32  | 0.43  | Ω    |
| Output leakage current                      | I <sub>O</sub> leak             | V <sub>O</sub> = 15V                 |         |       | 10    | μA   |
| Diode forward voltage                       | V <sub>D</sub>                  | I <sub>D</sub> = -800mA              |         | 1.0   | 1.2   | V    |
| Logic input                                 |                                 |                                      |         |       |       |      |
| 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>IN</sub> H               |                                      | 2.0     |       |       | V    |
| Logic low-level input voltage               | V <sub>IN</sub> L               |                                      |         |       | 0.8   | V    |
| Constant-current control                    |                                 |                                      |         |       |       |      |
| REG1 output voltage                         | VREG1                           |                                      | 0.95    | 1.0   | 1.05  | V    |
| VREF input current                          | I <sub>REF</sub>                | VREF = 1.0V                          | -0.5    |       |       | μA   |
| Current setting reference voltage           | V <sub>tatt</sub> 00            | VREF = 1.0V                          | 0.192   | 0.200 | 0.208 | V    |
|   | V <sub>tatt</sub> 01            | VREF = 1.0V                          | 0.152   | 0.160 | 0.168 | V    |
|   | V <sub>tatt</sub> 10            | VREF = 1.0V                          | 0.092   | 0.100 | 0.108 | V    |
|   | V <sub>tatt</sub> 11            | VREF = 1.0V                          | 0.032   | 0.040 | 0.048 | V    |
| Chopping frequency                          | F <sub>chop</sub>               | C <sub>chop</sub> = 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   |
| Output short-circuit protection             |                                 |                                      |         |       |       |      |
| EMO pin saturation voltage                  | V <sub>sat</sub> EMO            | I <sub>EMO</sub> = 1mA               |         | 250   | 400   | mV   |

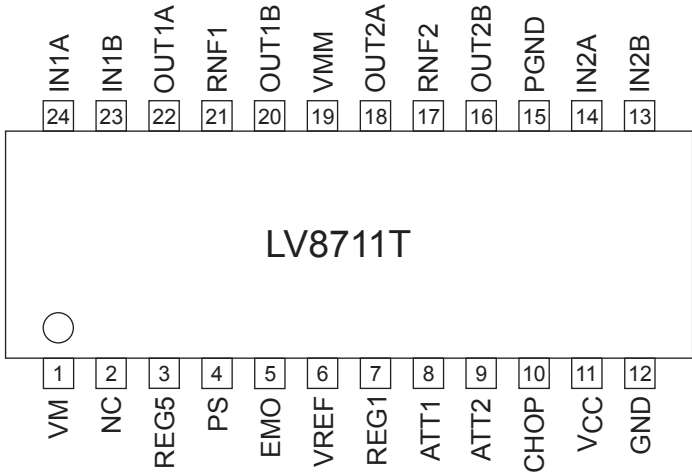
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Package Dimensions

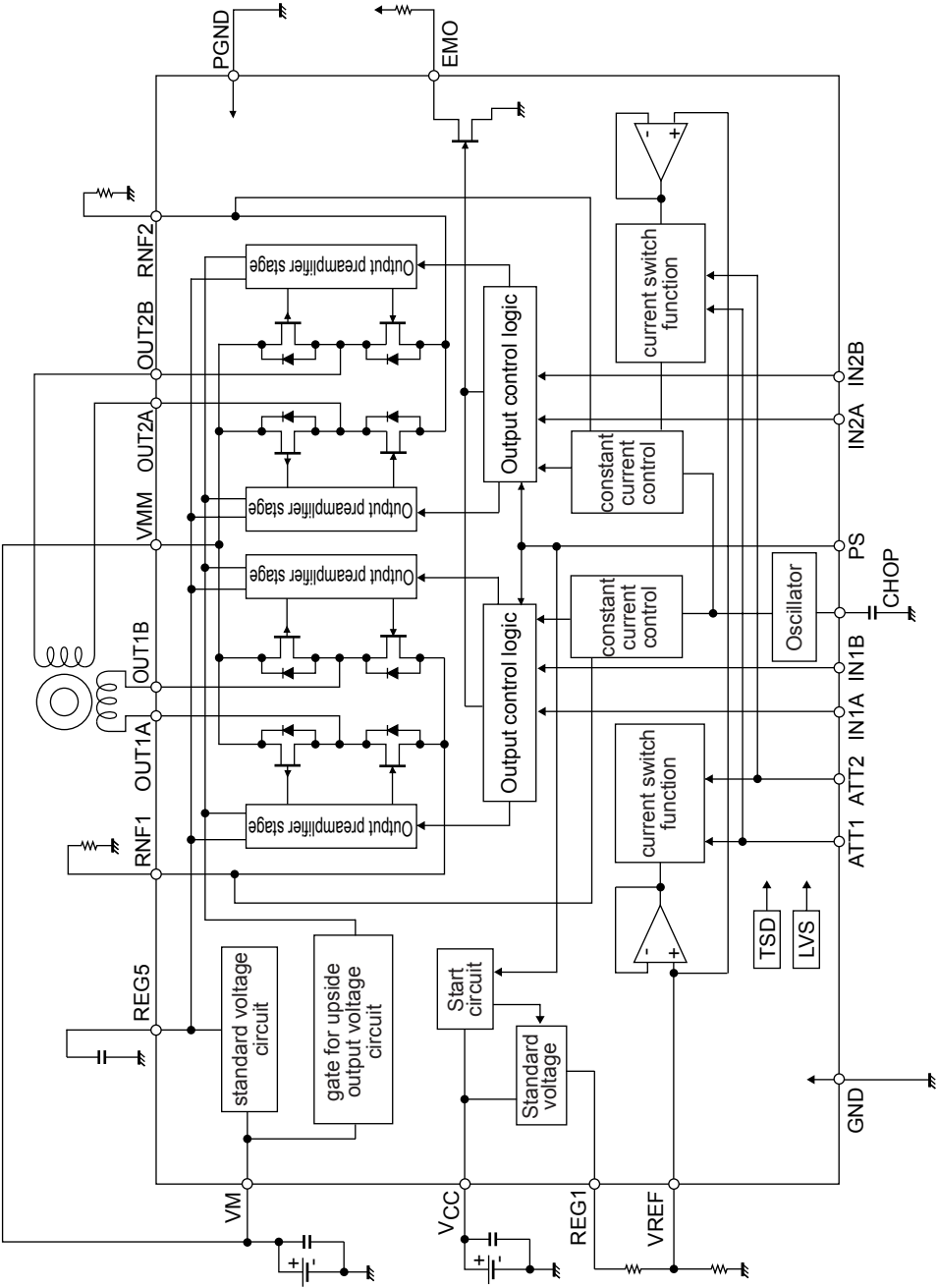
unit : mm (typ)  
3260A



Pin Assignment



Block Diagram



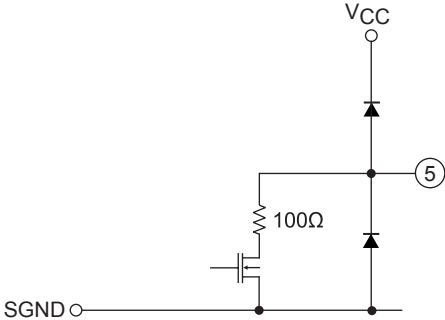
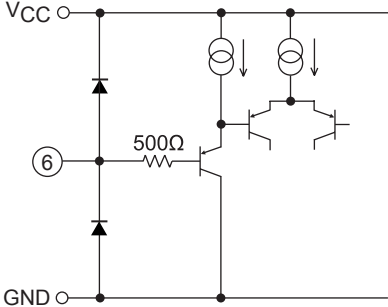
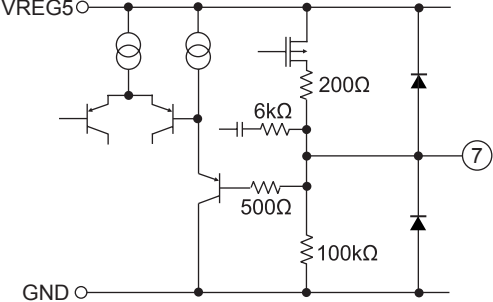
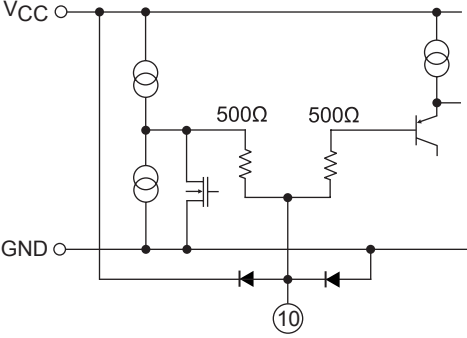
Pin Functions

| Pin No.                          | Pin Name   | Pin Function   | Equivalent Circuit |
|----------------------------------|--|--|--------------------|
| 8<br>9<br>13<br>14<br>23<br>24   | ATT1<br>ATT2<br>IN2B<br>IN2A<br>IN1B<br>IN1A     | Energization current switching pin 1.<br>Energization current switching pin 2.<br>Channel 2 driver output control input pin.<br>Channel 2 driver output control input pin.<br>Channel 1 driver output control input pin.<br>Channel 1 driver output control input pin. |                    |
| 4                                | PS   | Enable input pin.  |                    |
| 16<br>17<br>18<br>20<br>21<br>22 | OUT2B<br>RNF2<br>OUT2A<br>OUT1B<br>RNF1<br>OUT1A | Channel 2 OUTB output pin.<br>Channel 2 current sensing resistor connection pin.<br>Channel 2 OUTA output pin.<br>Channel 1 OUTB output pin.<br>Channel 1 current sensing resistor connection pin.<br>Channel 1 OUTA output pin.                                       |                    |
| 3                                | REG5   | Internal reference voltage output pin.   |                    |

Continued on next page.

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Continued from preceding page.

| Pin No. | Pin Name | Pin Function   | Equivalent Circuit   |
|---------|----------|--|--|
| 5       | EMO      | Abnormal condition warning output pin.                       |    |
| 6       | VREF     | Channel 1 and 2 current setting reference voltage input pin. |    |
| 7       | REG1     | Current setting reference voltage output pin.                |   |
| 10      | CHOP     | Chopping frequency setting capacitor connection pin.         |  |

## Input pin function

### (1) Chip enable function

Standby mode / operating mode of the IC are switched by setting the PS pin. In the standby-state, the IC enters a power saving mode and all logic is reset. In the standby-state, internal regulator circuit is not operative.

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

### (2) STM output control logic

| Parallel input |          | Output    |           | Current direction |
|----------------|----------|-----------|-----------|-------------------|
| IN1A(2A)       | IN1B(2B) | OUT1A(2A) | OUT1B(2B) |                   |
| Low            | Low      | OFF       | OFF       | Output OFF        |
| High           | Low      | High      | Low       | OUTA to OUTB      |
| Low            | High     | Low       | High      | OUTB to OUTA      |
| High           | High     | Low       | Low       | Brake(DCM mode)   |

### (3) Constant-current setting

The constant-current control setting consist of the VREF voltage setting and resistor (RNF) connected between RNF and ground. The current is set according to the following equation.

$$I_{OUT} [A] = VREF [V] / 5 / RNF [\Omega]$$

Also, the voltage applied to the VREF pin can be switched to four stages settings by the state of two inputs of the ATT1 and ATT2 pins. This function is effective for power saving when the motor holding current is applied.

Attenuation function of the VREF input voltage

| ATT1 | ATT2 | Current setting reference voltage attenuation ratio |
|------|------|---|
| Low  | Low  | 100%  |
| High | Low  | 80%   |
| Low  | High | 50%   |
| High | High | 20%   |

The output current calculation method for using of attenuation function of the VREF input voltage is as below.

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

e.g. When the VREF is 1.0V and the set reference voltage is 100% [(ATT1, ATT2) = (Low, Low)] and the RNF resistance is 0.47Ω, the following output current is set.

$$I_{OUT} = 1.0V / 5 \times 100\% / 0.47\Omega = 425mA$$

In this conditions, when (ATT1, ATT2) is set to (High, High),

$$I_{OUT} = 425mA \times 20\% = 85mA$$

Therefore, the power saving is executable by attenuation of the output current when motor holding current is supplied.

### (4) Setting the chopping frequency

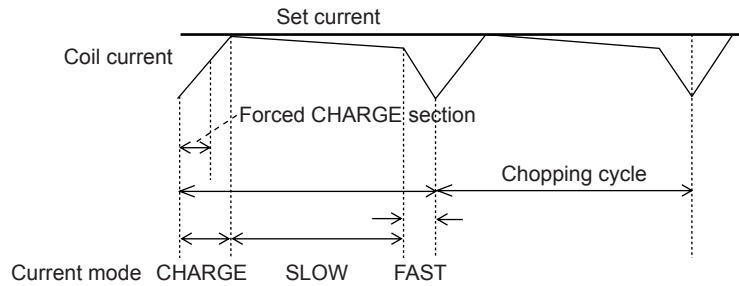
For constant-current control, chopping operation is made with the frequency determined by the external capacitor (connected to the CHOP pin). The chopping frequency to be set with the capacitor connected to the CHOP pin (pin 10) is as shown below.

|                           |  |           |
|---------------------------|--|-----------|
| Chopping period: Tchop    | $T_{chop} \approx C \times V \times 2 / I$ [s] |           |
|                           | V: Threshold voltage                           | Typ. 0.5V |
|                           | I : Charge / discharge current                 | Typ. 10μA |
| Chopping frequency: Fchop | $F_{chop} \approx 1 / Tchop$ [Hz]              |           |

(5) Constant-current control time chart (chopping operate)

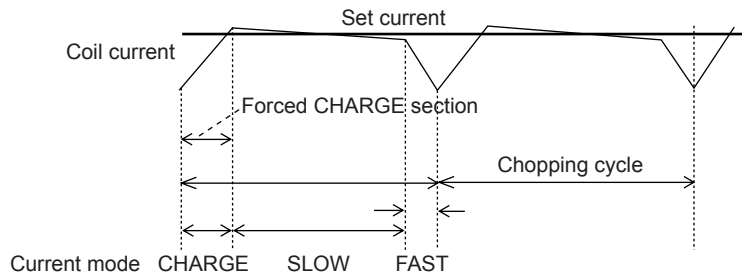
In each current mode, the operation sequence is as described below:

- At first of chopping cycle, the IC goes to CHARGE mode. (The Blanking section in which the CHARGE mode is forced regardless of the magnitudes of the coil current ( $I_{COIL}$ ) and the set current ( $I_{REF}$ ) exists for  $1\mu s$ .)
  - In Blanking section, the IC compares the coil current ( $I_{COIL}$ ) and the set current ( $I_{REF}$ ).
- If the  $I_{COIL} < I_{REF}$  state is existent in Blanking section.



Charge mode continues until  $I_{COIL} \geq I_{REF}$ . After that the IC switches to SLOW DECAY mode and then switches to FAST DECAY mode for the last about  $1\mu s$ .

If the  $I_{COIL} < I_{REF}$  state is non-existent in Blanking section.



The IC switches to SLOW DECAY after Blanking section, and then switches to FAST DECAY mode for the last about  $1\mu s$ .

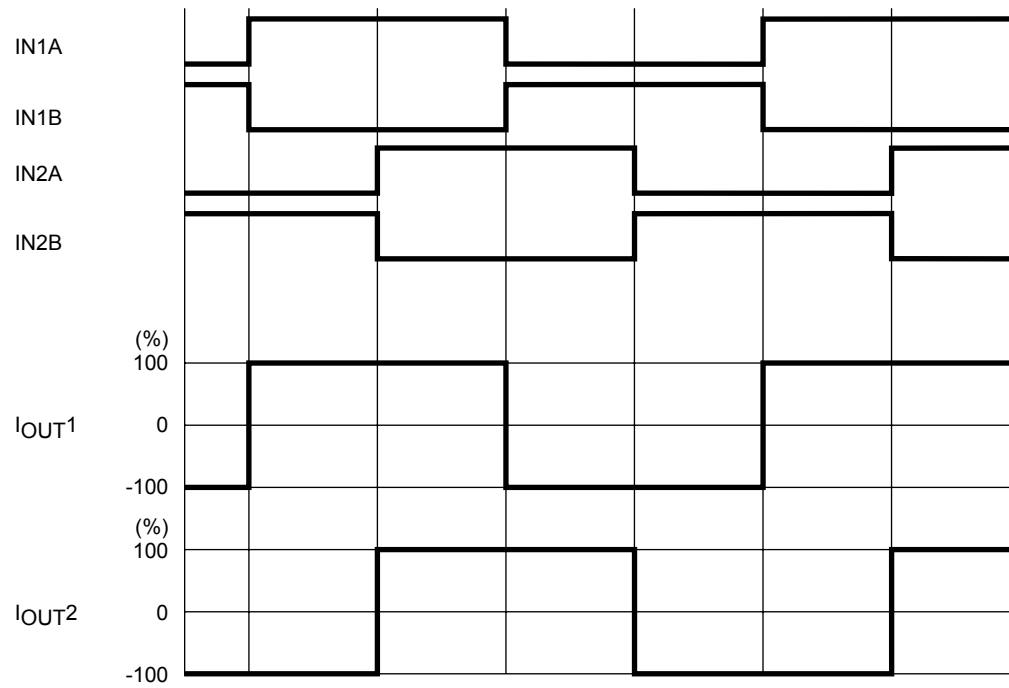
The IC repeats the above operation.



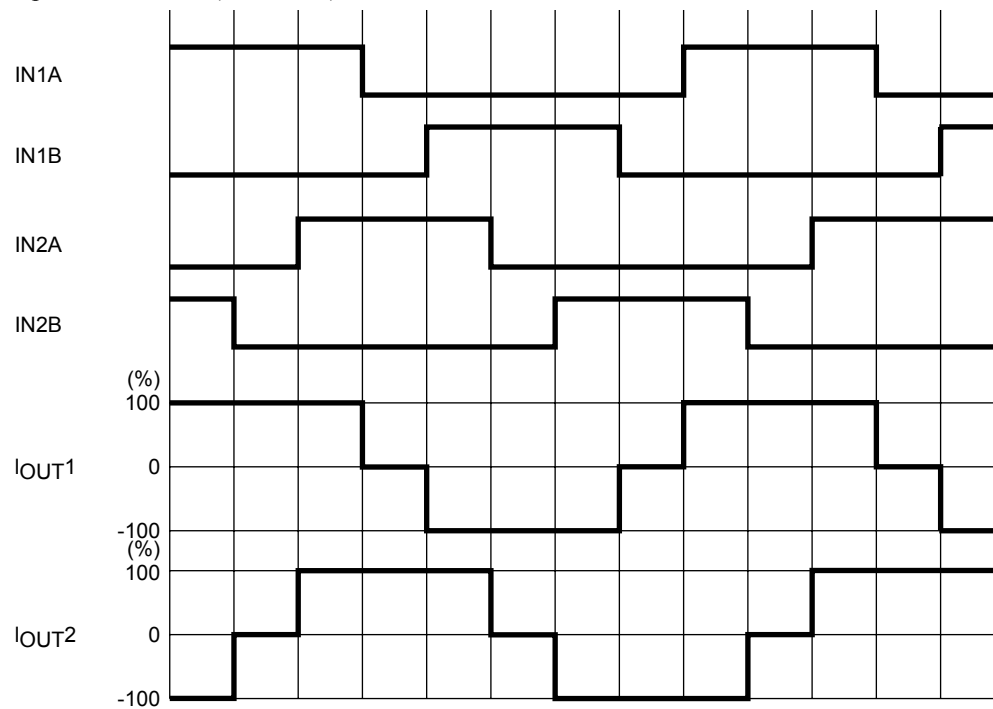
(6) Typical current waveform in each excitation mode

6-1) STM Drive mode

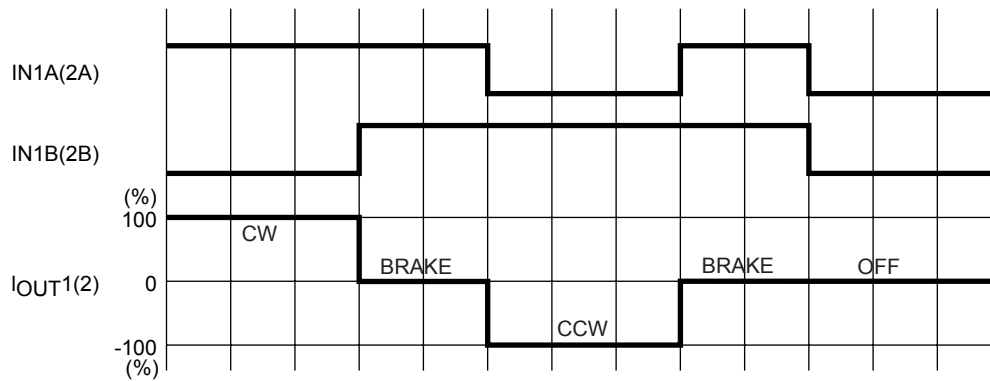
Two-phase excitation (CW mode)



1-2 phase excitation (CW mode)



6-2) DCM Drive mode



(7) Output short-circuit protection

To protect IC from damage due to short-circuit of the output caused by lightening or ground fault, the output short-circuit protection circuit to put the output in the OFF mode is incorporated.

7-1) Protective function operation (Latch method)

When detecting the output short-circuit state, the short-circuit protection circuit is activated.

When short-circuit state is detected  $\approx 4\mu\text{s}$  (count by the internal timer), detected output is OFF at the time.

Then, when the output exceeds the timer latch time counted by the internal counter, the output is ON. Still, the short circuit state is detected, the IC switches all output to stand-by mode and keep the state.

This state is released by setting PS = Low

(8) Abnormal condition warning output pin

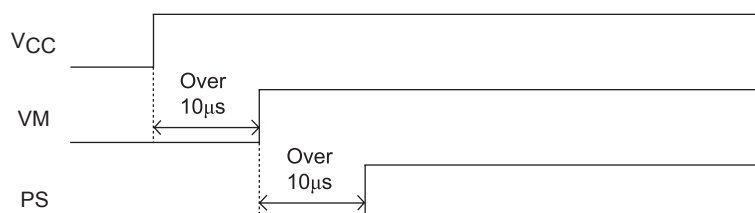
EMO, warning output pin of thermal shutdown circuit and the output short-circuit protection circuit, is an open-drain output. EMO outputs ON when output short-circuit is detected.

When detecting the output overdrive, the EMO outputs ON. If the junction temperature goes down at the time, EMO outputs OFF automatically.

(9) Recommended power-on sequence

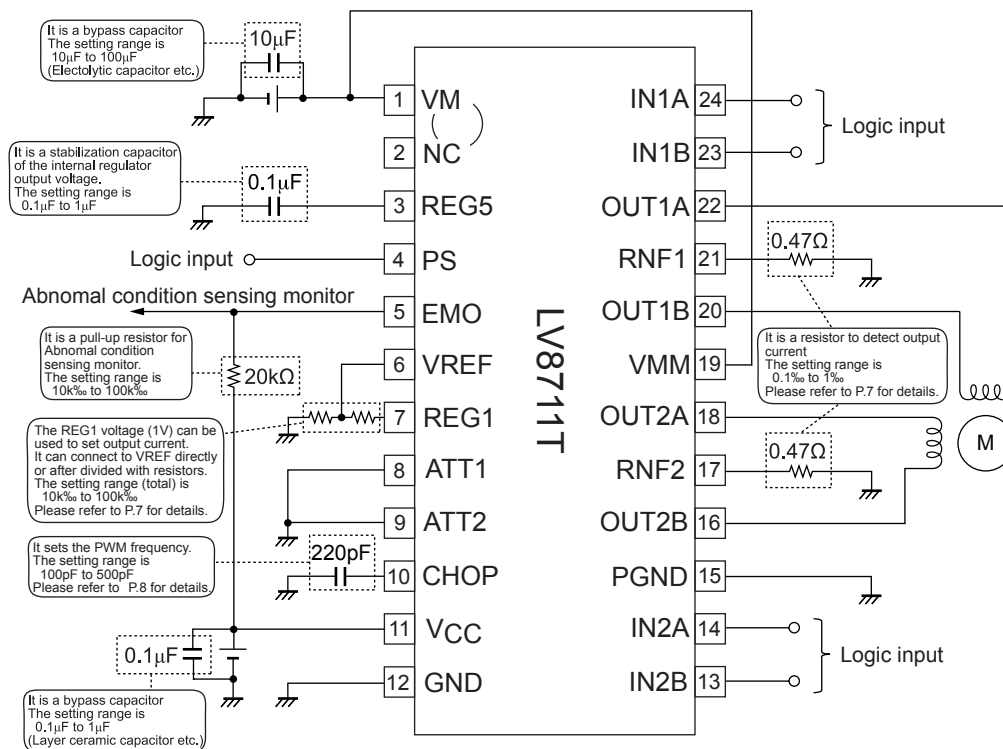
Provide a wait time of  $10\mu\text{s}$  or more after  $V_{CC}$  power supply rises before supplying VM power supply.

Provide a wait time of  $10\mu\text{s}$  or more after VM power supply raises before setting the PS pin High.



The above power-on sequence is only a recommendation, and there are no risks of damage or over current to the IC even if this sequence is not followed.

## Application Circuit Example



Each constant setting method for the above circuit diagram example is as follows :

Current LIMIT (100%) set

$V_{REF} = 1.0V$  (when internal regulator output is connected)

$$I_{LIMIT} = V_{REF} / 5 / R_{NF} \text{ resistance} \\ = 1.0V / 5 / 0.47\Omega = 425mA$$

Chopping frequency setting

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

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