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# M54679FP

## 2-Phase Stepper Motor Driver

REJ03F0047-0100Z

Rev.1.0

Sep.19.2003

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### Description

The M54679FP is a semiconductor integrated circuit designed for stepper motor driver used to Printer, PPC and Facsimile.

### Features

- Wide supply voltage sphere (10 – 35V).
- Bipolar, constant current PWM function.
- (Top side transistors PWM function, maximum current is 0.8 Amps).
- Few external components.  
(This IC can be operated with 1 capacitor and 2 resistances).
- 4 phases input style (include the protection function of output through current).
- Output current change function (2 bits, 4 type currents).
- Thermal protection circuit.
- Include flywheel diodes.

### Application

Printer, PPC and Facsimile.

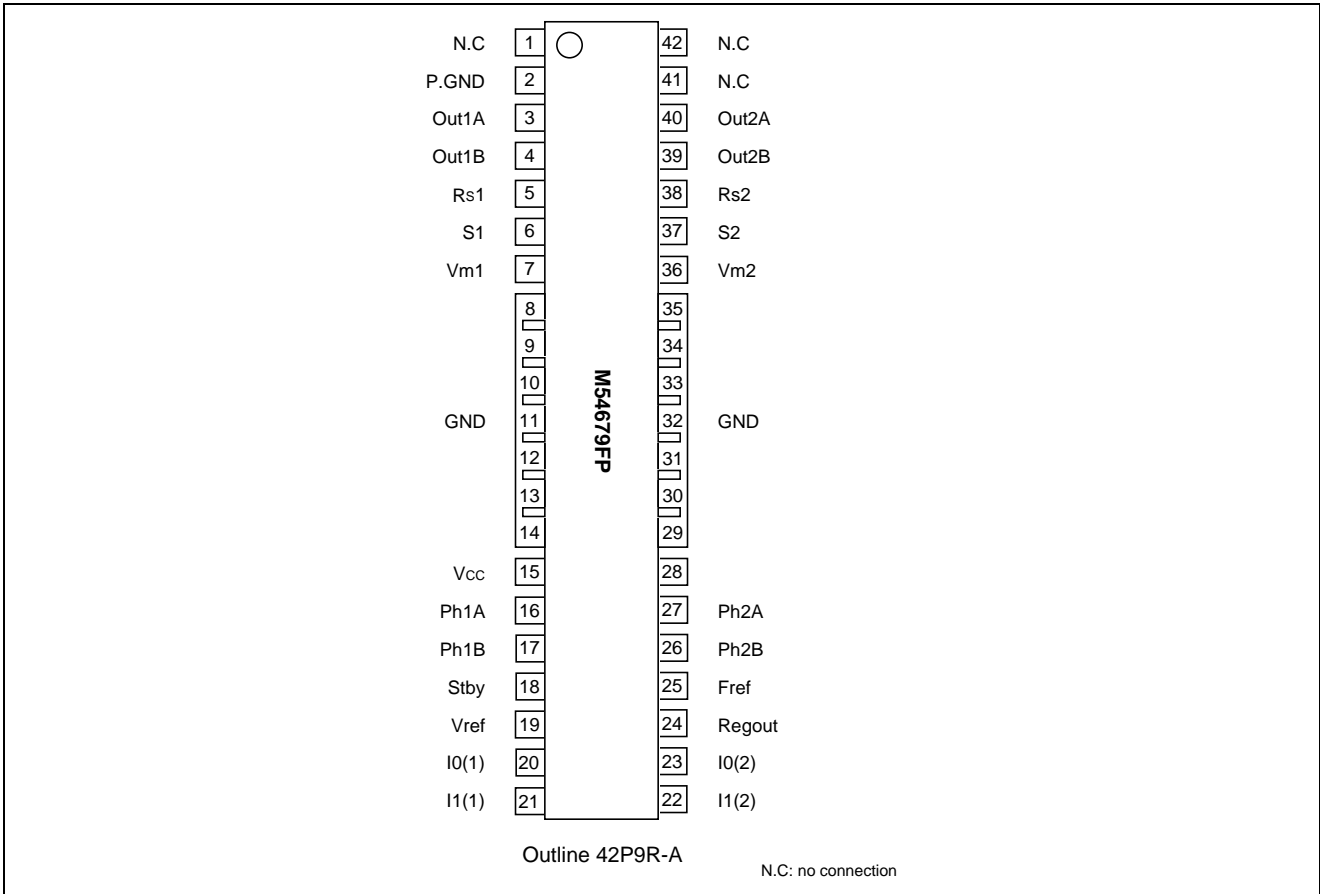
### Function

The M54679FP is a semiconductor integrated circuit which can drive two phase stepper motor.

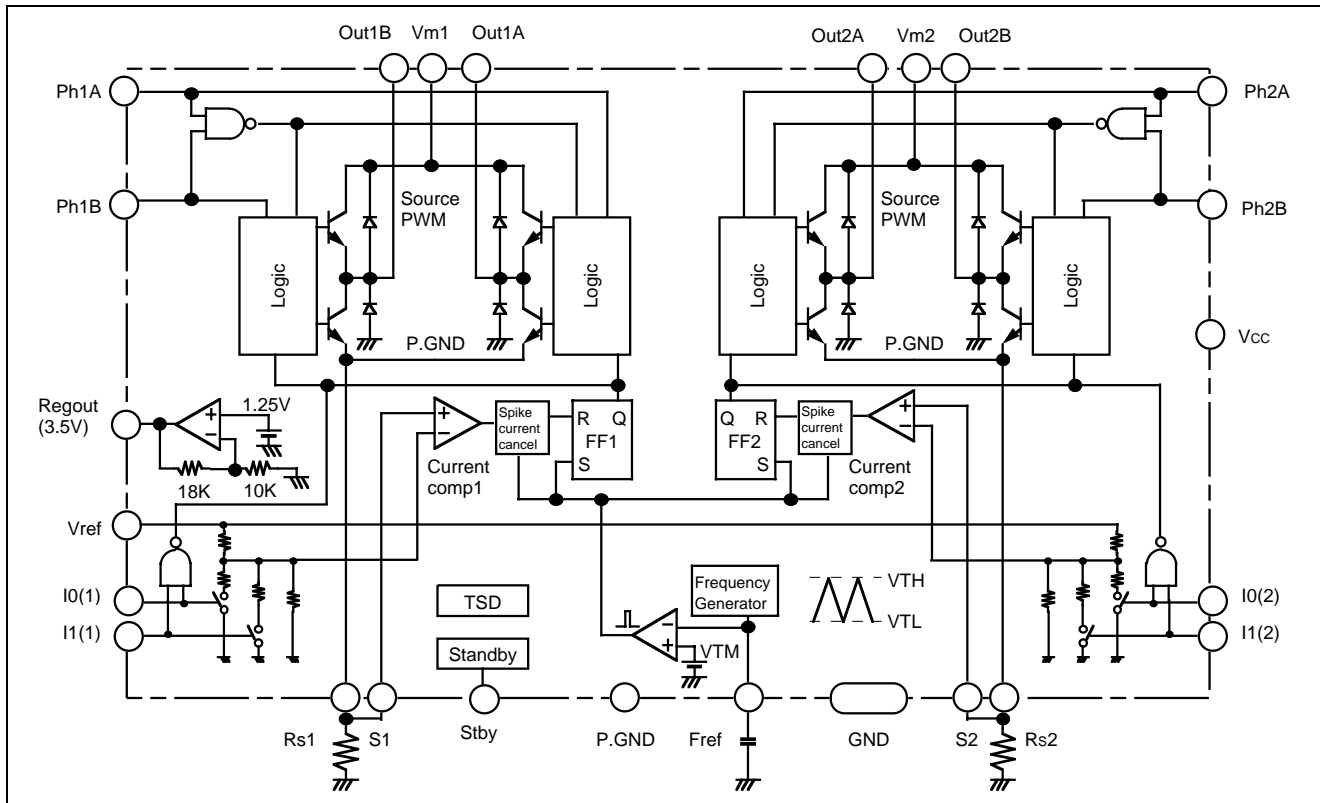
It can control the direction of motor current and output motor current (4 steps) by I0, I1 terminals.

Also, it can drive the two phase bipolar stepper motor by one IC as it include two current control circuits.

Pin Configuration



## Block Diagram



## Pin Function

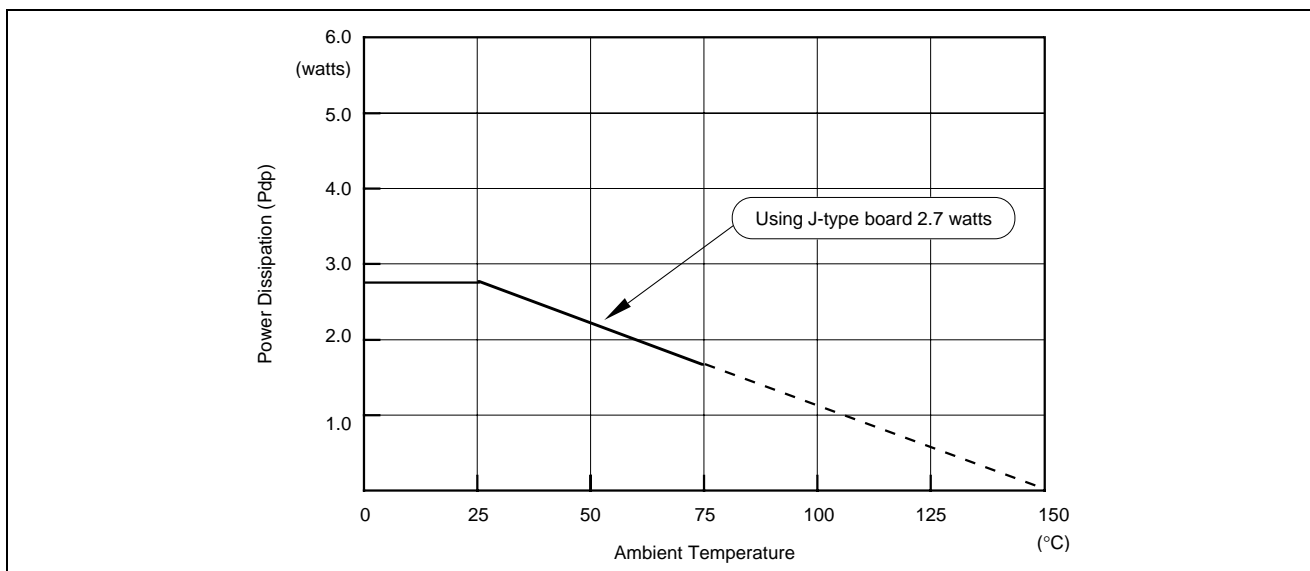
| Terminal                     | Symbol                     | Function  |
|------------------------------|----------------------------|---|
| Motor Supply Voltage         | Vm1, Vm2                   | Power supply for motor drive.                                   |
| Output terminals             | Out1A, Out1B, Out2A, Out2B | Motor drive output terminals.                                   |
| Current sensor               | Rs1, Rs2                   | Output current sensing resistor (Rs) connection terminals.      |
| Power supply                 | VCC                        | Control circuit power supply.                                   |
| Phase input                  | Ph1A, Ph1B, Ph2A, Ph2B     | Output current direction switch terminals.                      |
| Output current change        | I0(1), I1(1), I0(2), I1(2) | Output current change (100%, 70%, 33%, 0%) terminals.           |
| Standby input                | Stby                       | Standby input (L: Standby, H or open: motor function) terminal. |
| Sense inputs                 | S1, S2                     | Input voltage terminal of comparators.                          |
| Vref input                   | Vref                       | Reference voltage due to setting output current.                |
| Output of voltage stabilizer | Regout                     | Output of voltage stabilizer (3.5V).                            |
| A capacitor for oscillator   | Fref                       | A capacitor due to PWM carrier frequency.                       |
| Power GND                    | P.GND                      | The GND terminal of bottom side flywheel diodes.                |

## Absolute Maximum Ratings

(Ta = 25°C unless otherwise noted.)

| Parameter              | Symbol  | Ratings    | Units | Condition                            |
|------------------------|---------|------------|-------|--------------------------------------|
| Motor supply voltage   | Vm      | -0.3 – 37  | V     |                                      |
| Output current         | Iout    | ±0.8       | A     | Per one phase                        |
| Power supply           | VCC     | -0.3 – 7.0 | V     |                                      |
| Logic input voltage    | Vlogic  | -0.3 – VCC | V     | Ph1A, Ph1B, Ph2A, Ph2B, I0, I1, Stby |
| Analog input voltage   | Vanalog | -0.3 – VCC | V     | Vref, S1, S2                         |
| Output current sensing | VRs     | 1.5        | V     | Rs1, Rs2                             |
| Power dissipation      | Pd      | 2.7        | W     | Under board mount condition.         |
| Thermal derating       | Kθ      | 46         | °C/W  |                                      |
| Junction temperature   | Tj      | 150        | °C    |                                      |
| Operating temperature  | Topr    | -20 – 75   | °C    |                                      |
| Storage temperature    | Tstg    | -40 – 125  | °C    |                                      |

## Thermal Derating



## Recommended Operating Conditions

| Parameter                    | Symbol | Limits |      |      | Unit |
|------------------------------|--------|--------|------|------|------|
|                              |        | Min.   | Typ. | Max. |      |
| Power supply                 | Vcc    | 4.5    | 5.0  | 5.5  | V    |
| Motor supply voltage         | Vm     | 10     | —    | 35   | V    |
| Output current               | Iout   | 50     | —    | 800  | mA   |
| Rising time of logic inputs  | tPLH   | —      | —    | 2.0  | μS   |
| Falling time of logic inputs | tPHL   | —      | —    | 2.0  | μS   |
| PWM ON time                  | Ton    | 5.0    | —    | 50   | μS   |
| PWM OFF time                 | Toff   | 5.0    | —    | 50   | μS   |
| Thermal shut down            | TSDon  | —      | 160  | —    | °C   |

## Electrical characteristics

(Ta = 25°C, VCC = 5.0V, VM = 24V unless otherwise noted.)

### Control Circuit

| Parameter  | Symbol      | Limits |      |        | Unit | Conditions  |
|--|-------------|--------|------|--------|------|---|
|  |             | Min.   | Typ. | Max.   |      |   |
| Supply current   | ICC1        | 39     | 56   | 73     | mA   | Stby = H, Ph*A = H, Ph*B = L (Bridge ON)                        |
|  | ICC2        | 20     | 27   | 40     |      | Stby = H, Ph*A = Ph*B (Bridge OFF)                              |
|  | ICC3        | 2.0    | 4.0  | 6.0    |      | Stby = L (Standby condition)                                    |
| Logic input voltage<br>(Ph, I1, I0, Stby terminals)    | Vlogic H    | 2.4    | —    | Vcc    | V    |   |
|  | Vlogic L    | 0      | —    | 0.6    |      |   |
| Phase terminal input current                           | I(Ph) H     | —      | —    | 10     | μA   | Vin = 5V  |
|  | I(Ph) L     | -20    | -3.0 | —      |      | Vin = 0V  |
| I0, I1 terminals input current                         | I(I0, I1) H | —      | —    | 10     | μA   | Vin = 5V  |
|  | I(I0, I1) L | -400   | -300 | —      |      | Vin = 0V  |
| Standby terminal input current                         | I(Stby) H   | —      | —    | 10     | μA   | Vin = 5V  |
|  | I(Stby) L   | -400   | -300 | 5.0    |      | Vin = 0V  |
| Current sensing<br>Comparators input current           | I(S)        | -20    | -3.0 | —      | μA   | S1 or S2 terminals input current<br>(S1 or S2 = 0V, Vref = 5V). |
| Current sensing<br>Comparators input voltage<br>sphere | V(S)        | 0      | —    | VCH(H) | V    | S1 or S2 terminal input voltage sphere                          |
| Vref input current                                     | I(Vref)     | —      | 500  | 650    | μA   | Input current of Vref<br>(Vref = 5V, I0 = I1 = 0V)              |
| Vref input voltage sphere                              | V(Vref)     | 0      | —    | Vcc    | V    |   |
| Oscillation frequency of Fref                          | FC          | 20     | 30   | 40     | kHz  | C = 390pF, Fref terminal oscillation                            |
| Voltage stabilizer output                              | Vreg        | 3.35   | 3.50 | 3.65   | V    | Iout = -0.1mA – +1mA  |
| Current sensing<br>Comparators threshold<br>voltage    | VCH(H)      | 475    | 500  | 525    | mV   | I0 = L, I1 = L, Vref = 5V (Vref/10*100%)                        |
|  | VCH(M)      | 325    | 350  | 375    | mV   | I0 = H, I1 = L, Vref = 5V (Vref/10*70%)                         |
|  | VCH(L)      | 139    | 155  | 171    | mV   | I0 = L, I1 = H, Vref = 5V (Vref/10*33%)                         |

### Output Circuit

(Ta = 25°C, VCC = 5.0V, VM = 24V unless otherwise noted.)

| Parameter                     | Symbol | Limits |      |      | Unit | Conditions                                  |
|-------------------------------|--------|--------|------|------|------|---|
|                               |        | Min.   | Typ. | Max. |      |   |
| Output saturation voltage     | Vsat   | —      | 1.6  | 2.2  | V    | Top and Bottom at Load current 0.6A.        |
| Output leakage current        | Ileak  | -100   | —    | +100 | μA   |   |
| VF of flywheel diode (Top)    | VF(H)  | —      | 1.7  | 2.3  | V    | If = 0.6A                                   |
| VF of flywheel diode (Bottom) | VF(L)  | —      | 1.1  | 1.5  | V    | If = 0.6A                                   |
| Turn ON delay of output       | tdon   | —      | 0.5  | 2.0  | μS   | Time until output become ON since S > Vref  |
| Turn OFF delay of output      | tdoff  | —      | 2.0  | 3.5  | μS   | Time until output become OFF since S < Vref |

## Function Explanation

### 1. Ph inputs make a decision the output function.

| Ph*A | Ph*B | Out*A | Out*B |
|------|------|-------|-------|
| L    | L    | OFF   | OFF   |
| H    | L    | H     | L     |
| L    | H    | L     | H     |
| H    | H    | OFF   | OFF   |

\*: 1 or 2

The outputs shut off under Ph\*A and Ph\*B High condition at the same time.

### 2. Output current and terminal of output current setting.

| I0 | I1 | Output current ratio | Current sensing comparators threshold voltage (Vref=5V) |
|----|----|----------------------|---|
| L  | L  | 100%                 | 500mV   |
| H  | L  | 70%                  | 350mV   |
| L  | H  | 30%                  | 155mV   |
| H  | H  | 0%                   | —   |

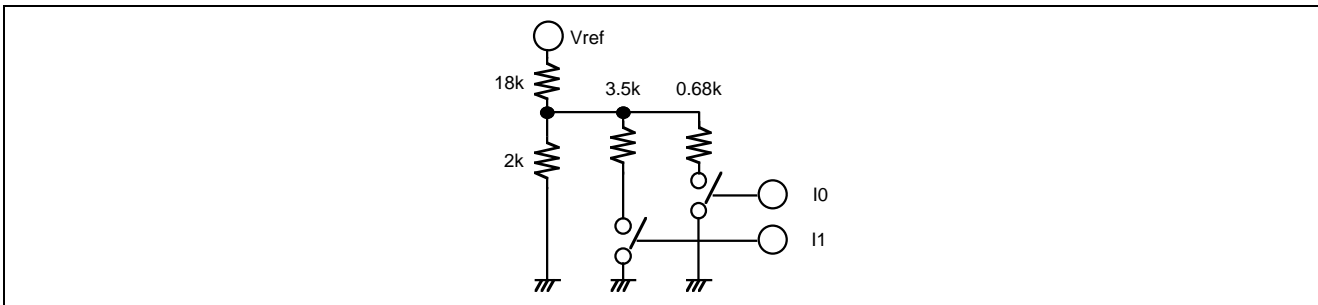
### 3. Equivalent circuit of Vref terminal.

The equivalent circuit of Vref terminal is shown in right circuit.

As Vref terminal needs typical 500 $\mu$ A input current, consider this value when Vref voltage is set.

### 4. Current sensing comparators.

The current sensing comparators compare the voltage (VRs) of current sensing resistor and threshold voltage ( $V_{CH}$ ) of this comparators, then if  $VRs > V_{CH}$ , the comparators output change and shut off the output.



**5. Oscillation circuit.**

External capacitor is charged and discharged by the constant current and a triangular waveform appears to Vref terminal.

The waveform voltage level is shown in right figure.

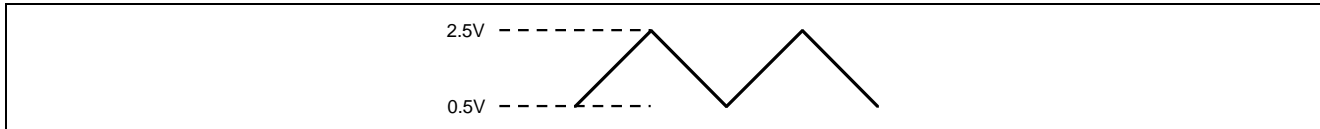
This triangular waveform is a carrier frequency of PWM circuit.

The carrier frequency change if this external capacitor value is changed.

M54679FP is designed that the oscillation frequency is 30kHz

if the external capacitor value is 390pF.

The oscillation frequency is in inverse proportion to the value of a external capacitor.

**6. Spike current cancellation.**

Output power transistors go to ON, then the spike current appears on the rs (current sensing) in a short time and this is caused by the internal delay time.

M54679FP has the cancellation circuit of the spike current as the current sensing comparators do not cause error functions.

So, the function of current sensing comparators are shut off during 2ms since the output power transistors go to ON.

**7. Ph signal delay circuit.**

M54679FP has a delay time of 3.0μs until output H-bridge power stage go to ON since Ph signal change Low to high.

This delay time is enough short time for the frequency (plus rate) of Ph signal and there is no problem in the normal function.

**8. Rs and S1 or S2 terminal.**

If S1 or S2 terminal (non-inverted input of the current sensing comparators) is connected the nearest position of current sensing resistor, the error of the current sensing by means of wire resistance on the board will be decreased.

**9. Voltage stabilizer.**

M54679FP has a voltage stabilizer of 3.5V.

The reference voltage (Vref) can connect the output (Regout) of voltage stabilizer directly.

In this case, the current capability of the output of voltage stabilizer is 1.0mA (source current), 0.1mA (sink current).

**10. Setting output current.**

As the output circuit of M54679FP is designed by the bipolar type NPN transistors, the current that go through the motor coil is smaller about 15mA (typical) than the current that go through the current sensing resistor.

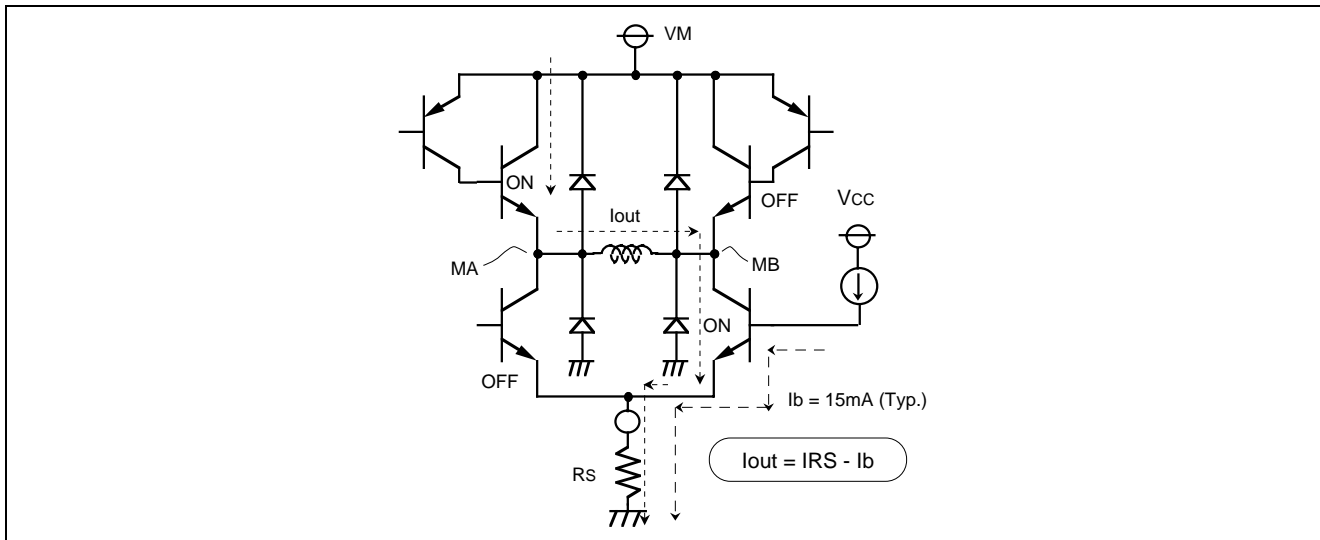
This is caused by the base current of the power transistors.

Therefore, be aware this base current when the output current is set.

**11. Power GND terminal.**

Power GND is connected the anodes of flywheel diodes of bottom side.

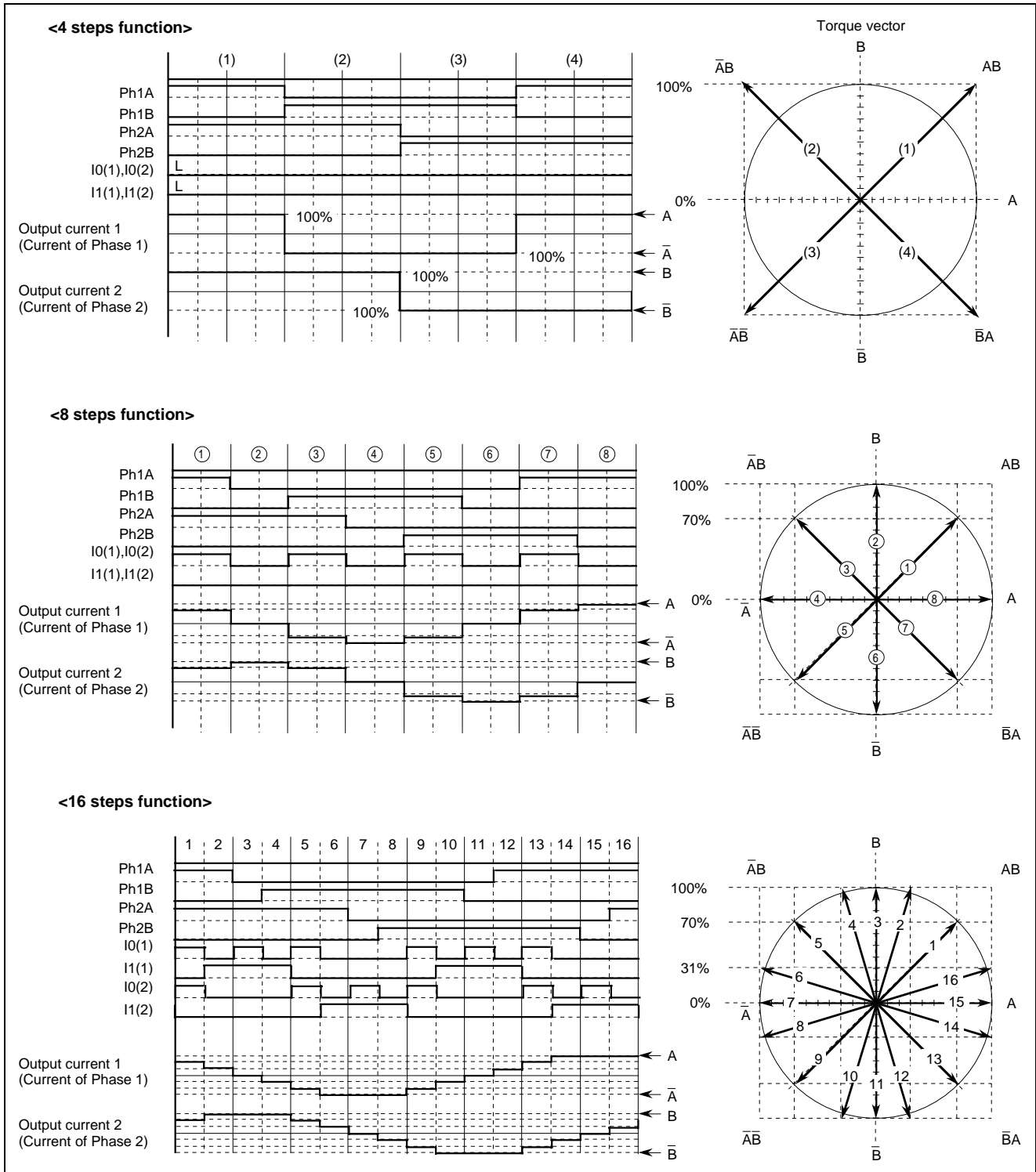
When the output H-bridge power stage goes to ON, as the flyback current go through this GND terminal, minimize the wire resistor of this GND on the board.



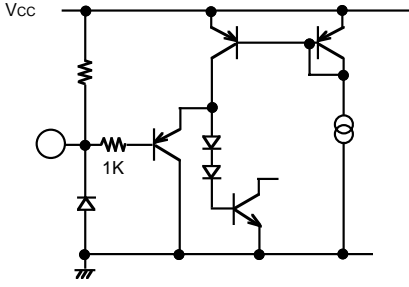
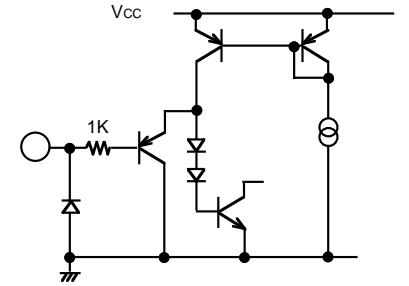
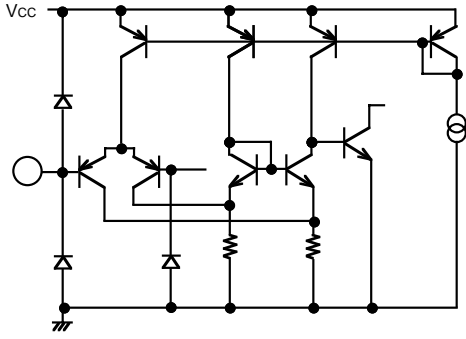
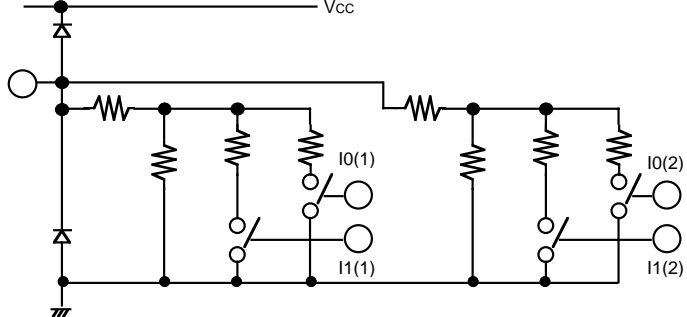


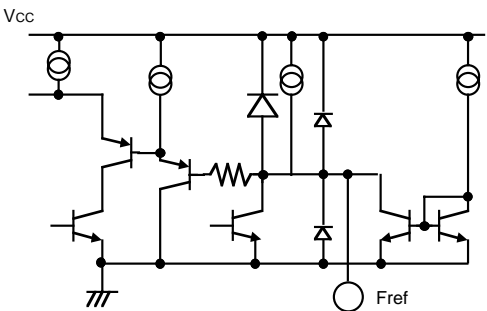
12. Output current timing chart under Ph inputs and I0, I1 output conditions.

Under output current wave forms show the current that a motor driver is going to control, so these do not show the actual current wave forms.

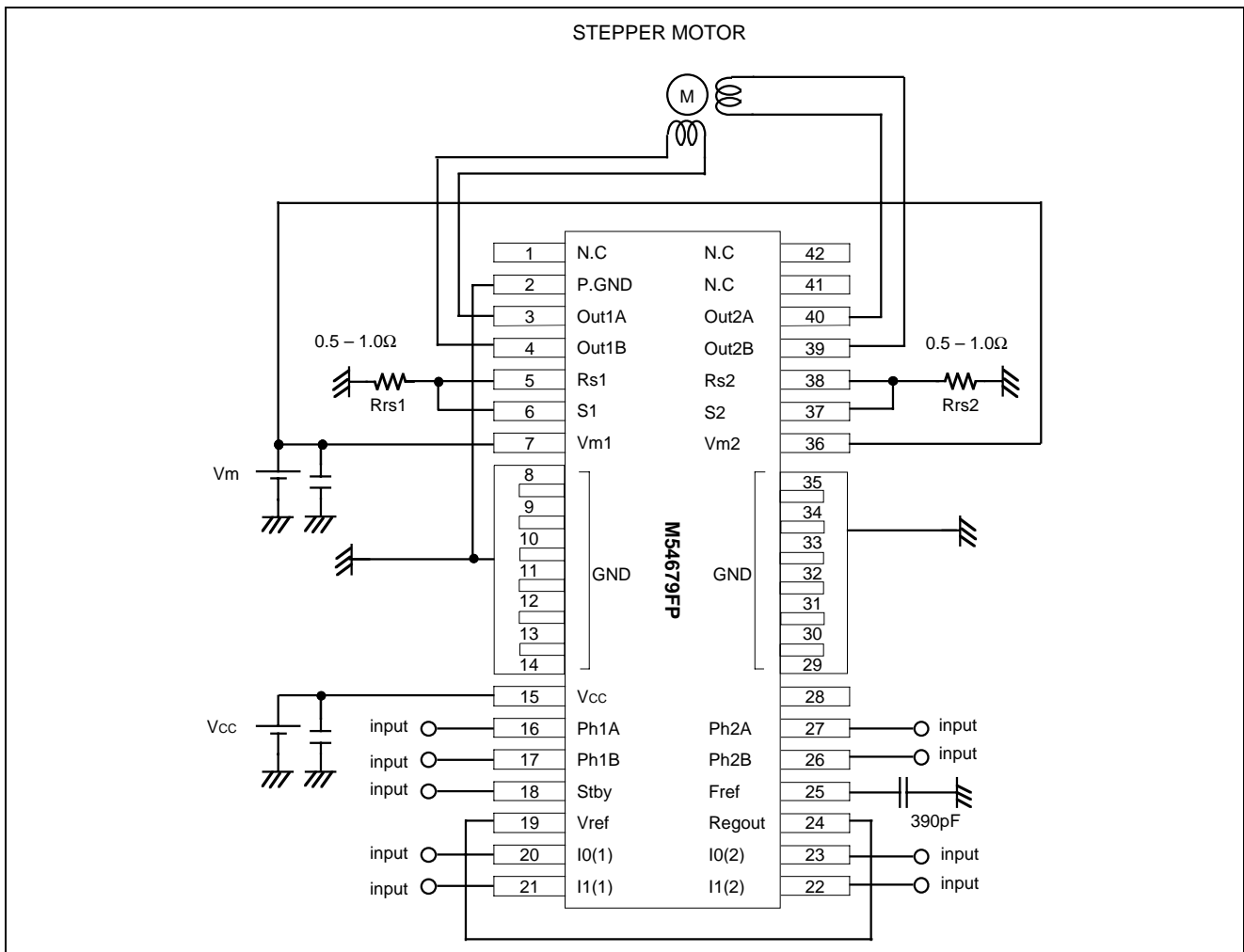


13. Inputs terminals.

| Symbol   | Equivalent circuit of the circumstance of input terminals.                           | Remarks |
|--|--|---------|
| <p>⑱ pin: Stby<br/>                     ⑳ pin: I0(1)<br/>                     ㉑ pin: I1(1)<br/>                     ㉓ pin: I0(2)<br/>                     ㉔ pin: I1(2)</p> |     |         |
| <p>⑯ pin: Ph1A<br/>                     ⑰ pin: Ph1B<br/>                     ㉗ pin: Ph2A<br/>                     ㉘ pin: Ph2B</p>  |     |         |
| <p>⑥ pin: S1<br/>                     ⑳ pin: S2</p>  |  |         |
| <p>⑲ pin: Vref</p>   |  |         |

| Symbol | Equivalent circuit of the circumstance of input terminals.                         | Remarks |
|--------|--|---------|
| Fref   |  |         |

### Application Circuit



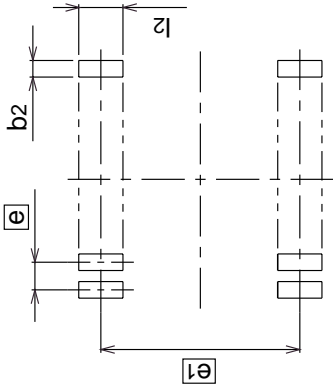
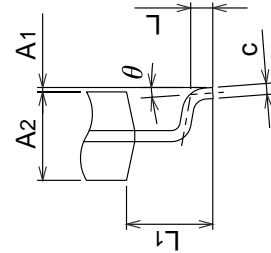
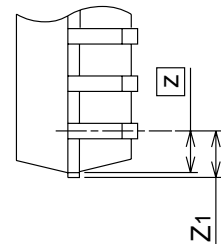
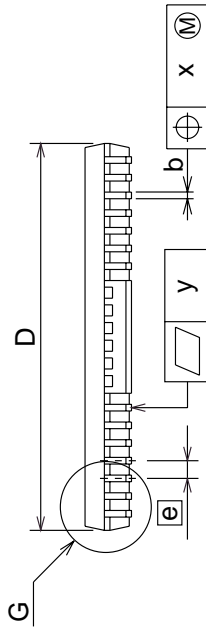
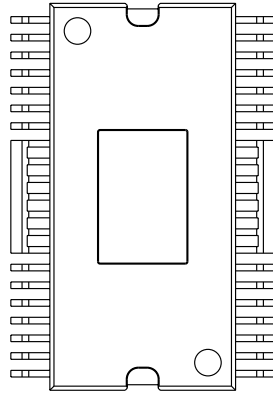
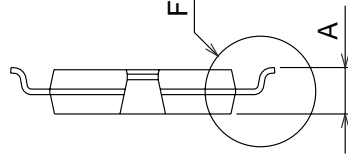
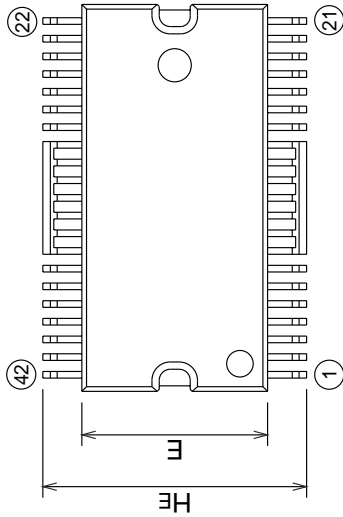
Package Dimensions

**42P9R-A**

(MMP)

**Plastic 42pin 450mil HSSOP**

|  |                 |                |                           |
|--|-----------------|----------------|---------------------------|
| EIAJ Package Code<br>HSSOP42-P-450-0.8 | JEDEC Code<br>— | Weight(g)<br>— | Lead Material<br>Cu Alloy |
|--|-----------------|----------------|---------------------------|



Recommended Mount Pad

| Symbol   | Dimension in Millimeters |       |       |
|----------|--------------------------|-------|-------|
|          | Min                      | Nom   | Max   |
| A        | —                        | —     | 2.2   |
| A1       | 0                        | 0.1   | 0.2   |
| A2       | —                        | 2.0   | —     |
| b        | 0.27                     | 0.32  | 0.37  |
| c        | 0.23                     | 0.25  | 0.3   |
| D        | 17.3                     | 17.5  | 17.7  |
| E        | 8.2                      | 8.4   | 8.6   |
| e        | —                        | 0.8   | —     |
| HE       | 11.63                    | 11.93 | 12.23 |
| L        | 0.3                      | 0.5   | 0.7   |
| L1       | —                        | 1.765 | —     |
| Z        | —                        | 0.75  | —     |
| Z1       | —                        | —     | 0.9   |
| x        | —                        | —     | 0.16  |
| y        | —                        | —     | 0.1   |
| $\theta$ | 0°                       | —     | 10°   |
| b2       | —                        | 0.5   | —     |
| e1       | —                        | 11.43 | —     |
| l2       | 1.27                     | —     | —     |

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