M54679FP

2-Phase Stepper Motor Driver

REJ03F0047-0100Z
Rev.1.0
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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.

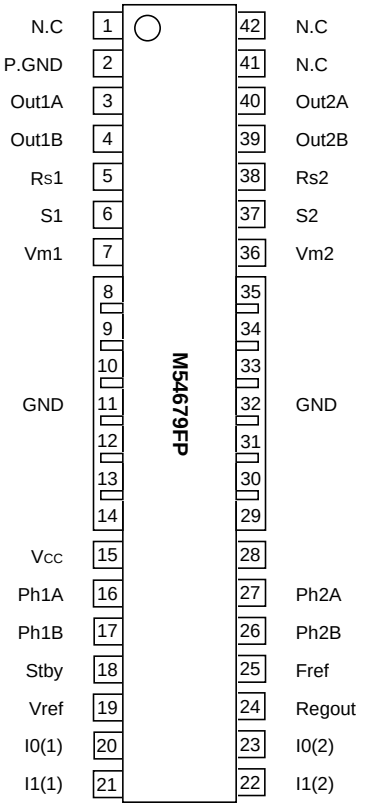
Function

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.

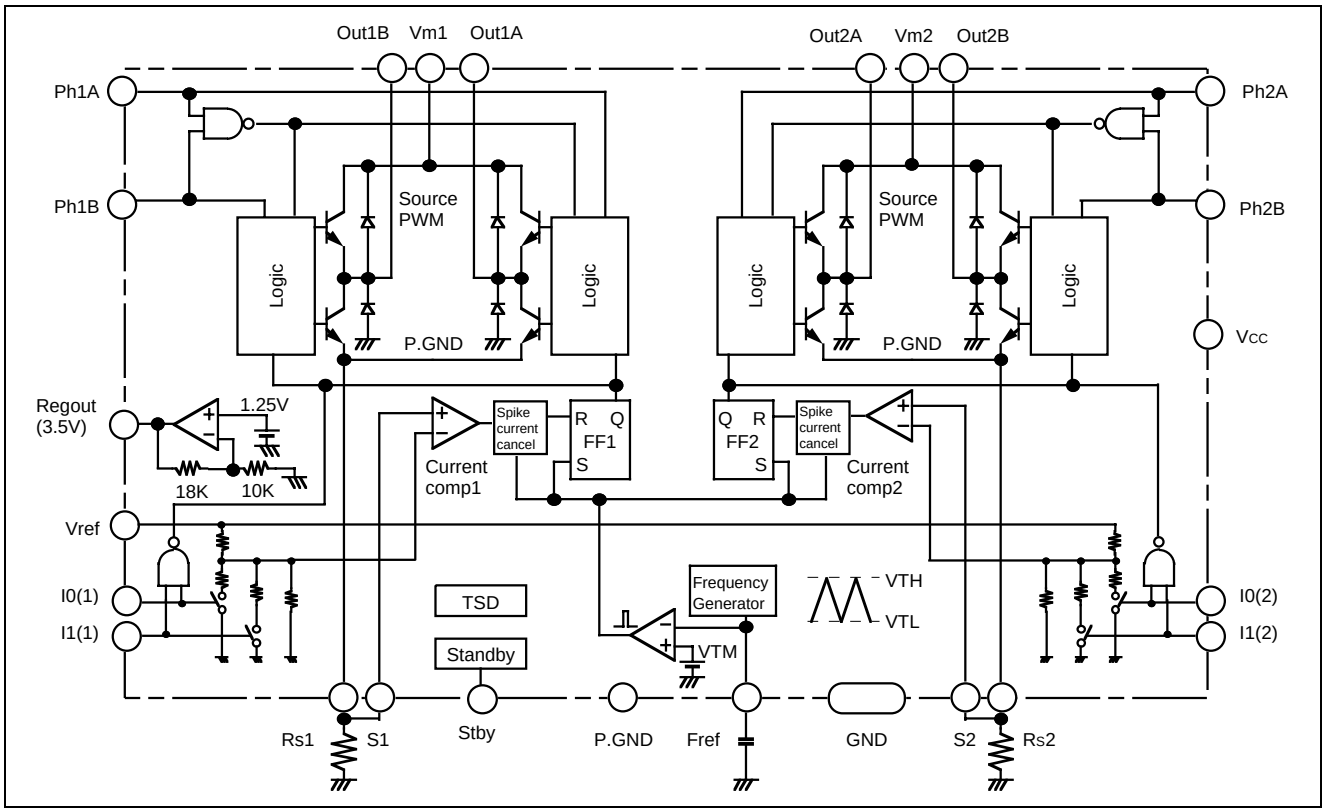
Pin Configuration



Outline 42P9R-A

N.C: no connection

Block Diagram



Pin Function

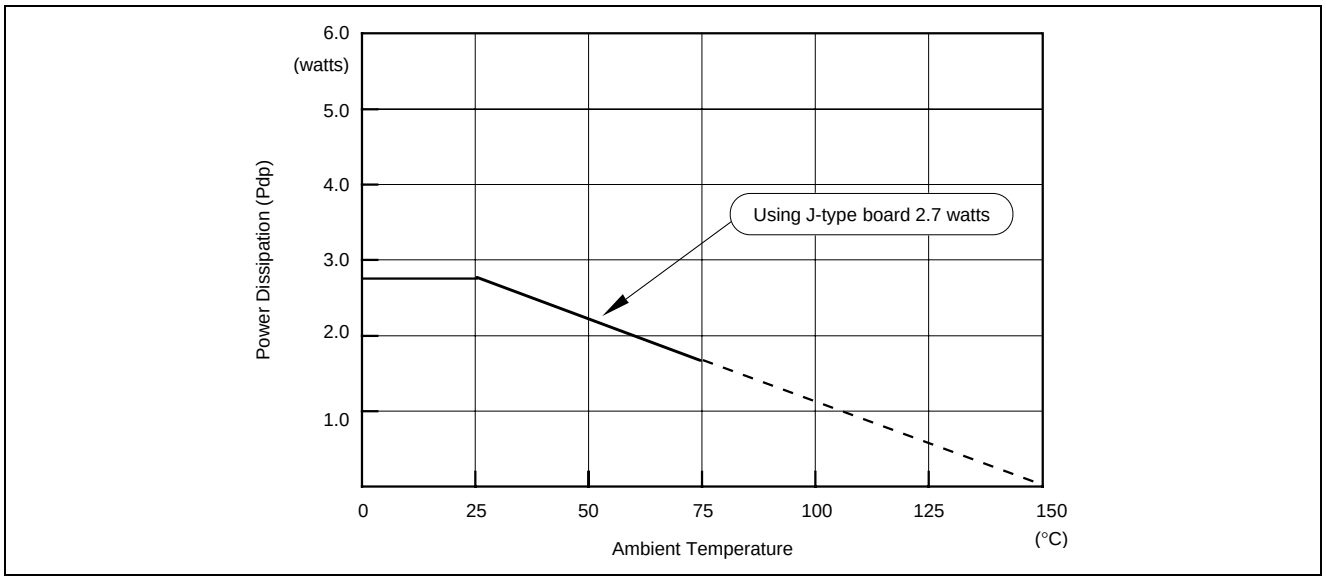
Terminal	Symbol	Function
Motor Supply Voltage	Vm1, Vm2	Power supply for motor drive.
Output terminals	Out1A, Out1B, Out2A, Out2B	Motor drive output terminals.
Current sensor	Rs1, Rs2	Output current sensing resistor (Rs) connection terminals.
Power supply	VCC	Control circuit power supply.
Phase input	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

		Limits			
Parameter	Symbol	Min.	Typ.	Max.	Unit
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 Min.	Typ.	Max.	Unit	Conditions
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 (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 Comparators input current	I(S)	–20	–3.0	—	µA	S1 or S2 terminals input current (S1 or S2 = 0V, Vref = 5V).
Current sensing Comparators input voltage 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 (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 Comparators threshold 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 Min.	Typ.	Max.	Unit	Conditions
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%	—

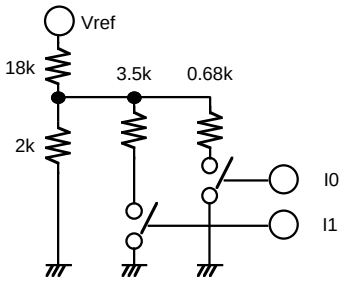
3. Equivalent circuit of Vref terminal.

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

As Vref terminal needs typical 500µA 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.

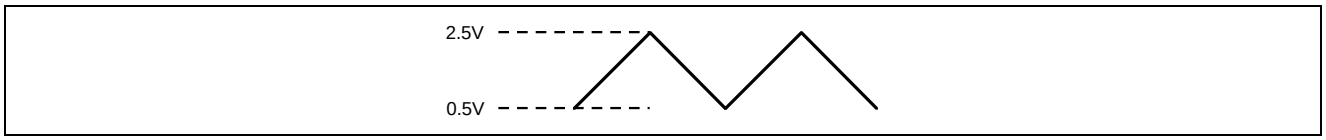
This triangular waveform is a carrier frequency of PWM circuit.

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 R_S (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.

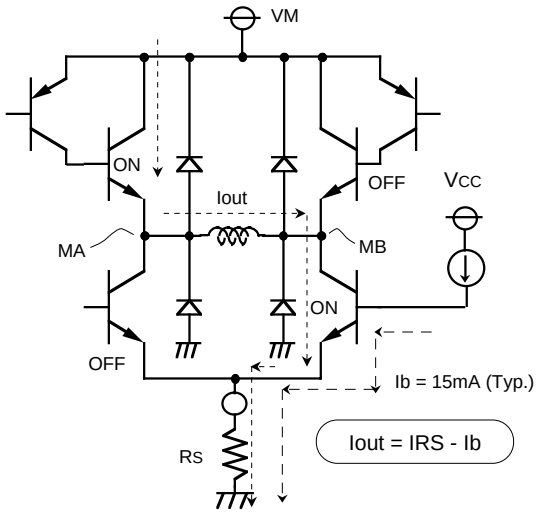
This is caused by the base current of the power transistors.

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.

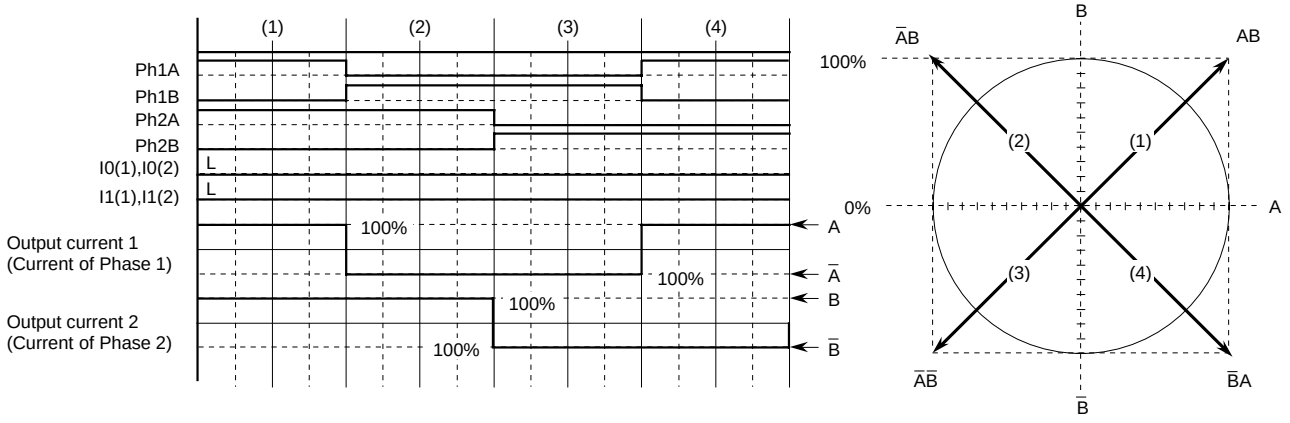
When the output H-bridge power stage goes to ON, as the flyback current go through this GND terminal, minimize the wire resistor of this GND on the board.



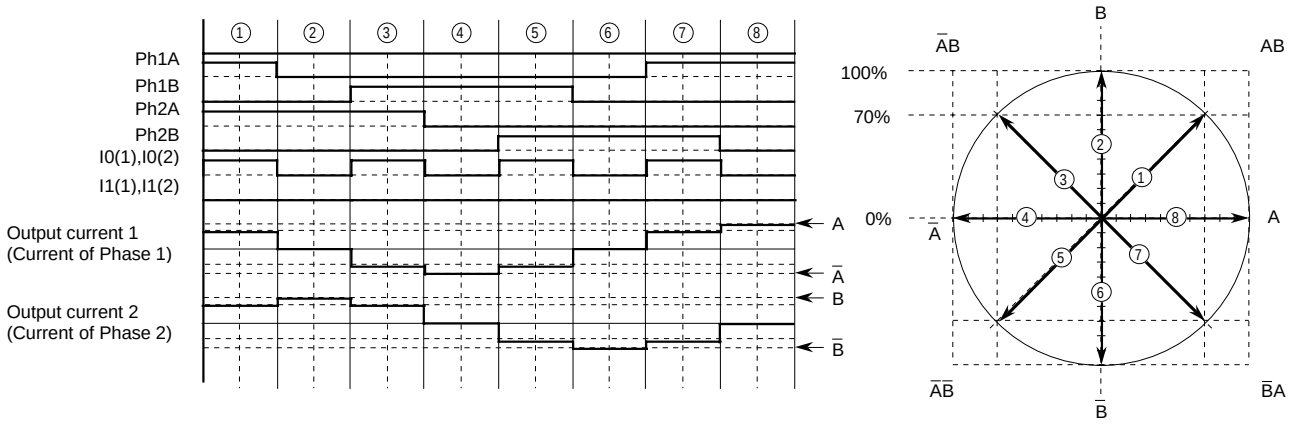
12. Output current timing chart under Ph inputs and I0, I1 output conditions.

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.

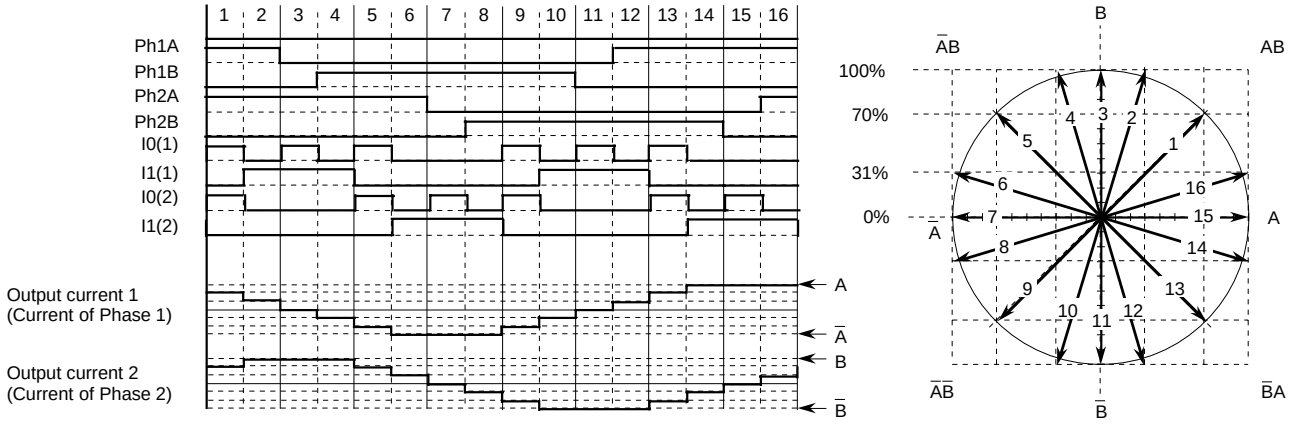
<4 steps function>



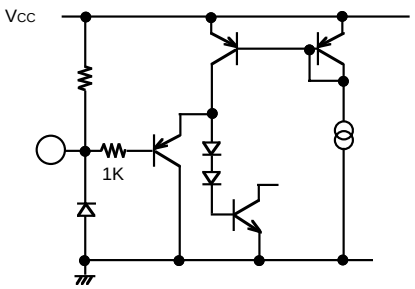
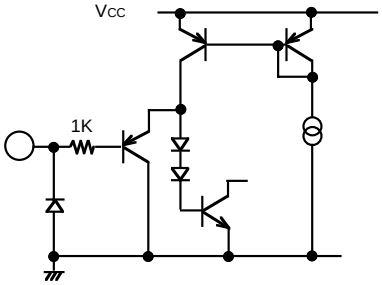
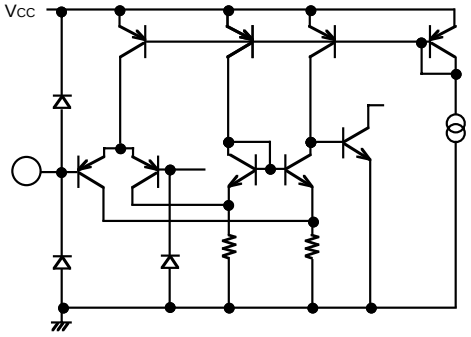
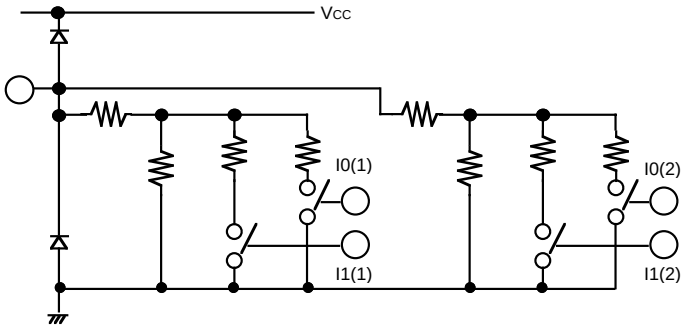
<8 steps function>

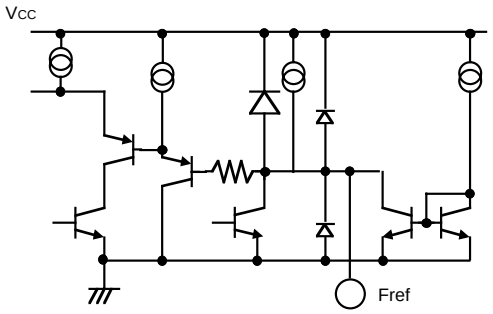


<16 steps function>

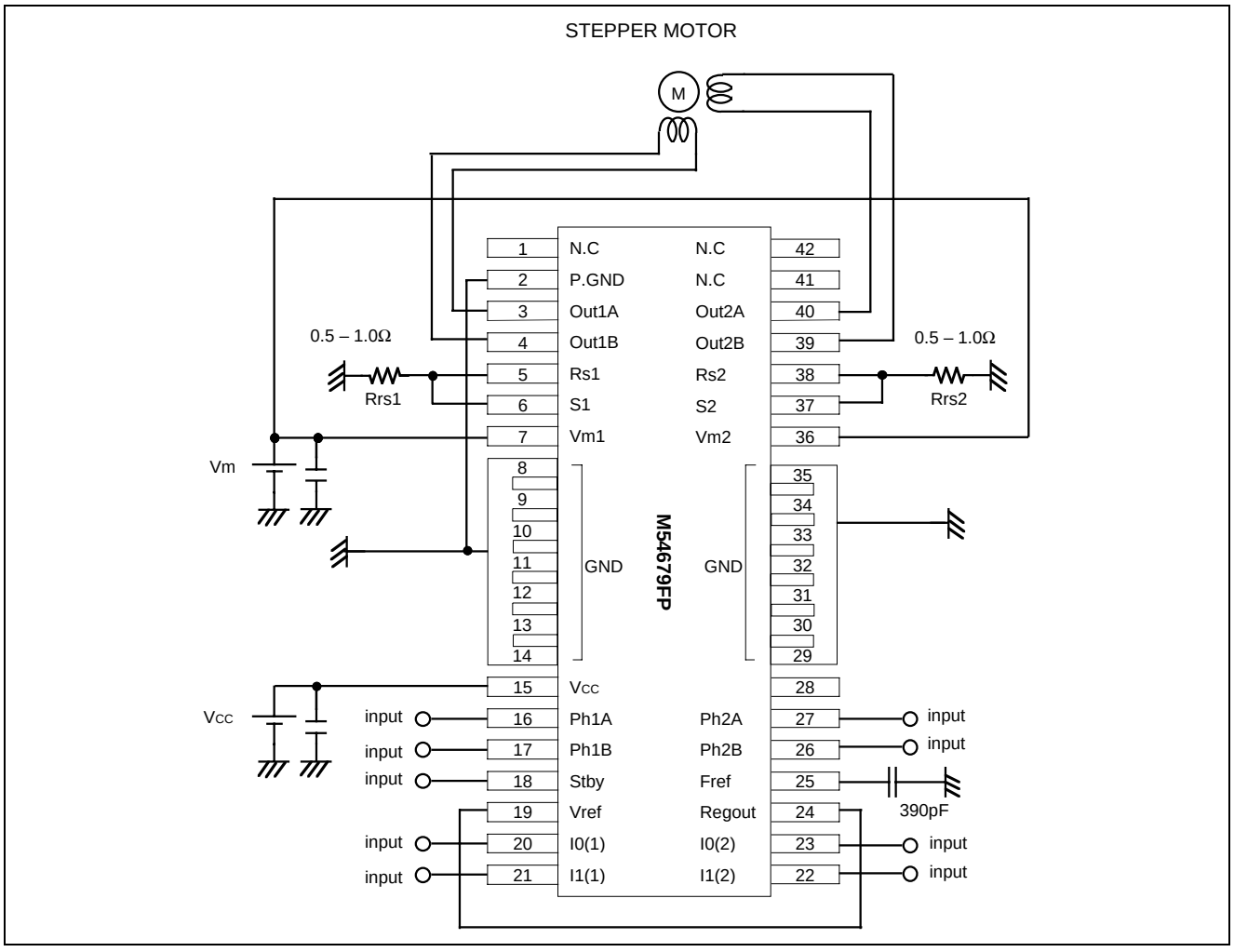


13. Inputs terminals.

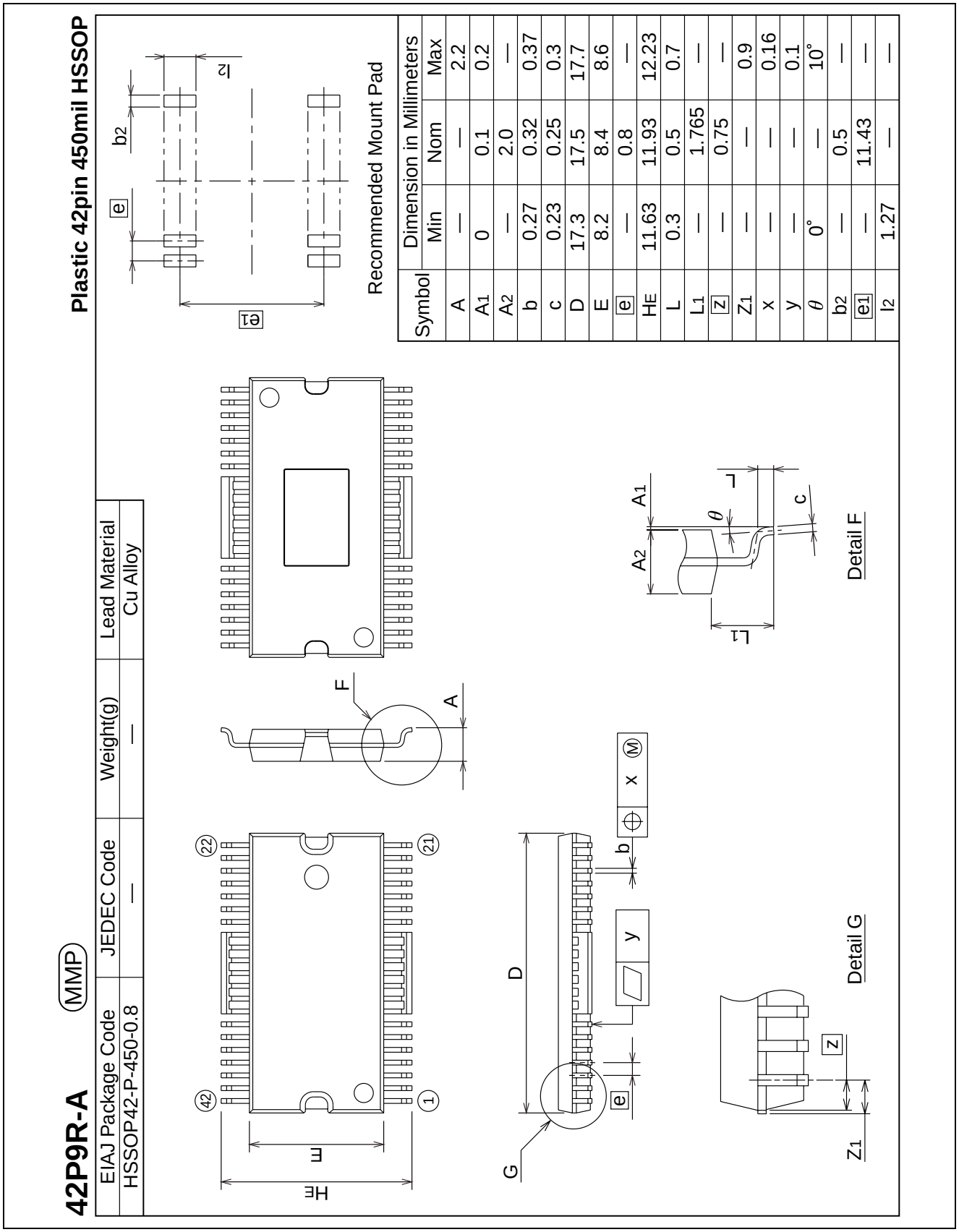
Symbol	Equivalent circuit of the circumstance of input terminals.	Remarks
⑱ pin: Stby ⑳ pin: I0(1) ㉑ pin: I1(1) ㉓ pin: I0(2) ㉒ pin: I1(2)		
⑯ pin: Ph1A ⑰ pin: Ph1B ㉗ pin: Ph2A ㉖ pin: Ph2B		
⑥ pin: S1 ㊲ pin: S2		
⑲ pin: Vref		

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

Application Circuit



Package Dimensions



Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	—	—	2.2
A_1	0	0.1	0.2
A_2	—	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	—
H_E	11.63	11.93	12.23
L	0.3	0.5	0.7
L_1	—	1.765	—
Z	—	0.75	—
Z_1	—	—	0.9
x	—	—	0.16
y	—	—	0.1
θ	0°	—	10°
b_2	—	0.5	—
e_1	—	11.43	—
l_2	1.27	—	—

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