PRELIMINARY

Notice: This is not a final specification.
Some parametric limits are subject to change.

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.
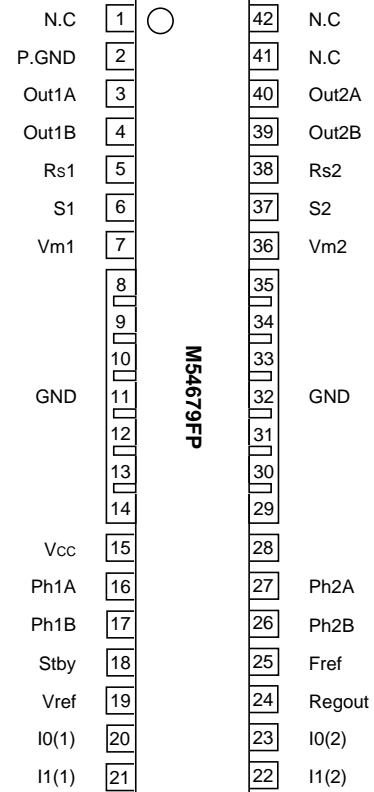- Include flywheel diodes.

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.
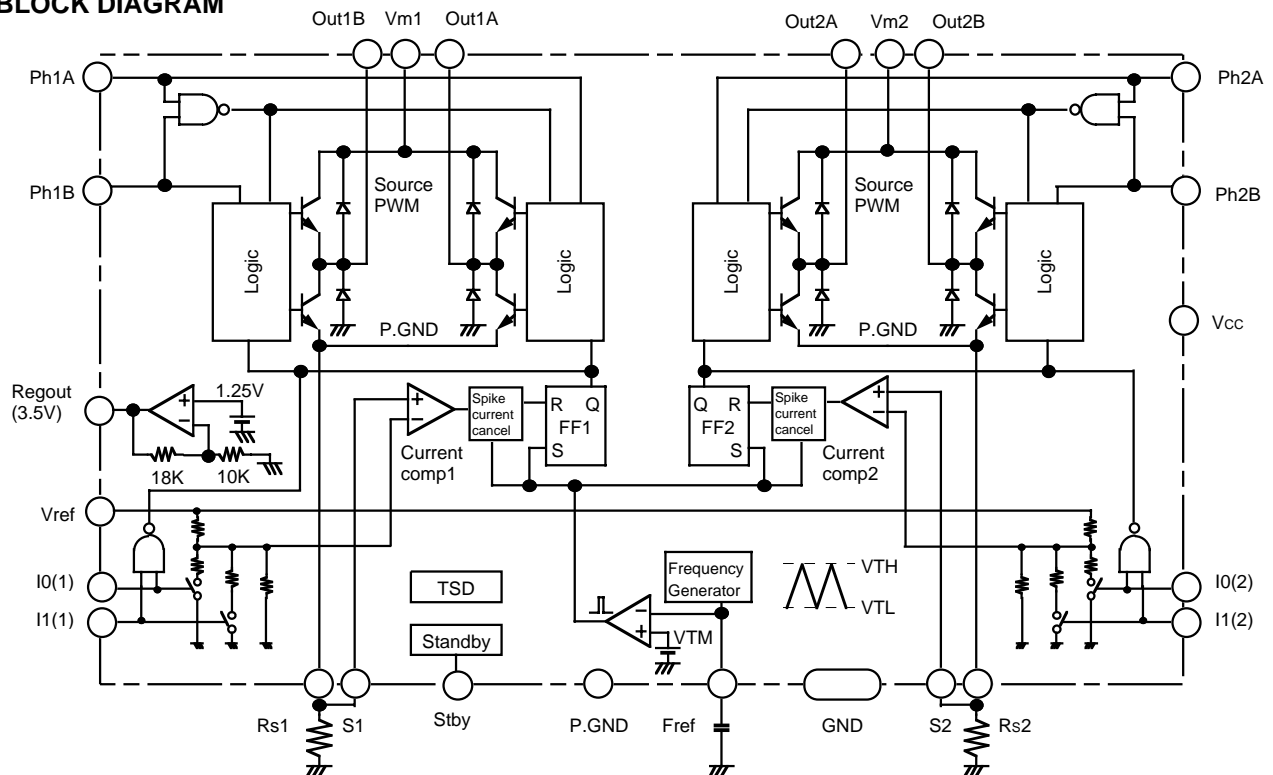
PIN CONFIGURATION (TOP VIEW)

N.C	1	42	N.C
P.GND	2	41	N.C
Out1A	3	40	Out2A
Out1B	4	39	Out2B
Rs1	5	38	Rs2
S1	6	37	S2
Vm1	7	36	Vm2
	8	35	
	9	34	
	10	33	
GND	11	32	GND
	12	31	
	13	30	
	14	29	
Vcc	15	28	
Ph1A	16	27	Ph2A
Ph1B	17	26	Ph2B
Stby	18	25	Fref
Vref	19	24	Regout
I0(1)	20	23	I0(2)
I1(1)	21	22	I1(2)

M54679FP

Outline 42P9R-A

N.C: no connection

BLOCK DIAGRAM

PRELIMINARY

Notice: This is not a final specification.
Some parametric limits are subject to change.

PIN FUNCTION

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

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C unless otherwise noted.)

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

FUNCTIONAL CONDITIONS

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

ELECTRICAL CHARACTERISTICS (Ta = 25deg, Vcc = 5.0V, VM = 24V unless otherwise noted.)

CONTROL CIRCUIT

Symbol	Parameter	Conditions	Limits			Units
			Min.	Typ.	Max.	
Icc1	Supply current	Stby = H, Ph*A = H, Ph*B = L (Bridge ON)	39	56	73	mA
Icc2		Stby = H, Ph*A = Ph*B (Bridge OFF)	20	27	40	
Icc3		Stby = L (Standby condition)	2.0	4.0	6.0	
Vlogic H	Logic input voltage		2.4	—	Vcc	V
Vlogic L	(Ph, I1, I0, Stby terminals)		0	—	0.6	
I(Ph) H	Phase terminal input current	Vin = 5V	—	—	10	μA
I(Ph) L		Vin = 0V	-20	-3.0	—	
I(I0, I1) H	I0, I1 terminals input current	Vin = 5V	—	—	10	μA
I(I0, I1) L		Vin = 0V	-400	-300	—	
I(Stby) H	Standby terminal input current	Vin = 5V	—	—	10	μA
I(Stby) L		Vin = 0V	-400	-300	5.0	
I(S)	Current sensing Comparators input current	S1 or S2 terminals input current (S1 or S2 = 0V, Vref = 5V).	-20	-3.0	—	μA
V(S)	Current sensing Comparators input voltage sphere	S1 or S2 terminal input voltage sphere	0	—	VCH(H)	V
I(Vref)	Vref input current	Input current of Vref (Vref = 5V, I0 = I1 = 0V)	—	500	650	μA
V(Vref)	Vref input voltage sphere		0	—	Vcc	V
FC	Oscillation frequency of Fref	C = 390pF, Fref terminal oscillation	20	30	40	kHz
Vreg	Voltage stabilizer output	Iout = -0.1mA – +1mA	3.35	3.50	3.65	V
VCH(H)	Current sensing Comparators threshold voltage	I0 = L, I1 = L, Vref = 5V (Vref/10*100%)	475	500	525	mV
VCH(M)		I0 = H, I1 = L, Vref = 5V (Vref/10*70%)	325	350	375	mV
VCH(L)		I0 = L, I1 = H, Vref = 5V (Vref/10*33%)	139	155	171	mV

OUTPUT CIRCUIT (Ta = 25deg, Vcc = 5.0V, VM = 24V unless otherwise noted.)

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

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 (VCH) of this comparators, then if VRS > VCH, the comparators output change and shut off the output.
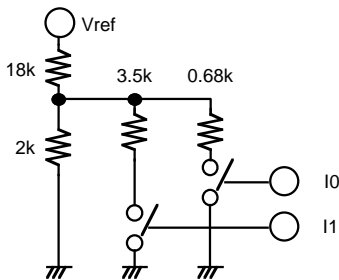
(5). Oscillation circuit.
External capacitor is charged and discharged by the constant current and a triangular waveform appears to Vref terminal.
The waveform voltage level is shown in right figure.
This triangular waveform is a carrier frequency of PWM circuit.
The carrier frequency change if this 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 2μs 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.
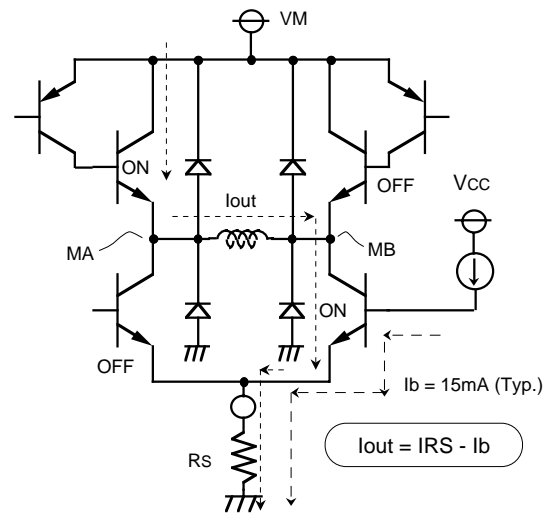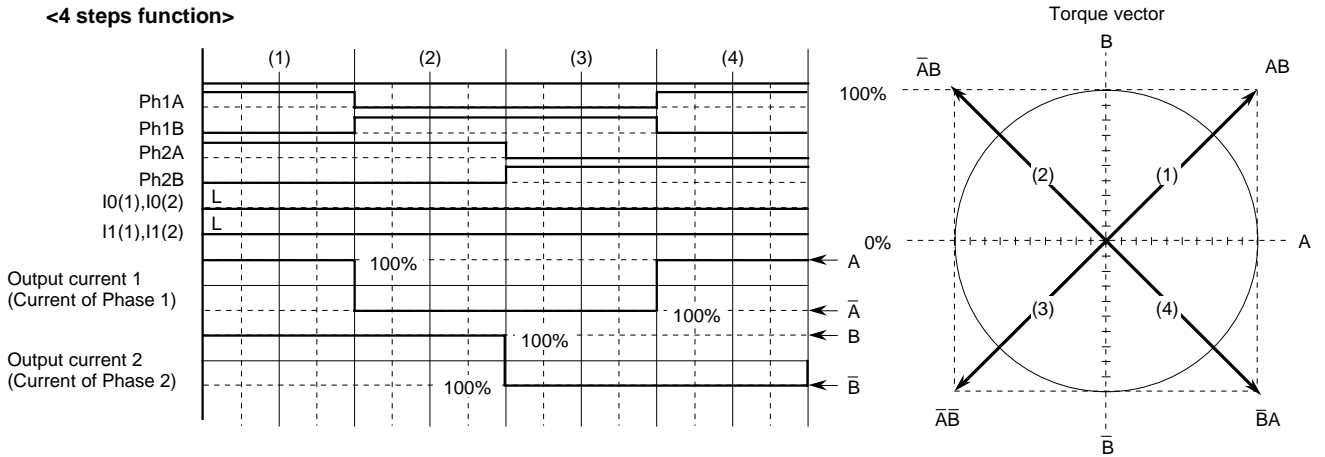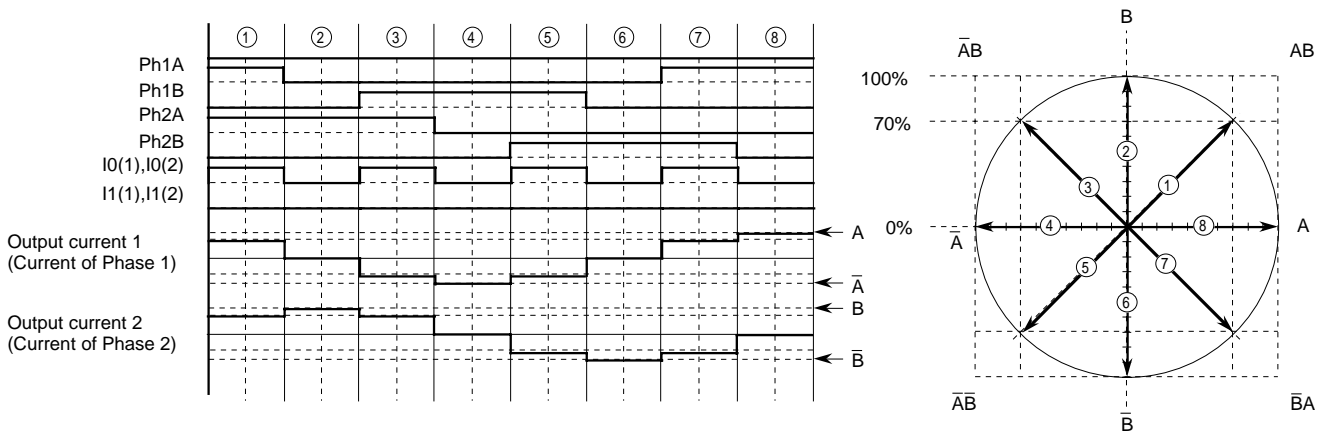

$Iout = IRS - Ib$

(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
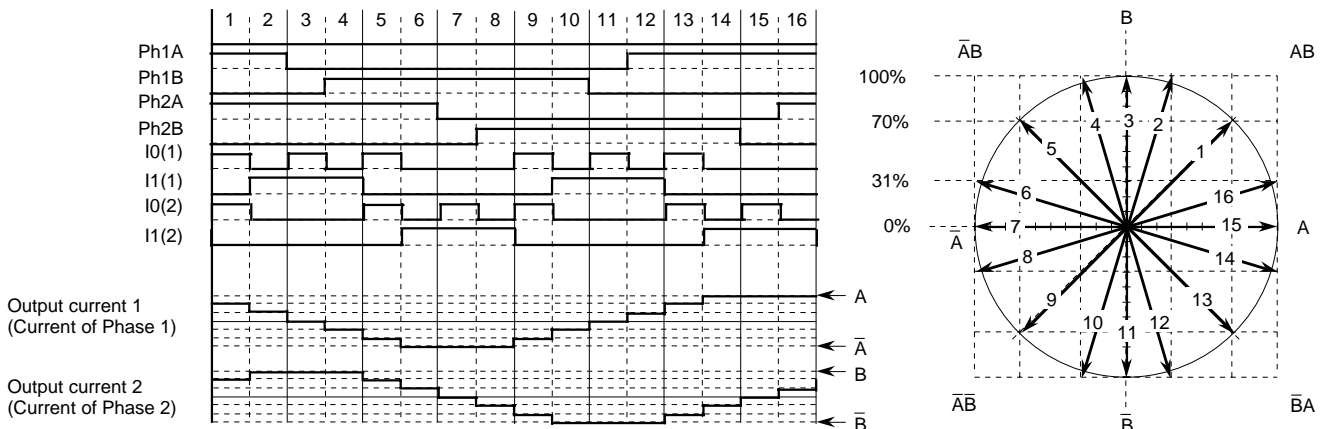actual current wave forms.

<4 steps function>
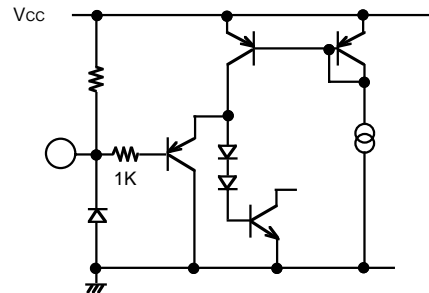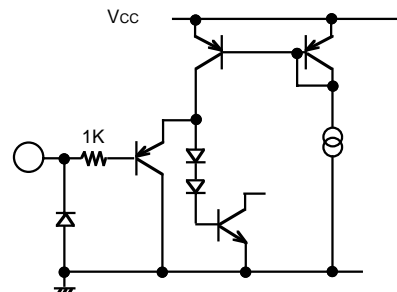

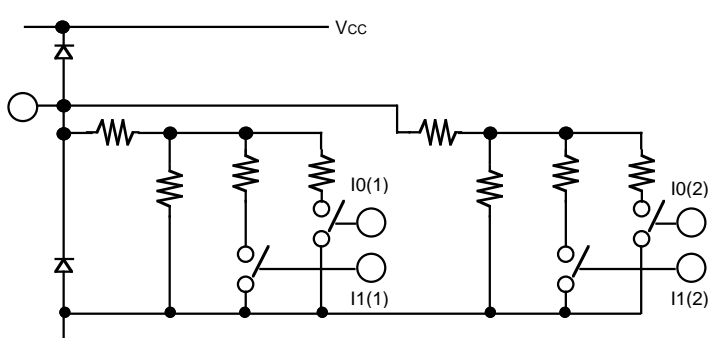**<8 steps function>**

<16 steps function>
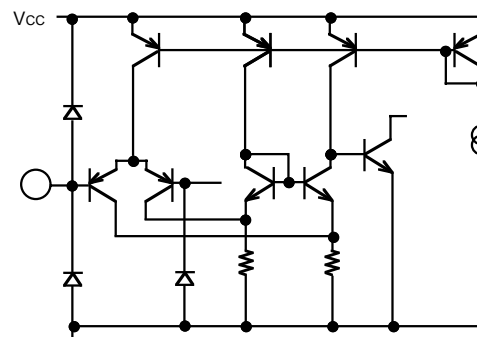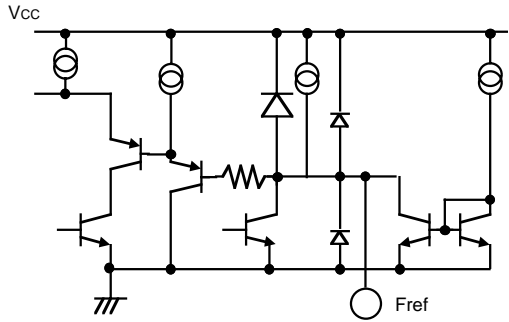
(13). Inputs terminals.

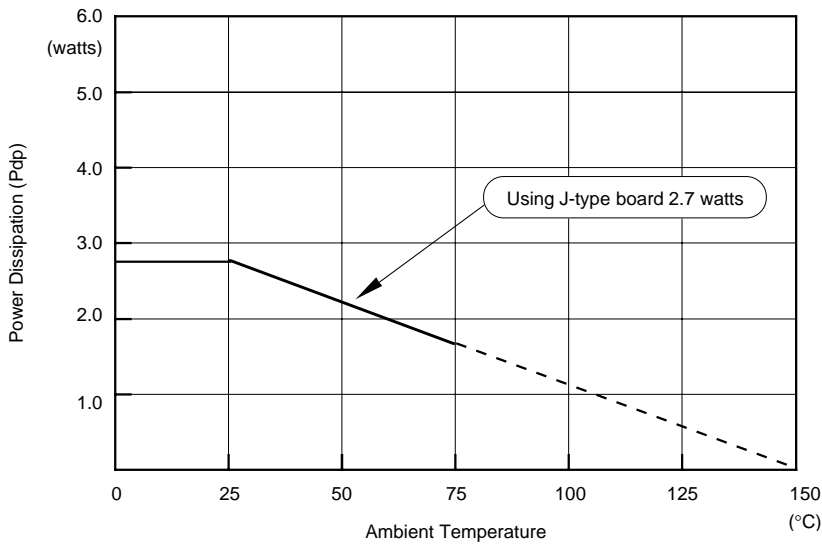| Symbol	Equivalent circuit of the circumstance of input terminals.	Remarks
⑱ pin: Stby ⑳ pin: I0(1) ㉑ pin: I1(1) ㉓ pin: I0(2) ㉒ pin: I1(2)		
⑯ pin: Ph1A ⑰ pin: Ph1B ㉗ pin: Ph2A ㉖ pin: Ph2B		
⑥ pin: S1 ㊲ pin: S2		
⑲ pin: Vref		

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

THERMAL DERATING

Using J-type board 2.7 watts

APPLICATION CIRCUIT

STEPPER MOTOR