

M54670P

2-PHASE STEPPER MOTOR DRIVER

DESCRIPTION

The M54670P is a semiconductor IC to drive a bipolar stepper motor directly by controlling the coil current with the constant current method.

FEATURES

- Wide operating voltage range (10 – 35V)
- Wide output current control range (20 – 800mA)
- Bipolar and constant current drive
- Built in flywheel
- Current level can be changed by steps or continuously.
- Built in a thermal shutdown circuit

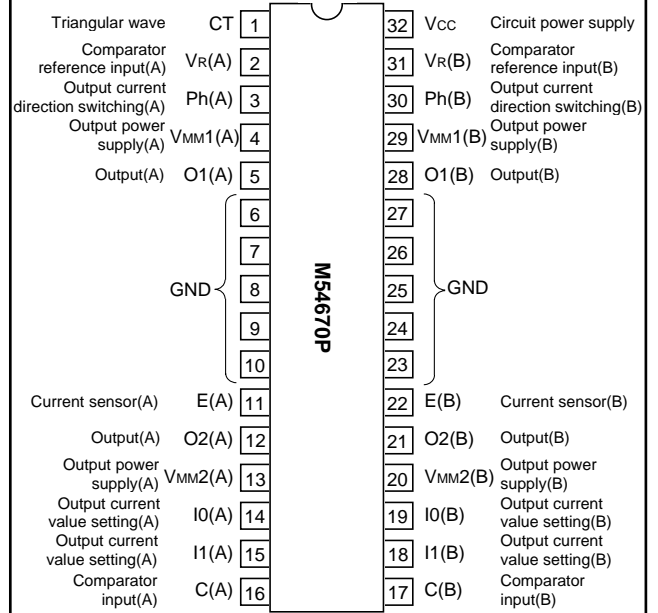
APPLICATION

Office automation equipment such as printer, FDD, HDD, and FAX

FUNCTION

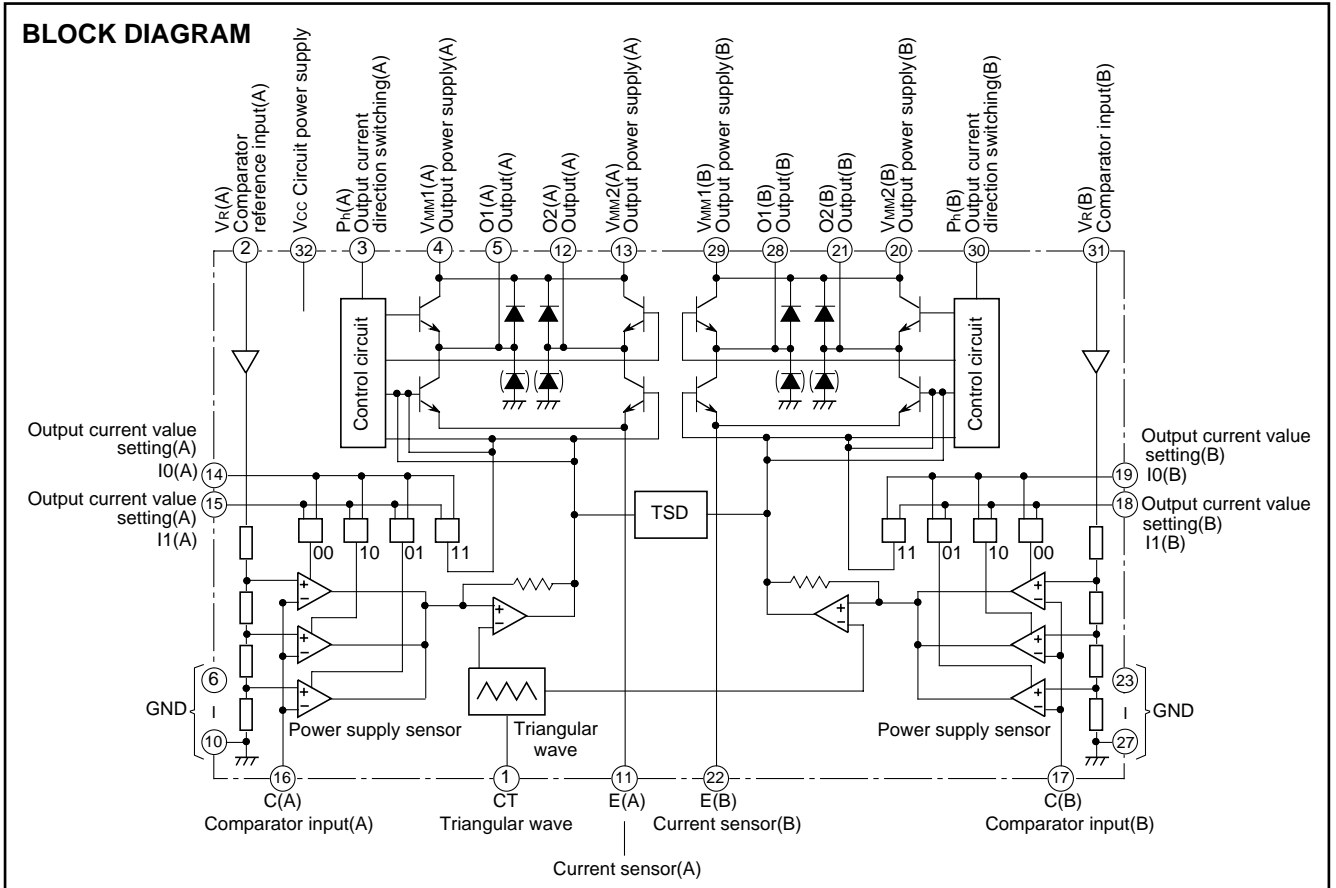
The M54670P can drive a stepper motor by the 2-phase bipolar method and also control the coil current. Furthermore, it controls the direction of the coil current with Ph input pins (pins 3 and 30). The coil current value can be selected among four levels (0 to max.) by selecting the combination of three internal comparators by logic input (pins 14, 15, 18 and 19). It also can be continuously controlled with Vr pins (pins 2 and 31). By selecting an I input pin among pins 14, 15, 18 or 19, the operation timing, 2-phase excitation, 1-2-phase excitation or microstep, can be selected. Because two control circuits are built in this IC, a stepper motor can be driven with a single IC by the 2-phase bipolar method.

PIN CONFIGURATION (TOP VIEW)



Outline 32P4B

BLOCK DIAGRAM



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

Symbol	Parameter	Conditions	Ratings	Unit
V _{CC}	Supply voltage		-0.3 – 7	V
V _{MM}	Output supply voltage		-0.3 – 40	V
V _I	Logic circuit input voltage		-0.3 – 6	V
V _C	Comparator input voltage		V _{CC}	V
V _R	Reference input voltage		7	V
I _O	Output current		±1.0	A
P _d	Allowable power dissipation	Mounted on a board	1.92	W
T _{opr}	Operating temperature		-20 – 75	°C
T _{stg}	Storage temperature		-55 – 125	°C

RECOMMENDED OPERATING CONDITIONS (V_{CC}=5.0V, Ta=25°C, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min.	Typ.	Max.	
V _{CC}	Supply voltage	4.75	5.00	5.25	V
V _{MM}	Output supply voltage	10		35	V
V _R	Reference input voltage	0	—	5	V
I _O	Output current	20		800	mA
t _{PLH}	Logic input rise time			2.0	μs
t _{PHL}	Logic input fall time			2.0	μs
T _{ON}	Thermal shutdown temperature *		175		°C

*: Refer to "PRECAUTIONS FOR USE."

ELECTRICAL CHARACTERISTICS (V_{CC}=5.0V, V_{MM}=10V, Ta=25°C, unless otherwise noted)

Symbol	Parameter		Test conditions	Limits			Unit
				Min.	Typ.	Max.	
V _{IH}	Logic input voltage	"H"	V _{CC} =5V	2.0	—	V _{CC}	V
V _{IL}		"L"		0	—	0.8	V
V _{CH}	Comparator threshold		V _R =5V, I ₀ =I ₁ =0	430	460	480	mV
V _{CM}			V _R =5V, I ₀ =1, I ₁ =0	265	285	305	mV
V _{CL}			V _R =5V, I ₀ =0, I ₁ =1	90	110	130	mV
I _{CO}	Comparator input current		I ₀ =I ₁ =1 (Ta=25°C)	-20	-2	20	μA
I _{OFF}	Output cutoff current			—	0	100	μA
V _{sat}	Saturation voltage		Voltage at sensing resistor is not included. I ₀ =500mA	—	3.0	4.5	V
f _c	PWM oscillator frequency		V _{MM} =10V, C _i =3900pF	16.5	33	66	kHz
t _d	Turn-off delay		Ta=25°C, dV/dt≥50mV/μs	—	1.0	2.0	μs
I _{CC}	Supply current		V _{CC} =5V	—	8.0	25	mA
I _{IH}	Logic input current	"H"	V _I =2.4V	—	180	400	μA
I _{IL}		"L"	V _I =0.4V	—	20	50	μA

APPLICATION DESCRIPTION

(1) PHASE INPUT

Phase input decides the output mode.

PHASE	O1	O2
H	L	H
L	H	L

(2) I₀, I₁

I₀ and I₁ fixed based on the comparative voltage V_R decide the output current level.

I ₀	I ₁	Current level
H	H	0
L	H	Low
H	L	Typ
L	L	High

(3) V_R (Comparative voltage)

The current level can be continuously changed by changing the voltage at V_R continuously.

(4) Current sensor

When the voltage fall at the current sensing resistor and the selected current level become of the same level, the output state is cut off for a certain time by inverting the comparator. During this cutoff time, the current volume decreases slightly due to the L component of the motor and falls short of the comparative level. During the time fixed based on the PWM frequency, the output stage goes in ON state and then in OFF state and this ON/OFF operation is repeated.

(5) PWM oscillator

A capacitor C_f is externally connected to C_T pin in order to fix the PWM oscillator frequency. The frequency f_c is calculated as follows.

$$f_c = \frac{1}{7.77 \times 10^3 \times C_f}$$

(6) Analog control

The output current level can be continuously changed by changing the voltage at V_R or the feedback voltage to the comparator.

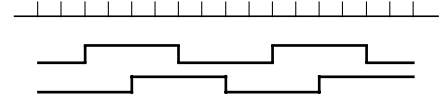
(7) Thermal shutdown function

This IC has a function to protect itself against thermal damage which is caused when the chip temperature rises abnormally. Regarding this function, refer to "PRECAUTIONS FOR USE."

TIMING CHART

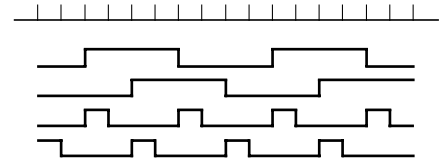
• 2-phase excitation

Phase 1
Phase 2
I₀, 1(A) = 0
I₀, 1(B) = 0



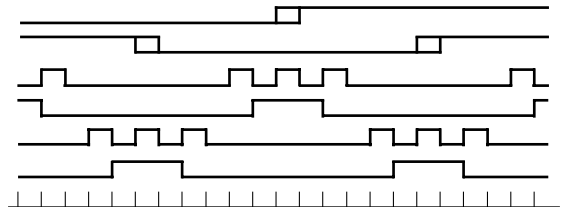
• 1-2-phase excitation

Phase 1
Phase 2
I₀, 1(A)
I₀, 1(B)

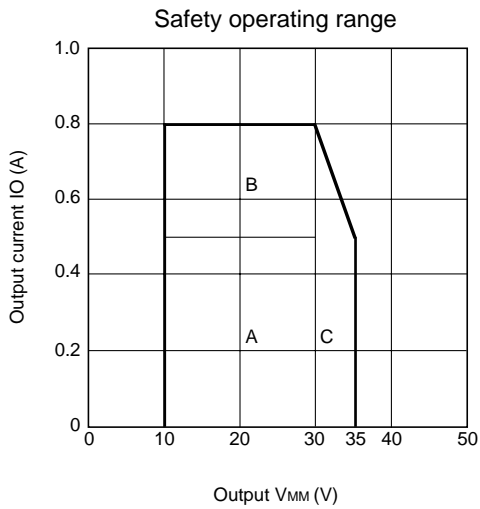


• Microstep

Phase 1
Phase 2
I₀(A)
I₁(A)
I₀(B)
I₁(B)



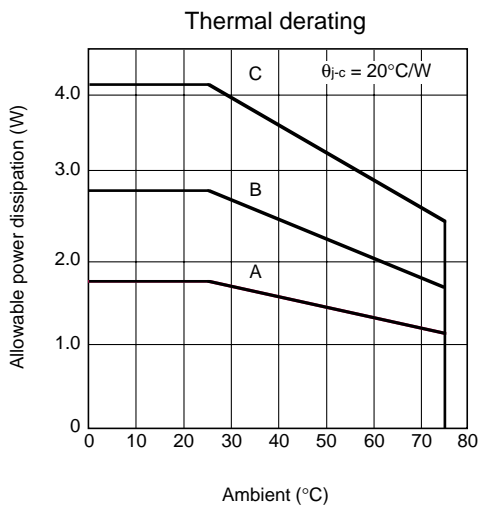
TYPICAL CHARACTERISTICS (ABSOLUTE MAXIMUM RATINGS)



A : Recommended

B : Schottky diodes should be externally connected between output pin and power supply pin.

C : Schottky diodes should be externally connected between output pin and power supply pin and between output pin and GND pin.



A : Free air
($\theta_{c-a} = 50^\circ\text{C/W}$)

B : With 10cm² aluminum heat
($\theta_{c-a} = 25^\circ\text{C/W}$)

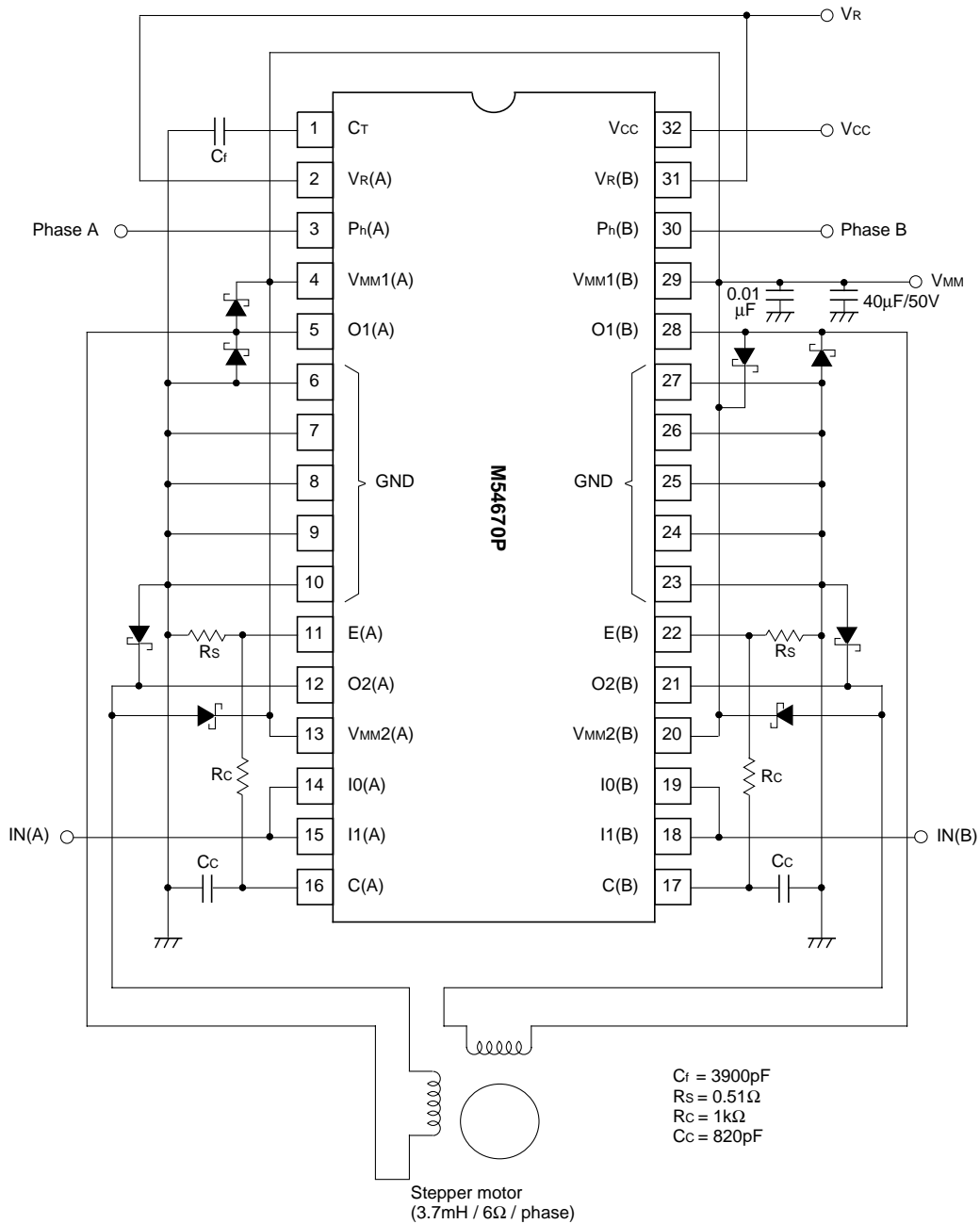
C : With 100cm² aluminum heat
($\theta_{c-a} = 10^\circ\text{C/W}$)

$T_{j(max)} = 150^\circ\text{C}$

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2-PHASE STEPPER MOTOR DRIVER

APPLICATION EXAMPLE (Stepping motor driver)



PRECAUTIONS FOR USE

- (1) When the whole output current changes by a large margin (for example, when thermal shutdown operation causes intermittent flow of output current), the supply voltage may undergo a change. Therefore, selection and wiring of power supply should be conducted cautiously to avoid such a situation that the supply voltage exceeds the absolute maximum ratings.
 - (2) When the supply voltage changes by a large margin, the operation of this IC may become unstable. In this case, the change of supply voltage can be controlled by connecting a capacitor between Vcc pin and GND pin.
 - (3) Thermal shutdown function
The state of thermal shutdown operation may differ according to the way of wiring within a board. Therefore, sufficient board evaluation should be conducted before use. When the board is changed, operation on the replacing board should be evaluated. The circuit board on which this IC is mounted is designed to realize low impedance between power supply and output pin. Therefore, it is desirable to take a safe measure such as fixing a fuse to avoid such a situation that the board is damaged by a fire when output pin is internally short-circuited by excessively applied surge voltage by accident.
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