M54676P

2-PHASE STEPPER MOTOR DRIVER

DESCRIPTION

The M54676P is a semiconductor IC to drive a bipolar stepper motor by the micro step method by changing the coil current of the motor continuously.

FEATURES

- Highly-accurate micro step drive by chopping sink output transistor and source output transistor simultaneously
- Bipolar and constant current drive
- Built in a thermal shutdown circuit and standby circuits
- Built in flywheel diodes

APPLICATION

Office automation equipment such as printer and FAX

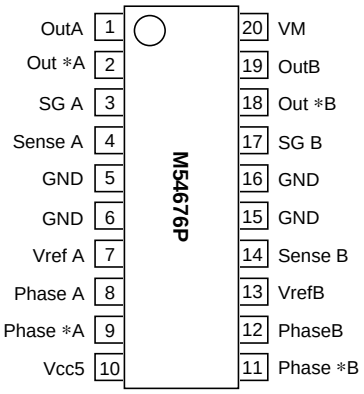
FUNCTION

The M54676P can drive a stepper motor by the 2-phase bipolar method and also controls the coil current.

Furthermore, it controls the direction of the coil current by Ph input and the coil current value by Vref pin.

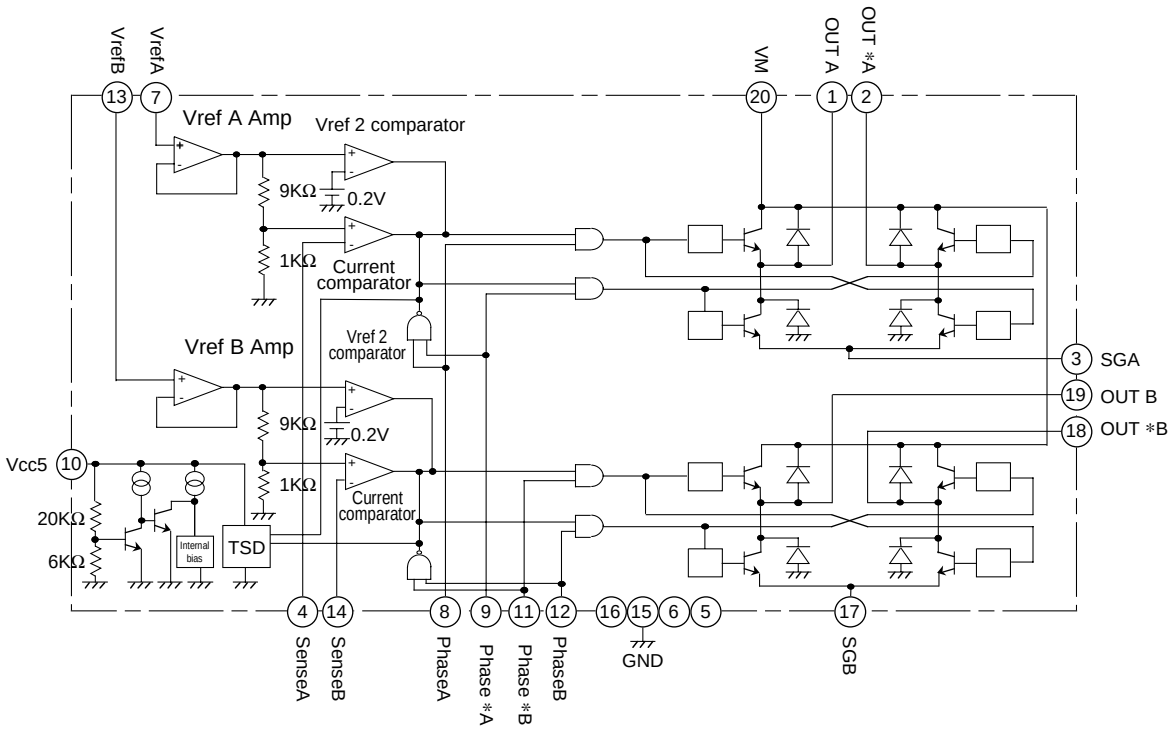
Because two control circuits are built in this IC, a stepper motor can be driven with a single IC by the 2-phase bipolar method.

PIN CONFIGURATION (TOP VIEW)



Outline 20P4

BLOCK DIAGRAM



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

Symbol	Parameter	Conditions	Ratings	Unit
VM	Supply voltage 1	Pin ⑳	Vcc5 – 20	V
Vcc5	Supply voltage 2	Pin ⑩	-0.3 – 7	V
Iout	Maximum output current		±500	mA
Vanalg	Analog input voltage	Pins ④ ⑦ ⑬ and ⑭	-0.3 – 7	V
Vlogic	Logic input voltage	Pins ⑧ ⑨ ⑪ and ⑫	-0.3 – 7	V
Pt	Allowable loss	100mm x 100mm, t=1.6mm Glass epoxy board (θ ja=50˚C/W)	2.5	W
Kθ	Thermal derating	ditto	20.0	mW/˚C
Tj	Junction temperature		150	˚C
Ta	Operating temperature		0 – 75	˚C
Tstg	Storage temperature		-20 – 125	˚C

ELECTRICAL CHARACTERISTICS (DC CHARACTERISTICS) (Ta=25˚C, VM=12V, Vcc=5V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
Vsat	Output saturation voltage	Load=350mA (total)		1.35	1.8	V
Vcc5 H	Vcc5 input voltage H	Pin ⑩ (Vcc5) voltage (Operating mode)	4.5	5.0	5.5	V
Vcc5 L	Vcc5 input voltage L	Pin ⑩ (Vcc5) voltage (Standby mode)	0		0.8	V
Icc10	Circuit current	Pin ⑩ current (Vcc5=5V)		38	57	mA
Icc20	VM reactive current	Pin ⑳ current (VM=12V, Vcc5=5V)		6	20	mA
Istby	Standby VM current	Pin ⑳ current (VM=12V, Vcc5=0V)		0	100	μA
Ivref	Vref input bias current	Vref=0V	-200	-10		nA
Vref	Vref amplifier input voltage range	See Vref-Vsense characteristics 12-4 Vcoff : Comparator OFF reference voltage	Vcc off		Vcc5 -1.5	V
Vsense	Sense pin threshold voltage	Sense pin voltage when output changes at Vref=2.5V	230	250	270	mV
Vcoff	Comparator OFF reference voltage		0.1	0.2	0.3	V
Vin H	Logic input voltage H	Pins ⑧ ⑨ ⑪ and ⑫	2.0		Vcc5	V
Vin L	Logic input voltage L	Pins ⑧ ⑨ ⑪ and ⑫	0		0.8	V
Iin H	Logic input current H	Pins ⑧ ⑨ ⑪ and ⑫ =5V		0	10	μA
Iin L	Logic input current L	Pins ⑧ ⑨ ⑪ and ⑫ =0V	-20	-7		μA
Isense	Sense input current	Pins ④ ⑭ =0V	-15	-2		μA
Ioff	Output cutoff current	Pins ① ② ⑪ and ⑫		0	100	μA

ELECTRICAL CHARACTERISTICS (AC CHARACTERISTICS) (Ta=25˚C, VM=12V, Vcc=5V, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
Tdon	Output turn-on delay	Time required to turn on output when Sense pin voltage is decreased from 0.5V to 0V at Vref=2.5V		0.3	1.0	μS
Tdoff	Output turn-off delay	Time required to turn off output when Sense pin voltage is increased from 0V to 0.5V at Vref=2.5V		1.5	2.5	μS
Tdamp	Vref amplifier response time	Time required to turn on output when Vref pin voltage is increased from 0V to 3.5V at Sense=0.25V		10	30	μS
Tdph	Phase delay time	Time required to turn on output when Phase pin voltage is increased from 0V to 5V at Vref=2.5V and Sense=0V	Tdoff Tdon	3	12	μS

FUNCTION DESCRIPTION

• Phase input

Phase input decides the output mode.

PhaseA (PhaseB)	Phase ∗A (Phase ∗B)	OutA (OutB)	Out ∗A (Out ∗B)
H	L	H	L
L	H	L	H
H	H	Z	Z
L	L	Z	Z

*Z: High impedance

In order to prevent through current caused by turning on output transistors simultaneously at PhaseA=Phase ∗A="H", both phase inputs go in the high mode simultaneously and output goes in the high impedance state.

Furthermore, as a countermeasure against output through current at the time of phase switching, a delay time (3us) to turn on the motor drive output when phase input goes in high state is set within the IC.

• Vref input (Comparative voltage)

Chopper current (motor current) is controlled by changing Vref input voltage.

By inputting SIN wave to VrefA and COS wave to VrefB, A-phase coil current and B-phase coil current change continuously and the microstep drive of a stepper motor is performed.

• Current comparator

Sense pin voltage (voltage fall at current sensing resistor = motor current) and Vref input proportional voltage (Vref/10) are compared.

Sense pin voltage < Vref/10: the comparator output is in high state and output transistors are turned on. Then, current flows into the motor.

Sense pin voltage > Vref/10: the comparator output is in low state and output transistors are turned off. Current does not flow into the motor.

The above operation is repeated to control the current of the motor.

• Vref comparator

Vref input proportional voltage {(Vref/10)} and internal reference voltage are compared. If Vref input voltage is 0.3V or lower, output transistors are turned off and motor current stops regardless of Phase input and Sense input.

• Standby circuit

When Vcc5 voltage is 0.8V or below or open, the IC goes in the standby state. In the standby state, leak current does not flow into VM power supply, logic input pins (Phase input), and analog input pins (Vref input and Sense input). Never forget to set VM power supply to be the maximum voltage level among all voltages applied to the IC in the standby state. (As for details, refer to "PRECAUTIONS FOR USE.")

• Thermal shutdown (TSD) circuit

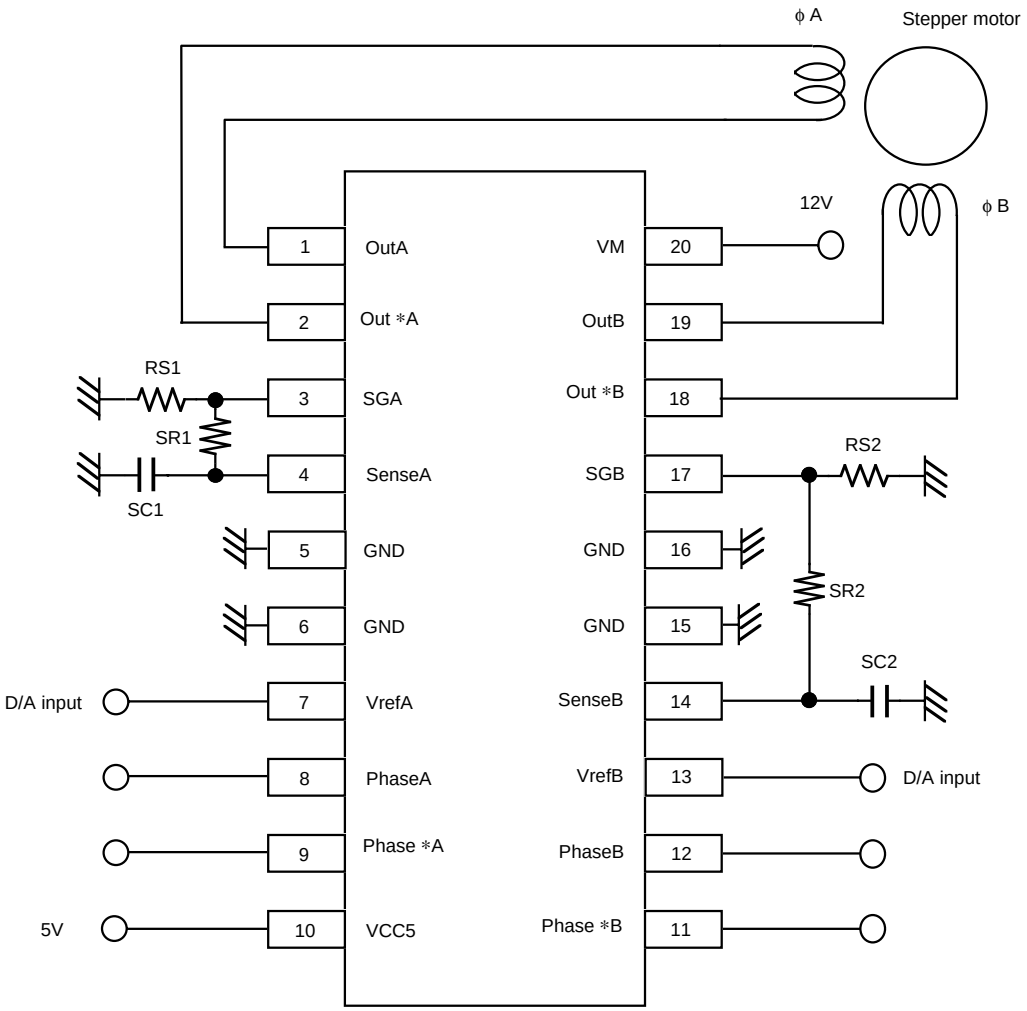
This IC has the thermal shutdown function to protect itself against damage by a fire when chip temperature rises abnormally.

• Flywheel diode

Because flywheel diodes for chopper current control are built in this IC, it is not necessary to connect external flywheel diodes.

Also, by connecting schottky diodes with low VF externally, it is possible to reduce thermal loss.

APPLICATION EXAMPLE



RS1,RS2 = 0.5Ω
SR1,SR2 = 1.6KΩ
SC1,SC2 = 0.1μF

PRECAUTIONS FOR USE

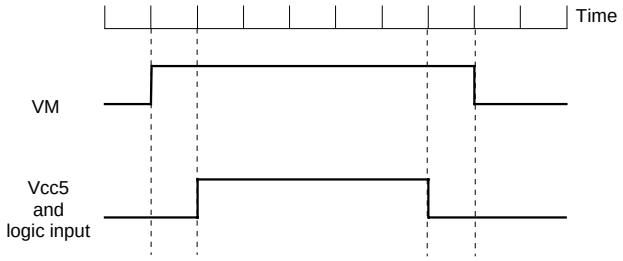
Sequence of supply voltage (VM and Vcc5) and logic input voltage

The VM voltage should be the maximum voltage among all voltages applied to this IC. If no voltage is applied to VM and 5V voltage is applied to Vcc5 pin and logic input pin, leak current flows from Vcc5 pin and logic input pin to VM through a surge protection diode.

VM	Vcc5	Logic input	Mode
12V	5V	5V,0V	Normal operation mode
12V	0V (Open)	5V,0V	Standby mode (No current flows to logic input pin and Vcc pin.)
0V (Open)	5V	5V,0V	Leak current flows from Vcc5 pin and logic input pin to VM pin. (Prohibited)

Sequence

After the VM voltage rises, set the Vcc5 power supply voltage and logic input voltage. Similarly, after Vcc5 supply voltage and logic input voltage rise, raise the VM supply voltage.



Thermal shutdown function

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 excessive surge voltage applied externally by accident (or when the TSD function is damaged).

Thermal loss

In case that conditions for use (regarding supply voltage and output current) or a board used is changed, sufficient thermal evaluation should be conducted and design should be worked out to leave a margin for thermal loss. The higher the chopping frequency is, the larger switching loss within the IC becomes.

Wiring on the board

Current is controlled by flowing output current to the current sensing resistor (1 ohmlevel) to measure the voltage fall.
The output current performs the chopping operation at high speed. Therefore, wiring to flow current and to connect the high-impedance input pin (Vref) should be conducted carefully not to cause a cross talk.