MITSUBISHI <CONTROL / DRIVER IC>

M54671SP

2-PHASE STEPPER MOTOR DRIVER

DESCRIPTION

The M54671SP is a semiconductor IC to drive a bipolar stepper motor directly by controlling the coil current with the constant current method.

FEATURES

● Wide output current control range (20 – 1200mA)
● Bipolar and constant current
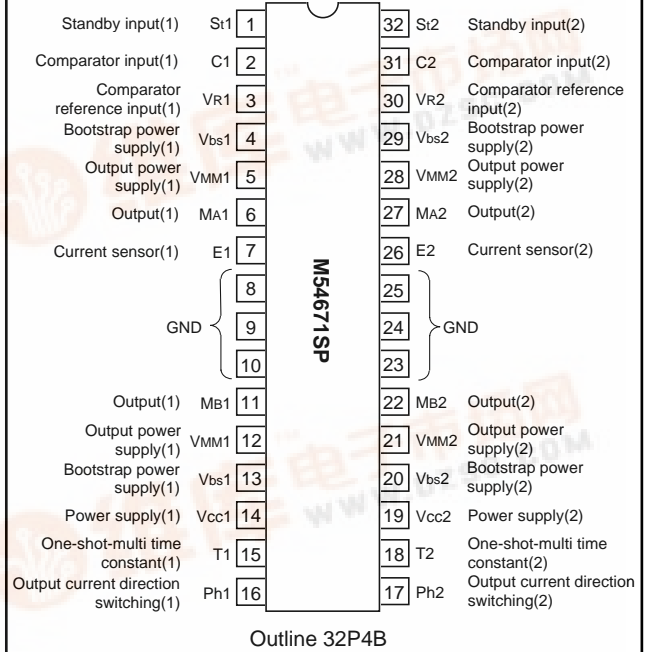● Built in a thermal shutdown circuit

APPLICATION

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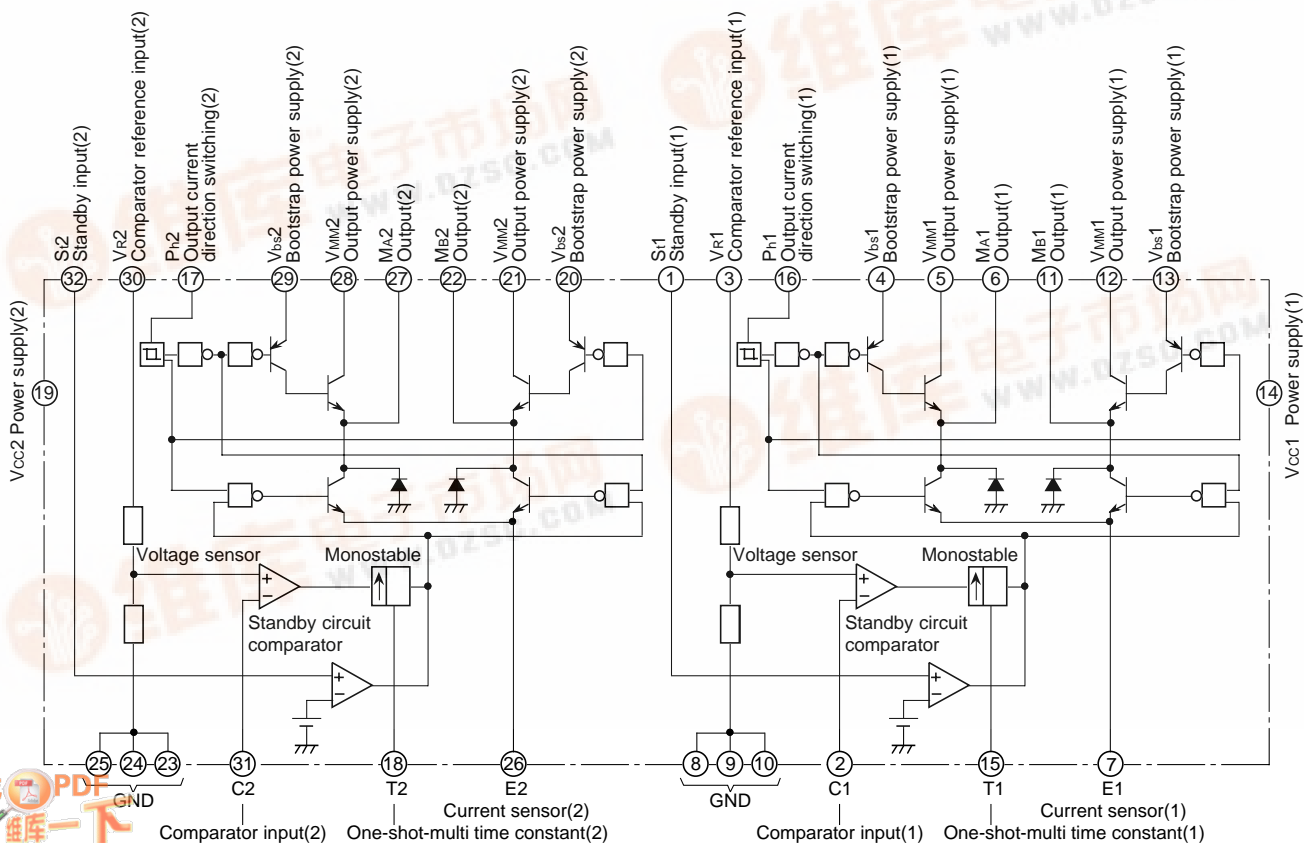
FUNCTION

The M54671SP 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 16 and 17) and the coil current value with V_R pins (pins 3 and 30).

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

PIN CONFIGURATION (TOP VIEW)

Left	Pin		Pin	Right
Standby input(1)	St1	1	32	St2	Standby input(2)
Comparator input(1)	C1	2	31	C2	Comparator input(2)
Comparator reference input(1)	VR1	3	30	VR2	Comparator reference input(2)
Bootstrap power supply(1)	Vbs1	4	29	Vbs2	Bootstrap power supply(2)
Output power supply(1)	VMM1	5	28	VMM2	Output power supply(2)
Output(1)	MA1	6	27	MA2	Output(2)
Current sensor(1)	E1	7	26	E2	Current sensor(2)
GND		8	25		GND
GND		9	24		GND
GND		10	23		GND
Output(1)	MB1	11	22	MB2	Output(2)
Output power supply(1)	VMM1	12	21	VMM2	Output power supply(2)
Bootstrap power supply(1)	Vbs1	13	20	Vbs2	Bootstrap power supply(2)
Power supply(1)	Vcc1	14	19	Vcc2	Power supply(2)
One-shot-multi time constant(1)	T1	15	18	T2	One-shot-multi time constant(2)
Output current direction switching(1)	Ph1	16	17	Ph2	Output current direction switching(2)

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 – 24	V
V_{bs}	Bootstrap supply voltage		-0.3 – 27	V
V_L	Logic input voltage		-0.3 – 6	V
V_C	Analog input voltage		-0.3 – V_{CC}	V
V_R	Comparative input voltage		-0.3 – 15	V
I_L	Logic input current		-10	mA
I_C	Analog input current		-10	mA
I_{MM}	Output supply current		±1500	mA
P_d	Allowable loss		1.70	W
T_{opr}	Operating temperature		-20 – 75	˚C
T_{stg}	Storage temperature		-55 – 125	˚C

RECOMMENDED OPERATING CONDITIONS (Ta=25˚C, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min.	Typ.	Max.	
V_{CC}	Supply voltage	4.5	5	5.5	V
V_{MM}	Output supply voltage	10	12	20	V
V_{bs}	Bootstrap supply voltage	$V_{bs} \geq V_{MM}+1V$		24	V
I_O	Output current	20	800	1200	mA
t_{PLH}	Logic input rise time			2	μs
t_{PHL}	Logic input fall time			2	μs
T_{ON}	Thermal shutdown		160		˚C

ELECTRICAL CHARACTERISTICS (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	420	450	480	mV
I_{CO}	Comparator input current			-20		20	μA
I_{OFF}	Output cutoff current					100	μA
V_{sat}	Saturation voltage		Voltage at sensing resistor is not included. V_{bs}=12.7V, V_{MM}=12V, I_O=800mA		1.0	1.5	V
t_{OFF}	Cutoff time		V_{MM}=12V, $t_{ON} \geq 5μs$	5	10	15	μs
t_d	Turn-off delay		$dVK/dt \geq 50mV/μs$		1.6	2.0	μs
I_{CC}	Supply current		V_{CC}=5V, 1phase			25	mA
I_{IH}	Logic input current	"H"	V_I=2.4V			100	μA
I_{IL}		"L"	V_I=0.4V	-0.4			mA

SWITCHING CHARACTERISTICS

Switching waveforms

V_{MA}-V_{MB} or V_{MB}-V_{MA}

$$T_{OFF} = 0.69 \times R_T \times C_T$$
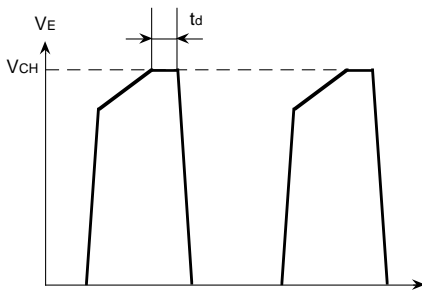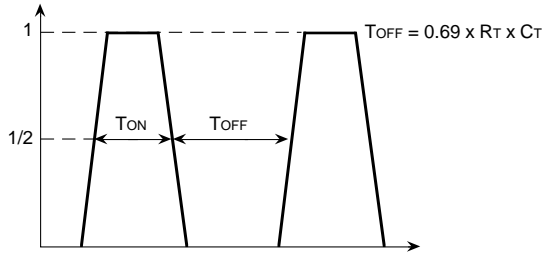
TIMING CHART
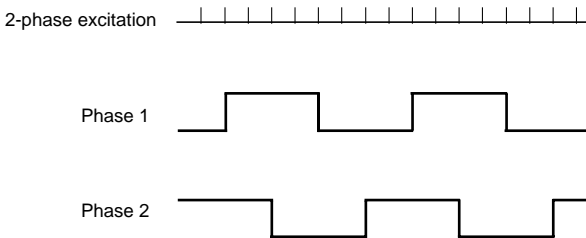
APPLICATION DESCRIPTION

(1) PHASE INPUT

Phase input decides the output mode.

PHASE	M_A	M_B
H	H	L
L	L	H

(2) V_R (Comparative voltage)

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

(3) Current sensor

When the voltage fall at the current sensing resistor and the selected current level become of the same level, the comparator triggers monostable. Then the output stage is cut off for a certain time (T_{OFF}). During this cutoff time, the current decreases slightly and falls short of the comparative level.

After the cutoff time (T_{OFF}), the output stage is in ON state again. This operation is repeated.

(4) Single pulse generator

At the comparator output rise edge, the monostable is triggered. The pulse width of the monostable at the external timing C_T and R_T is as follows.
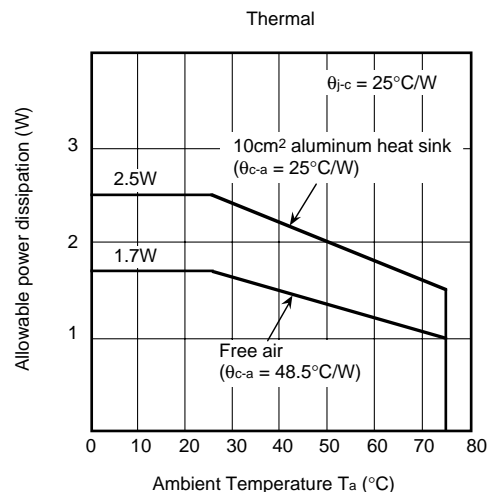
$$T_{OFF} = 0.69 \times C_T \times R_T$$

Retrigger during T_{OFF} is neglected.

(5) Analog control

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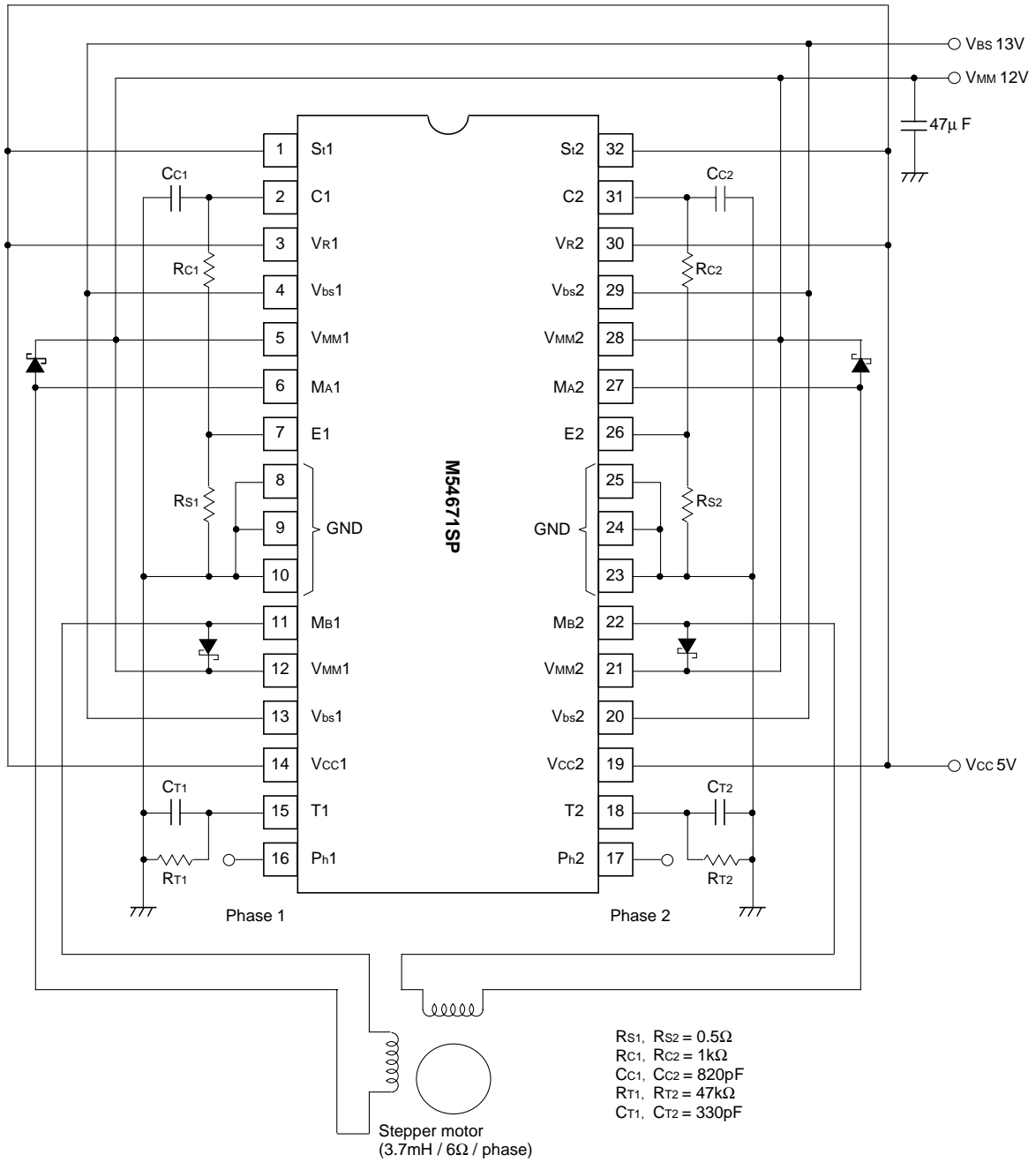
TYPICAL CHARACTERISTICS

Thermal

$\theta_{j-c} = 25°C/W$

10cm² aluminum heat sink
($\theta_{c-a} = 25°C/W$)

2.5W

1.7W

Free air
($\theta_{c-a} = 48.5°C/W$)

Allowable power dissipation (W)

Ambient Temperature T_a (°C)

APPLICATION EXAMPLE (Stepping motor driver)

VBS 13V

VMM 12V

47μ F

1	St1	St2	32
2	C1	C2	31
3	VR1	VR2	30
4	Vbs1	Vbs2	29
5	VMM1	VMM2	28
6	MA1	MA2	27
7	E1	E2	26
8	GND	GND	25
9			24
10			23
11	MB1	MB2	22
12	VMM1	VMM2	21
13	Vbs1	Vbs2	20
14	Vcc1	Vcc2	19
15	T1	T2	18
16	Ph1	Ph2	17

M54671SP

CC1
RC1
RS1
CT1
RT1

CC2
RC2
RS2
CT2
RT2

Phase 1

Phase 2

Vcc 5V

Stepper motor
(3.7mH / 6Ω / phase)

RS1, RS2 = 0.5Ω
RC1, RC2 = 1kΩ
CC1, CC2 = 820pF
RT1, RT2 = 47kΩ
CT1, CT2 = 330pF

PRECAUTIONS FOR USE

(1) Before use, never forget to short-circuit Vcc1 and Vcc2.

(2) 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.

(3) 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.

(4) 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.

(5) Flywheel

Flywheel diode is not built in this IC. Before use, connect a flywheel diode between each output ($M_{A}1$, $M_{B}1$, $M_{A}2$, and $M_{B}2$) and output power supply (V_{MM}). (Refer to APPLICATION EXAMPLE.)