5-phase Stepper Motor Pentagon Connection Driver ICs

SI-7502
SLA5011
SLA6503

■ Absolute maximum ratings

(Ta = 25°C)

Type No.	Parameter	Symbol	Ratings	Unit
SI-7502	Motor supply voltage	V_{CC}	44	V
	Auxiliary supply voltage	V_S	15	V
	Control voltage	V_b	7	V
	Reference voltage	V_{ref}	1.5	V
	Detected voltage	V_{RS}	5	V
	Power dissipation	P_D	1	W
	Ambient operating temperature	T_{OP}	0 to +65	°C
SLA5011	Drain source voltage	V_{DSS}	60	V
	Drain current	I_D	±5	A
	Avalanche energy proof quantity (Single pulse)	E_{AS}	2	mJ
	Power dissipation	P_T	35	W
	Channel temperature	T_{ch}	150	°C
	Storage temperature	T_{stg}	−40 to +150	°C
SLA6503	Collector-Base voltage	V_{CBO}	−60	V
	Controller-Emitter voltage	V_{CEO}	−60	V
	Emitter-Base voltage	V_{EBO}	−6	V
	Collector current	I_C	−3	A
	Collector current (Pulse)	I_C (pulse)	−6	A
	Base current	I_B	−1	A
	Power dissipation	P_T	35	W
	Junction temperature	T_j	150	°C
	Storage temperature	T_{stg}	−40 to +150	°C

SI-7502, SLA5011 and SLA6503

■ Electrical characteristics

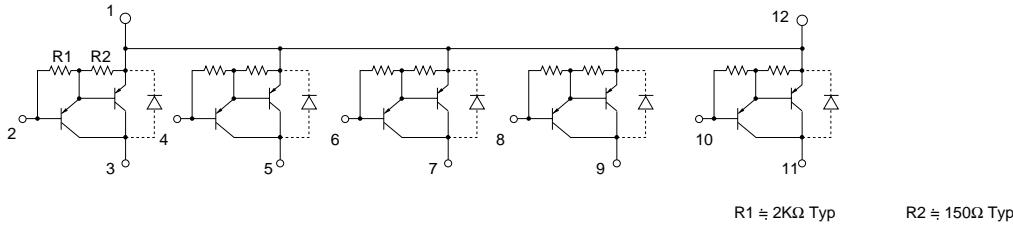| Type No.	Parameter	Symbol	Limit min	Limit typ	Limit max	Unit	Condition
SI-7502	Supply current	I_{CC}			40	mA	$V_{CC} = 42V$, $V_b = 5.5V$
		I_S			12.5	mA	$V_S = 12.4V$
		I_b			50	mA	$V_b = 5.5V$
	Input current	I_{IU-L}, I_{IL-L}			1.6	mA	$V_{IU} = V_{IL} = 0.4V$
	Upper drive circuit drive current	I_{OU}-on	8		11	mA	$V_b = 5V$, AIU to EIU pin open
		I_{OU}-off			10	μA	$V_b = 5V$
	Lower drive circuit voltage	V_{OL}-on	V_S–1.5			V	$V_b = 5V$, AIL-EIL pin open
		V_{OL}-off			1.5	V	$V_b = 5V$
	Oscillation frequency	F	20		30	kHz	$V_b = 5V$
	Detected current	V_{RS}	0.8		1.05	V	$V_b = 5V$, Vref pin
SLA5011	Gate threshold voltage	V_{TH}	2.0		4.0	V	$V_{DS} = 10V$, $I_D = 250$μA
	Current transmission conductance	Re(yfs)	2.2	3.3		S	$V_{DS} = 10V$, $I_D = 5A$
	DC ON-resistance	$R_{DS}(ON)$		0.17	0.22	Ω	$V_{GS} = 10V$, $I_D = 5A$
	Input capacity	C_{ISS}		300		pF	$V_{DS} = 25V$, f = 1.0MHz,
	Output capacity	C_{OSS}		160		pF	$V_{GS} = 0V$
	Di forward voltage between source and drain	V_{SD}		1.1	1.5	V	$I_{SD} = 5A$
	Di reverse recovery time between source and drain	trr		150		ns	$I_{SD} = \pm100$mA
SLA6503	Collector cut-off current	I_{CBO}			−10	μA	$V_{CB} = −60V$
	Collector emitter voltage	V_{CEO}	−60			V	$I_C = −10$mA
	DC current gain	h_{FE}	2000				$V_{CE} = −4V$, $I_C = −3A$
	Collector emitter saturation voltage	$V_{CE}(sat)$			−1.5	V	$I_C = −3A$, $I_B = −6$mA

■ Block diagram
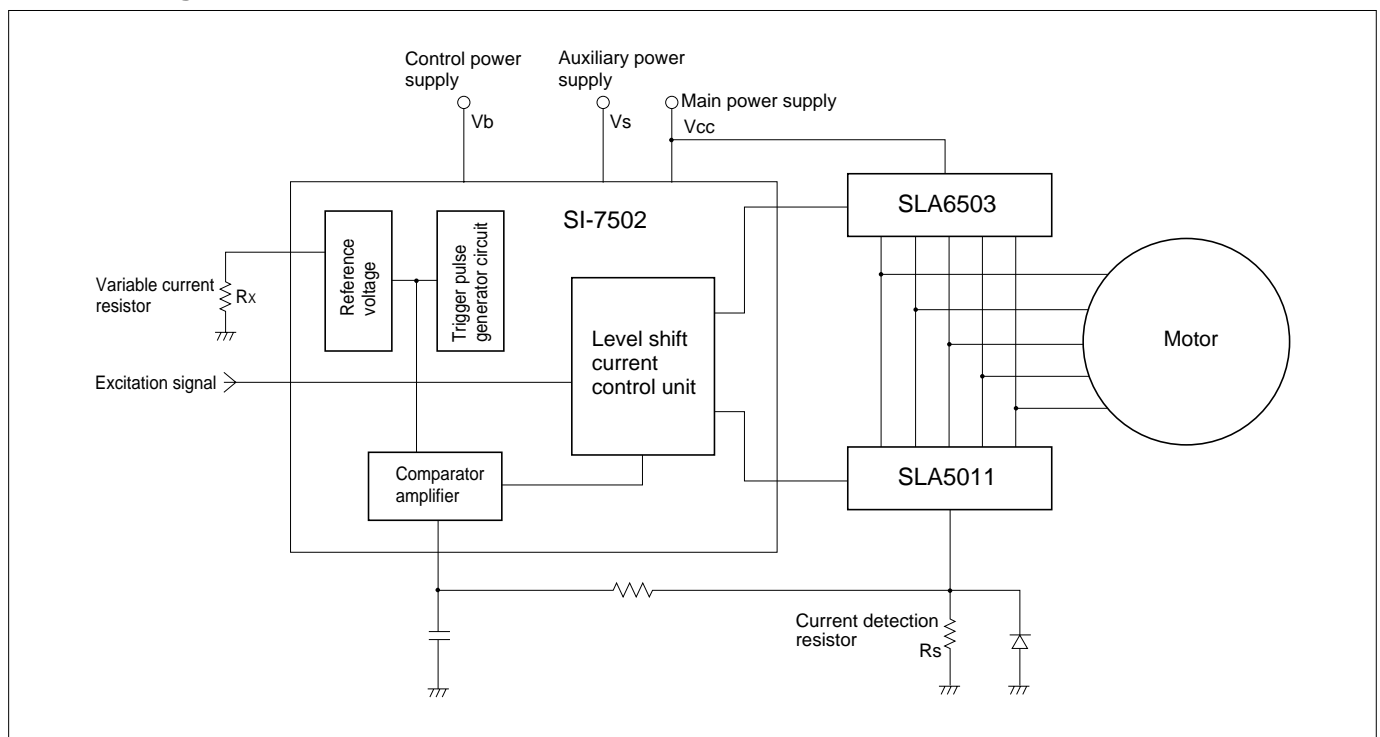
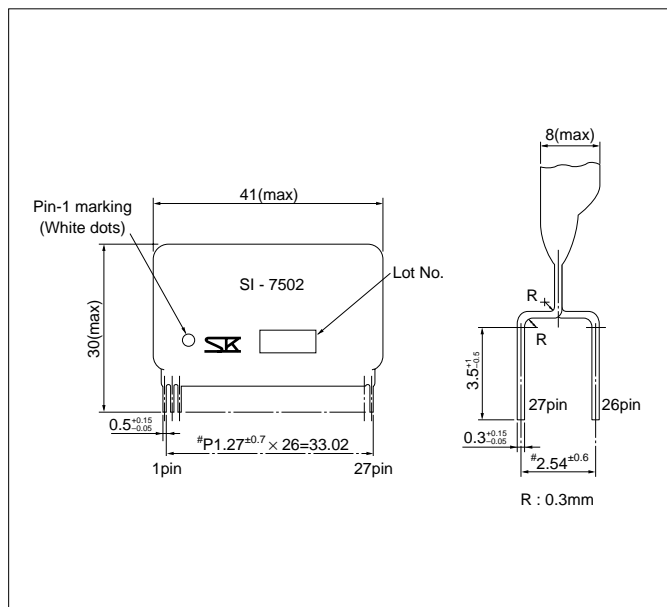# SI-7502, SLA5011 and SLA6503

■ Equivalent circuit diagram

SI-7502

SLA6503

R1 ≒ 2KΩ Typ   R2 ≒ 150Ω Typ
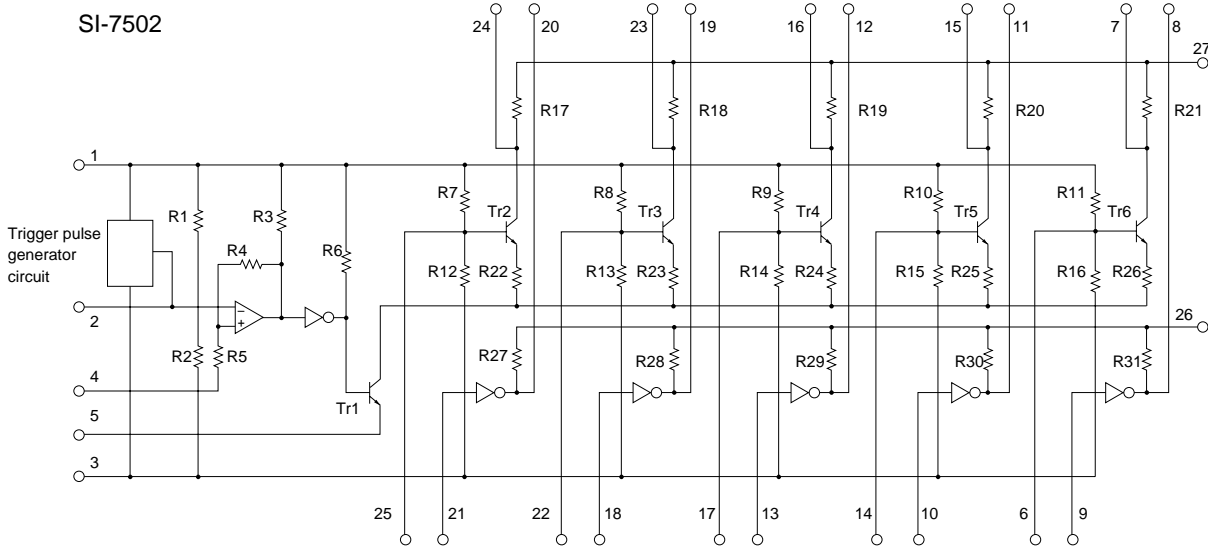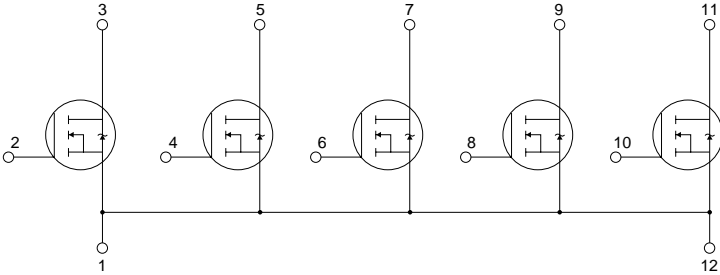
SLA5011

SI-7502, SLA5011 and SLA6503

■ External connection diagram

VB (5V)
VS(12V)
VCC(15~42V)

C1 : 100 μF/63V
C2 : 50 μF/25V
C3 : 10 μF/10V
C4 : 470pF
R1 : 1kΩ
DI : RK-34 (Sanken)

C3 +
C1 + C2 +

1 26 27

Aiu 7407 25
Biu 22
Ciu 17
Diu 14
Eiu 6

Excitation signal input

Ail 7406 21
Bil 18
Cil 13
Dil 10
Eil 9

Activ High

SI-7502

24 2
23 4
16 6
15 8
7 10

20 2
19 4
12 6
11 8
8 10

SLA6503
1 12
3
5
7
9
11

SLA5011
1 12
3
5
7
9
11

Ao
Bo
Co
Do
Eo

Stepper motor

2 3 5 4
RX
PD
1 12 IO
R1
C4
RS DI

$I_O \text{ (typ)} = 0.92/R_S$
$I_{OPD} \text{ (typ)} = (1.3 \times a - 0.01) / R_S$
$a = V_b \times R' / (30000 + R')$
$R' = 5100 \times R_X / (5100 + R_X)$

■ External dimensions (Unit: mm)

SI-7502

Pin-1 marking (White dots)
41(max)
8(max)
SI - 7502
Lot No.
30(max)
$0.5^{+0.15}_{-0.05}$
#P1.27±0.7 × 26=33.02
1pin 27pin
$3.5^{+1}_{-0.5}$
27pin 26pin
$0.3^{+0.15}_{-0.05}$
#2.54±0.6
R : 0.3mm

SLA6503/SLA5011

$\phi 3.2^{\pm 0.15}$
31.0±0.2
24.4±0.2
16.4±0.2
3.2±0.15 × 3.8
4.8±0.2
1.7±0.1
16.0±0.2
13.0±0.2
9.9±0.2
8.5max.
Lead board thickness resin 0.8 max.
SK JAPAN
a
b
9.5min(10.4)
2.7
Pin 1 12
1.2±0.15
$0.85^{+0.2}_{-0.1}$
1.45±0.15
11×P2.54±0.7=27.94±1.0
$0.55^{+0.2}_{-0.1}$
2.2±0.7
31.5max.
1 2 3 4 5 6 7 8 9 10 11 12
a : Type No.
b : Lot No.
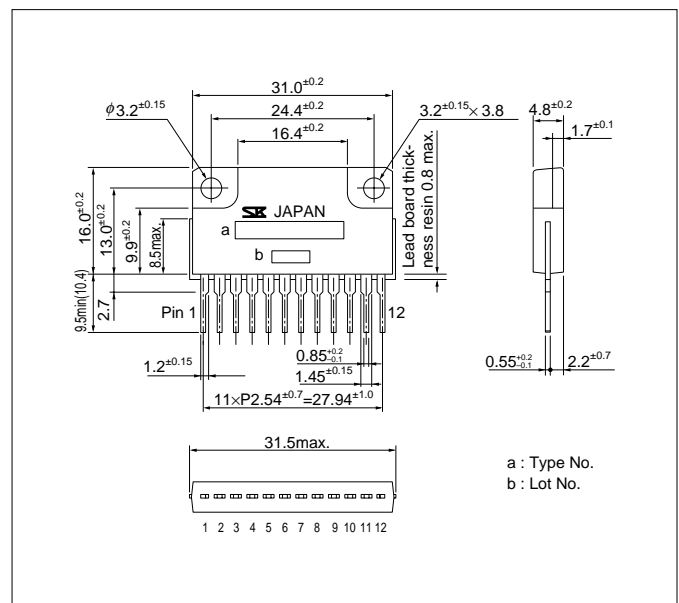
Application Note

■ Determining the output current Io (motor coil current)

The main elements that determine the output current are Current detection resistor Rs, Supply voltage Vb, and Variable current resistor R_X.

(1) Normal mode

To operate a motor at maximum current level, set R_X to infinity (open).

From Fig. A, when the maximum output current ripple is designated as I_{OH}, its value will be,

$$I_{OH} = \frac{V_{RSH}}{R_S} \quad\text{...} \quad [A]$$

V_{RSH} can be computed as follows:

$$V_{RSH} = 0.19 \times Vb - 0.03 \text{ (center value) ....} \quad [B]$$
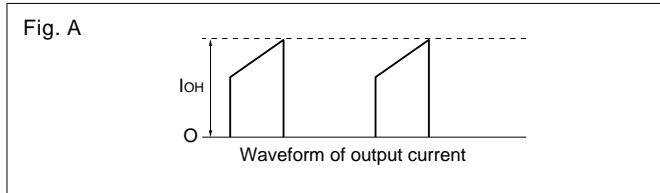
From equations [A] and [B], the output current I_{OH} can be computed as follows:

$$I_{OH} = \frac{I}{R_S} \ (0.19 \times Vb - 0.03)$$

The relationship between I_{OH} and R_S is shown in Fig. B.

(2) Power down mode

When an external resistor R_X is connected, V_{RSH} changes as shown in the Fig. C even when R_S is retained. Obtain the power down output current I_{OHPD} from Fig. C and equation [A].

Fig. A

Waveform of output current

■ Relation between Output Current Io (Control Current) and Motor Winding Current I_{OM}

The SI-7502 adopts the total current control system; therefore, the output current Io is different from the motor winding current. In a general pentagonal driving system, the current flows as shown in Figure D. The relation between Io and I_{OM} is as follows:

$$Io = 4 \times I_{OM}$$

The following relation is obtained depending on driving systems:

$$Io = 2 \times I_{OM}$$
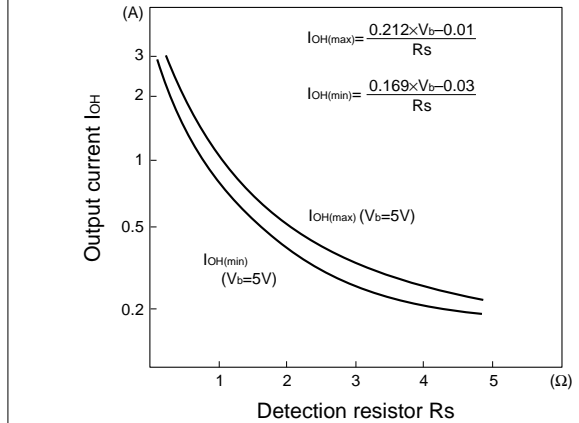
Fig. B Output current vs. Current detection resistor

$$I_{OH(max)} = \frac{0.212 \times V_b - 0.01}{R_s}$$

$$I_{OH(min)} = \frac{0.169 \times V_b - 0.03}{R_s}$$

$I_{OH(max)}$ (Vb=5V)

$I_{OH(min)}$ (Vb=5V)

Output current I_{OH} (A)

Detection resistor Rs (Ω)

Fig. C Detection voltage vs. Variable current resistor

$$V_{RSH(max)} = \frac{7.2 \times R_x}{152.6 + 33.8 \times R_x} \times V_b - 0.01$$

$$V_{RSH(min)} = \frac{6.1 \times R_x}{152.6 + 33.8 \times R_x} \times V_b - 0.03$$

$V_{RSH(max)}$ (Vb=5V)

$V_{RSH(min)}$ (Vb=5V)

Detection voltage V_{RSH} (V)

Variable current resistor Rx (KΩ)
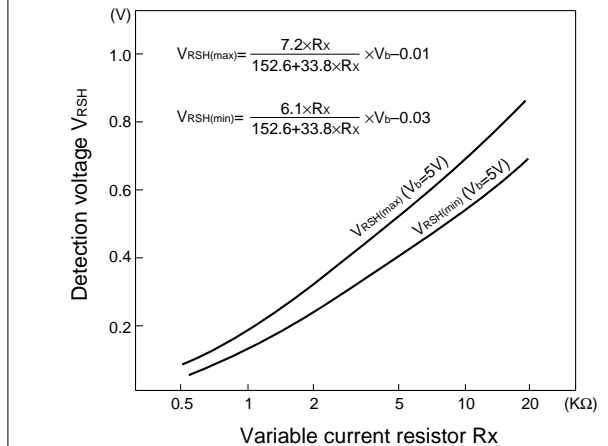
Fig. D Coil current flow at pentagonal driving

I_{OM}

$2 \times I_{OM}$

Vcc

To SI-7502

Detection resistor RS $4 \times I_{OM}$
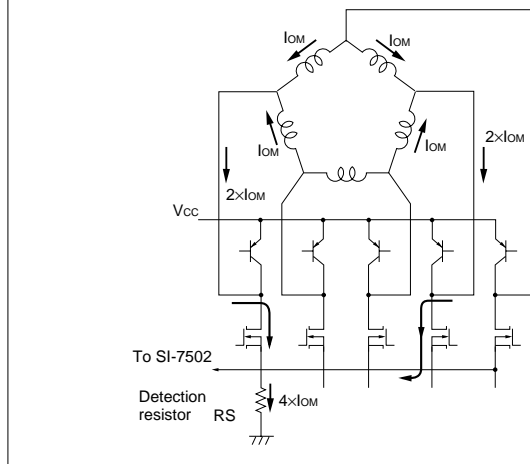
SI-7502, SLA5011 and SLA6503

■ Motor connection

The 5-phase stepping motor supports various driving systems and the motor connection varies depending on those driving systems.

In some driving systems, the use of the motor may be restricted by patents. Therefore, be sure to ask the motor manufacturer about the motor connection and driving system to be used.

■ Thermal design

The driver (SLA5011/SLA6503) dissipation varies depending on a driving system to be used even if those output currents (control current) are the same. Therefore, measure the temperature rise of the driver under the actual operation conditions and determine the size of heatsink.

Figure E shows an SLA5011/SLA6503 derating curve. This derating curve indicates $T_j = 150°C$; however, before using this device, set a margin and select a heatsink so that $T_c < 100°C$ (Al FIN temperature on the back of the SLA) is obtained.

Fig. E   SLA5011/SLA6503 Derating curve