5-phase Stepper Motor Pentagon Connection Driver ICs

SI-7502
SLA5011
SLA6503

■ Absolute maximum ratings

(Ta = 25°C)

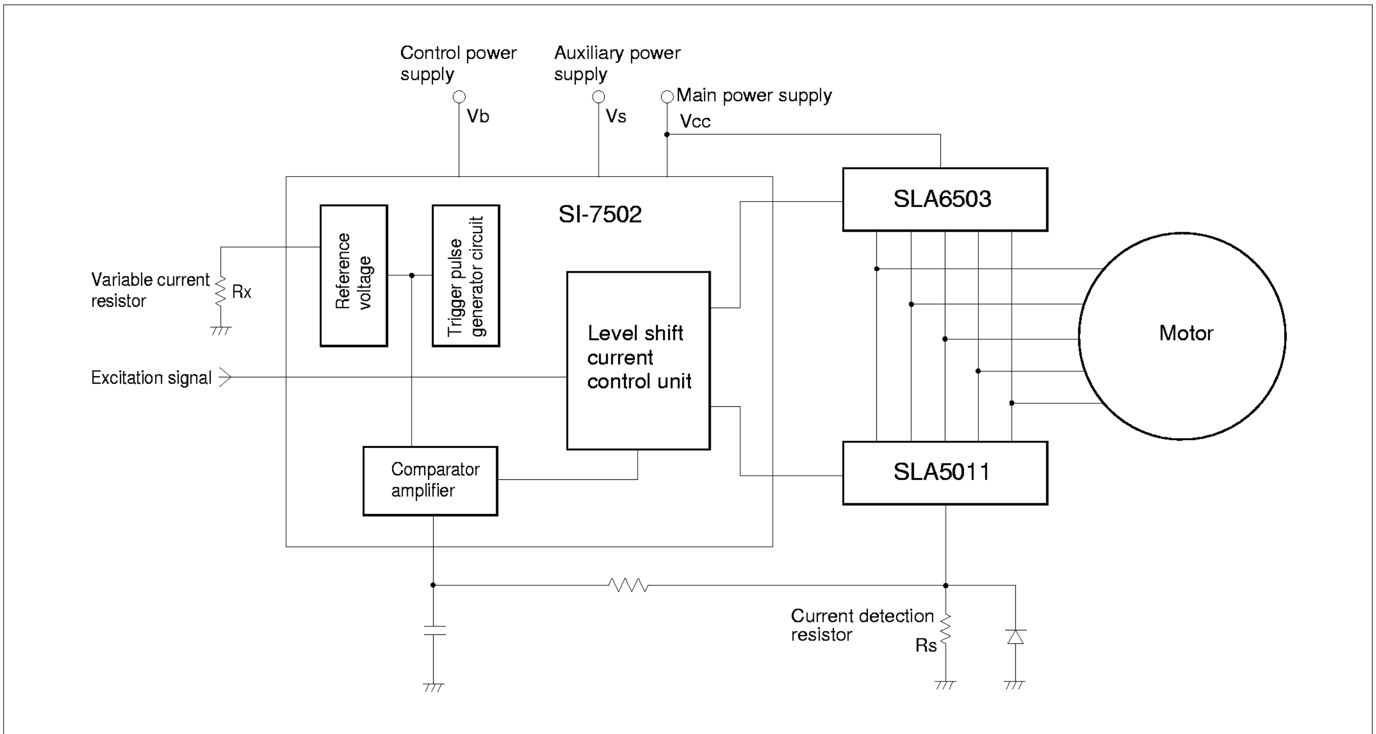
Type No.	Parameter	Symbol	Ratings	Unit
SI-7502	Motor supply voltage	V_{CC}	44	V
	Auxiliary supply voltage	V_S	15	V
	Control voltage	Vb	7	V
	Reference voltage	Vref	1.5	V
	Detected voltage	V_{RS}	5	V
	Power dissipation	P_D	1	W
	Ambient operating temperature	T_{OP}	0 to +65	°C
SLA5011	Drain source voltage	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	Tch	150	°C
	Storage temperature	Tstg	–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	Tj	150	°C
	Storage temperature	Tstg	–40 to +150	°C

SI-7502, SLA5011 and SLA6503

■ Electrical characteristics

Type No.	Parameter	Symbol	Limit			Unit	Condition
			min	typ	max		
SI-7502	Supply current	I_{CC}			40	mA	V_{CC} = 42V, Vb = 5.5V
		Is			12.5	mA	V_S = 12.4V
		Ib			50	mA	Vb = 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	Vb = 5V, AIU to EIU pin open
		I_{OU}-off			10	µA	Vb = 5V
	Lower drive circuit voltage	V_{OL}-on	V_S–1.5			V	Vb = 5V, AIL-EIL pin open
		V_{OL}-off			1.5	V	Vb = 5V
	Oscillation frequency	F	20		30	kHz	Vb = 5V
	Detected current	V_{RS}	0.8		1.05	V	Vb = 5V, Vref pin
SLA5011	Gate threshold voltage	V_{TH}	2.0		4.0	V	V_{DS} = 10V, ID = 250µA
	Current transmission conductance	Re(yfs)	2.2	3.3		S	V_{DS} = 10V, ID = 5A
	DC ON-resistance	R_{DS}(ON)		0.17	0.22	Ω	V_{GS} = 10V, ID = 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} = ±100mA
SLA6503	Collector cut-off current	I_{CBO}			–10	µA	V_{CB} = –60V
	Collector emitter voltage	V_{CEO}	–60			V	I_C = –10mA
	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 = –6mA

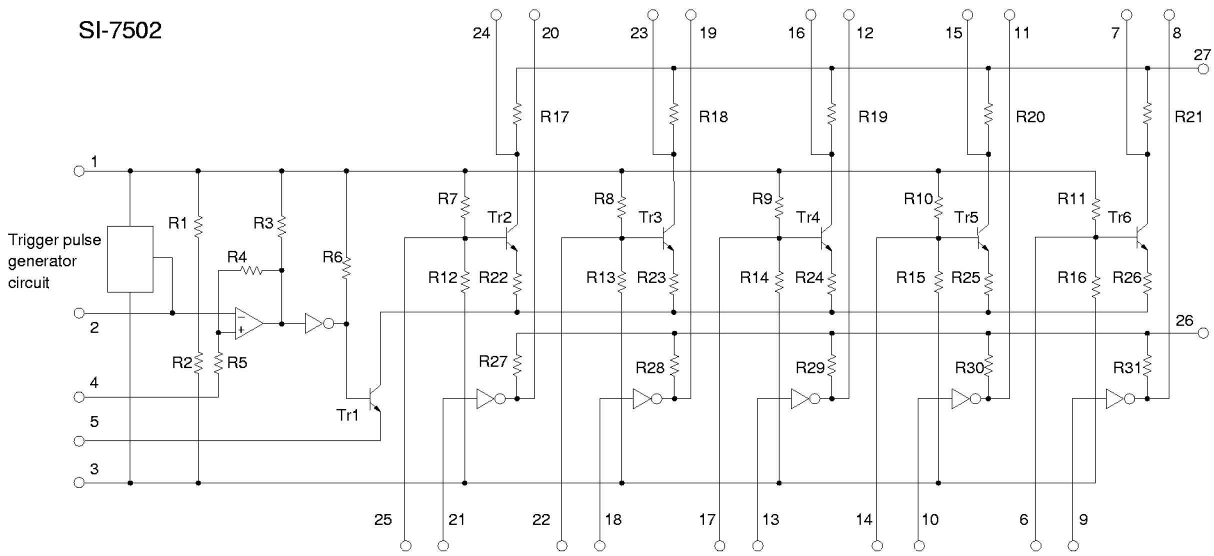
■ Block diagram



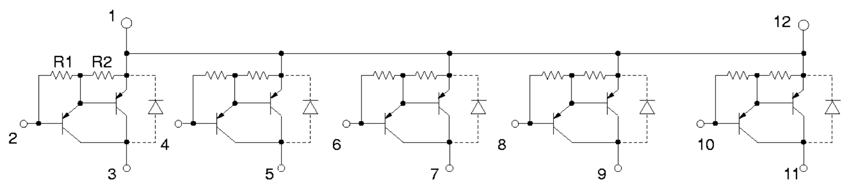
SI-7502, SLA5011 and SLA6503

■ Equivalent circuit diagram

SI-7502

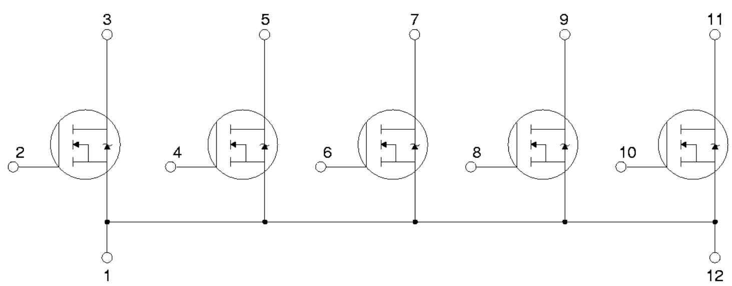


SLA6503



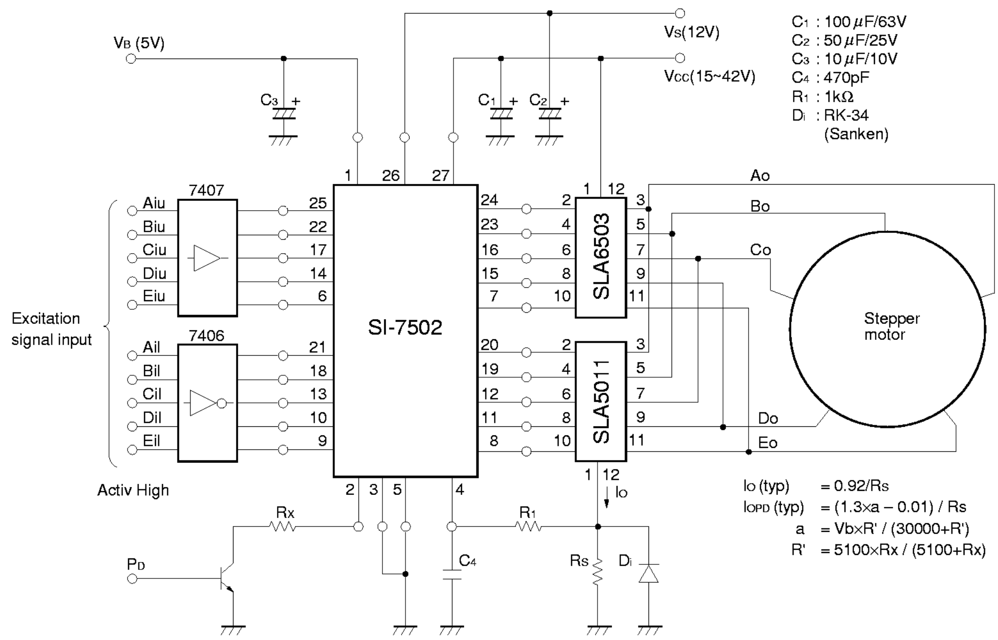
R1 ≒ 2KΩ Typ   R2 ≒ 150Ω Typ

SLA5011



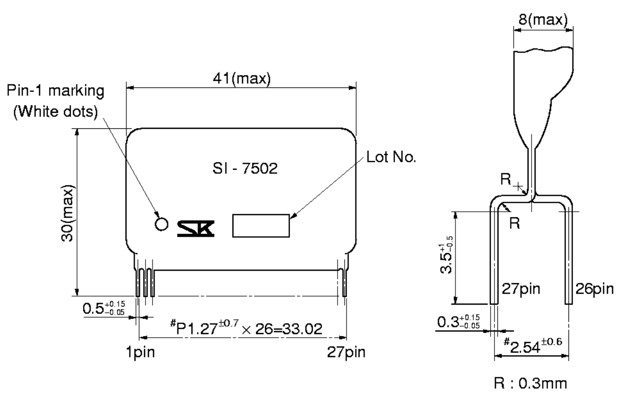
SI-7502, SLA5011 and SLA6503

■ External connection diagram

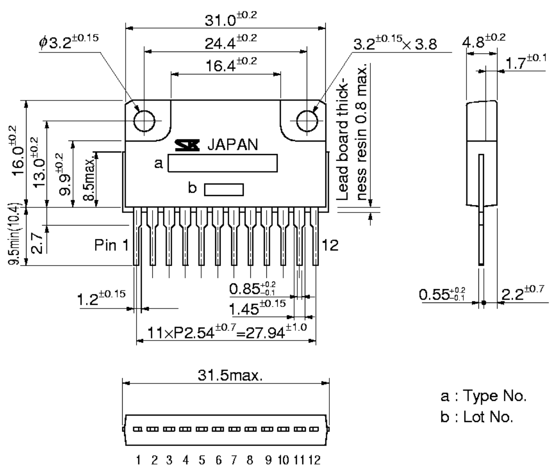


■ External dimensions (Unit: mm)

SI-7502



SLA6503/SLA5011



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 Rx.

(1) Normal mode
To operate a motor at maximum current level, set Rx to infinity (open).
From Fig. A, when the maximum output current ripple is designated as I_{OH}, its value will be,

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

V_{RSH} can be computed as follows:

$$V_{RSH} = 0.19 \times Vb - 0.03 \text{ (center value)} \quad \text{[B]}$$

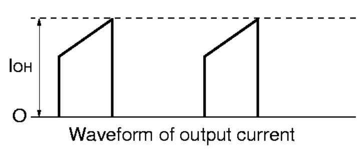
From equations [A] and [B], the output current I_{OH} can be computed as follows:

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

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

(2) Power down mode
When an external resistor Rx 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



■ 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

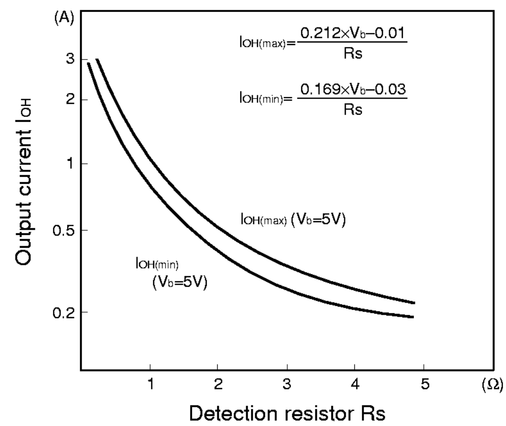


Fig. C Detection voltage vs. Variable current resistor

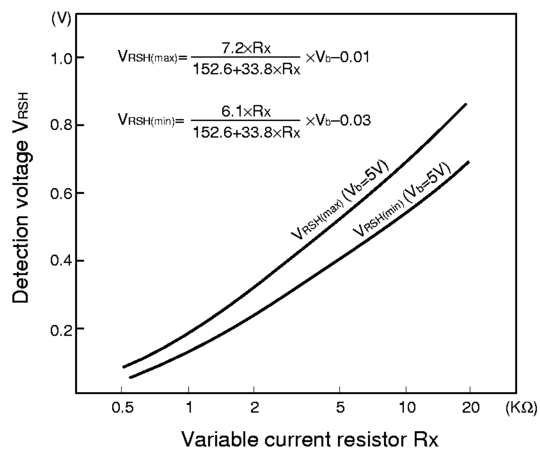
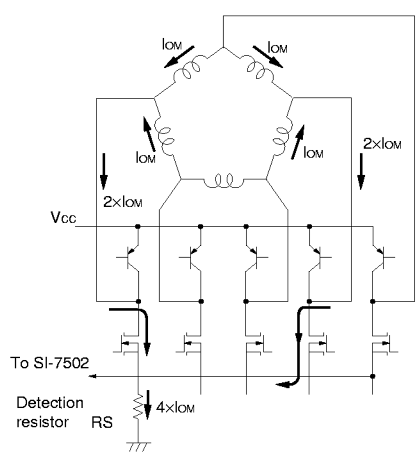


Fig. D Coil current flow at pentagonal driving



■ 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 Tj = 150°C; however, before using this device, set a margin and select a heatsink so that Tc < 100°C (Al FIN temperature on the back of the SLA) is obtained.

Fig. E SLA5011/SLA6503 Derating curve