SLA7020M SLA7021M WITH MOSFETs

■ Ratings

Absolute maximum ratings / Type No.	Motor supply Voltage (V)	FET output breakdown voltage (V)	Control voltage (V)	TTL input voltage (V)	Reference voltage (V)	Output current (A)	Power dissipation (W)	Channel temperature (°C)	Storage temperature (°C)
	V_{CC}	V_{DS}	V_S	V_{IN}	V_{REF}	I_O	P_D	T_{ch}	T_{stg}
SLA7020M	46	100	32	7	2	1.5	4.5 (No Fin)	150	–40 to +150
SLA7021M						3			

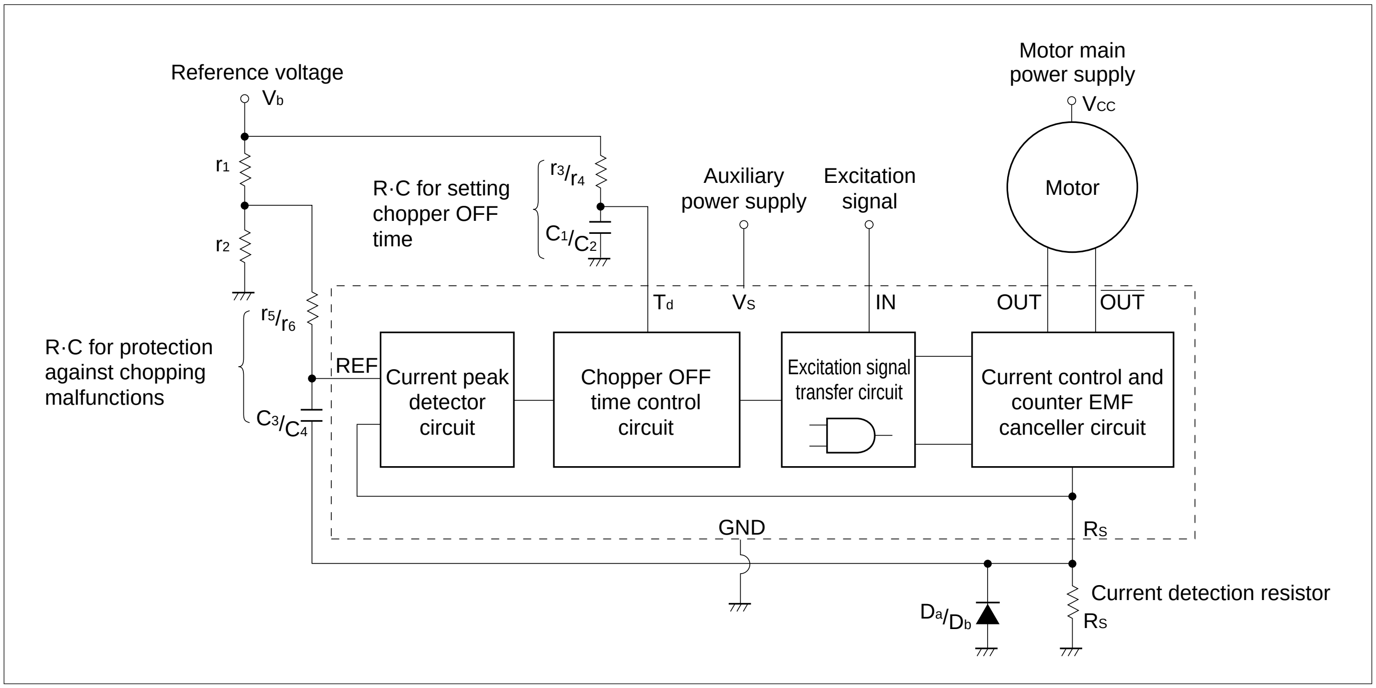
■ Characteristics (1) DC Characteristics

Electrical characteristics	Control current (mA)			Control voltage (V)			FET turn-on voltage (V)			FET drain leak current (mA)			TTL input current (μA)			TTL input current (mA)			TTL input voltage (OUT) (V)			TTL input voltage (V)			TTL input voltage ($\overline{OUT}$) (V)			TTL input voltage (V)		
	V_S = 30V						(7020M) I_D =1A, V_S =14V (7021M) I_D =3A, V_S =14V			V_{DSS} = 100V V_S = 30V			V_{IH} = 2.4V V_S = 30V			V_{IL} = 0.4V V_S = 30V			I_D = 1A			V_{DSS} = 100V			V_{DSS} = 100V			I_D = 1A		
	I_S			V_S			V_{DS}			I_{DSS}			I_{IH}			I_{IL}			V_{IH}			V_{IL}			V_{IH}			V_{IL}		
Type No.	min	typ	max	min	typ	max	min	typ	max	min	typ	max	min	typ	max	min	typ	max	min	typ	max	min	typ	max	min	typ	max	min	typ	max
SLA7020M	5.5	10	15	10	19	30			0.6			4			40			–0.8	2.0					0.8	2.0					0.8
SLA7021M									0.85																					

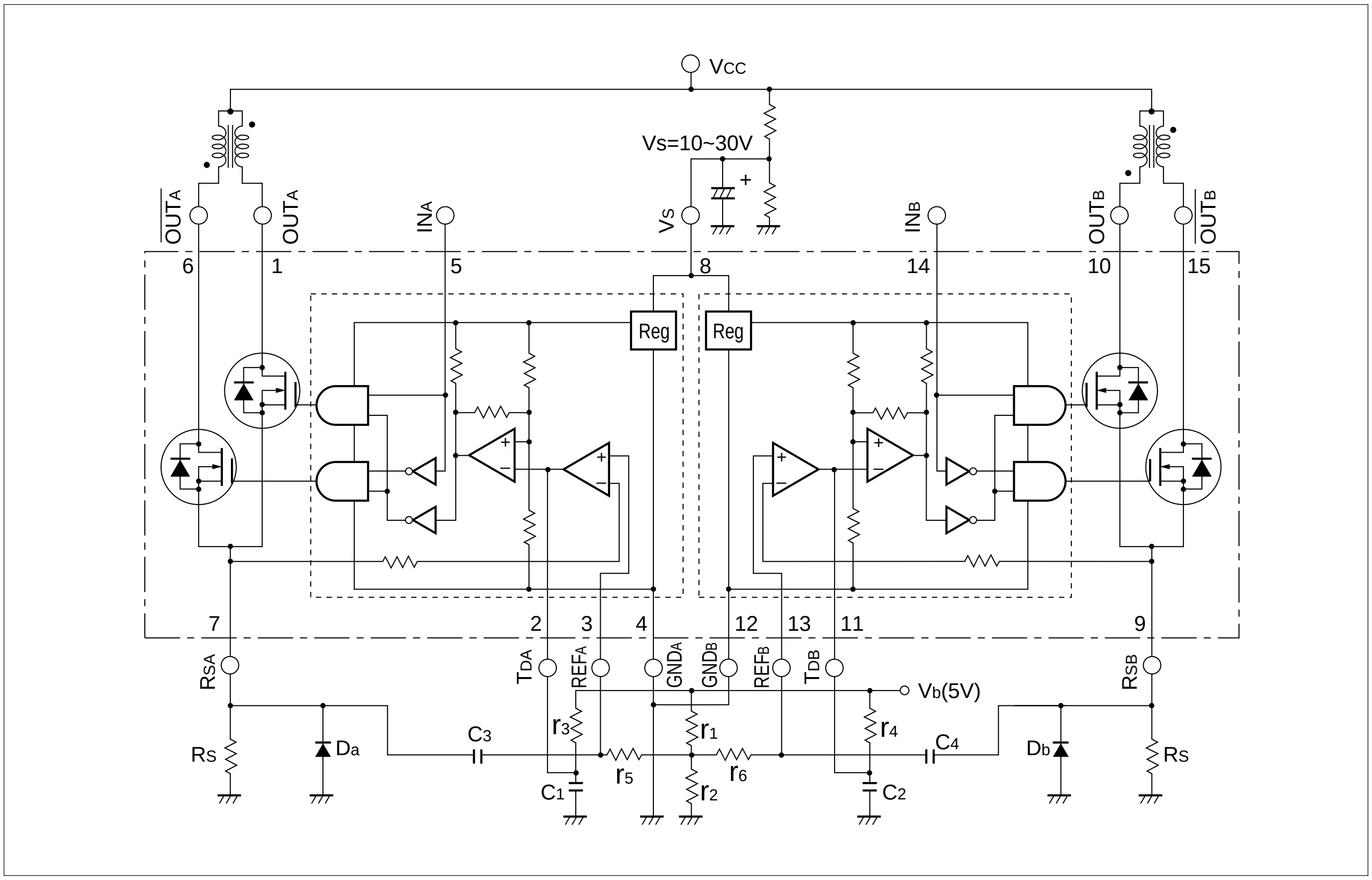
(2) AC Characteristics

Electrical characteristics	FET diode forward voltage (V)			Switching time (μs)								
	(7020M) I_{SD} = 1A (7021M) I_{SD} = 3A			V_S = 24V I_D = 1A								
	V_{SD}			T_r			T_{stg}			T_f		
Type No.	min	typ	max	min	typ	max	min	typ	max	min	typ	max
SLA7020M			1.1		0.5			0.7			0.1	
SLA7021M			2.3									

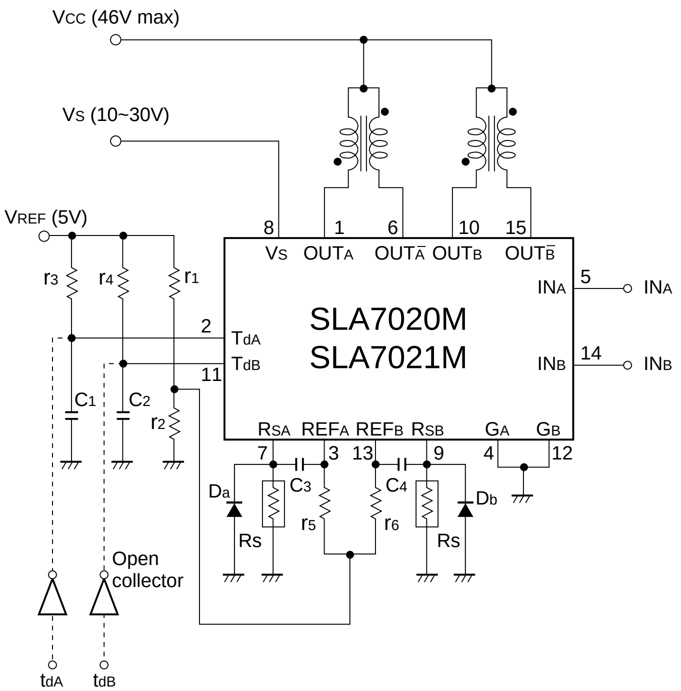
■ Block diagram



■ Internal circuit diagram (enclosed with chain line)



■ Diagram of standard external circuit (Recommended circuit constants)



Excitation signal time chart
2-phase excitation

clock	0	1	2	3	0	1
INA	H	H	L	L	H	H
INB	L	H	H	L	L	H

1-2 phase excitation

clock	0	1	2	3	4	5	6	7	0	1	2	3
INA	H	H	H	H	L	L	L	L	H	H	H	H
tdA	L	L	L	H	L	L	L	H	L	L	L	H
INB	L	L	H	H	H	H	L	L	L	L	H	H
tdB	L	H	L	L	L	H	L	L	L	H	L	L

• tdA and tdB are signals before the inverter stage.

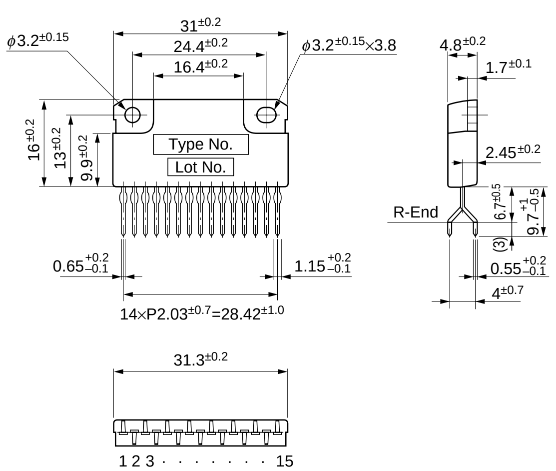
r1	510Ω
r2	100Ω (VR)
r3	47kΩ
r4	47kΩ
r5	2.4kΩ
r6	2.4kΩ
C1	470pF
C2	470pF
C3	2200pF
C4	2200pF

	7020M	7021M
Da. Db	EK03	RK34
Rs	1Ω typ	0.68Ω typ

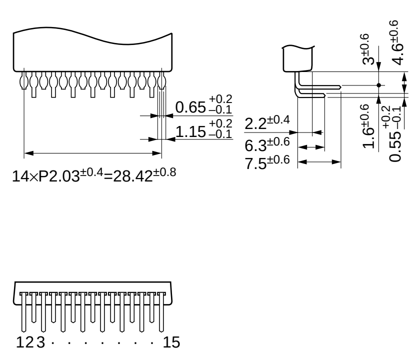
■ External dimensions

(Unit: mm)

Epoxy resin package



Forming number No. 853



Forming number No. 855

Application Note

■ Determining the output current

Fig. 1 shows the waveform of the output current (motor coil current). The method of determining the peak value (Io) of the output current based on this waveform is shown below.

<Parameters for determining the output current Io>

- V_b : Reference supply voltage
- r_1, r_2 : Voltage-divider resistors for the reference supply voltage
- R_s : Current detection resistor

(1) Normal rotation mode

Io is determined as follows when current flows at the maximum level during motor rotation. See Fig. 2, 3 and 4.

$$I_O \fallingdotseq \frac{r_2}{r_1+r_2} \bullet \frac{V_b}{R_s} \quad \text{......} \quad ①$$

(2) Power down mode

The circuits in Fig. 5, 6 and 7 (rx and Tr) are added in order to decrease the coil current. Io is then determined as follows.

$$I_{OPD} \fallingdotseq \frac{1}{1+\frac{r_1(r_2+r_x)}{r_2 \bullet r_x}} \bullet \frac{V_b}{R_s} \quad \text{......} \quad ②$$

To determine rx, equation ② can be modified to obtain equation ③.

$$r_x \fallingdotseq \frac{1}{\frac{1}{r_1}\left(\frac{V_b}{R_s \bullet I_{OPD}} - 1\right) - \frac{1}{r_2}} \quad \text{......} \quad ③$$

Fig. 1 Waveform of coil current (Phase A excitation ON)

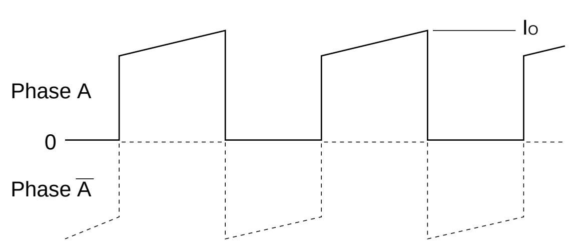


Fig. 2 Circuit for fixing the coil current

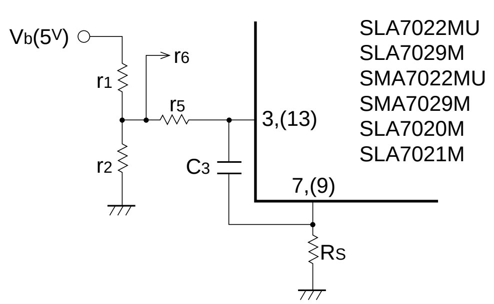


Fig. 3 Circuit for fixing the coil current

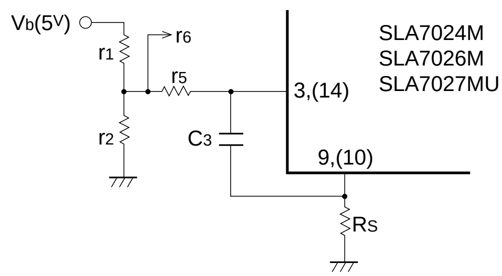


Fig. 4 Circuit for fixing the coil current

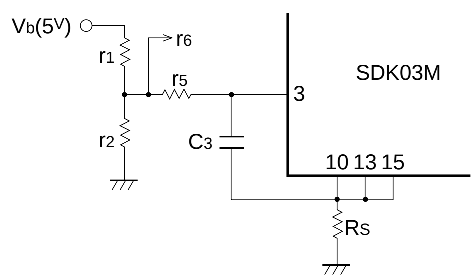
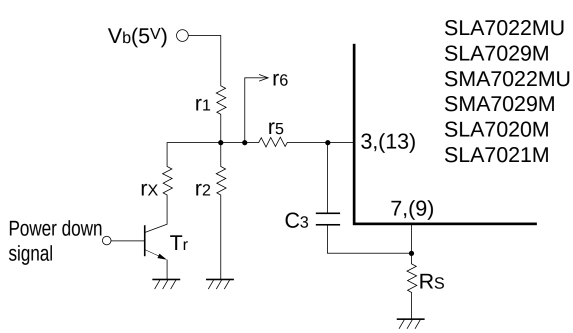


Fig. 5 Circuit for fixing the coil current



Application Note

Fig. 6 Circuit for fixing the coil current

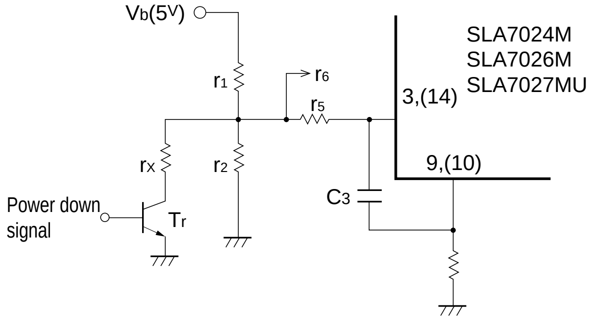


Fig. 7 Circuit for fixing the coil current

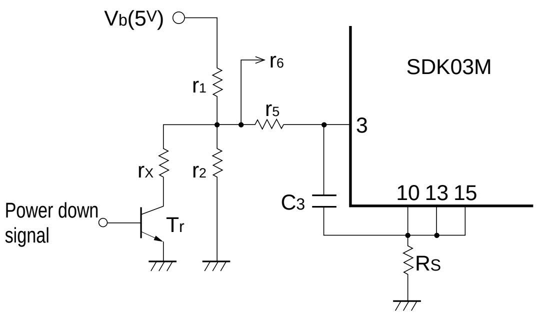


Fig. 8 and 9 show the graphs of equations ① and ②, respectively.

Fig. 8 Output current Io vs. Current detection resistor Rs

SLA7024M, SLA7026M, SLA7029M, SLA7027MU, SLA7022MU, SLA7020M, SLA7021M, SMA7029M, SMA7022MU, SDK03M

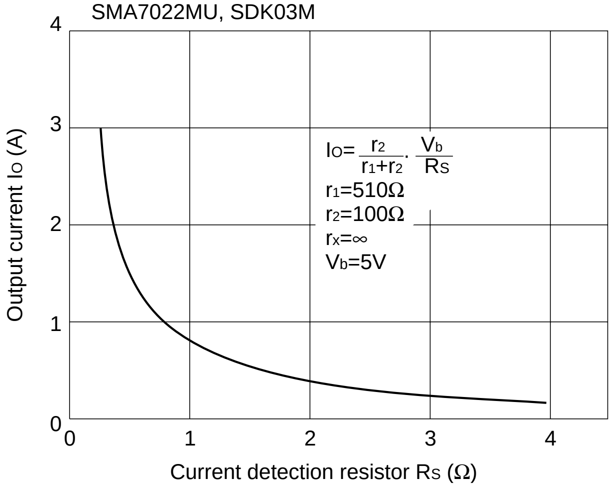
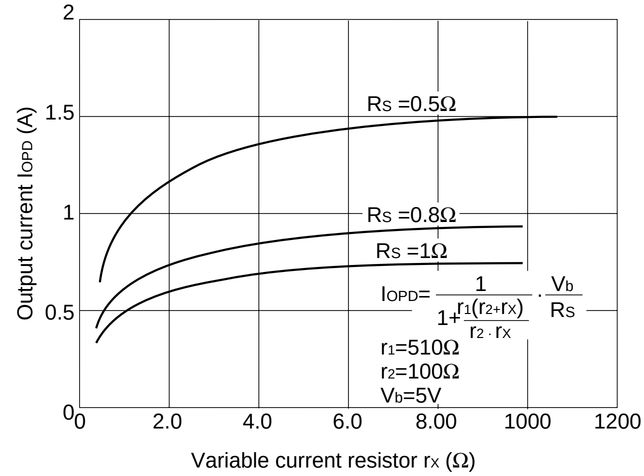


Fig. 9 Output current I_{OPD} vs. Variable current resistor r_x

SLA7024M, SLA7026M, SLA7029M, SLA7027MU, SLA7022MU, SLA7020M, SLA7021M, SMA7029M, SMA7022MU, SDK03M



NOTE:
Ringing noise is produced in the current detection resistor Rs when the MOSFET is switched ON and OFF through chopping. This noise is also generated in feedback signals from Rs which may therefore causes the comparator to malfunction.
To prevent chopping malfunctions, r_5(r_6) and C_3(C_4) are added in order to act as noise filter.
However, when the values of these constants are increased, the response from Rs to the comparator becomes slow. Hence, the value of the output current Io is higher to some extent than the computed value.

Application Note

■ Determining the chopper frequency

Determining T_{OFF}: SLA7000M series, SMA7000M series and SDK03M are self-excited choppers. The chopping OFF time T_{OFF} is fixed by r_3/C_1 and r_4/C_2 connected to terminal Td.

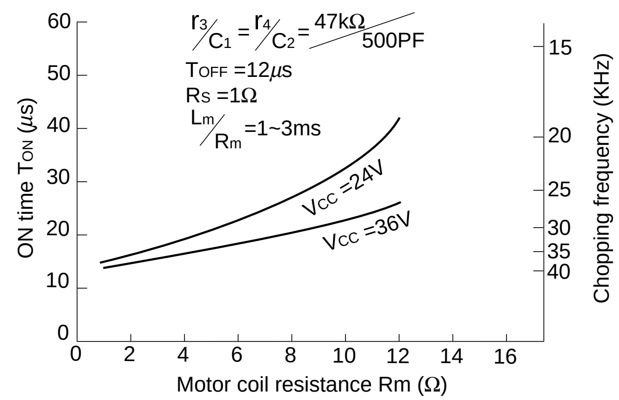
T_{OFF} can be computed through the following formula:

$$T_{OFF} \fallingdotseq -r_3 \bullet C_1 \ell n(1- \frac{2}{V_b}) = -r_4 \bullet C_2 \ell n(1- \frac{2}{V_b})$$

The circuit constants and the T_{OFF} value shown below are recommended.

T_{OFF}	=	12 µs
r_3	=	47 KΩ
C_1	=	500 pF
V_b	=	5 V

Fig. 10 Chopper frequency vs. Motor coil resistance



■ Thermal design

An outline on the method of computing heat dissipation is shown below.

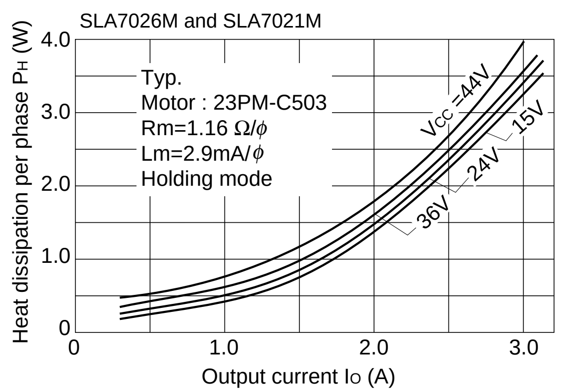
(1) Obtain the P_H that corresponds to the motor coil current I_O from Fig. 11 "Heat dissipation per phase P_H vs. Output current Io".

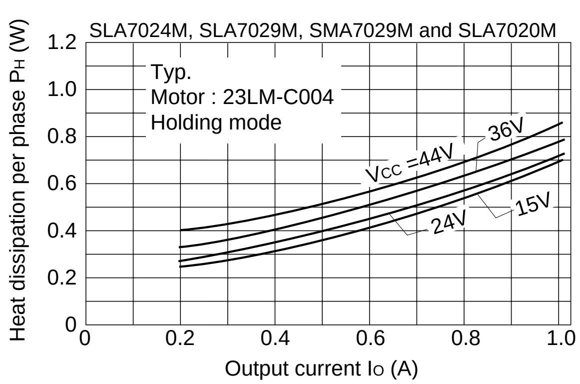
(2) The power dissipation Pdiss is obtained through the following formula.

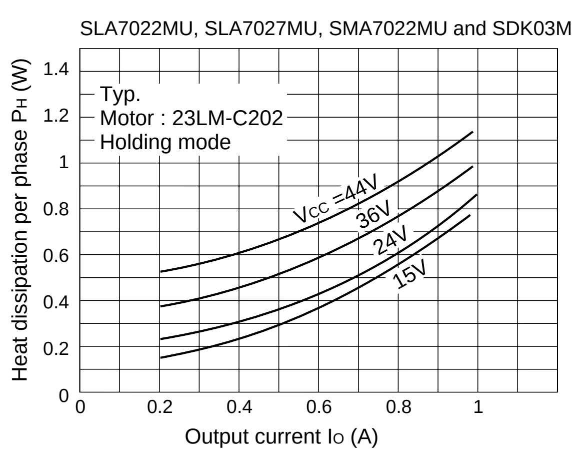
- SLA7000M and SMA7000M series
  2-phase excitation : $Pdiss \fallingdotseq 2P_H + 0.015 \times Vs$ (W)
  1-2 phase excitation : $Pdiss \fallingdotseq \frac{3}{2}P_H + 0.015 \times Vs$ (W)
- SDK03M
  2-phase excitation : $Pdiss \fallingdotseq P_H + 0.015 \times Vs$ (W)
  1-2 phase excitation : $Pdiss \fallingdotseq \frac{3}{4}P_H + 0.015 \times Vs$ (W)

(3) Obtain the temperature rise that corresponds to the computed Pdiss from Fig. 12 "Temperature rise curve."

Fig. 11 Heat dissipation per phase P_H vs. Output current Io

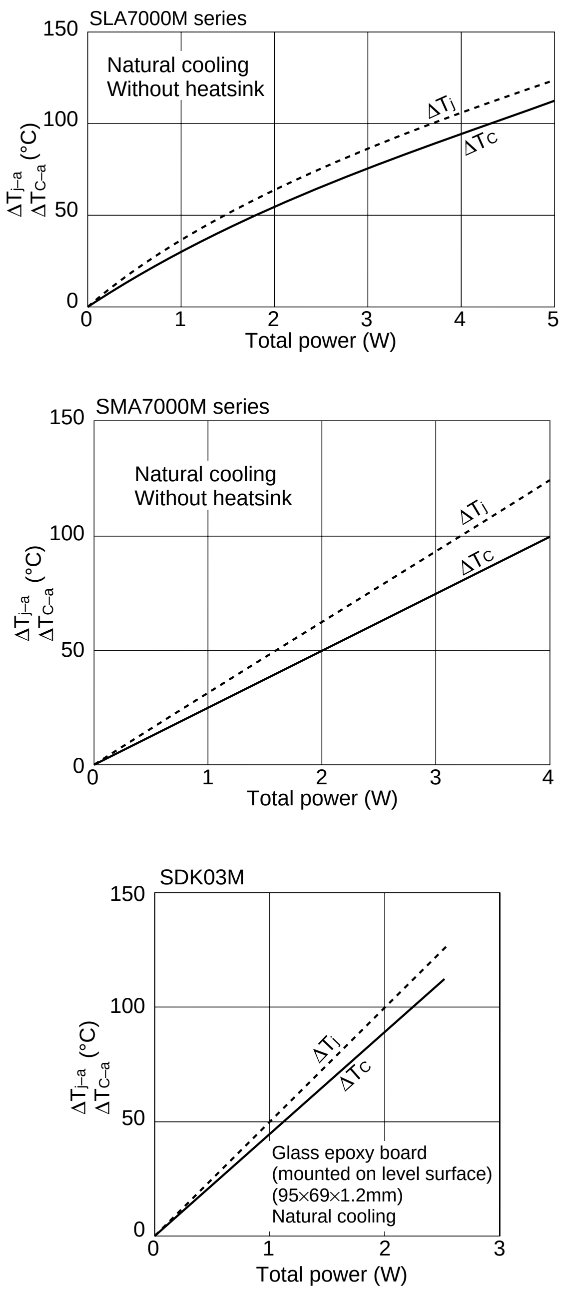




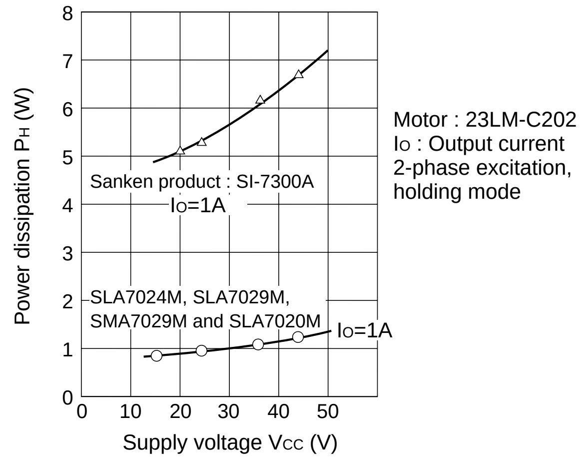


Application Note

Fig. 12 Temperature rise curve

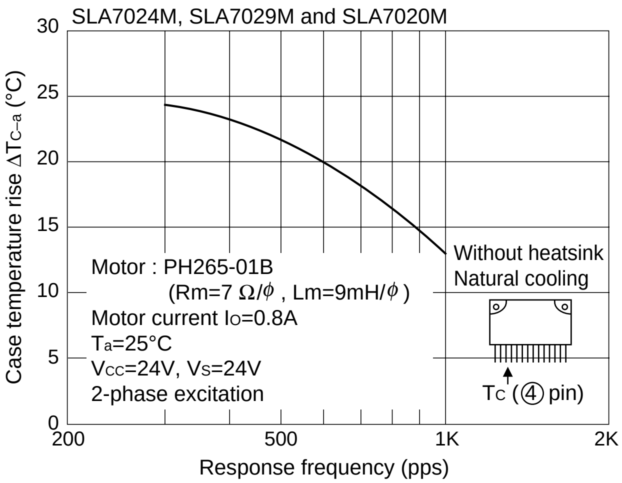


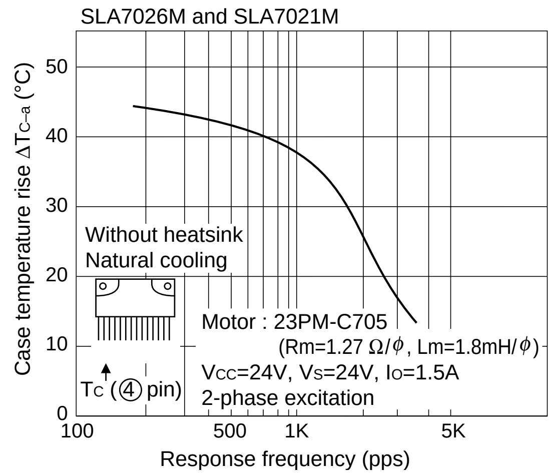
Comparison of losses

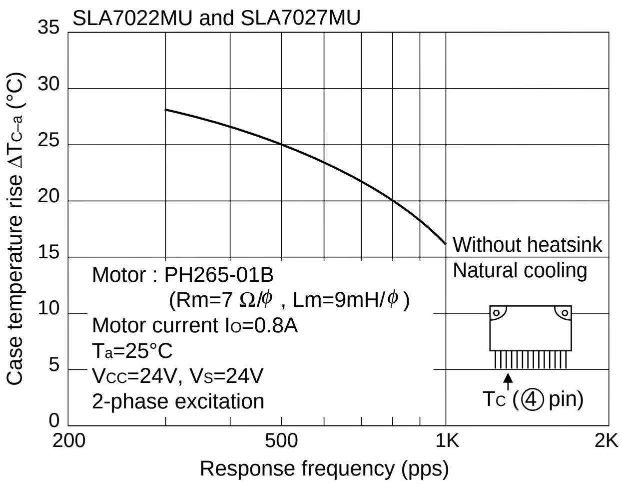


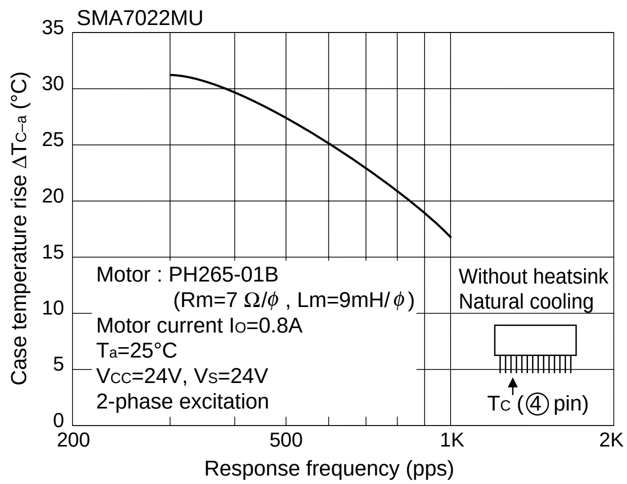
Application Note

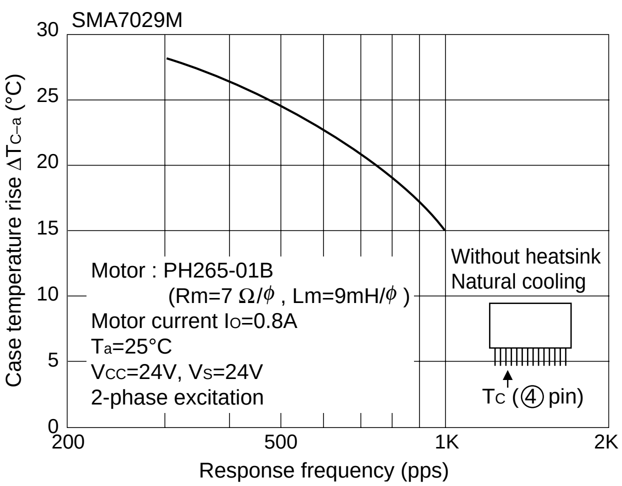
Heat dissipation characteristics

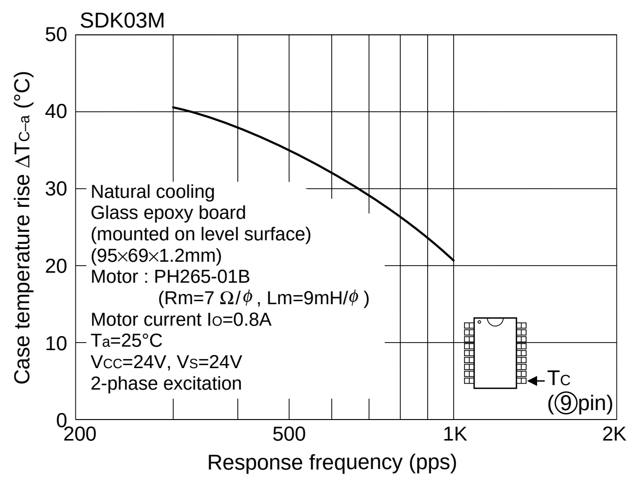








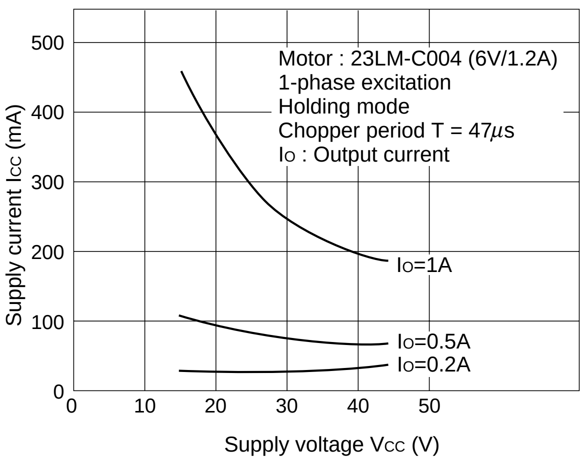




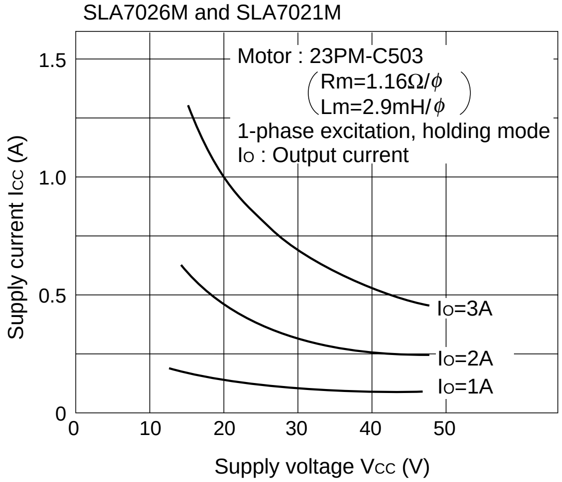
Application Note

Supply voltage Vcc vs. Supply current Icc

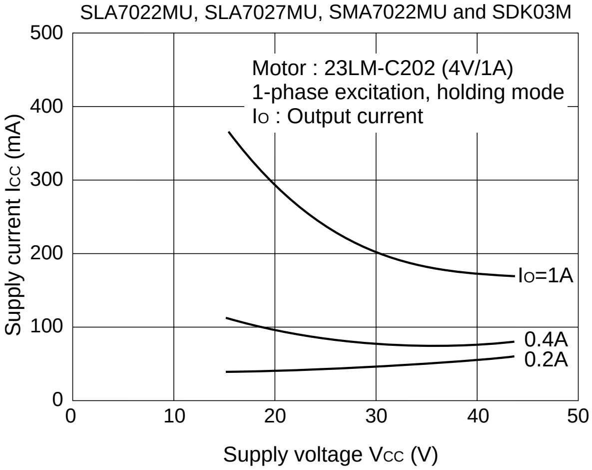
SLA7024M, SLA7029M, SMA7029M and SLA7020M



SLA7026M and SLA7021M

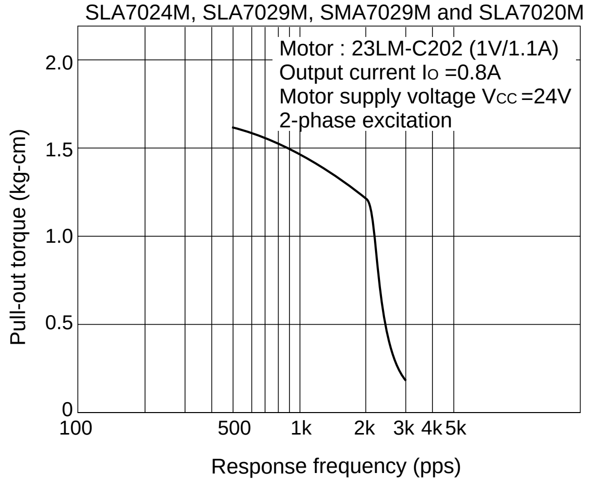


SLA7022MU, SLA7027MU, SMA7022MU and SDK03M

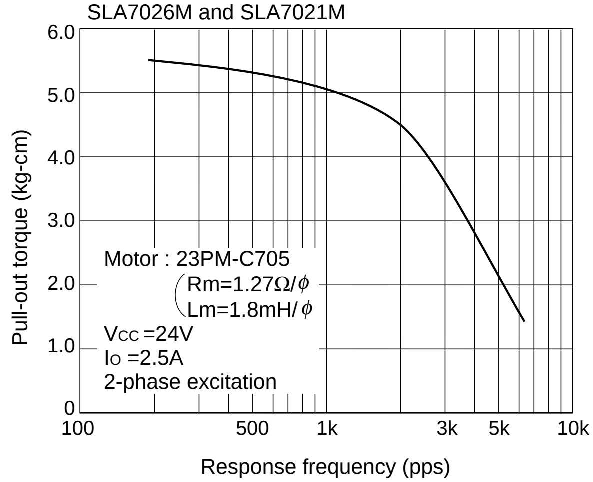


Torque characteristics

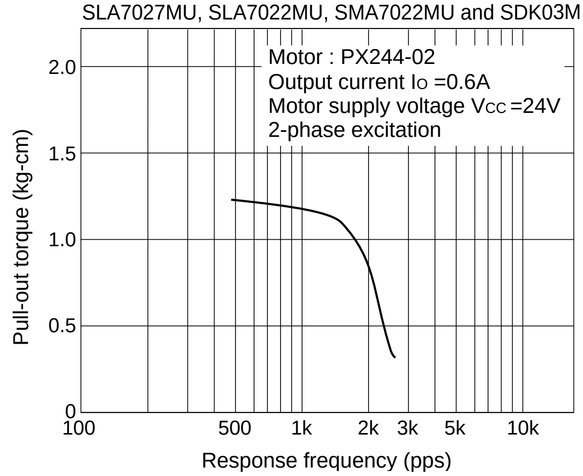
SLA7024M, SLA7029M, SMA7029M and SLA7020M



SLA7026M and SLA7021M

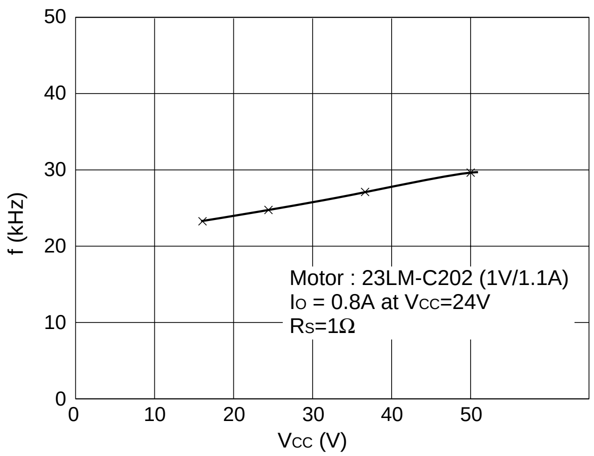


SLA7027MU, SLA7022MU, SMA7022MU and SDK03M

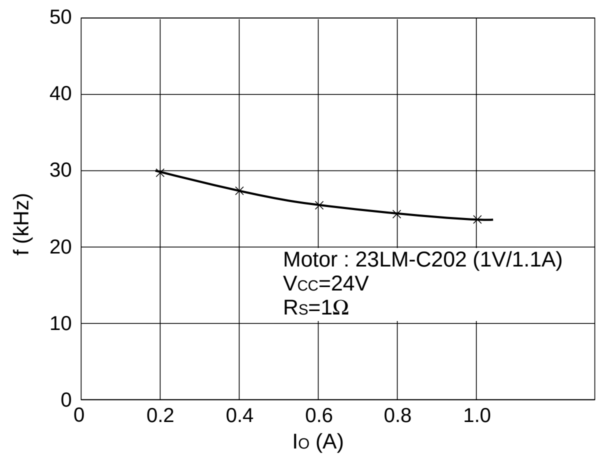


Application Note

Chopper frequency vs. Supply voltage



Chopper frequency vs. Output current



■ NOTE

Either active high or active low excitation input signals can be used for SLA7024M, SLA7026M, SLA7027MU and SDK03M. However, take note of the output that corresponds to a specified input as shown in the table below.

- SLA7024M, SLA7026M and SLA7027MU

Active High

Input	Output
IN_A (6 pin)	OUT_A (1 pin)
$IN_{\bar{A}}$ (5 pin)	$OUT_{\bar{A}}$ (8 pin)
IN_B (17 pin)	OUT_B (11 pin)
$IN_{\bar{B}}$ (16 pin)	$OUT_{\bar{B}}$ (18 pin)

Active Low

Input	Output
IN_A (6 pin)	OUT_A (8 pin)
$IN_{\bar{A}}$ (5 pin)	$OUT_{\bar{A}}$ (1 pin)
IN_B (17 pin)	OUT_B (18 pin)
$IN_{\bar{B}}$ (16 pin)	$OUT_{\bar{B}}$ (11 pin)

- SDK03M

Active High

Input	Output
IN_1 (6 pin)	OUT_1 (1, 16 pin)
IN_2 (5 pin)	OUT_2 (8, 9 pin)

Active Low

Input	Output
IN_1 (6 pin)	OUT_1 (8, 9 pin)
IN_2 (5 pin)	OUT_2 (1, 16 pin)