2-Phase Stepper Motor Unipolar Driver ICs

■Absolute Maximum Ratings

(T_a=25°C)

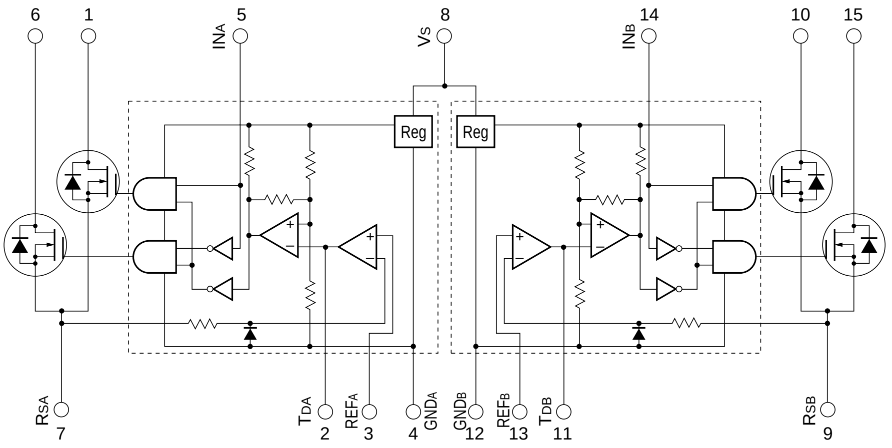
Parameter	Symbol	Ratings				Units
		SLA7022MU	SLA7029M	SMA7022MU	SMA7029M	
Motor supply voltage	V_{CC}	46				V
FET Drain-Source voltage	V_{DSS}	100				V
Control supply voltage	V_S	46				V
TTL input voltage	V_{IN}	7				V
Reference voltage	V_{REF}	2				V
Output current	I_O	1	1.5	1	1.5	A
Power dissipation	P_{D1}	4.5 (Without Heatsink)		4.0 (Without Heatsink)		W
	P_{D2}	35 (T_C=25°C)		28(T_C=25°C)		W
Channel temperature	T_{ch}	+150				°C
Storage temperature	T_{stg}	–40 to +150				°C

■Electrical Characteristics

(T_a=25°C)

	Parameter	Symbol	Ratings												Units
			SLA7022MU			SLA7029M			SMA7022MU			SMA7029M			
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
DC characteristics	Control supply current	I_S		10	15		10	15		10	15		10	15	mA
		Condition	V_S=44V			V_S=44V			V_S=44V			V_S=44V			
	Control supply voltage	V_S	10	24	44	10	24	44	10	24	44	10	24	44	V
	FET Drain-Source voltage	V_{DSS}	100			100			100			100			V
		Condition	V_S=44V, I_{DSS}=250 μA			V_S=44V, I_{DSS}=250 μA			V_S=44V, I_{DSS}=250 μA			V_S=44V, I_{DSS}=250 μA			
	FET ON voltage	V_{DS}			0.85			0.6			0.85			0.6	V
		Condition	I_D=1A, V_S=14V			I_D=1A, V_S=14V			I_D=1A, V_S=14V			I_D=1A, V_S=14V			
	FET drain leakage current	I_{DSS}			4			4			4			4	mA
		Condition	V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			
	FET diode forward voltage	V_{SD}			1.2			1.1			1.2			1.1	V
		Condition	I_D=1A			I_D=1A			I_D=1A			I_D=1A			
	TTL input current	I_{IH}			40			40			40			40	μA
		Condition	V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			
		I_{IL}			–0.8			–0.8			–0.8			–0.8	mA
		Condition	V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			
	TTL input voltage (Active High)	V_{IH}	2			2			2			2			V
		Condition	I_D=1A			I_D=1A			I_D=1A			I_D=1A			
		V_{IL}			0.8			0.8			0.8			0.8	
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
	TTL input voltage (Active Low)	V_{IH}	2			2			2			2			V
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
		V_{IL}			0.8			0.8			0.8			0.8	
		Condition	I_D=1A			I_D=1A			I_D=1A			I_D=1A			
AC characteristics	Switching time	T_r		0.5			0.5			0.5			0.5		μs
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			
		T_{stg}		0.7			0.7			0.7			0.7		
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			
		T_f		0.1			0.1			0.1			0.1		
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			

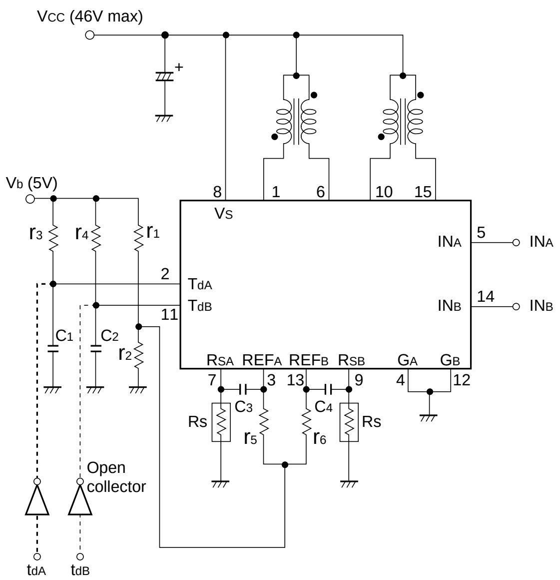
■Internal Block Diagram



1, 6, 10, 15pin
Description of pins

	Excitation input	
	Active H	Active L
1pin	OUT A	OUT $\overline{A}$
6pin	OUT $\overline{A}$	OUT A
10pin	OUT B	OUT $\overline{B}$
15pin	OUT $\overline{B}$	OUT B

■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

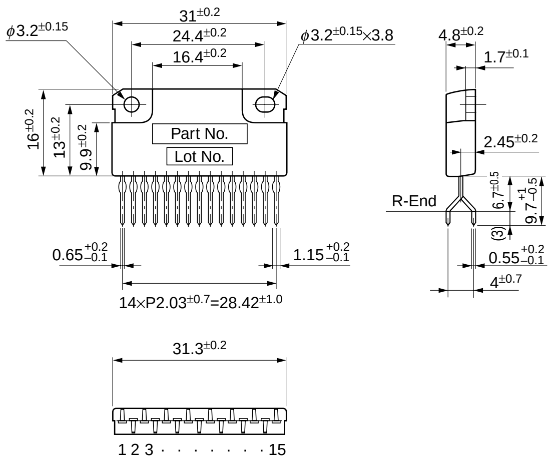
● tdA and tdB are signals before the inverter stage.

r_1 : 510Ω
r_2 : 100Ω (VR)
r_3 : 47kΩ
r_4 : 47kΩ
r_5 : 2.4kΩ
r_6 : 2.4kΩ
C_1 : 330 to 500pF
C_2 : 330 to 500pF
C_3 : 2200pF
C_4 : 2200pF
Rs (1 to 2W) : 1.8Ω typ(7022MU)
1Ω typ(7029M)

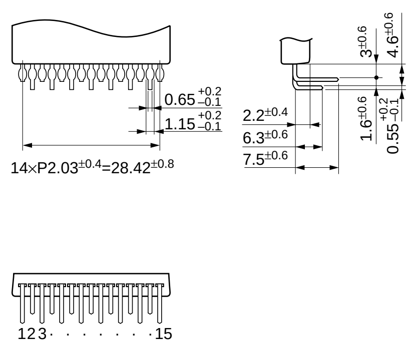
■External Dimensions SLA7022MU/SLA7029M

(Unit: mm)

Epoxy resin package



Forming No. No.853



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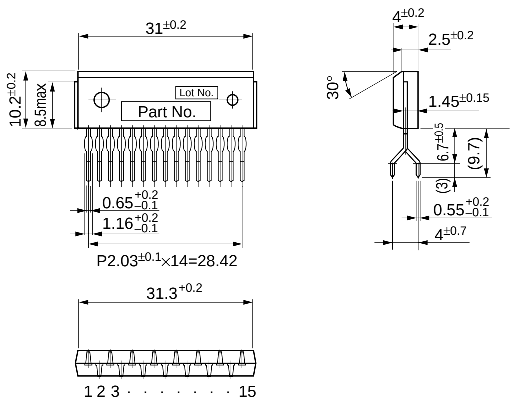
■External Dimensions SMA7022MU/SMA7029MA

(Unit: mm)

Epoxy resin package



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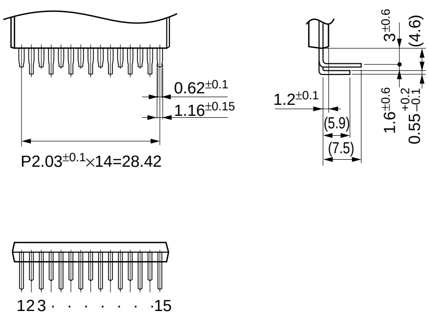

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Application Notes

■Determining the Output Current

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

(Parameters for determining the output current I_O)

V_b: Reference supply voltage

r_1,r_2: Voltage-divider resistors for the reference supply voltage

R_S: Current sense resistor

(1) Normal rotation mode

I_O is determined as follows when current flows at the maximum level during motor rotation. (See Fig.2.)

$$I_O \cong \frac{r_2}{r_1+r_2} \bullet \frac{V_b}{R_S} \quad \cdots\cdots (1)$$

(2) Power down mode

The circuit in Fig.3 (rx and Tr) is added in order to decrease the coil current. I_O is then determined as follows.

$$I_{OPD} \cong \frac{1}{1+\frac{r_1(r_2+r_X)}{r_2 \bullet r_X}} \bullet \frac{V_b}{R_S} \quad \cdots\cdots (2)$$

Equation (2) can be modified to obtain equation to determine rx.

$$r_X = \frac{1}{\frac{1}{r_1}\left(\frac{V_b}{R_S \bullet I_{OPD}} - 1\right) - \frac{1}{r_2}}$$

Fig. 4 and 5 show the graphs of equations (1) and (2) respectively.

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

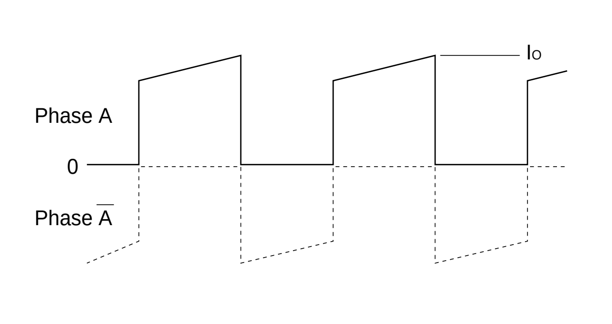


Fig. 2 Normal mode

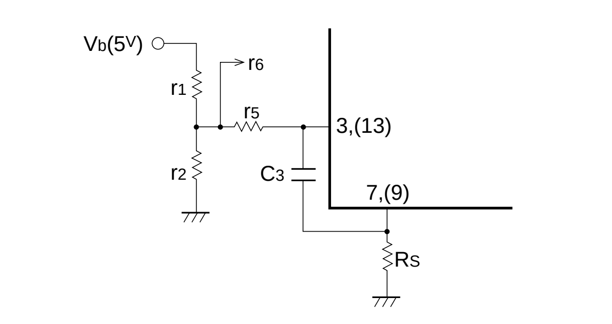


Fig. 3 Power down mode

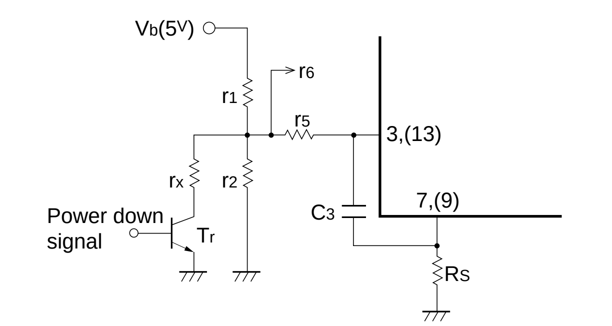


Fig. 4 Output current I_O vs. Current sense resistor R_S

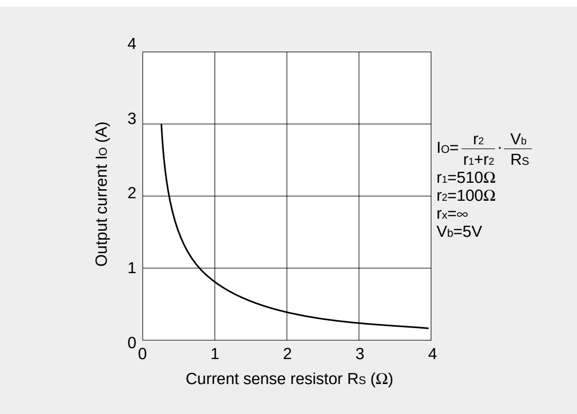
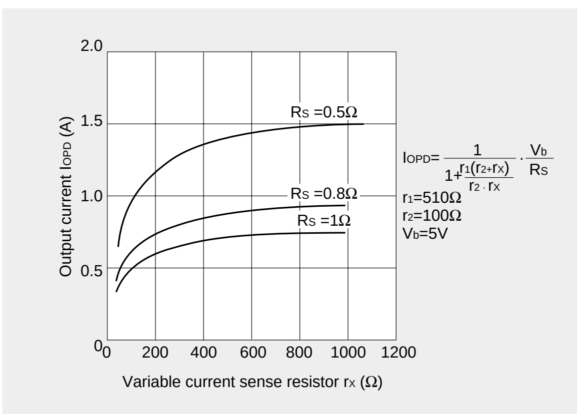


Fig. 5 Output current I_{OPD} vs. Variable current sense resistor rx



(NOTE)

Ringing noise is produced in the current sense resistor R_S when the MOSFET is switched ON and OFF by chopping. This noise is also generated in feedback signals from R_S which may therefore cause the comparator to malfunction. To prevent chopping malfunctions, r_5(r_6) and C_3(C_4) are added to act as a noise filter. However, when the values of these constants are increased, the response from R_S to the comparator becomes slow. Hence the value of the output current I_O is somewhat higher than the calculated value.

■Determining the chopper frequency

Determining T_{OFF}

The SLA7000M and SMA7000M series 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.

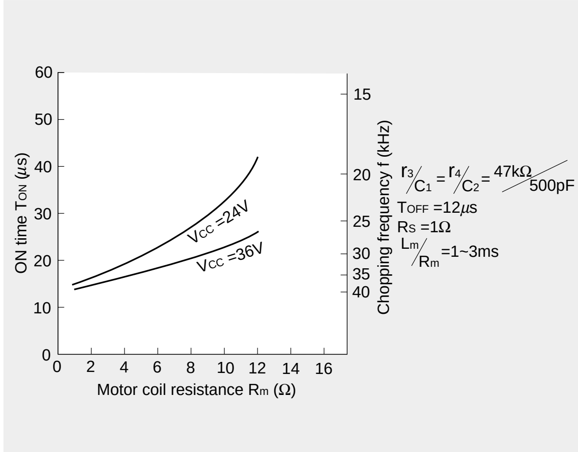
T_{OFF} can be calculated using the following formula:

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

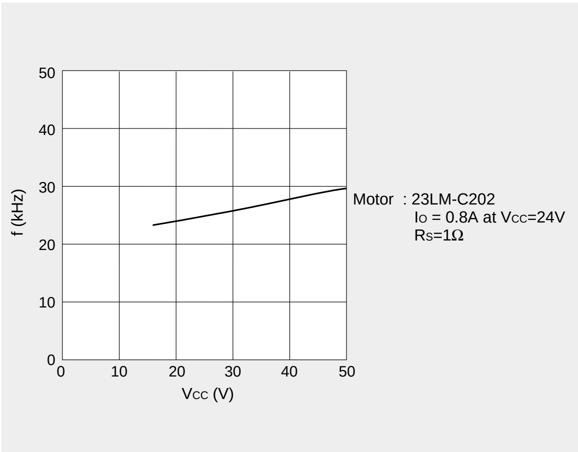
The circuit constants and the T_{OFF} value shown below are recommended.

T_{OFF} = 12μs at r_3=47kΩ, C_1=500pF, V_b=5V

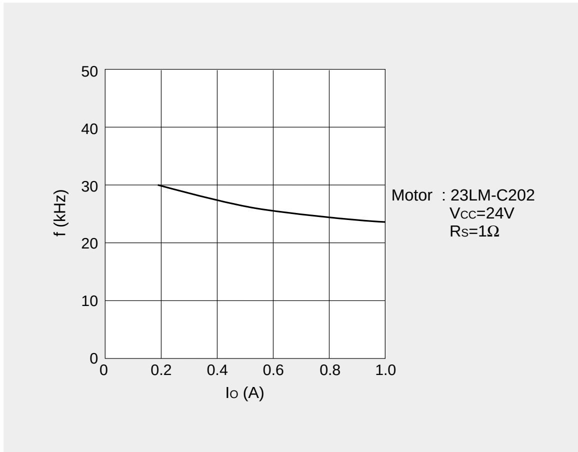
Fig. 6 Chopper frequency vs. Motor coil resistance



■Chopper frequency vs. Supply voltage



■Chopper frequency vs. Output current



■Thermal Design

An outline of the method for calculating heat dissipation is shown below.

(1) Obtain the value of P_H that corresponds to the motor coil current I_O from Fig. 7 "Heat dissipation per phase P_H vs. Output current I_O."

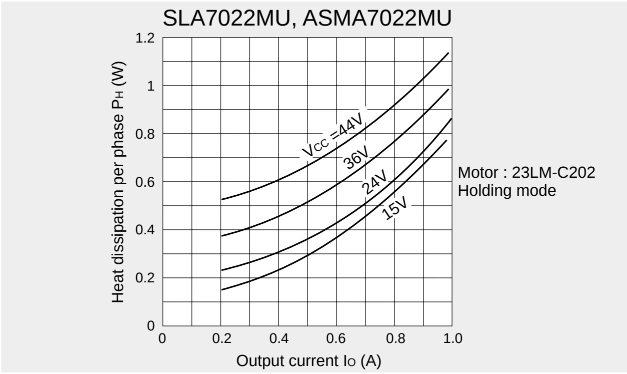
(2) The power dissipation P_{diss} is obtained using the following formula.

2-phase excitation: $P_{diss} \cong 2P_H + 0.015 \times V_S$ (W)

1-2 phase excitation: $P_{diss} \cong \frac{3}{2} P_H + 0.015 \times V_S$ (W)

(3) Obtain the temperature rise that corresponds to the calculated value of P_{diss} from Fig. 8 "Temperature rise."

Fig. 7 Heat dissipation per phase P_H vs. Output current I_O



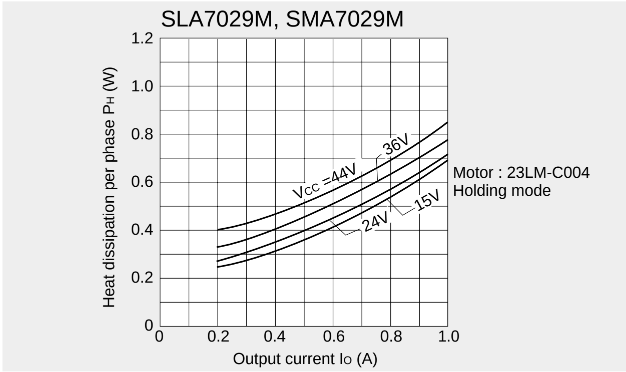
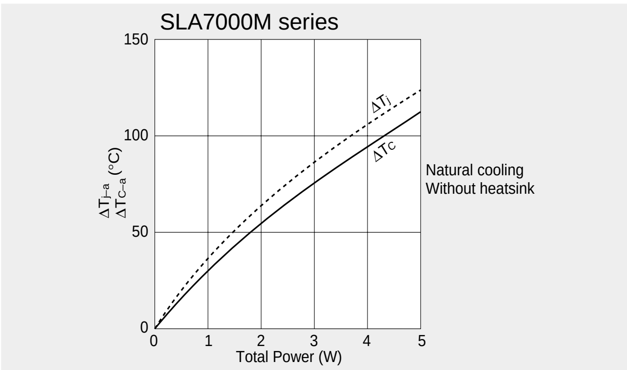
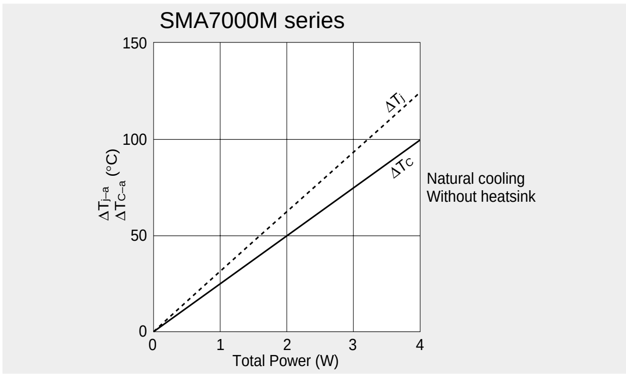
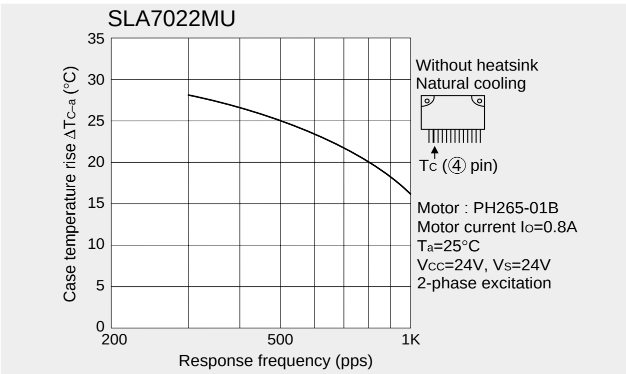


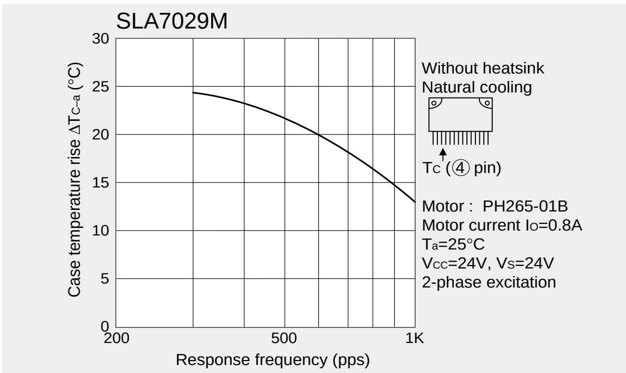
Fig. 8 Temperature rise

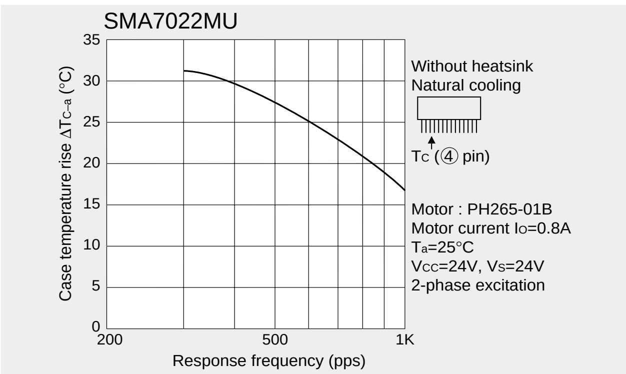


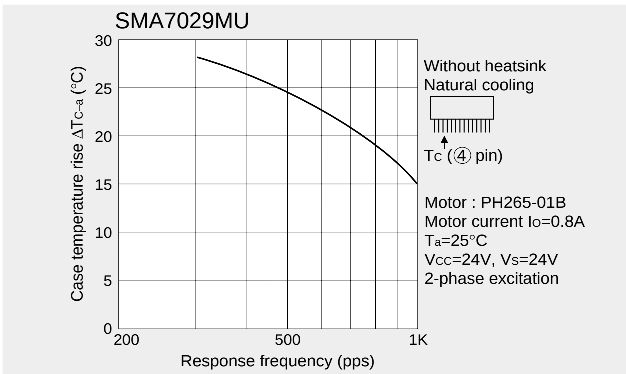


Thermal characteristics

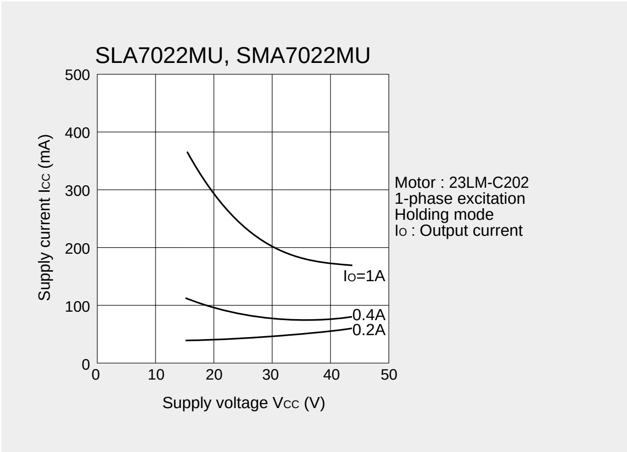


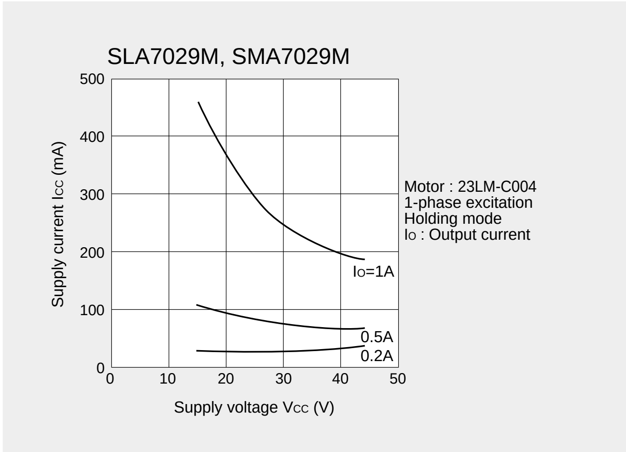






■Supply Voltage V_{CC} vs. Supply Current I_{CC}





■Torque Characteristics