2-Phase Stepper Motor Unipolar Driver ICs

■Absolute Maximum Ratings

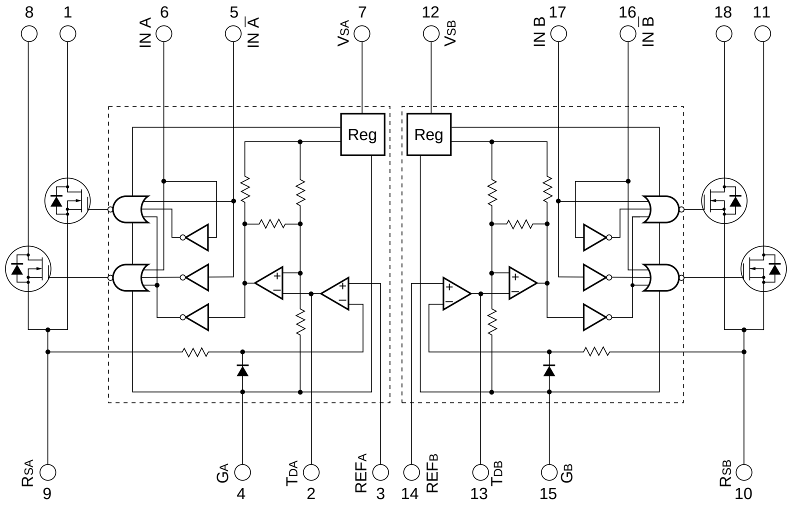
(Ta=25°C)

Parameter	Symbol	Ratings SLA7027MU	Ratings SLA7024M	Ratings SLA7026M	Units
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	3	A
Power dissipation	P_{D1}	4.5 (Without Heatsink)			W
	P_{D2}	35 (T_C=25°C)			W
Channel temperature	T_{ch}	+150			°C
Storage temperature	T_{stg}	–40 to +150			°C

■Electrical Characteristics

	Parameter	Symbol	SLA7027MU min	SLA7027MU typ	SLA7027MU max	SLA7024M min	SLA7024M typ	SLA7024M max	SLA7026M min	SLA7026M typ	SLA7026M max	Units
DC characteristics	Control supply current	I_S		10	15		10	15		10	15	mA
		Condition	V_S=44V			V_S=44V			V_S=44V			
	Control supply voltage	V_S	10	24	44	10	24	44	10	24	44	V
	FET Drain-Source voltage	V_{DSS}	100			100			100			V
		Condition	V_S=44V, I_{DSS}=250μA			V_S=44V, I_{DSS}=250μA			V_S=44V, I_{DSS}=250μA			
	FET ON voltage	V_{DS}			0.85			0.6			0.85	V
		Condition	I_D=1A, AV_S=14V			I_D=1A, V_S=14V			I_D=3A, V_S=14V			
	FET drain leakage current	I_{DSS}			4			4			4	mA
		Condition	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			2.3	V
		Condition	I_D=1A			I_D=1A			I_D=3A			
	TTL input current	I_{IH}			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			
		I_{IL}			–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			
	TTL input voltage (Active High)	V_{IH}	2			2			2			V
		Condition	I_D=1A			I_D=1A			I_D=3A			
		V_{IL}			0.8			0.8			0.8	
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
	TTL input voltage (Active Low)	V_{IH}	2			2			2			V
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
		V_{IL}			0.8			0.8			0.8	
		Condition	I_D=1A			I_D=1A			I_D=3A			
AC characteristics	Switching time	T_r		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=1A			
		T_{stg}		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=1A			
		T_f		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=1A			

■Internal Block Diagram



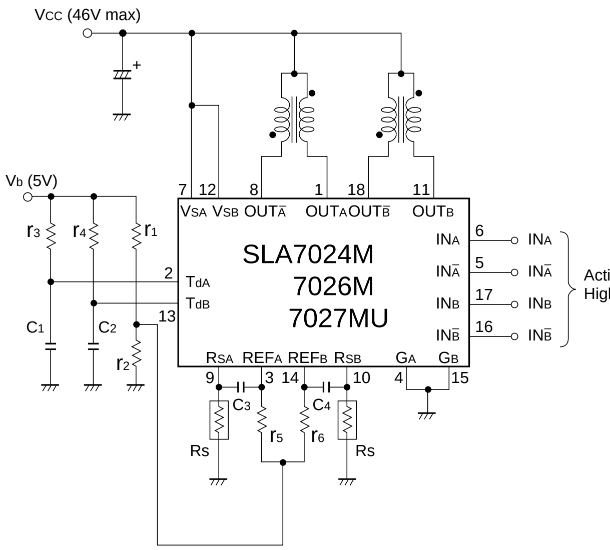
1, 8, 11, 18pin

Description of pins

	Excitation input	
	Active H	Active L
Pin 1	OUT_A	$OUT_{\overline{A}}$
Pin 8	$OUT_{\overline{A}}$	OUT_A
Pin 11	OUT_B	$OUT_{\overline{B}}$
Pin 18	$OUT_{\overline{B}}$	OUT_B

■Diagram of Standard External Circuit(Recommended Circuit Constants)

Active High



Excitation signal time chart

2-phase excitation

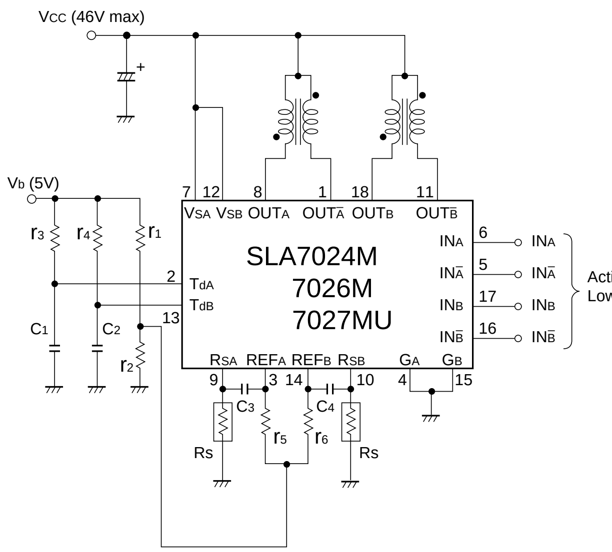
clock	0	1	2	3	0	1
IN_A	H	L	L	H	H	L
$IN_{\overline{A}}$	L	H	H	L	L	H
IN_B	H	H	L	L	H	H
$IN_{\overline{B}}$	L	L	H	H	L	L

r_1 : 510Ω
r_2 : 100Ω (VR)
r_3 : 47kΩ
r_4 : 47kΩ
r_5 : 2.4kΩ
r_6 : 2.4kΩ
C_1 : 470pF
C_2 : 470pF
C_3 : 2200pF
C_4 : 2200pF
R_s : 1Ω typ(7024M)
(1 to 2W) 0.68Ω typ(7026M)
1.8Ω typ(7027MU)

1-2 phase excitation

clock	0	1	2	3	4	5	6	7	0	1	2	3
IN_A	H	H	L	L	L	L	L	H	H	H	L	L
$IN_{\overline{A}}$	L	L	L	H	H	H	L	L	L	L	L	H
IN_B	L	H	H	H	L	L	L	L	L	H	H	H
$IN_{\overline{B}}$	L	L	L	L	L	H	H	H	L	L	L	L

Active Low



Excitation signal time chart

2-phase excitation

clock	0	1	2	3	0	1
IN_A	L	H	H	L	L	H
$IN_{\overline{A}}$	H	L	L	H	H	L
IN_B	L	L	H	H	L	L
$IN_{\overline{B}}$	H	H	L	L	H	H

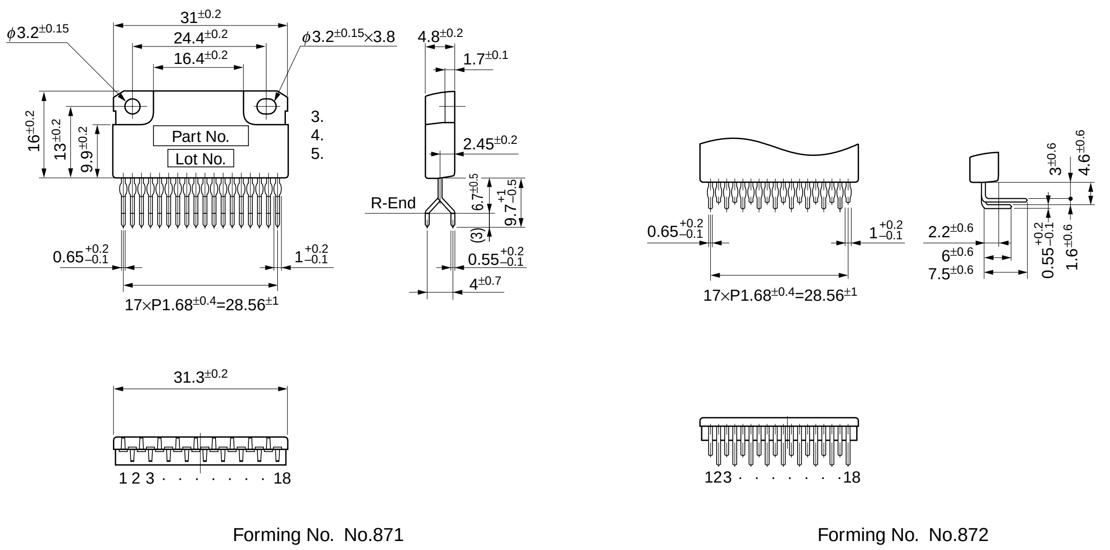
r_1 : 510Ω
r_2 : 100Ω(VR)
r_3 : 47kΩ
r_4 : 47kΩ
r_5 : 2.4kΩ
r_6 : 2.4kΩ
C_1 : 470pF
C_2 : 470pF
C_3 : 2200pF
C_4 : 2200pF
R_s : 1Ω typ(7024M)
(1 to 2W) 0.68Ω typ(7026M)
1.8Ω typ(7027MU)

1-2 phase excitation

clock	0	1	2	3	4	5	6	7	0	1	2	3
IN_A	L	L	H	H	H	H	H	L	L	L	H	H
$IN_{\overline{A}}$	H	H	H	L	L	L	H	H	H	H	H	L
IN_B	H	L	L	L	H	H	H	H	H	L	L	L
$IN_{\overline{B}}$	H	H	H	H	H	L	L	L	H	H	H	H

■External Dimensions

(Unit: mm)



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 (r_X and Tr) is added in order to decrease the coil current. I_O is then determined as follows.

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

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

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

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

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

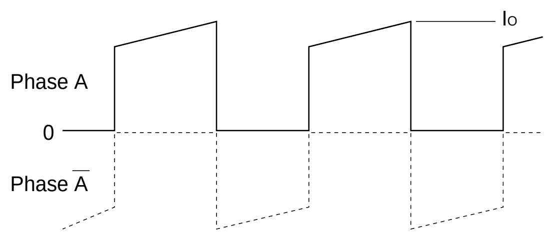


Fig. 2 Normal mode

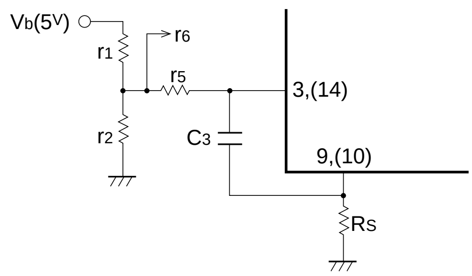


Fig. 3 Power down mode

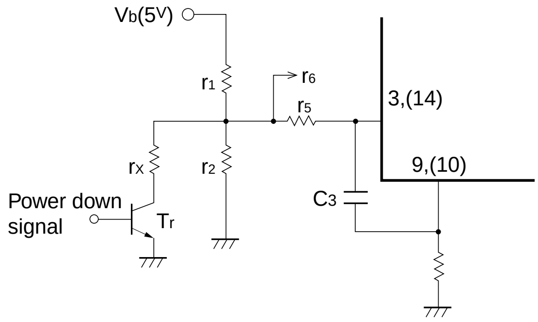


Fig. 4 Output current I_O vs. Current sense resistor R_S

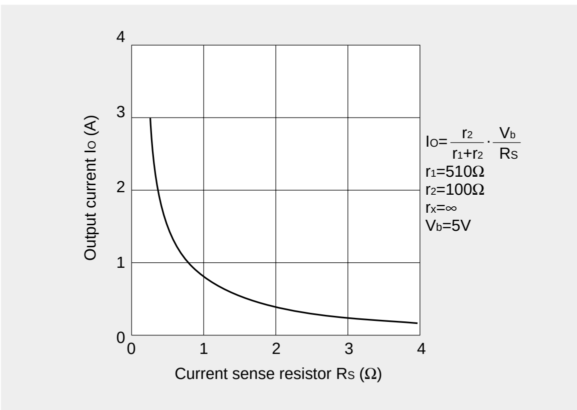
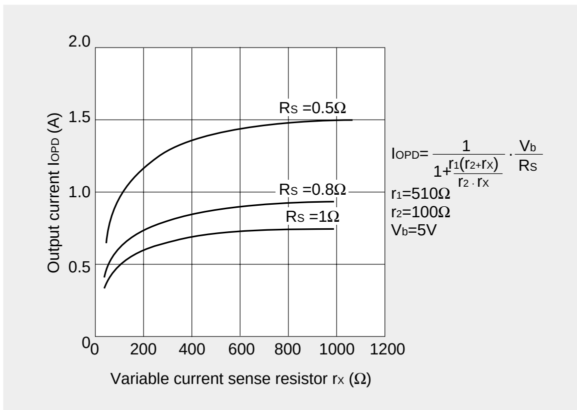


Fig. 5 Output current I_{OPD} vs. Variable current sense resistor rx



(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 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.

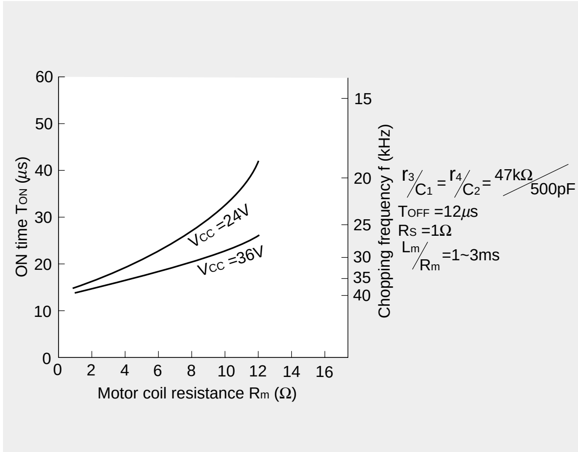
T_{OFF} can be calculated using the following formula:

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

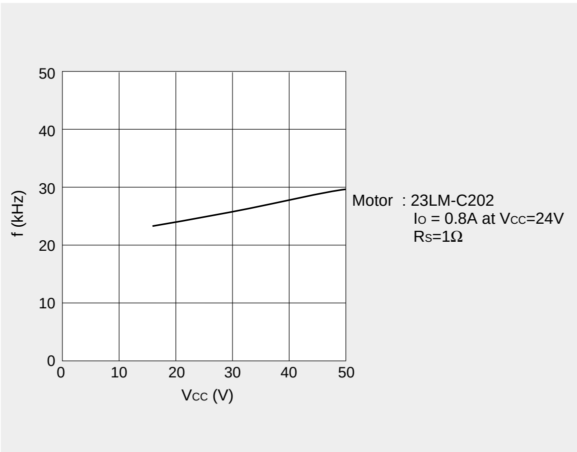
The circuit constants and the T_{OFF} value shown below are recommended.

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

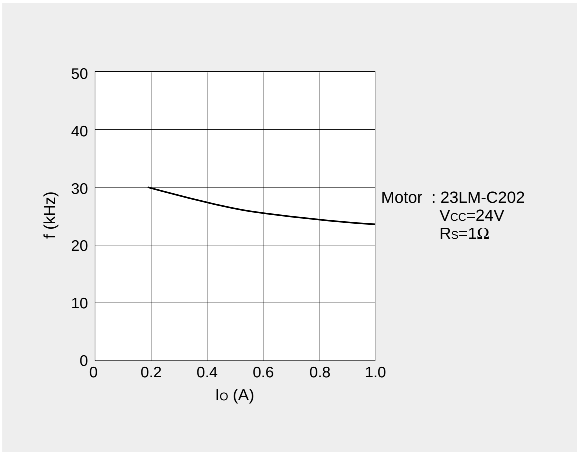
Fig. 6 Chopper frequency vs. Motor coil resistance



■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."

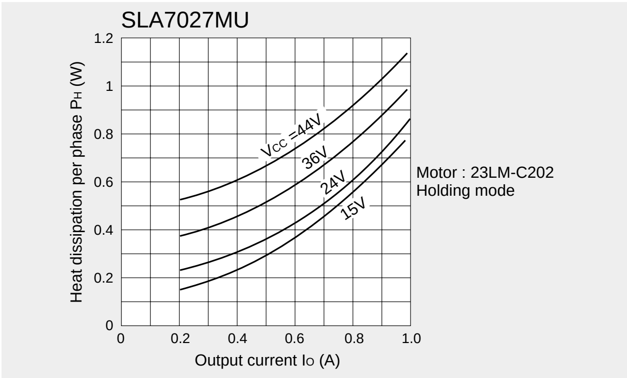
(2) The power dissipation Pdiss is obtained using the following formula.

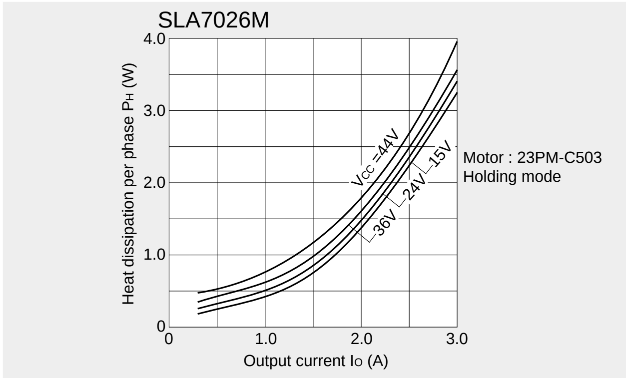
2-phase excitation: $P_{diss} \cong 2P_H + 0.015 \times V_S$ (W)

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 Pdiss from Fig. 8 "Temperature rise."

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





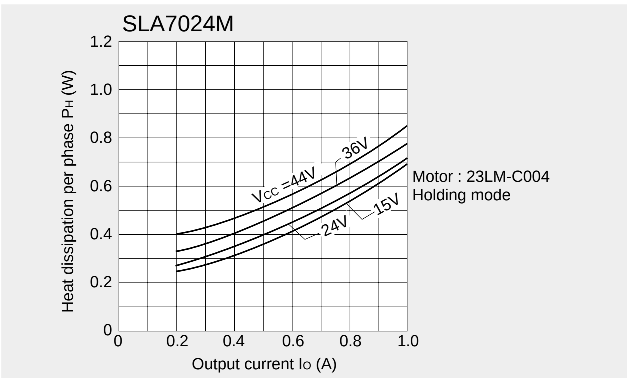
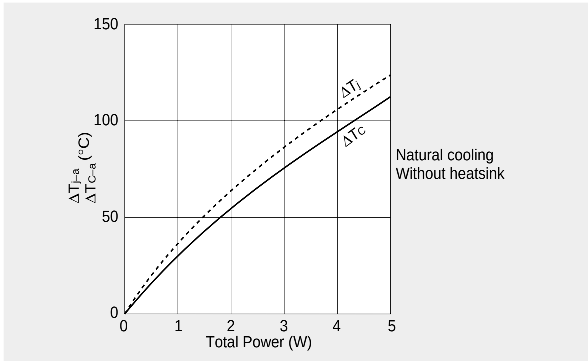
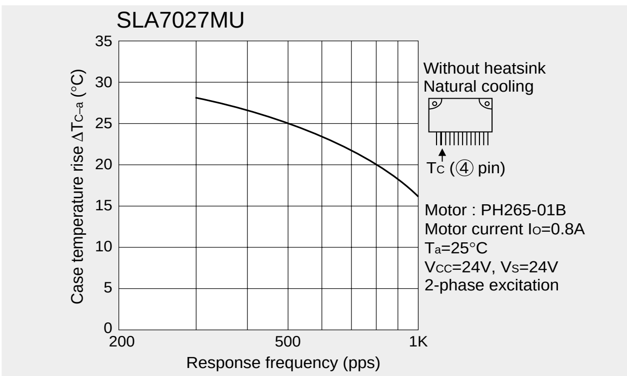
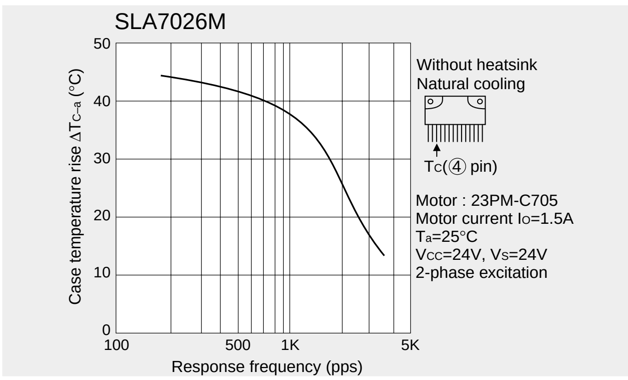


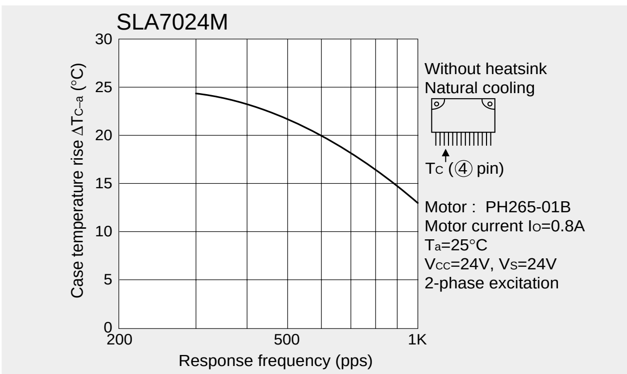
Fig. 8 Temperature rise



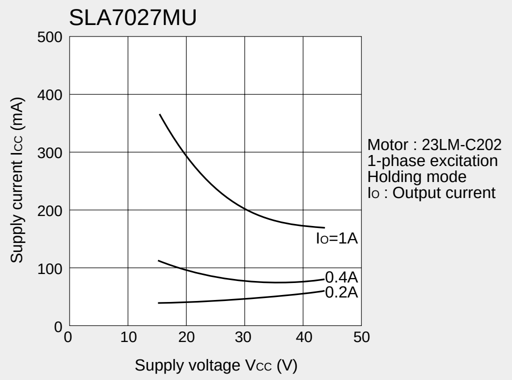
Thermal characteristics

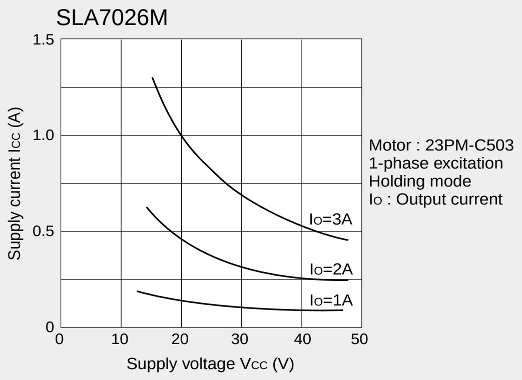


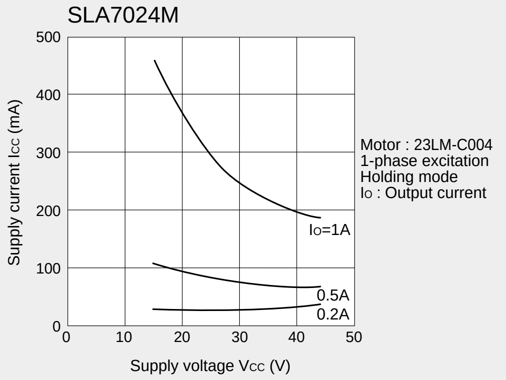




■Supply Voltage V_{CC} vs. Supply Current I_{CC}







■Note

The excitation input signals of the SLA7027MU, SLA7024M and SLA7026M can be used as either Active High or Active Low. Note, however, that the corresponding output (OUT) changes depending on the input (IN).

Active High

Input	Corresponding output
IN_A (pin6)	OUT_A (pin1)
$IN_{\bar{A}}$ (pin5)	$OUT_{\bar{A}}$ (pin8)
IN_B (pin17)	OUT_B (pin11)
$IN_{\bar{B}}$ (pin16)	$OUT_{\bar{B}}$ (pin18)

Active Low

Input	Corresponding output
IN_A (pin6)	OUT_A (pin8)
$IN_{\bar{A}}$ (pin5)	$OUT_{\bar{A}}$ (pin1)
IN_B (pin17)	OUT_B (pin18)
$IN_{\bar{B}}$ (pin16)	$OUT_{\bar{B}}$ (pin11)