

2-Phase Stepper Motor Unipolar Driver ICs

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	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	A
Power dissipation	P_D	2.5 (Without Heatsink)	W
Channel temperature	T_{ch}	+150	°C
Storage temperature	T_{stg}	-40 to +150	°C

■Electrical Characteristics

Parameter	Symbol	Ratings			Units	
		min	typ	max		
DC characteristics	Control supply current	I_S		5	7.5	mA
		Condition	$V_S=44V$			
	Control supply voltage	V_S	10	24	44	V
	FET Drain-Source voltage	V_{DSS}	100			V
		Condition	$V_S=44V, I_{DSS}=250\mu A$			
	FET ON voltage	V_{DS}			0.85	V
		Condition	$I_D=1A, V_S=14V$			
	FET drain leakage current	I_{DSS}			4	mA
		Condition	$V_{DSS}=100V, V_S=44V$			
	FET diode forward voltage	V_{SD}			1.2	V
		Condition	$I_D=1A$			
	TTL input current	I_{IH}			40	μA
		Condition	$V_{IH}=2.4V, V_S=44V$			
		I_{IL}			-0.8	mA
	Condition	$V_{IL}=0.4V, V_S=44V$				
	TTL input voltage (Active High)	V_{IH}	2			V
		Condition	$I_D=1A$			
		V_{IL}			0.8	
Condition	$V_{DSS}=100V$					
TTL input voltage (Active Low)	V_{IH}	2			V	
	Condition	$V_{DSS}=100V$				
	V_{IL}			0.8		
Condition	$I_D=1A$					
AC characteristics	Switching time	T_r		0.5	μs	
		Condition	$V_S=24V, I_D=0.8A$			
		T_{slg}		0.7		
		Condition	$V_S=24V, I_D=0.8A$			
		T_f		0.1		
Condition	$V_S=24V, I_D=0.8A$					

Internal Block Diagram

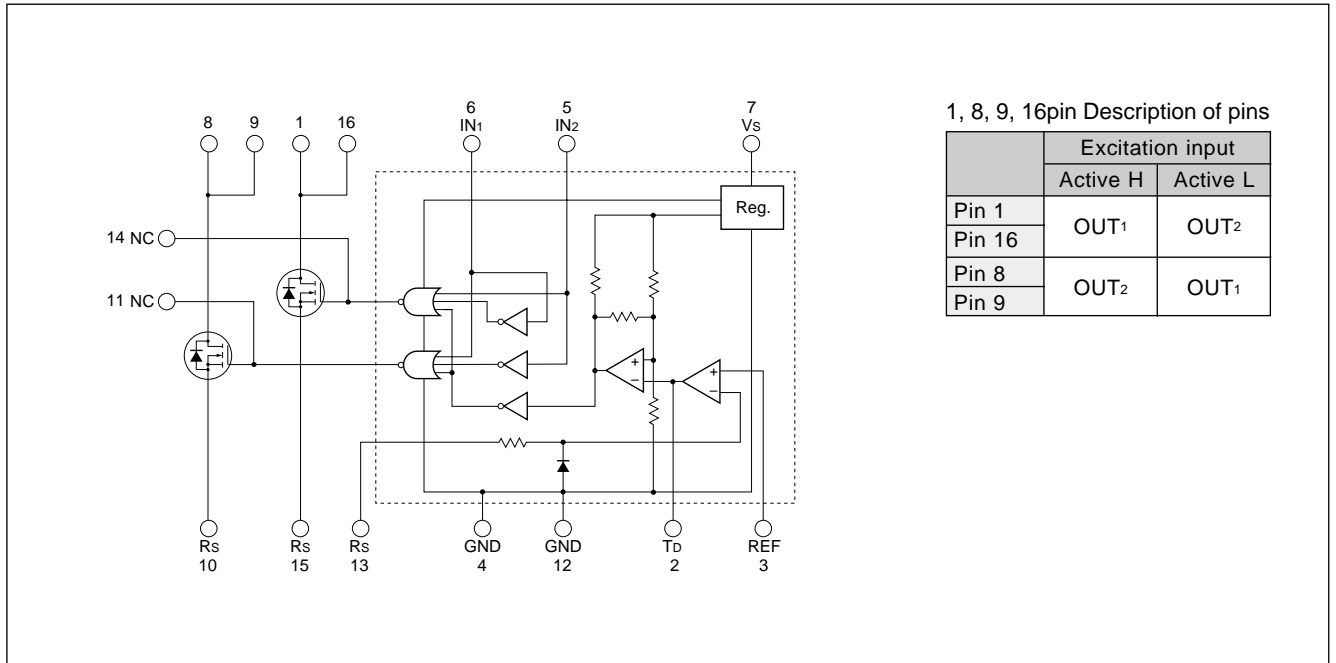
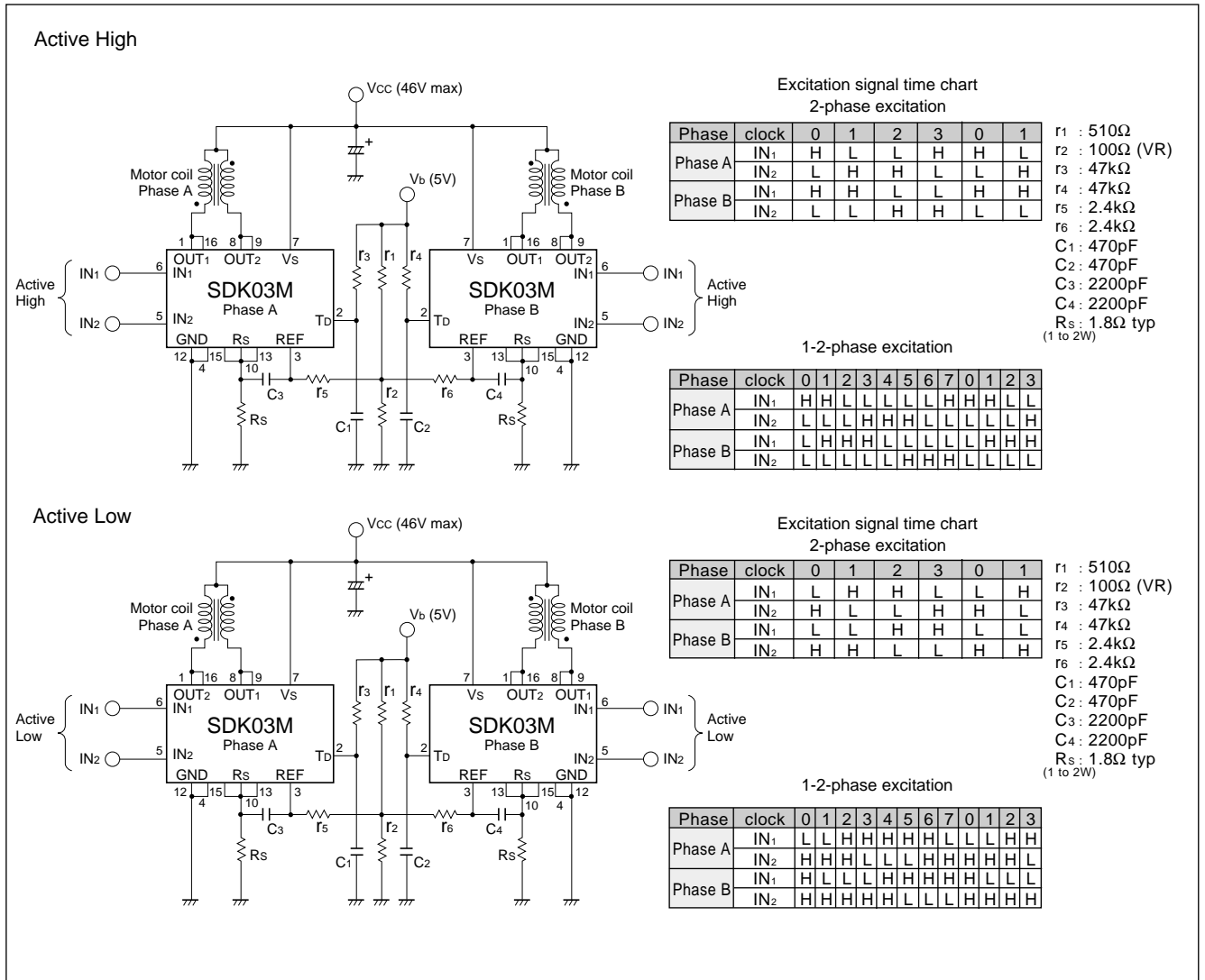
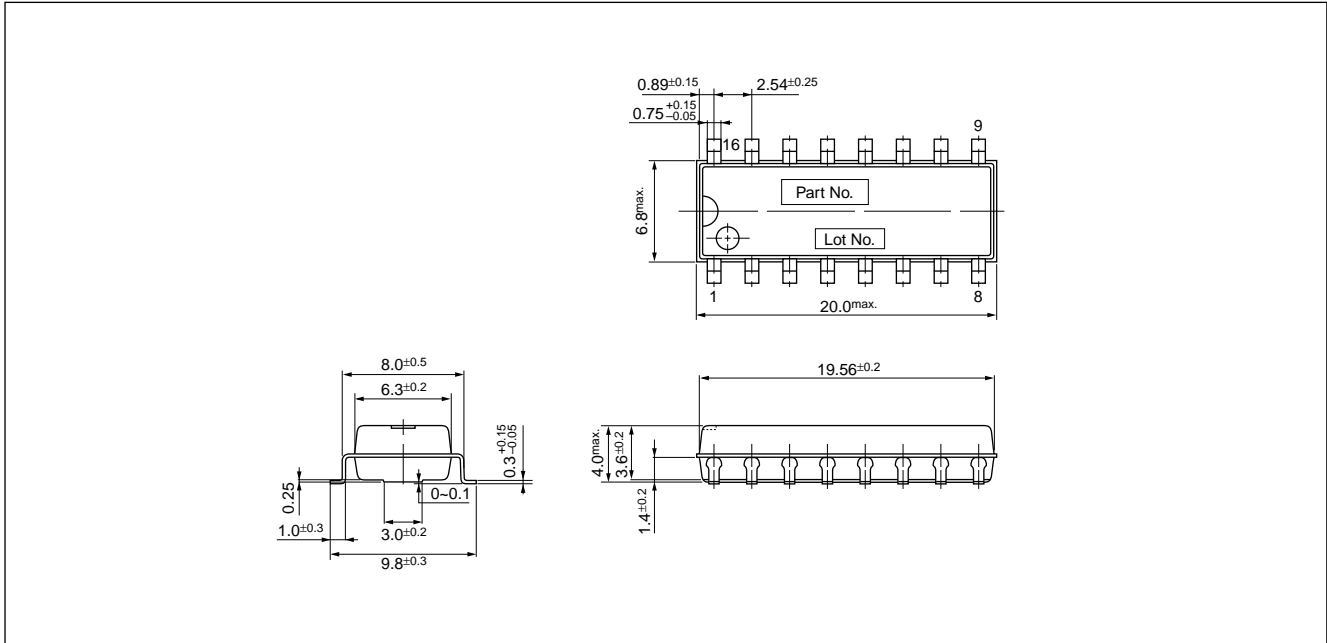


Diagram of Standard External Circuit (Recommended Circuit Constants)



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.)

$$I_o \cong \frac{r_2}{r_1+r_2} \cdot \frac{V_b}{R_s} \dots\dots\dots (1)$$

(2) Power down mode

The circuit in Fig.3 (r_x and T_r) is added in order to decrease the coil current. I_o is then determined as follows.

$$I_{OPD} \cong \frac{1}{1 + \frac{r_1(r_2+r_x)}{r_2 \cdot r_x}} \cdot \frac{V_b}{R_s} \dots\dots\dots (2)$$

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

$$r_x = \frac{1}{\frac{1}{r_1} \left(\frac{V_b}{R_s \cdot I_{OPD}} - 1 \right) - \frac{1}{r_2}}$$

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

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

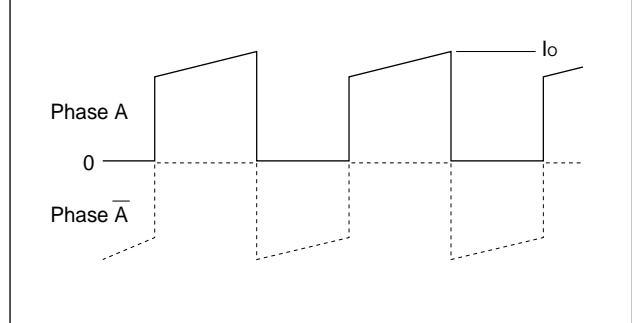


Fig. 2 Normal mode

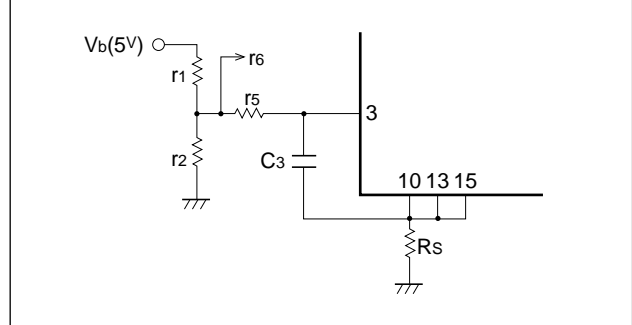


Fig. 3 Power down mode

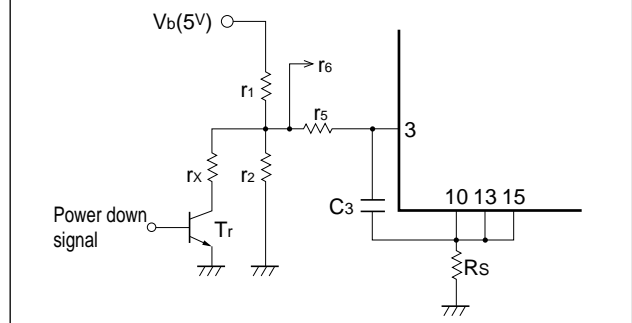


Fig. 4 Output current I_o vs. Current sense resistor R_s

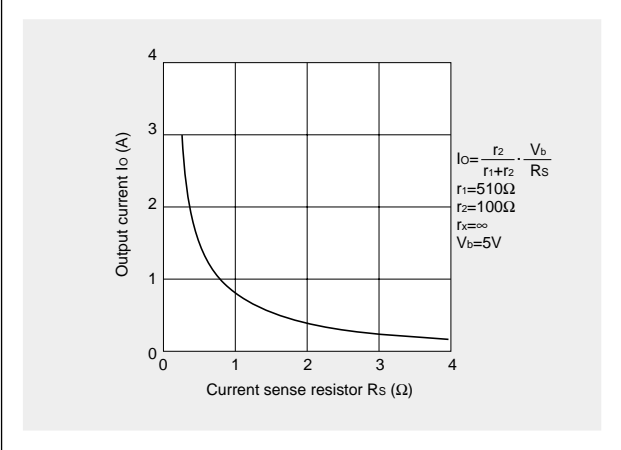
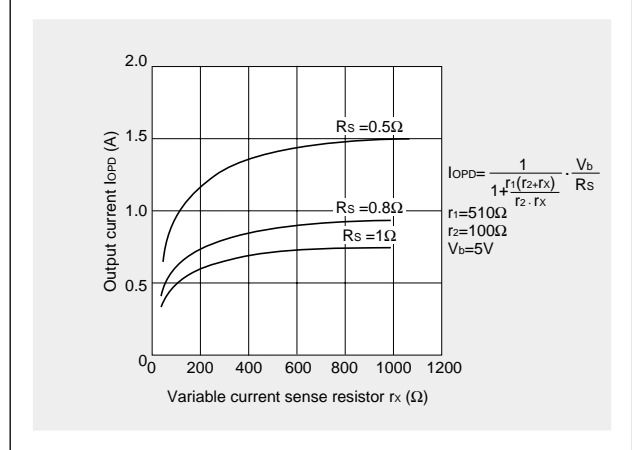


Fig. 5 Output current I_{OPD} vs. Variable current sense resistor r_x



(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}

SDK03M is self-excited choppers. The chopping OFF time T_{OFF} is fixed by r₃/C₁ and r₄/C₂ connected to terminal T_d.

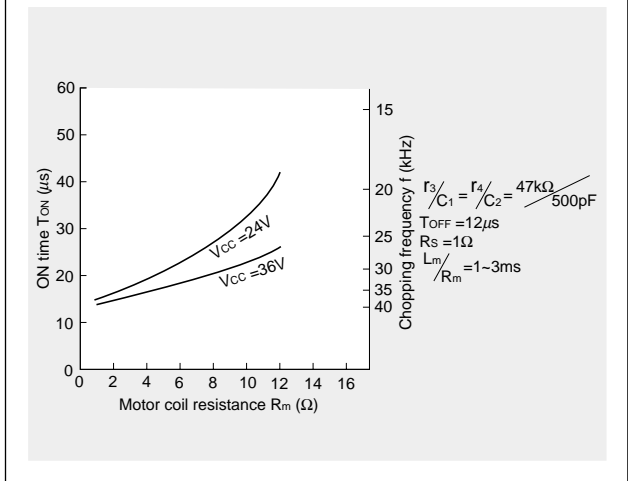
T_{OFF} can be calculated using the following formula:

$$T_{OFF} \approx -r_3 \cdot C_1 \ln \left(1 - \frac{2}{V_b}\right) = -r_4 \cdot C_2 \ln \left(1 - \frac{2}{V_b}\right)$$

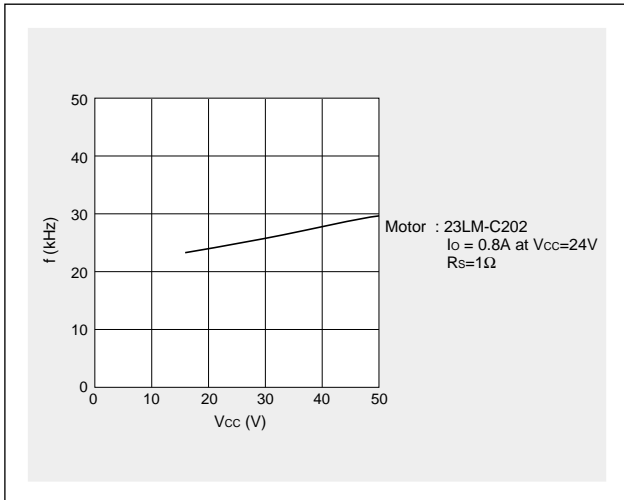
The circuit constants and the T_{OFF} value shown below are recommended.

T_{OFF} = 12μs at r₃=47kΩ, C₁=500pF, V_b=5V

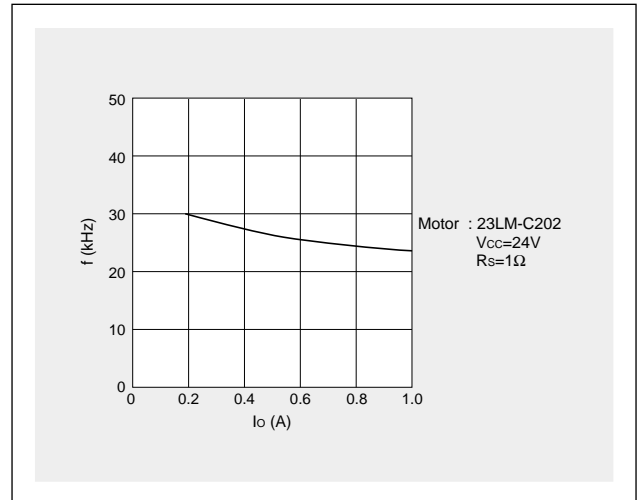
Fig. 6 Chopper frequency vs. Motor coil resistance



Chopper frequency vs. Supply voltage



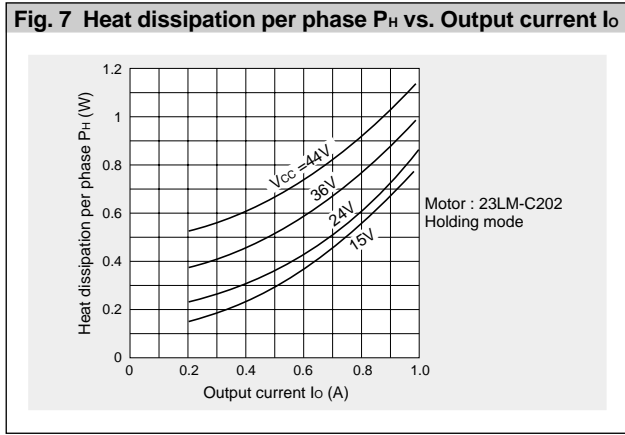
Chopper frequency vs. Output current



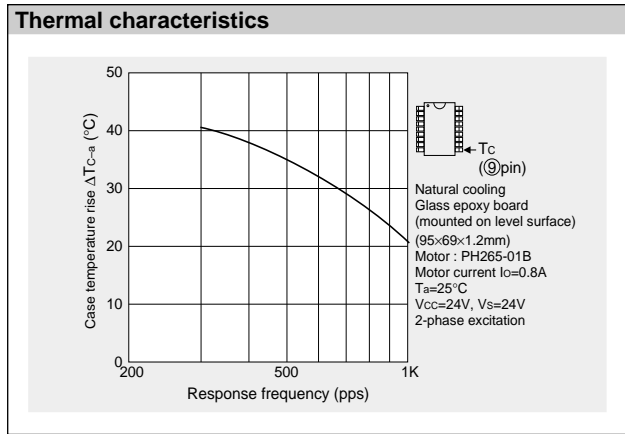
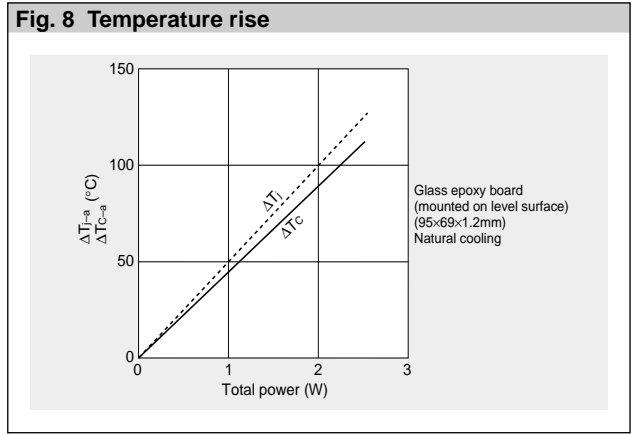
Thermal Design

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

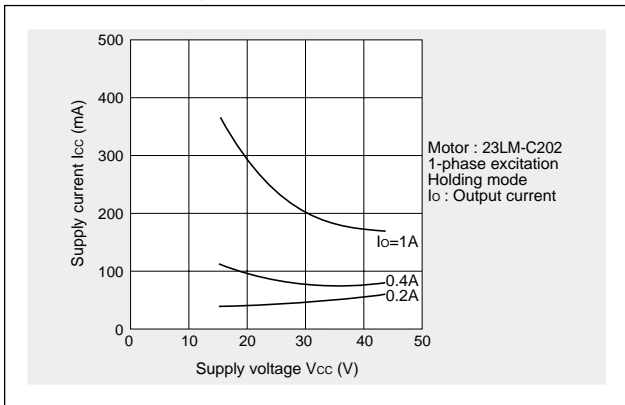
- (1) Obtain the value of P_H that corresponds to the motor coil current I_o from Fig. 7 "Heat dissipation per phase P_H vs. Output current I_o ."



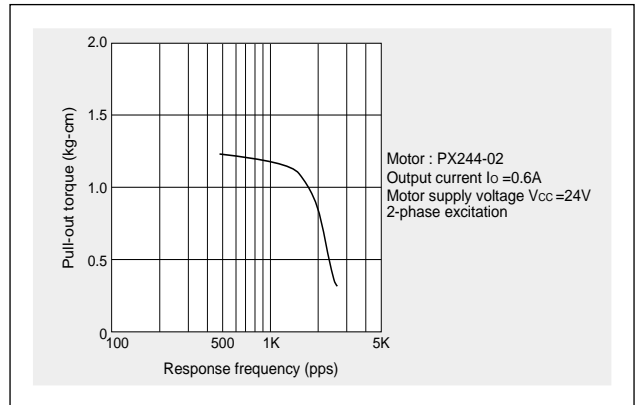
- (2) The power dissipation P_{diss} is obtained using the following formula.
 2-phase excitation: $P_{diss} \cong P_H + 0.0075 \times V_s$ (W)
 1-2 phase excitation: $P_{diss} \cong \frac{3}{4} P_H + 0.0075 \times V_s$ (W)
- (3) Obtain the temperature rise that corresponds to the calculated value of P_{diss} from Fig. 8 "Temperature rise."



Supply Voltage Vcc vs. Supply Current Icc



Torque Characteristics



Note

The excitation input signals of the SDK03M 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 ₁ (pin6)	OUT ₁ (pin1, 16)
IN ₂ (pin5)	OUT ₂ (pin8, 9)

Active Low

Input	Corresponding output
IN ₁ (pin6)	OUT ₁ (pin8, 9)
IN ₂ (pin5)	OUT ₂ (pin1, 16)