2-Phase Stepper Motor Unipolar Driver IC

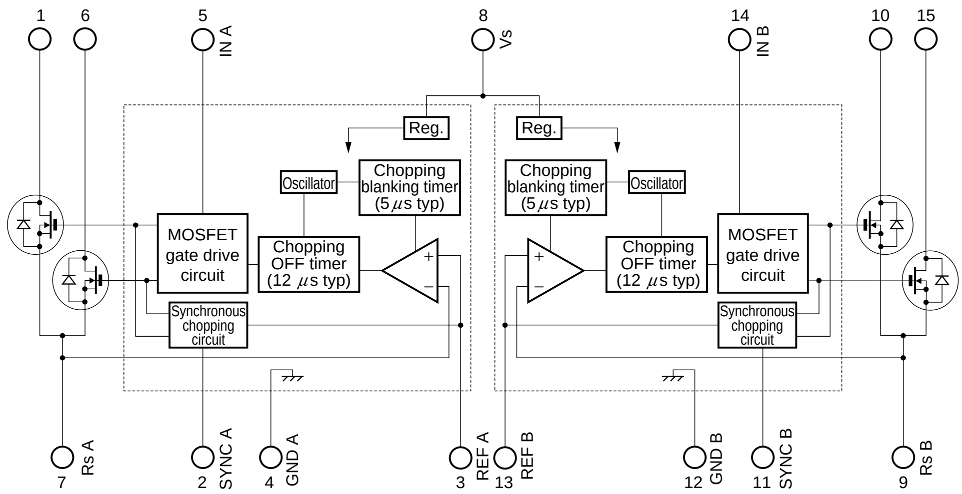
■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Units
Motor supply voltage	V_{CC}	46	V
Control supply voltage	V_S	46	V
FET Drain-Source voltage	V_{DSS}	100	V
TTL input voltage	V_{IN}	−0.3 to +7	V
SYNC terminal voltage	V_{SYNC}	−0.3 to +7	V
Reference voltage	V_{REF}	−0.3 to +7	V
Sense voltage	V_{RS}	−5 to +7	V
Output current	I_O	1.5	A
Power dissipation	P_{D1}	4.0 (T_a=25°C)	W
	P_{D2}	28 (T_c=25°C)	W
Channel temperature	T_{ch}	150	°C
Storage temperature	T_{stg}	−40 to +150	°C
Ambient operating temperature	T_a	−20 to +85	°C

■Electrical Characteristics

	Parameter		Symbol	Ratings min	Ratings typ	Ratings max	Units
DC characteristics	Control supply current		I_S		10	15	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 μA			
	FET ON voltage		V_{DS}			0.6	V
			Condition	I_D=1A, V_S=10V			
	FET diode forward voltage		V_{SD}			1.1	V
			Condition	I_{SD}=1A			
	FET drain leakage current		I_{DSS}			250	μA
			Condition	V_{DSS}=100V, V_S=44V			
	IN terminal	Active H	V_{IH}	2			V
			Condition	I_D=1A			
			V_{IL}			0.8	
			Condition	V_{DSS}=100V			
		Active L	V_{IH}	2			V
			Condition	V_{DSS}=100V			
			V_{IL}			0.8	
			Condition	I_D=1A			
		Input current	I_I			±1	μA
			Condition	V_S=44V, V_I=0 or 5V			
	SYNC terminal	Input voltage	$V_{SYNC}H$	4.0			V
			Condition	Synchronous chopping mode			
			$V_{SYNC}L$			0.8	
			Condition	Asynchronous chopping mode			
		Input current	$I_{SYNC}H$			0.1	mA
			Condition	V_S=44V, V_{YS}=5V			
			$I_{SYNC}L$			−0.1	
			Condition	V_S=44V, V_{YS}=0V			
	REF terminal	Input voltage	V_{REF}	0		2.0	V
			Condition	Reference voltage input			
			V_{REF}	4.0		5.5	
			Condition	Output FET OFF			
		Input current	I_{REF}			±1	μA
			Condition	No synchronous trigger			
		Internal resistance	R_{REF}		40		Ω
			Condition	Resistance between GND and REF terminal at synchronous trigger			
AC characteristics	Switching time		T_{on}		1.5		μs
			Condition	V_S=24V, I_D=1A			
			T_r		0.5		
			Condition	V_S=24V, I_D=1A			
			T_{stg}		0.9		
			Condition	V_S=24V, I_D=1A			
			T_f		0.1		
			Condition	V_S=24V, I_D=1A			
	Chopping OFF time		T_{OFF}		12		μs
			Condition	V_S=24V			

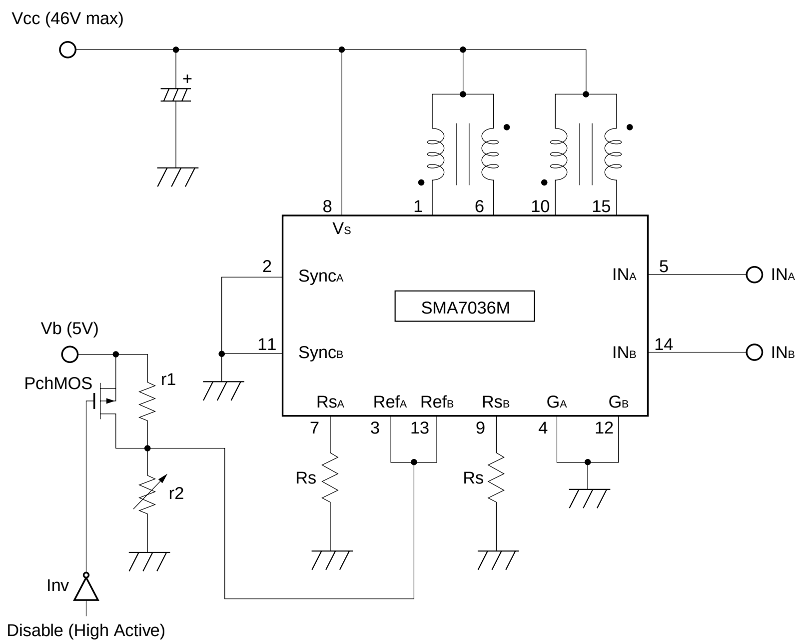
■Internal Block Diagram



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

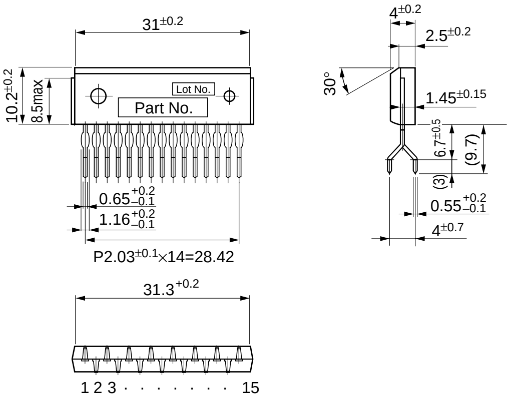
clock	0	1	2	3	0	1
IN_A	H	H	L	L	H	H
IN_B	L	H	H	L	L	H

r_1 : 8kΩ
r_2 : 2kΩ (VR)
R_S (1 to 2W) : 1Ω typ
PchMOS : HN1J02FU (Toshiba)
Inv : 7404

■External Dimensions

(Unit: mm)

Epoxy resin package



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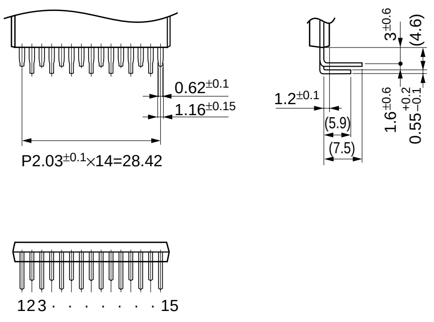

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Application Notes

■Outline

SMA7036M is a stepper motor driver IC developed to reduce the number of external parts required by the conventional SMA7029M. This IC successfully eliminates the need for some external parts without sacrificing the features of SMA7029M. The basic function pins are compatible with those of SMA7029M.

■Notes on Replacing SMA7029M

SMA7036M is pin-compatible with SMA7029M. When using the IC on an existing board, the following preparations are necessary:

(1) Remove the resistors and capacitors attached for setting the chopping OFF time. (r_3, r_4, C_1, and C_2 in the catalog)

(2) Remove the resistors and capacitors attached for preventing noise in the detection voltage V_{RS} from causing malfunctioning and short the sections from which the resistors were removed using jumper wires. (r_5, r_6, C_3, and C_4 in the catalog)

(3) Normally, keep pins 2 and 11 grounded because their functions have changed to synchronous and asynchronous switching (SYNC terminals). For details, see "Circuit for Preventing Abnormal Noise When the Motor Is Not Running (Synchronous circuit)." (Low: asynchronous, High: synchronous)

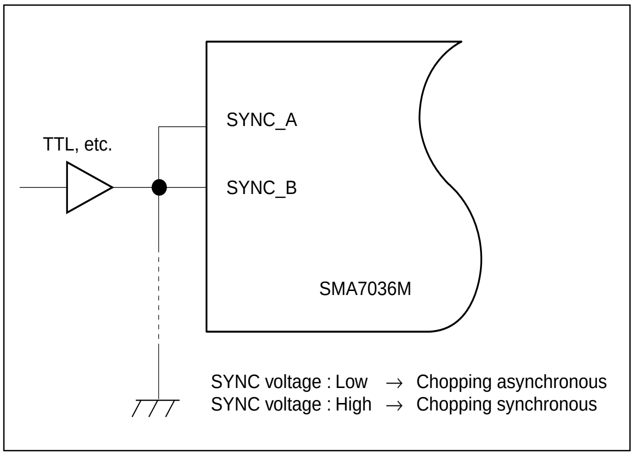
■Circuit for Preventing Abnormal Noise When the Motor Is Not Running (Synchronous Circuit)

A motor may generate abnormal noise when it is not running. This phenomenon is attributable to asynchronous chopping between phases A and B. To prevent the phenomenon, SMA7036M contains a synchronous chopping circuit. Do not leave the SYNC terminals open because they are for CMOS input.

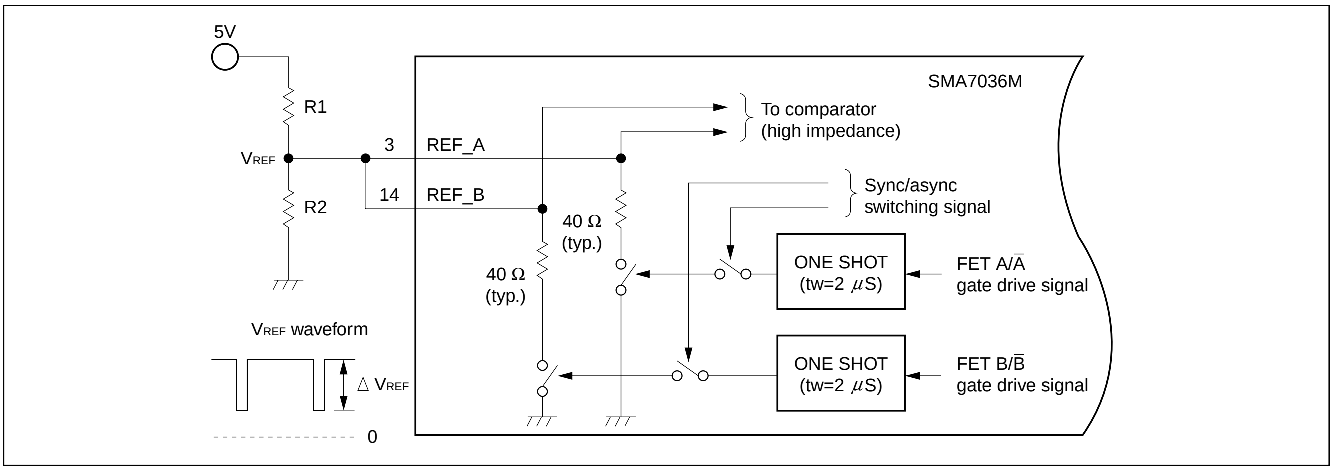
Connect TTL or similar to the SYNC terminals and switch the SYNC terminal level high or low.

When the motor is not running, set the TTL signal high (SYNC terminal voltage: 4 V or more) to make chopping synchronous. When the motor is running, set the TTL signal low (SYNC terminal voltage: 0.8 V or less) to make chopping asynchronous. If chopping is set to synchronous when the motor is running, the motor torque deteriorates before the coil current reaches the set value.

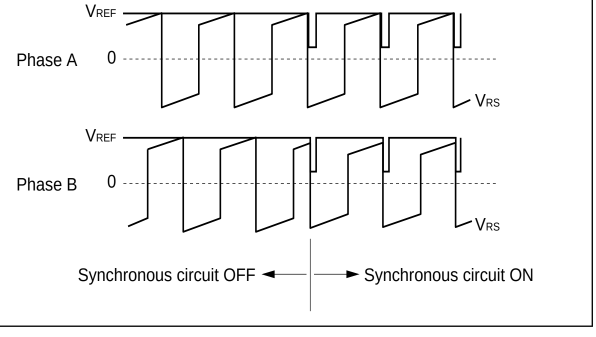
If no abnormal noise occurs when the motor is not running, ground the SYNC terminals (TTL not necessary).



The built-in synchronous chopping circuit superimposes a trigger signal on the REF terminal for synchronization between the two phases. The figure below shows the internal circuit of the REF terminal. Since the ΔV_{REF} varies depending on the values of R1 and R2, determine these values for when the motor is not running within the range where the two phases are synchronized.



■Synchronous circuit operating waveform



■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 T_r) 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)

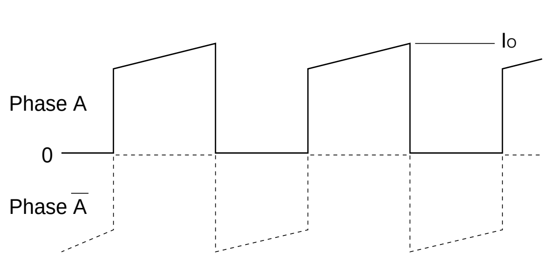


Fig. 2 Normal mode

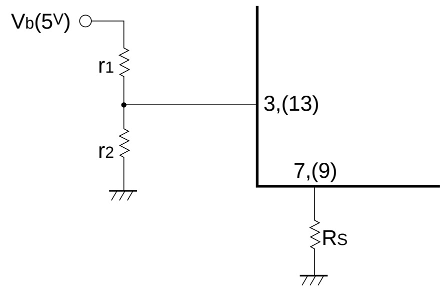


Fig. 3 Power down mode

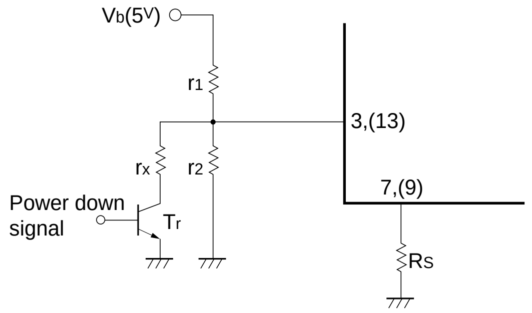


Fig. 4 Output current I_O vs. Current sense resistor R_S

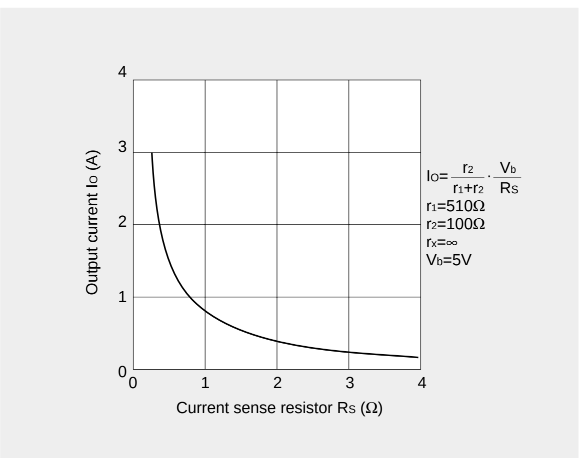
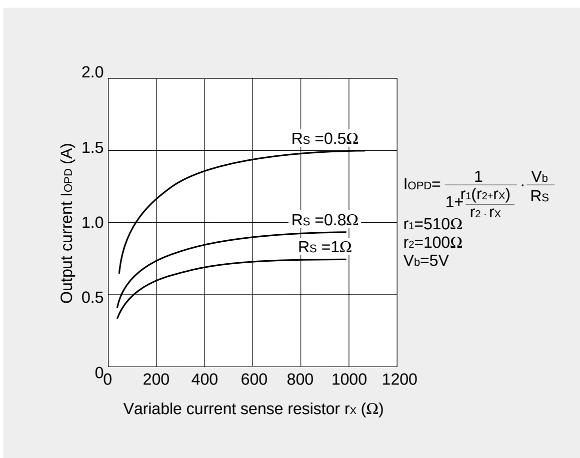


Fig. 5 Output current I_{OPD} vs. Variable current sense resistor rx



■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. 6 "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. 7 "Temperature rise."

Fig. 6 Heat dissipation per phase P_H vs. Output current I_O

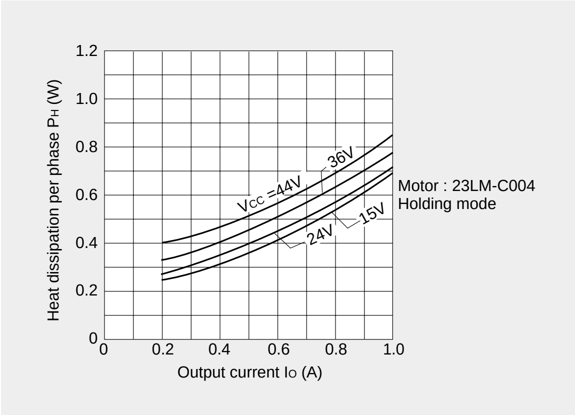
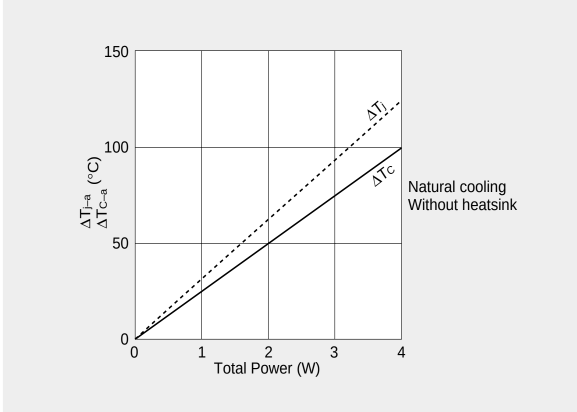
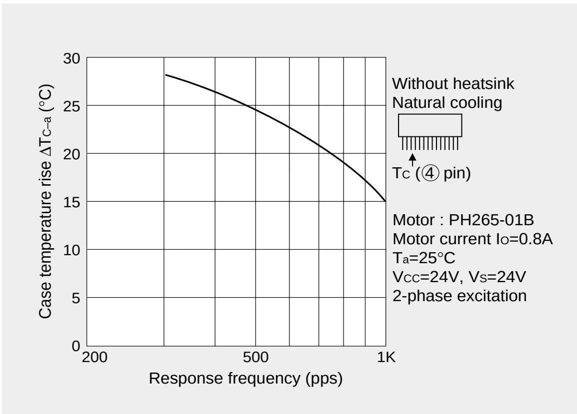


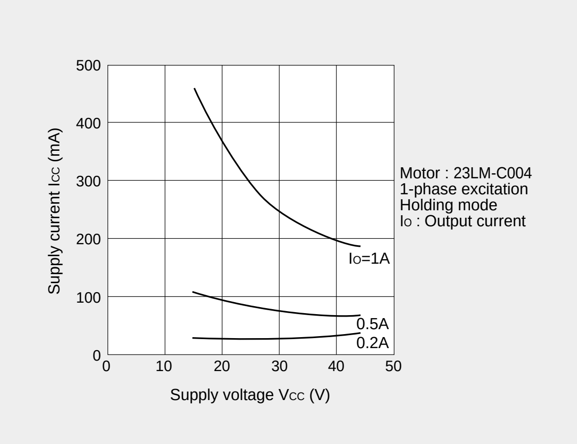
Fig. 7 Temperature rise



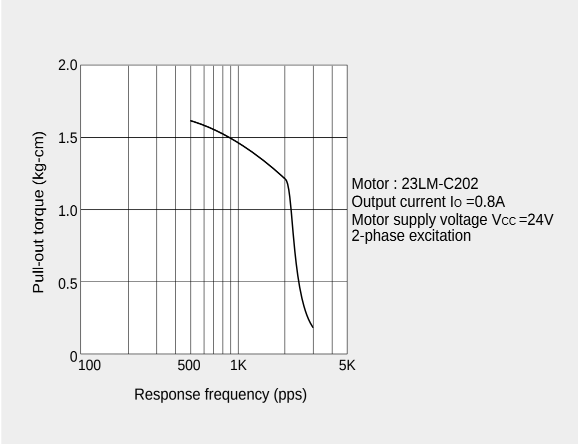
Thermal characteristics



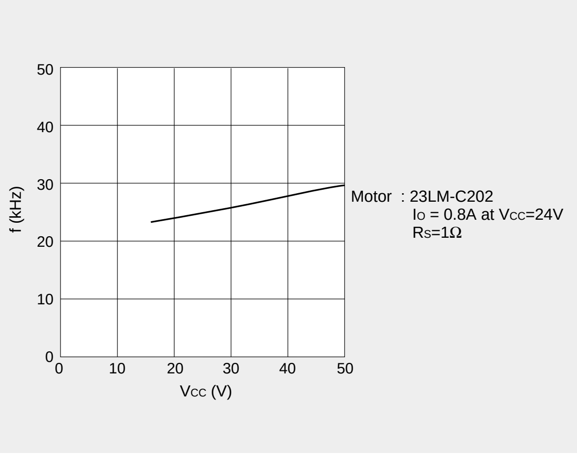
■Supply Voltage V_{CC} vs. Supply Current I_{CC}



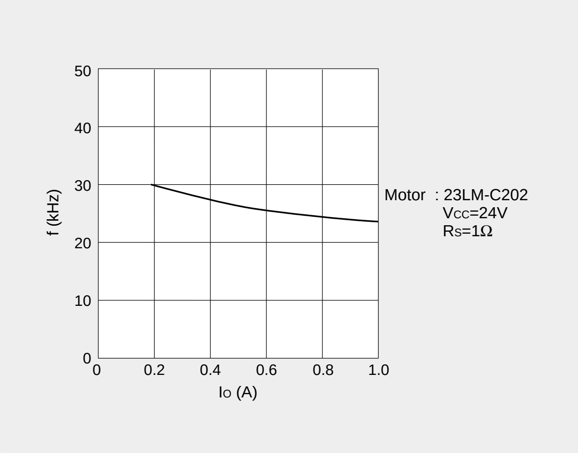
■Torque Characteristics



■Chopper frequency vs. Supply voltage



■Chopper frequency vs. Output current



■Handling Precautions

The input terminals of this product use C-MOS circuits. Observe the following precautions.

- Carefully control the humidity of the room to prevent the buildup of static electricity. Since static electricity is particularly a problem during the winter, be sure to take sufficient precautions.
- Take care to make sure that static electricity is not applied to the IC during wiring and assembly. Take precautions such as shorting the terminals of the printed wiring board to ensure that they are at the same electrical potential.