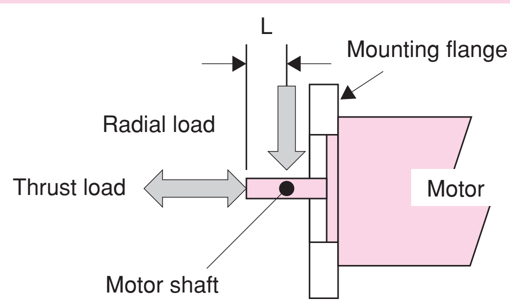
CONTENTS

Max. Allowable Load / Runout for motor shaft

Load for motor shaft

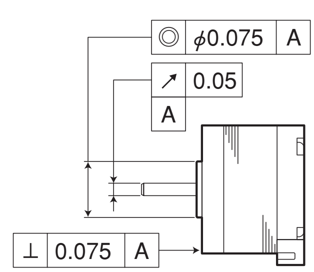
Type	Thrust load	Radial load	
		Load	L
KH39 KH42 KT35 KT42 KR42	14.7N・m (1.5kgf)	19.6N・m (2.0kgf)	10mm
KH56 KT60	40N・m (4.1kgf)	70N・m (7.1kgf)	



Shaft run out

Shaft run out	0.05T.I.R. (mm) ※
Concentricity between shaft and mounting circle	0.075T.I.R. (mm) ※
Perpendicularity between shaft and mounting face	0.075T.I.R. (mm) ※

※ T.I.R. (Total Indicator Reading)



2-Phase Hybrid Stepping Motors & Drivers

Product Number Code

Stepping motors

KH 42 H M 2 - 901

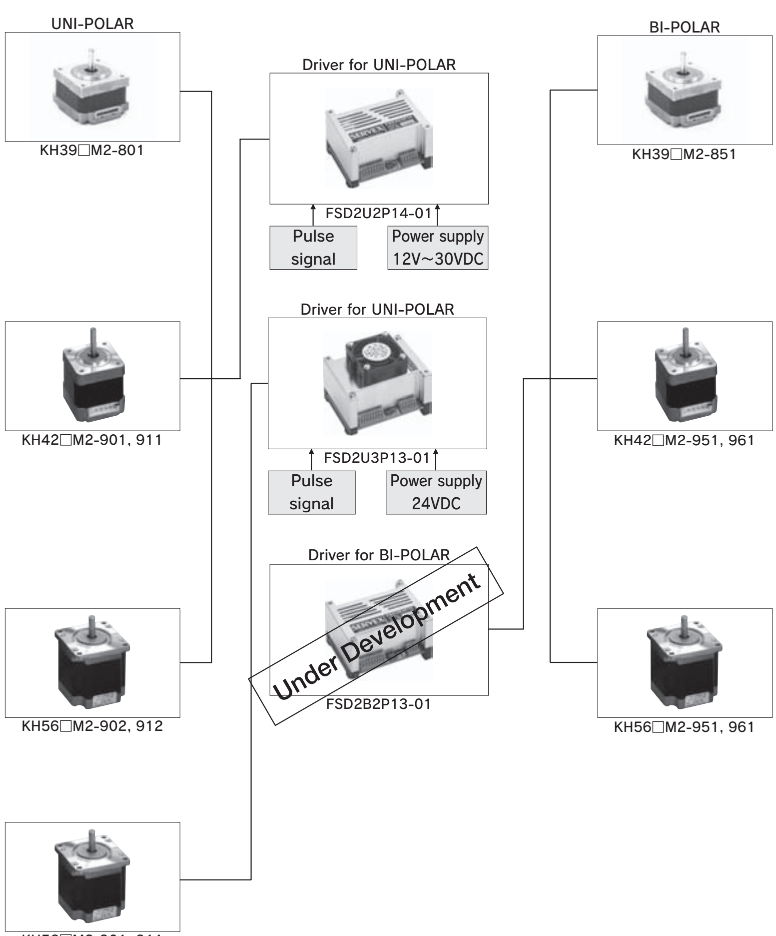
- Winding specifications
- Step angle(degree)
  - 06 : 0.6
  - 1 : 1.2
  - 2 : 1.8
  - 4 : 3.75
- Motor Type
  - M : HB Type
- Motor length(mm)
  - E : 20.8
  - F : 27
  - G : 31
  - H : 34
  - J : 40~42
  - K : 50~54
  - Q : 76
- Mounting size(mm)
- Series name
  - KH Series : 2Ph Stepping motors

Drivers

FSD 2 U 2 P 14 - 01

- Accessories (Connector of lead wires)
  - with 01: with cable
  - without 01: without cable
- Serial number
- Supply voltage
  - P : DC
- Output current
  - 2 : 2A
  - 3 : 3A
- Drive systems
  - 2U : 2Ph Unipolor
  - 2B : 2Ph Bipolor
- Series name
  - FSD Series
  - 2Ph Type(KH Series model)

System Configuration



■2 - PHASE STEPPING MOTORS

1 .Unipolar type   Stepping angle = 1.8 deg./step Vcc = 24 V

Standard size				Holding Torque		Winding Resistance	Current	Voltage	Inductance	Model	Driver	Page
mm		inch		mN・m	oz・in	Ω/phase	A/phase	V	mH/phase			
39 sq.x	20.8	1.54 sq.x	0.82	59	8.3	14	0.4	5.6	6.4	KH39EM2-801	○	4
	27		1.06	88	13.0	15	0.42	6.3	8.5	KH39FM2-801	○	6
	31		1.22	127	18.0	13.6	0.47	6.4	9.8	KH39GM2-801	○	8
42 sq.x	34	1.65 sq.x	1.34	140	20	3.4	0.9	3.06	2.4	KH42HM2-901, 911	○	10
						9.6	0.58	5.57	6.0	-902, 912	-	
						14.7	0.46	6.76	9.3	-903, 913	-	
	40		1.58	236	33	2.85	1.2	3.42	2.5	KH42JM2-901, 911	○	12
						5.5	0.88	4.4	5.1	-902, 912	-	
						18.5	0.5	9.25	16.3	-903, 913	-	
	50		1.97	340	48	3.1	1.2	3.72	3.1	KH42KM2-901, 911	○	14
56 sq.x	42	2.2 sq.x	1.65	422	60	0.58	3.0	1.74	0.61	KH56JM2-901, 911	◇	16
						1.39	2.0	2.78	1.8	-902, 912	○	
						4.9	1.0	4.9	6.68	-903, 913	-	
	54		2.13	834	118	0.77	3.0	2.3	1.04	KH56KM2-901, 911	◇	18
						1.79	2.0	3.6	3.0	-902, 912	○	
						6.71	1.0	6.71	9.36	-903, 913	-	
	76		2.99	1324	187	1.18	3.0	3.54	2.4	KH56QM2-901, 911	◇	20
						2.73	2.0	5.46	5.4	-902, 912	○	
						9.9	1.0	9.9	21.6	-903, 913	-	

Note; Driver model FSD2U2P14-01 is applicable to the motors with ○.
Note; Driver model FSD2U3P13-01 is applicable to the motors with ◇.

2 .Bipolar type   Stepping angle = 1.8 deg./step Vcc = 24 V

Standard size				Holding Torque		Winding Resistance	Current	Voltage	Inductance	Model	Driver	Page
mm		inch		mN・m	oz・in	Ω/phase	A/phase	V	mH/phase			
39 sq.x	20.8	1.54 sq.x	0.82	78	11	6.0	0.6	3.6	5.5	KH39EM2-851	○	4
	27		1.06	118	17	6.0	0.67	4.0	6.8	KH39FM2-851	○	6
	31		1.22	157	22	7.0	0.65	4.6	9.8	KH39GM2-851	○	8
42 sq.x	34	1.65 sq.x	1.34	197	28	3.1	1.0	3.1	4.3	KH42HM2-951, 961	○	10
	40		1.58	314	44	5.4	0.85	4.59	9.3	KH42JM2-951, 961	○	12
	50		1.97	403	57	2.3	1.2	2.76	4.0	KH42KM2-951, 961	○	14
56 sq.x	42	2.2 sq.x	1.65	490	69	0.98	2.0	1.96	2.27	KH56JM2-951, 961	○	16
	54		2.13	932	132	1.32	2.0	2.4	3.19	KH56KM2-951, 961	○	18
	76		2.99	1373	194	2.0	2.0	4.0	7.35	KH56QM2-951, 961	○	20

Note; Driver model FSD2B2P13-01 is applicable to the motors with ○.

■2 - Phase Drivers

Applicable motors type	Standard size		Power supply	OUTPUT current A	Step angle	Model	Page
	mm	inch					
Uni-poler	57×73×42	2.25×2.88×1.65	12-30V DC	0.33-2.0	1/1, 1/2, 1/4	FSD2U2P14-01	22
Uni-poler	57×73×56	2.25×2.88×2.21	24V DC	0.5-3.0	1/1, 1/2, 1/4	FSD2U3P13-01	24
Bi-poler					1/1, 1/2, 1/4	FSD2B2P13-01	26

3-Phase Hybrid Stepping Motors & Drivers

HIGH TORQUE, SILENT ROTATION

Product Number Code

Stepping Motors

KT 42 H M 06 - 551

- Winding specifications (551)
- Step angle(degree) (06)
  - 06 : 0.6
  - 1 : 1.2
  - 2 : 1.8
  - 4 : 3.75
- Motor type (M)
  - M : HB Type
- Motor length(mm) (H)
  - E : 20.8
  - F : 28
  - H : 34
  - J : 40~42
  - K : 47~54
  - L : 58~65
  - Q : 76
- Mounting size(mm) (42)
- Series Name (KT)
  - KT Series : 3Ph Stepping motors
  - KR Series : 3Ph Ring Rotor Type Stepping motors

Drivers

FTD 3 S 2 P 22 - 01

- Accessories (01)
  - (Connector of lead wires)
  - with 01: with cable
  - without 01: without cable
- Serial number (22)
- Supply voltage (P)
  - P : DC
- Output current (2)
  - 2 : 2A
  - 3 : 3A
- Drive systems (3S)
  - 3S : 3Ph Bipolor
- Series name (FTD)
  - FTD Series

■3- PHASE STEPPING MOTORS

1.Low speed high torque type   Vcc = 24 V

Step angle deg./step	Standard size mm		Standard size inch		Holding Torque mN·m	Holding Torque oz·in	Winding Resistance Ω/2phase	Current A/2phase	Voltage V	Inductance mH/2phase	Model	Driver		Page
0.6	42 sq.x	21	1.65 sq.x	0.8	45	6.4	5.9	0.9	5.3	3.1	KT42EM06-551	-	-	34
		34		1.34	90	12.7	1.2	2.4	2.88	0.8	KT42HM06-551	○	□	
		40		1.58	180	25.5	1.3	2.4	3.12	1.3	KT42JM06-551	○	□	
		48		1.89	200	28.3	2.0	2.3	4.6	1.4	KT42KM06-551	○	□	
	60 sq.x	47	2.36 sq.x	1.85	300	42	0.55	3.8	2.09	1.0	KT60KM06-751	-	-	44
							1.6	2.2	3.52	3.1	-752	○	□	
					500	69	0.55	3.8	2.09	1.0	KT60KM06-551	-	-	
							1.6	2.2	3.52	3.0	-552	○	□	
		58		2.29	600	83	0.73	3.8	2.77	1.8	KT60LM06-751	-	-	46
							2.2	2.2	4.84	5.7	-752	○	□	
					900	125	0.73	3.8	2.77	1.7	KT60LM06-551	-	-	
							2.2	2.2	4.84	5.6	-552	-	□	
1.2	35 sq.x	28	1.38 sq.x	1.10	59	8.3	39.0	0.3	11.7	26.0	KT35FM1-552	○	-	32
	42 sq.x	21	1.65 sq.x	0.8	70	9.9	5.9	0.9	5.3	2.6	KT42EM1-551	-	-	36
		34		1.34	140	19.8	1.1	2.4	2.6	0.5	KT42HM1-551	○	□	
		40		1.58	210	29.7	1.2	2.4	2.88	0.8	KT42JM1-551	○	□	
		48		1.89	280	39.6	1.5	2.4	3.6	1.0	KT42KM1-551	○	□	
	50 sq.x	51	1.97 sq.x	2.02	440	62.3	1.3	3.0	3.9	1.6	KT50KM1-551	-	□	40
		65		2.56	580	82.1	1.6	3.0	4.8	1.6	KT50LM1-551	-	□	
	56 sq.x	52	2.21 sq.x	2.04	690	97.4	1.4	3.0	4.2	1.4	KT56KM1-551	-	□	42
		76		2.98	1100	156	1.7	3.0	5.1	1.7	KT56QM1-551	-	□	
	60sq.x	47	2.36 sq.x	1.85	320	45.3	0.55	3.8	2.09	0.8	KT60KM1-551	-	-	48
		47		1.85	320	45.3	1.6	2.2	3.52	2.5	-552	○	□	
		58		2.29	600	85	0.73	3.8	2.77	1.0	KT60LM1-551	-	-	50
		58		2.29	600	85	2.2	2.2	4.84	3.3	-552	○	□	
		86		3.37	1680	238	2.0	3.0	6.0	3.2	KT60RM1-551	-	□	52
	86 dia.x	61	3.38dia.x	2.40	2000	278	1.8	3.0	5.4	18.0	KT86LM1-551	-	□	54
		95		3.74	4000	556	2.8	2.5	7.0	36.6	KT86SM1-551	-	□	
3.75	42 sq.x	20	1.65 sq.x	0.79	70	9.7	6.6	0.8	5.28	5.7	KT42EM4-551	-	-	38
		34		1.34	130	18	3.4	1.3	4.42	4.7	KT42HM4-551	○	-	
							8.8	0.8	7.04	12.3	-552	-	-	
		40		1.58	180	25	4.3	1.2	5.16	8.7	KT42JM4-551	○	-	
							11.0	0.8	8.8	22.0	-552	-	-	

Note-1; Driver model FTD3S2P22-01 is applicable to the motors with ○. The MAX output current is 2 A/phase.
Note-2; Driver model FTD3S3P17-01 is applicable to the motors with □.

2.High speed steady torque type   Vcc = 24 V

Step angle deg./step	Standard size mm		Standard size inch		Holding Torque mN·m	Holding Torque oz·in	Winding Resistance Ω/2phase	Current A/2phase	Voltage V	Inductance mH/2phase	Model	Driver		Page
3.75	42 sq.x	34	1.65 sq.x	1.34	49	6.9	1.4	2.0	2.8	1.7	KR42HM4-551	○	□	56
							3.4	1.3	4.42	4.0	-552	○	-	
		40		1.58	88	12.5	1.75	2.0	3.5	2.1	KR42JM4-551	○	□	58
							4.3	1.2	5.16	8.7	-552	○	-	
		48		1.89	118	16.7	1.4	2.5	3.5	1.7	KR42KM4-551	-	□	60
							5.0	1.3	6.5	7.7	-552	○	-	

Note-1; Driver model FTD3S2P22-01 is applicable to the motors with ○.
Note-2; Driver model FTD3S3P17-01 is applicable to the motors with □.

■3- Phase Drivers

Standard size mm	Standard size inch	Power supply	OUTPUT current A	Step angle	Model	Page
57×73×42	2.25×2.88×1.65	12-24V DC	1.0-2.0	1/1, 1/2, 1/4, 1/8	FTD3S2P22-01	62
70×134×35	2.76×5.28×1.38	24V DC 5V DC	1.5-3.0	1/1, 1/2, 1/4, 1/8	FTD3S3P17-01	64

3-Phase Hybrid Stepping Motor Driver

HIGH TORQUE, SILENT ROTATION

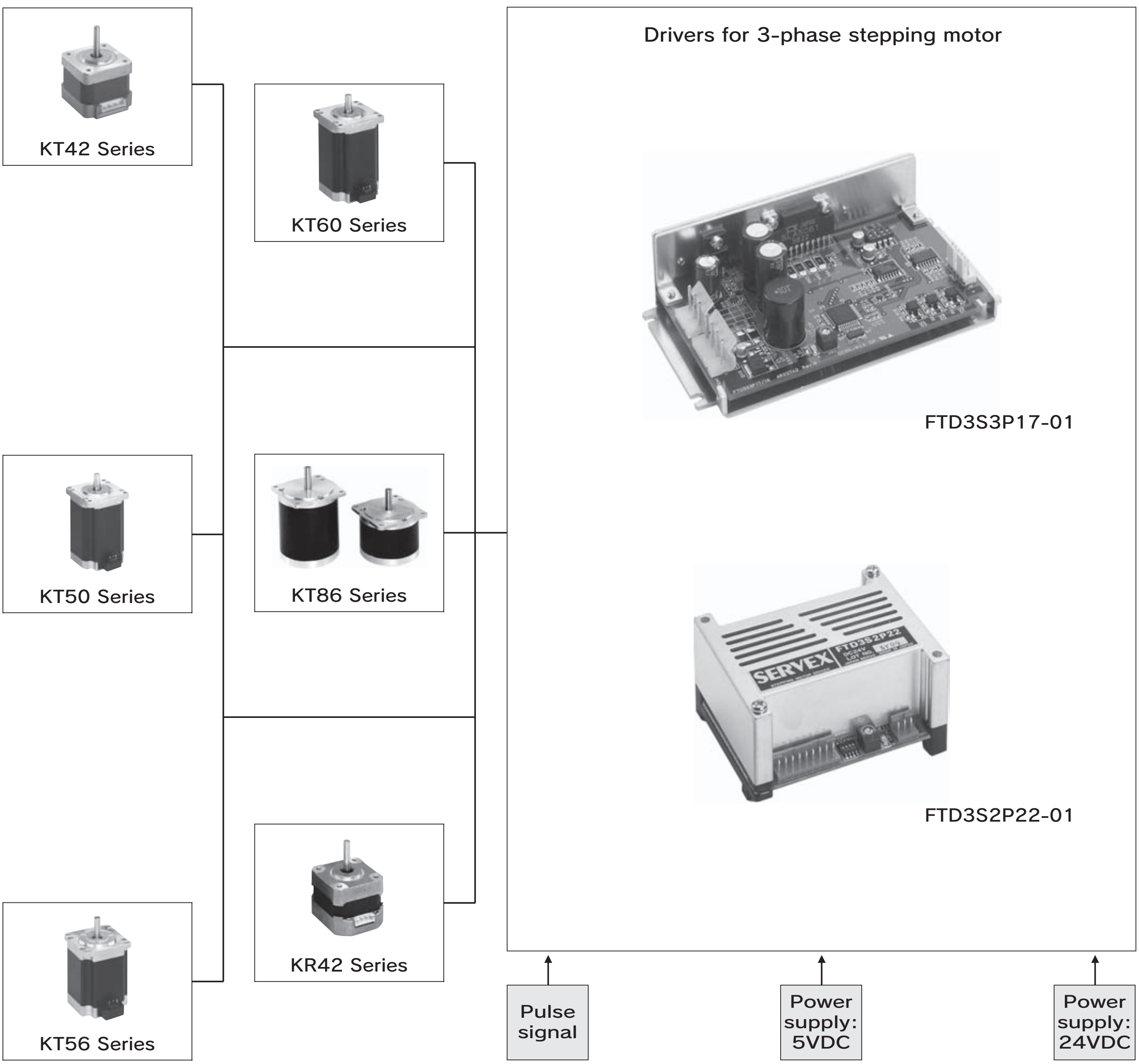
Features

1. Drive circuit is simplified because the motor is driven with star wiring connection.
2. High torque is obtained at low speed with the micro-step driver.
3. Ultra-low vibration and low noise achieved with our micro-step driver.
4. The step angle of 1/1, 1/2, 1/4, and 1/8 may be chosen using our micro-step driver.

Applications

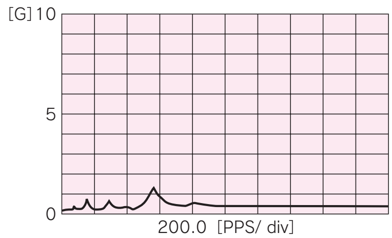
Suitable as controlled driving source in scientific or high precision industrial equipment such as OA equipment, measuring equipment, medical treatment equipment, physics and chemistry equipment, optical equipment, semiconductor processing equipment, and other precision machinery.

System Configuration

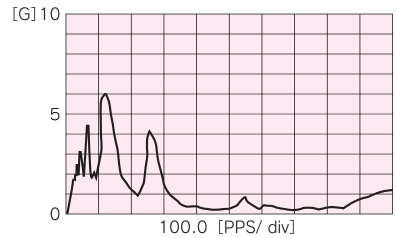


Vibration Comparison

Micro-Step drive 1/8



Full-Step drive



Advantage

Constant current driver

With the fixed current drive method, a voltage sufficiently higher than the specified voltage, of the motor, is finely sliced in the switching circuit than applied to the motor coil. The current is maintained at a constant level whether the motor is rotating at low or high speed. With this method the output torque during high speed rotation is greatly improved with power consumption minimized.

Micro-step driver

With the micro-step drive method, the mechanically determined step angle (3.75°, 1.2° or 0.60°) is divided by an electronic circuit and the motor is gradually rotated by a fine angle. The conventional excitation method makes a rotor rotates by a fixed angle by turning the magnetizing phase on and off through an input pulse. On the other hand, with the micro-step driving method, the current of one phase of the magnetizing phase can be gradually increased while the current of other phase is decreased thereby further dividing the step angle of the motor and making rotation even smoother.
THE FTD3S3P17 driver, the FTD3S2P22 enable to set to step divisions of 1/4 and 1/8. Micro stepping drive is effective to reduce mechanical driving noise particularly when divisions not exceeding 1/8.

Rectangular wave drive

● 2-phase excitation (full-step)
This is then or mal 2-phase excitation method. Torque is large and damping characteristics are excellent.

	Noise level	Vibration	Torque		High speed capability
			Low speed	High speed	
Micro-step drive	○	○	○	△	△
Rectangular wave drive	△	△	○	○	○

Explanation of the Dynamic Torque Curve

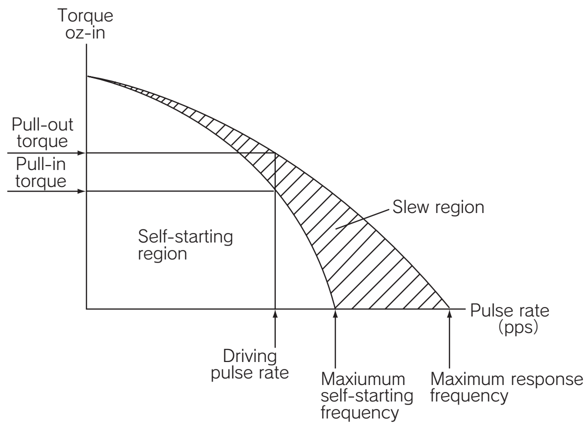


Fig. 1 Torque/speed characteristics curve

Self-starting region
This is the region in which motors can be started and stopped instantaneously.

Pulse rate
The number of pulses in a unit of time, and is shown in the unit "pps" which means "pulses per second". The relation between pulse rate, speed (rpm) and angular velocity (rad/s) is given below.

$$\omega = \frac{\pi}{180}\,\theta s \cdot P \rightarrow P = \frac{180}{\pi} \cdot \frac{\omega}{\theta s}$$

$$N = \frac{1}{6}\,\theta s \cdot P \rightarrow P = \frac{6N}{\theta s}$$

where ω : Angular velocity (rad/s)
θs : Step angle (deg.)
N : Speed (rpm)
P : Driving pulse rate (pps)

Maximum self-starting frequency (pps)
This is the maximum pulse rate in the self-starting region. Care must be taken, because it varies depending on the load inertia.

Slew region
In this region, driving is possible only by slow acceleration/slow deceleration control.

Maximum response frequency (pps)
This is the maximum pulse rate in the slew region.

Pull-in torque
This is the torque generated when started in the self-starting region. It is also called the "synchronization torque".

Pull-out torque
This is the torque generated when driven in the slew region.

Pull-out
This means the motor is coming out of synchronized operation by being not able to follow the pulse signal from the pulse generator.
Over-loading is the general cause, but noise (Electric/Electro-magnetic) is also a cause in some cases.

Slow acceleration/slow deceleration
This is a kind of control to raise or lower the pulse rate to drive stepping motors in the slew region so they exhibit their full capability. There are various methods but one example, called trapezoidal driving, is shown in Fig. 2.

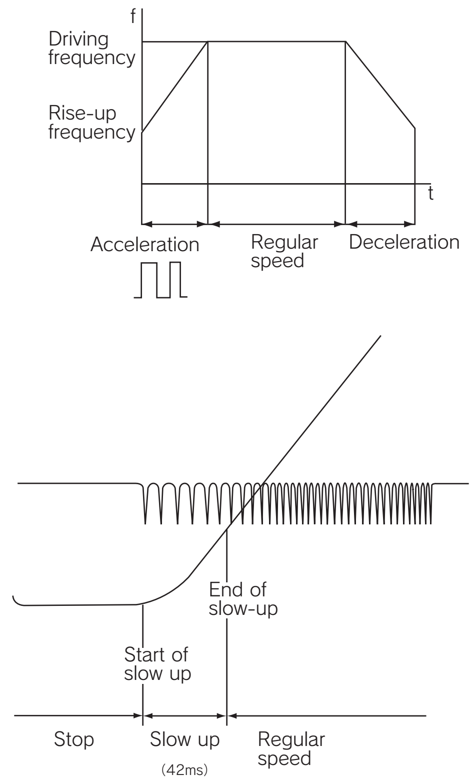


Fig. 2 Trapezoidal drive of slow-up/slow down control

Resonance phenomenon
When stepping motors are driven, torque decrease, miss-steps, vibration and other unfavorable phenomena may occur at some specific frequencies. This is called a "Resonance phenomenon", and is caused by the coincidence of intrinsic vibration frequency and input pulse frequency of the motor. It is experienced generally in the range of 100 to 200 pps. It is impossible to eliminate this resonance fully, but the defect can be reduced by changing the excitation mode or providing damper.