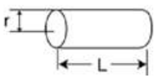
A stepper motor should provide an output torque larger than load torque and be required to start and stop at a proper step rate against load inertia. Also, while operating the motor at a rate higher than the starting pulse rate, the rate needs to be varied within a proper acceleration time. Here are some basic formulas to help you determine the torque, inertia and acceleration/deceleration time you require of the stepper motor to fit your application.

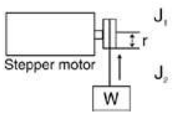
Obtaining Load Inertia

$$= \frac{Mr^2}{2} = \frac{W}{g} \times \frac{r^2}{2} = \frac{\pi r^2 \bullet L \bullet \rho \bullet r^2}{981 \times 2} = \frac{\pi \bullet \rho \bullet Lr^4}{1962}$$



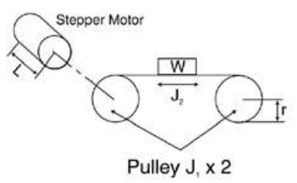
where:
J = Load inertia (kg • cm • s^2)
π = Ratio of the circumference of a circle to its diameter (3.14)
ρ = Specific gravity of cylinder material (kg/cm^3)
(Iron = 7.8 x 10^{-3}, Aluminum = 2.7 x 10^{-3})
L = Length of cylinder (cm)
r = Radius (cm)
g = Gravitational acceleration 981 (cm • s^2)

$$J = J_1 + J_2 = \frac{\pi\rho \bullet L \bullet r^4}{1962} + \frac{Wr^2}{981}$$



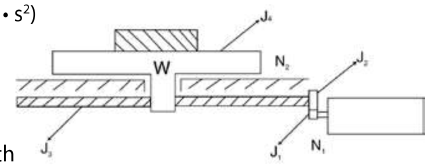
where:
J = Load inertia (kg • cm • s^2)
J_1 = Inertia of pulley (kg • cm • s^2)
J_2 = Inertia of take-up (kg • cm • s^2)
W = Weight of material to be wound (kg)
r = Radius of pulley (cm)

$$J = 2 \times J_1 + J_2 = 2\left(\frac{\pi\rho Lr^4}{1962}\right) + \frac{Wr^2}{981}$$



where:
J = Load inertia (kg • cm • s^2)
J_1 = Inertia of pulley (kg • cm • s^2)
J_2 = Inertia of linear movement (kg • cm • s^2)
W = Weight of belt and material (kg)
r = Radius of pulley (cm)
L = Length (cm)

$$J_0 = J_1 + (J_2 + J_3)\left(\frac{N_1}{N_2}\right)^2 + J_4$$



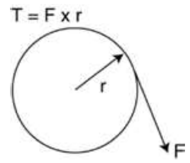
$$J_4 = \frac{W}{981}\left(\frac{\delta}{\frac{\pi}{180} \bullet \alpha}\right)^2$$

$$\text{or } J_4 = \frac{W}{981}\left(\frac{P}{2\pi} \bullet \frac{N_1}{N_2}\right)^2$$

where:
J_0 = Load inertia (kg • cm • s^2)
J_1 = Inertia of pinion (kg • cm • s^2)
J_2 = Inertia of gear (kg • cm • s^2)
J_3 = Inertia of feed screw (kg • cm • s^2)
J_4 = Inertia of work and table (kg • cm • s^2)
N_1 = Number of pinion teeth
N_2 = Number of gear teeth
W = Weight of work and table (kg)
π = Ratio of the circumference of a circle to its diameter (3.14)
α = Step angle per pulse (°)
δ = Table movement per pulse (cm)
P = Pitch of feed screw (cm)

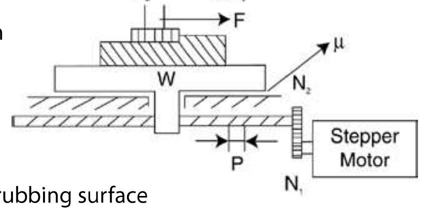
Obtaining Load Torque

$T = F \times r$



where:
T = Load torque (kg • cm)
F = Force to rotate the coupling shaft of a stepper motor (cm)
r = Radius to apply the force (F) (cm)

$$T = \frac{N_1}{N_2} \times \frac{(F + \mu W)P}{2\pi\eta}$$



where:
T = Load torque (kg • cm)
N_1 = Number of pinion teeth
N_2 = Number of gear teeth
W = Weight of table and work (kg)
F = Cutting resistance (kg)
μ = Frictional resistance of rubbing surface
P = Pitch of feed screw (cm)
η = Transfer efficiency of the system including feed screw and gear

Obtaining Acceleration/Deceleration Time

$$t_{acc} = (J_r + J_l)\, 2\pi * (f_h - f_l) / (nq * T_a)$$

where:
t_{acc} = Acceleration time (S)
J_r = Rotor inertia (g • cm • s^2)
J_l = Load inertia (g • cm • s^2)
f_h = Slew speed (pps)
f_l = Starting speed (pps)
nq = Step/revolution
T_a = Acceleration torque (g • cm)

Obtaining Acceleration/Deceleration Torque

$$T_a = (J_r + J_l)\, 2\pi * (f_s)^2 / (nq * n)$$

where:
T_a = Acceleration torque (g • cm)
J_r = Rotor inertia (g • cm • s^2)
J_l = Load inertia (g • cm • s^2)
f_s = Max no load slew rate under specific drive conditions (pps)
nq = Step/revolution
n = Index No for drive method (Full step mode = 2; Half step mode = 4)

Calculating Output Torque From Gearhead

$$T_{gh} = T_m \times G_r \times 0.85^n$$

where:
T_{gh} = Torque from Gearhead
T_m = Torque from motor
G_r = Gearhead ratio (# of times motor turns per 1 turn of gearhead)
example: 1/3 gearhead G_r = 3
n = Number of gears

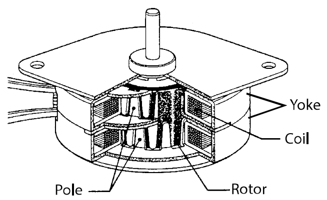
Permanent Magnet Motors

Nippon Pulse's permanent magnet (PM) step motors (PF series tin-can steppers) have been well-established in the engineering world, and have many advantages over other kinds of stepper motors. PM motors strike the perfect balance between efficiency and affordability, as they are low-inertia, low-resolution motors that are a low-priced alternative to hybrid stepper motors in many applications.

PM step motors have a typical step angle between 3.75 and 18 degrees, and offer position resolution on the order of ±5 percent. Its structure demonstrates ferromagnetism, with alternating north and south poles set in a straight, parallel line to the rotor shaft. The rotor is moved through the action of permanent magnets, providing increased magnetic flux intensity. This intensity results in improved torque characteristics for the PM motor, compared to variable resistance step motors.

Nippon Pulse provides high-quality PM motors to industries and professionals all over the world. Take a look at our standard PM motors over the following pages to find the one that most closely fits your needs. An application engineer can work with you to make any customizations necessary to make our PM motors a perfect fit.

Basic Structure of 2-Phase Permanent Magnet Motor



Below are Nippon Pulse's permanent magnet stepper motors:

- **PF series** - Nippon Pulse's original PM stepper motors
- **PFC series** - PF series tin-can steppers with a fully automated coil assembly
- **PFL series (Linearstep)** - linear actuators that utilize the PF series construction
- **NFC series** - high-force, short-stroke linear actuators that utilize the PF series construction
- **PTM/PTMC series** - synchronous timing motors based on the PF series.

Terminology

Continuous Rating
Specifications are continuously applicable to the rated output.

Dielectric Strength
The maximum voltage between the case and the coils that can be sustained for one minute without damaging the motor.

- 500Vac for one minute with operating voltage <30V
- 1000Vac for one minute with operating voltage 30-150V
- 1500Vac for one minute with operating voltage >150V

Intermittent Rating
Specifications are applicable for a specific time length to the rated output.

Motor Speed
Number of revolutions per minute.

Operating Temperature Range
Ambient temperature range in which the motor can normally be driven.

Operating Voltage Range
The voltage range in which the motor can normally be driven with Constant Voltage drive.

Temperature Rise
The temperature of the motor rises whenever power is applied. Temperature rise is determined by applying the motor's rated voltage and measuring the increased coil resistance or the change in surface temperature of the motor.

Abbreviations/Units

A
SI base unit for current (ampere)

AC
Alternating current

CCW
Counterclockwise

CW
Clockwise

DC
Direct Current

Hz
SI induced unit for frequency (cycles per second)

K
SI base unit for temperature (Kelvin); often used for temperature rise

PPS
Pulses per second

RPM
Revolutions per minute

V
SI induced unit for voltage (volts)

RoHS Compliance

All Nippon Pulse stepper motor products are RoHS compliant.

PFL35T and PFC25

Tin-Can Models by Outer Diameter

OD (mm)	Tin-Can	Synchronous		Linear Stepper
		Dual Direction	Single Direction	
10	PFC10	--	--	--
20	PFCU20 PFC20T	--	--	--
25	PF(C)25 PFCU25	PTM-24P	--	PFCL25
30	PFCU30	--	--	--
35	PF35 PF35T	PTM-24M PTM-24T	PTM-24B	PFL35T
42	PF42 PFC42H PF(C)42T	PTM-24H PTMC-24S2	PTM-12K PTM-12E	--
55	PF(C)55 PFC55H	PTM-24F	--	--

Insulation Ratings

Insulation Class	Y	A	E	B	F	H	C
Allowable Temp (°C)	90	105	120	130	155	180	>180

Note: All tin-can motors and linear steppers in this catalog are insulation Class E unless otherwise noted.

Permanent Magnet Motor Features and Customization Options

Coil
An encapsulated and welded stator design gives stronger design, greater dimensional control and improved thermal characteristics.

Mounting Plate
Custom and standard shaped mounting plates are available. Mounting holes can be threaded, tapped, slotted or customized to your application requirements.

Permanent Magnet Rotor
Three types of permanent magnets are available: ferrite anisotropic, ferrite isotropic, and neodymium.

Bushings and Bearings
Long life oil-impregnated bushings are standard in our PF, PFC, NFC, PTM and PTMC motors. Ball bearings can be requested, and are standard in the PFL series Linearstep motors.

Shaft
A variety of shaft options are available.

- Custom lengths
- Single and double shafts
- D-cut(s)
- Turn downs
- Threaded
- Knurled
- Grooved

Gears & Pulleys
A variety of gear and pulley options are available.

- Machined
- Plastic molded
- Powdered metal (sintered)

Connector
Motor side connection method. Lead wire options available.

Lead Wire
Options to change the lead wire exit direction and exit angle.

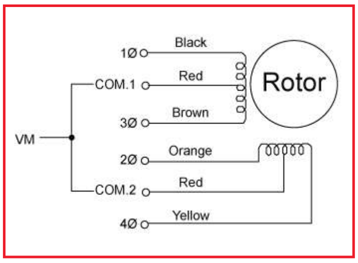
Wire Leads
Driver side connector options.

- Standard flying leads
- Customer-selected connectors

See page 41 for additional motor customization options and for information about creating a fully custom step motor.

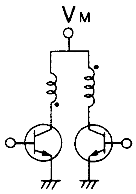
Unipolar Drive

Six lead wires are connected



Current: Single direction
Coil: Bifilar winding
Leadwires: 6

The basic circuit (constant voltage) is shown to the right



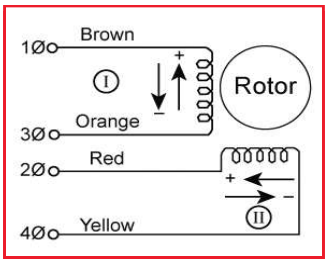
2-2 phase excitation sequence

CW ↓ / ↑ CCW

Step	Black	Brown	Orange	Yellow	Step
1	ON	OFF	ON	OFF	4
2	OFF	ON	ON	OFF	3
3	OFF	ON	OFF	ON	2
4	ON	OFF	OFF	ON	1

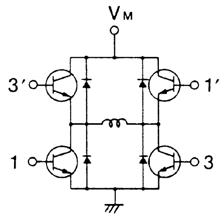
Bipolar Drive

Four lead wires are connected



Current: Dual direction
Coil: Monofilar winding
Leadwires: 4

The basic circuit (constant voltage) is shown to the right



2-2 phase excitation sequence

CW ↓ / ↑ CCW

Step	Ⅰ	Ⅱ
1	+	+
2	-	+
3	-	-
4	+	-

		Unipolar	Bipolar
Number of Transistors		1	2
To ensure the same temperature rise of motor	Current Torque High-speed performance Voltage	1 1 1 1	1/√2 √2 0.5 √2
To obtain same torque	Current Temperature rise High-speed performance Voltage	1 1 1 1	0.5 0.5 0.5 1

This chart shows the comparison between bipolar and unipolar drives with parameters of unipolar set to one.

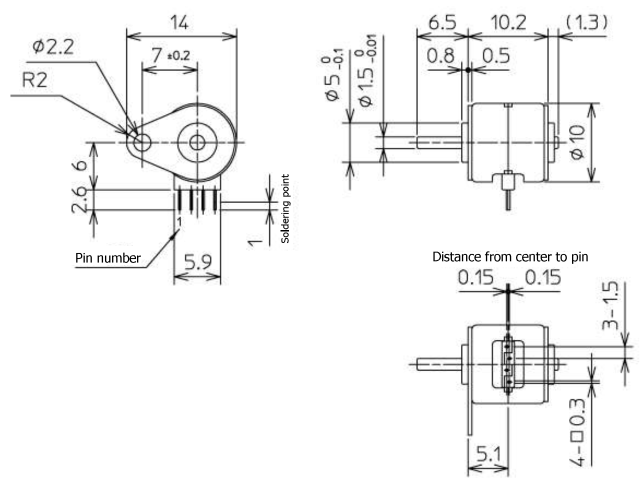
Model Number Explanation (for PF and PFC series)

PF(C) -	42	T -	48	C	1	G	1/50
1	2	3	4	5	6	7	8

1 - Series Designation
  PF: Flying lead joint type
  PFC: Connector joint type
2 - Outer Diameter in mm
3 - Type
  Blank: Standard
  T: Thin stack
  H: High torque
4 - Steps per Revolution
  24: 15˚/step
  48: 7.5˚/step
  96: 3.75˚/step
5 - Winding
  C: 12V unipolar
  D: 5V unipolar
  P: 12V bipolar
  Q: 5V bipolar

6 - Magnet Material
  1: Ferrite Anisotropic
  3: Ferrite Isotropic
  4: Neodymium
  6: Molded Neodymium*
7 - Gear Head
  Blank: No Gear Head
  G: Gear Head Integrated
8 - Gear Ratio
  With geared models only

*Only applicable for PFC10 and PFC20T.

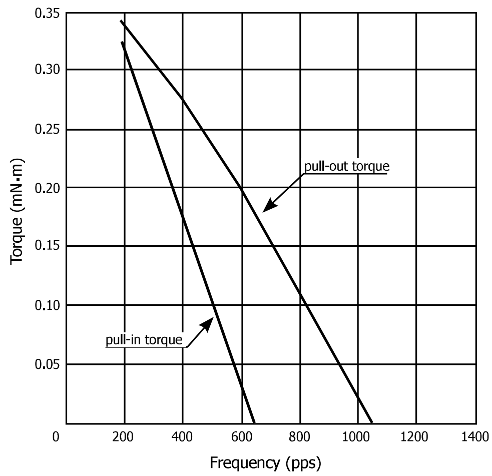


Specifications

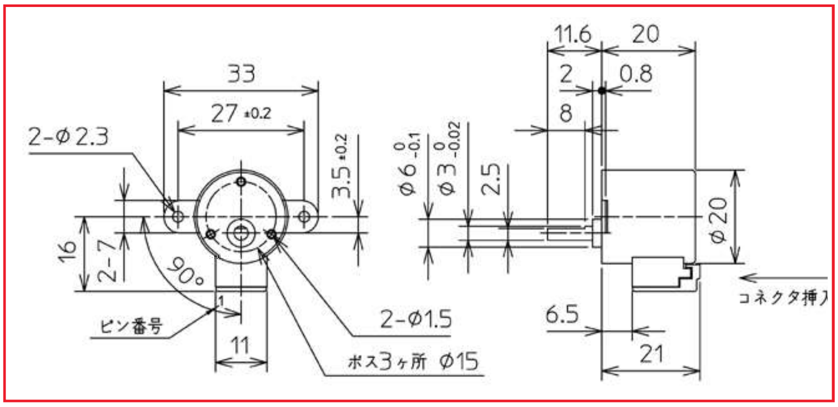
Specification	Unit	PFC10-20R6
Type of Winding		Bipolar
Excitation Mode*		Full step (2-2)
Steps/Revolution		20
Step Angle	°	18
Holding Torque	mN·m	1.0
Rated Voltage	V	2.7
Rated Current	mA/phase	135
Resistance	Ω	20
Inductance	mH / ϕ	3.2
Winding		R
Starting Pulse Rate	pps	960
Slewing Pulse Rate	pps	1600
Rotor Inertia	kg·m²	0.03 x 10^{-7}
Operating Temp. Range	˚C	-10 to +50
Storage Temp. Range	˚C	-30 to +80
Insulation Class		E
Temperature Rise	K	70
RoHS Compliant		Yes
Weight	g	5

All tin-can motor specifications are based on full-step constant voltage operation.
When the rated voltage is 5V, the terminal voltage is 4V.
Do not use this product over maximum operating temperature (100°C).

Torque Curve Characteristics



Pin	Coil Phase
1	4ϕ $\overline{B}$
2	1ϕ A
3	2ϕ B
4	3ϕ $\overline{A}$



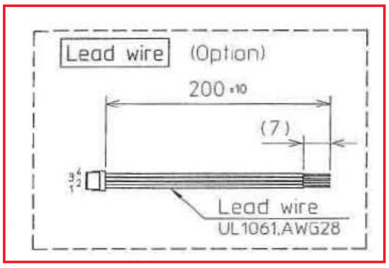
Specifications

Specification	Unit	PFCU20-40_-4GM2 (1/10)		PFCU20-40_-4GM2 (1/18)	
Excitation Mode		Full-step (2-2)			
Step Angle	°	0.9		0.5	
Steps Per Revolution*		400		720	
Winding		S	V	S	V
Rated Voltage	V	11	8.7	11	8.7
Resistance[1]	Ω	160	100	160	100
Inductance[1]	mH/ϕ	59	39	59	39
Maximum Torque	mN·m	20			
Destruction Torque	mN·m	60			
Gear Ratio/Backlash	pps	1/10		1/18	
Operating Temp. Range	˚C	-10 ~ +50			
Temperature Rise*	K	70			
Weight	g	25			

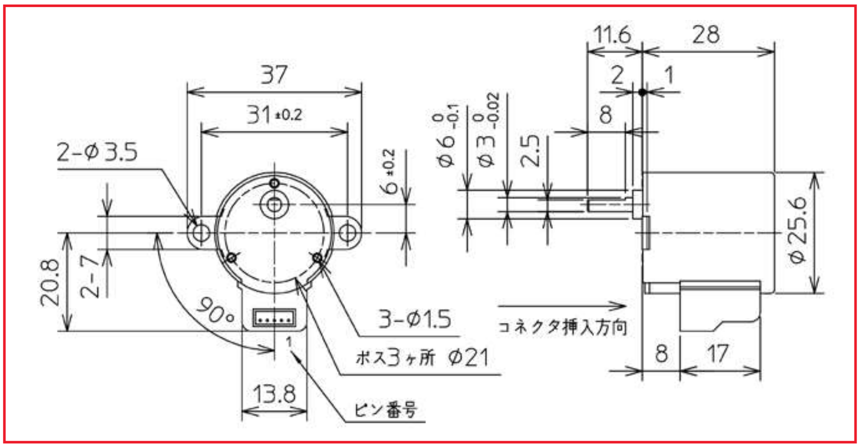
All tin-can motor specifications are based on full-step constant voltage operation.
Magnet type: Neodymium
[1] Supply voltage 12V ±2% and at a temperature of 20˚C ±5% and relative humidity 65% ±20%.
[2] Stated terminal voltage is with supply voltage 12V.
[3] Stated temperature rise is at the time of saturation.
*Under test conditions

Connector (JST)

Applicable Housing: SHR-04V-S
Applicable Contact: SSH-003T-P0.2-H
Applicable Wire: AWG 32 to 28 (outer diameter of wire insulation: 0.4 to 0.8 mm)



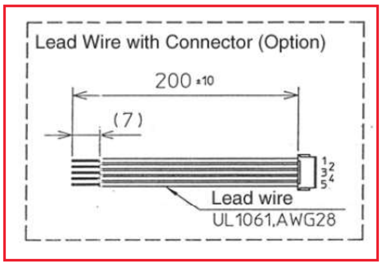
Pin	Coil Phase
1	4ϕ B-
2	3ϕ A-
3	1ϕ A
4	2ϕ B



Specifications

Specification	Unit	PFCU25-24_-1GM (1/18)		PFCU25-24_-1GM (1/20)		PFCU25-24_-1GM (1/30)	
Excitation Mode		Full Step (2-2)					
Step Angle	°	1		0.75		0.5	
Steps Per Revolution*		360		480		720	
Winding		P	T	P	T	P	T
Rated Voltage	V	12.6	6.5	12.6	6.5	12.6	6.5
Resistance[1]	Ω	122	32	122	32	122	32
Inductance[1]	mH/ϕ	66	16	66	16	66	16
Maximum Torque	mN·m	50					
Destruction Torque	mN·m	150					
Operating Temp. Range	˚C	-10 ~ +50					
Temperature Rise*	K	70					
Weight	g	55					
Gear Ratio, Backlash		1/15		1/20		1/30	

All tin-can motor specifications are based on full-step constant voltage operation,
Magnet type: Anisotropic
[1] Supply voltage 12V ±2% and at a temperature of 20˚C ±5% and relative humidity 65% ±20%.
[2] Stated terminal voltage is with supply voltage 12V.
[3] Stated temperature rise is at the time of saturation.
*Under test conditions

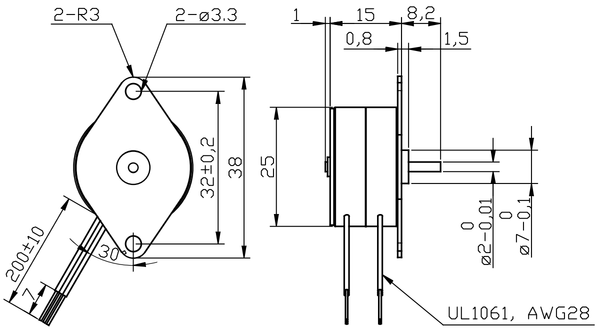


Pin	Coil Phase
1	3ϕ A-
2	2ϕ B
3	1ϕ A
4	4ϕ B-

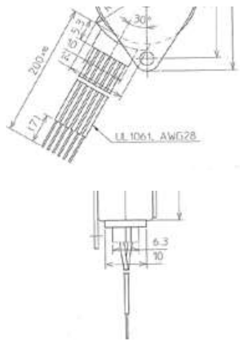
Connector (JST)

Applicable Housing: ZHR-4
Applicable Contact: SZH-002T-P0.5
Applicable Wire: AWG 28 to 26 (outer diameter of wire insulation: 0.8 to 1.1 mm)

PF25



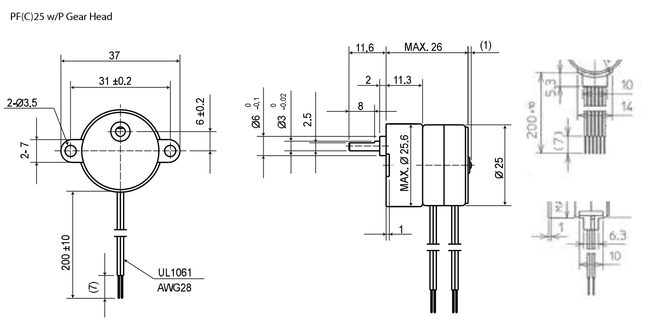
PFC25



Specifications

Specification	Unit	PF(C)25-24				PF(C)25-48			
Type of Winding		Unipolar		Bipolar		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)				Full step (2-2)			
Step Angle	°	15 ±5%				7.5 ±5%			
Steps Per Revolution*		24				48			
Winding		C	D	P	Q	C	D	P	Q
Rated Voltage	V	12	5	12	5	12	5	12	5
Resistance	Ω	120	16	122	15	120	16	122	15
Inductance	mH	34	4.5	66	8	37	5	81	10
Holding Torque*	mN·m	8	8	10	10	10	10	12	12
Rotor Inertia	kg·m²	1.0 x 10⁻⁷				1.0 x 10⁻⁷			
Starting Pulse Rate*	pps	490				790			
Slewing Pulse Rate*	pps	900							
Operating Temp. Range	°C	-10 to +50							
Temperature Rise*	K	70							
Weight	g	35							

Dimensions of Geared Model



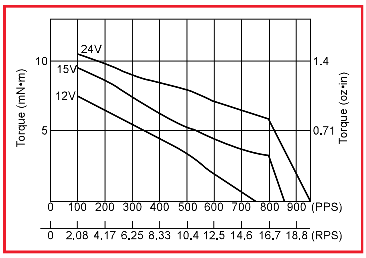
Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20
Ordinary Torque	20mN·m				50mN·m			
Destruction Torque	60mN·m				150mN·m			

Gear Ratio	1/25	1/30	1/50	1/60	1/75	2/125
Ordinary Torque	70mN·m					
Destruction Torque	210mN·m					

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	100mN·m						
Destruction Torque	300mN·m						

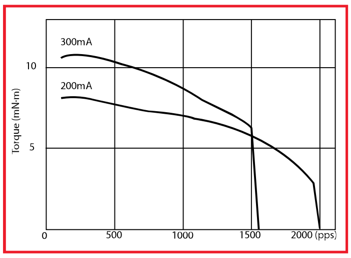
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48P1)



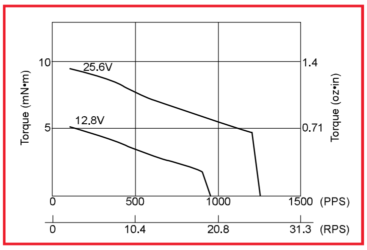
Coil Resistance: 122Ω

Bipolar Constant Current (48R1)



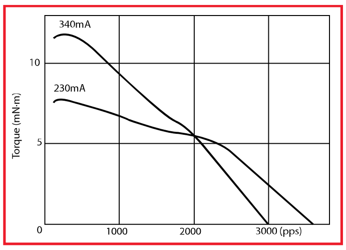
Coil Resistance: 35Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



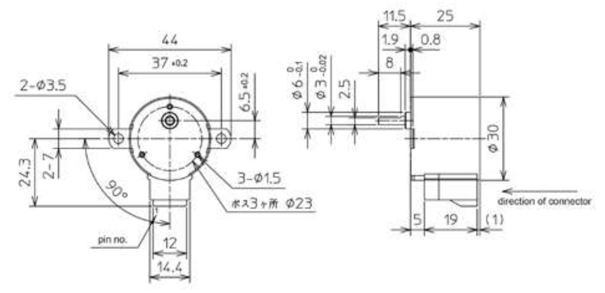
Coil Resistance: 120Ω

Unipolar Constant Current (48H1)



Coil Resistance: 34Ω Supply Voltage: 24V

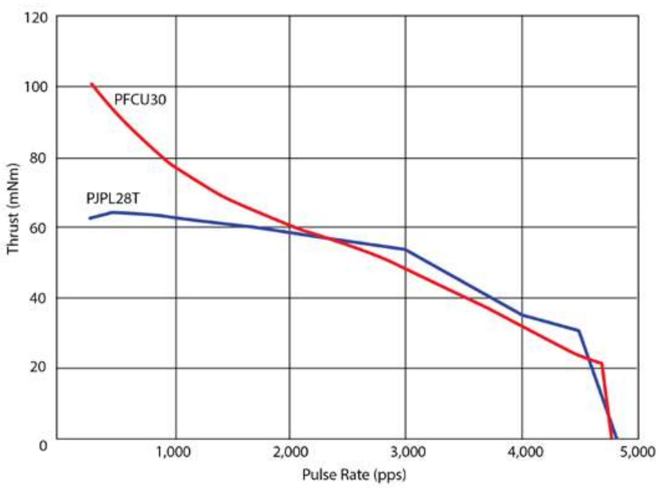
All tin-can motor specifications are based on full-step constant voltage operation.
Magnet type: Anisotropic
*Torque curves are for reference only and are not guaranteed

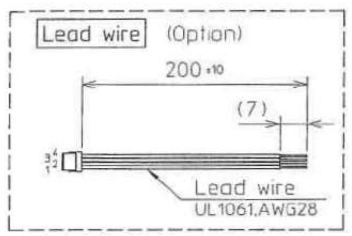


Specifications

Specifications	Unit	PFCU30-24_-4GM (1/5)		PFCU30-24_-4GM (3/25)		PFCU30-24_-4GM (1/12)	
Type of Winding		Bipolar					
Excitation Mode*		Full step (2-2)					
Step Angle	°	3		1.8		1.25	
Steps Per Revolution*		120		200		288	
Gear Ratio		1/5		3/25		1/12	
Winding		T	V	T	V	T	V
Rated Voltage	V	9.8	6.9	9.8	6.9	9.8	6.9
Resistance	Ω	60	30	60	30	60	30
Inductance	mH / ϕ	49	26	49	26	49	26
Ordinary Torque	mN·m	100					
Destruction Torque	mN·m	300					
Operating Temp. Range	˚C	-10 ~ +50					
Storage Temp. Range	˚C	-30 ~ +80					
Temperature Rise*	K	70 (at 700pps)					
Weight	g	75					

PFCU30-24-_4GM(3/25) vs. PJP28T32E16 (Hybrid)

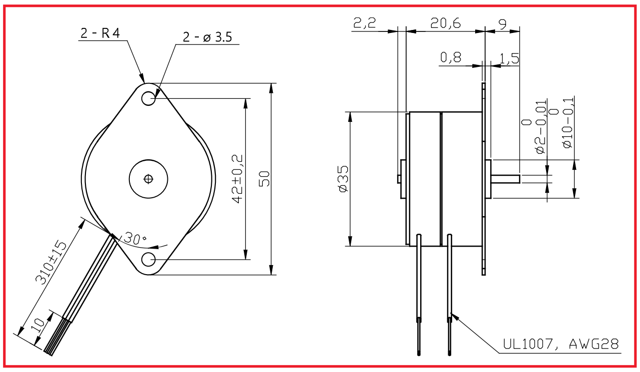




Connector

Applicable Housing: ZHR-4
Applicable Contact: SZH-002T-P0.5
Applicable Wire: AWG 28 to 26 (outer diameter of wire insulation: 0.4 to 0.8 mm)

Pin	Coil Phase
1	4ϕ B-
2	3ϕ A-
3	1ϕ A
4	2ϕ B

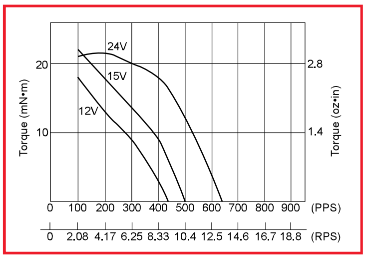


Specifications

Specification	Unit	PF35-24				PF35-48			
Type of Winding		Unipolar		Bipolar		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)				Full step (2-2)			
Step Angle	°	15 ±5%				7.5 ±5%			
Steps Per Revolution*		24				48			
Winding		C	D	P	Q	C	D	P	Q
Rated Voltage	V	12	5	12	5	12	5	12	5
Resistance	Ω	90	16	100	17	90	16	100	17
Inductance	mH	37	8.7	95	14	48	8.9	124	19
Holding Torque	mN·m	15	15	19	19	20	20	25	25
Rotor Inertia	kg·m^2	4.5 x 10^{-7}				4.5 x 10^{-7}			
Starting Pulse Rate*	pps	310				500			
Slewing Pulse Rate*	pps	410				530			
Operating Temp. Range	°C	-10 to +50							
Temperature Rise*	K	55							
Weight	g	80							

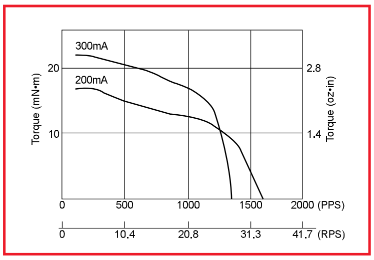
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48P1)



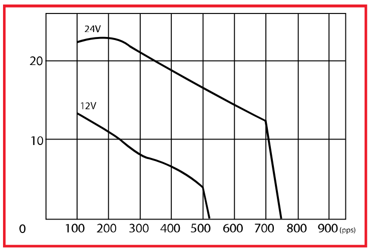
Coil Resistance: 100Ω

Bipolar Constant Current (48181)



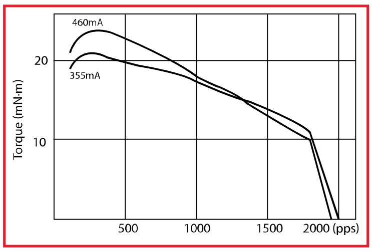
Coil Resistance: 18Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



Coil Resistance: 90Ω

Unipolar Constant Current (48071)

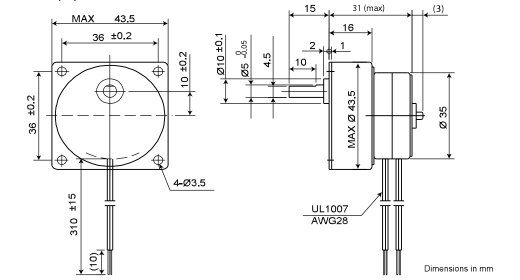


Coil Resistance: 20Ω Supply Voltage: 24V

All tin-can motor specifications are based on full-step constant voltage operation.
Magnet type: Anisotropic
*Torque curves are for reference only and are not guaranteed

Dimensions of Geared Model

PF35(T) w/H Gear Head

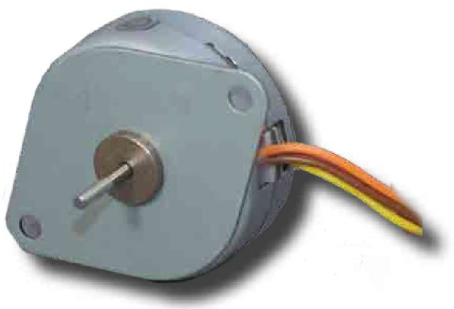


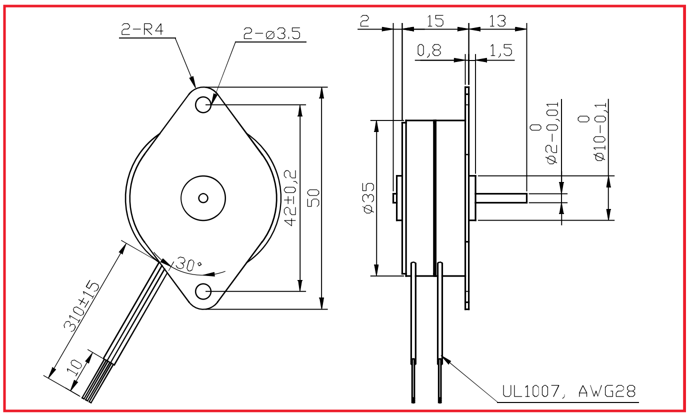
Gear Ratio	6/25	1/5	3/25	1/10
Ordinary Torque	200mN·m			
Destruction Torque	600mN·m			

Gear Ratio	2/25	1/15	3/50	1/20	1/25
Ordinary Torque	250mN·m				
Destruction Torque	750mN·m				

Gear Ratio	1/30	1/50	1/60	2/125	1/75
Ordinary Torque	300mN·m				
Destruction Torque	900mN·m				

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	400mN·m						
Destruction Torque	1200mN·m						



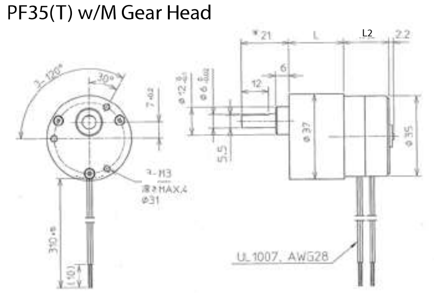


Specifications

Specifications	Unit	PF35T-48			
Type of Winding		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)			
Step Angle	°	7.5 ±5%			
Steps Per Revolution*		48			
Winding		C	D	R	Q
Rated Voltage	V	12	5	12	5
Resistance	Ω	70	12	72	16
Inductance	mH	30	6.5	60	6.2
Holding Torque	mN·m	18	18	27	27
Rotor Inertia	kg·m²	2.7 x 10^{-7}			
Starting Pulse Rate*	pps	600			
Slewing Pulse Rate*	pps	610			
Operating Temp. Range	˚C	-10 to +50			
Temperature Rise*	K	70			
Weight	g	77			

Dimensions of Geared Model

PF35(T) w/M Gear Head



	L2
PF35	19.8
PF35T	14.2

Gear Ratio	1/5	1/6	1/10	1/12	1/15	1/18	1/25	1/30
Ordinary Torque	100mN·m		200mN·m					
Destruction Torque	300mN·m		600mN·m					

Gear Ratio	1/40	1/50	1/60	1/75	1/90	1/100	1/120
Ordinary Torque	300mN·m						
Destruction Torque	900mN·m						

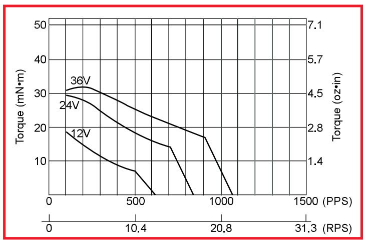
Gear Ratio	1/5	1/6	1/10	1/18	1/30	1/40	1/50	1/60	1/75	1/90	1/100	1/120	1/125	1/150	1/180	1/200	1/300
L	19.5	19.5	19.5	19.5	19.5	21.7	21.7	21.7	21.7	21.7	21.7	21.7	23.8	23.8	23.8	23.8	23.8

Gear Ratio	1/125	1/150	1/180	1/200	1/250	1/300
Ordinary Torque	600mN·m					
Destruction Torque	1800mN·m					

Available with H or M gearhead. See page 12 for H gearhead drawing.

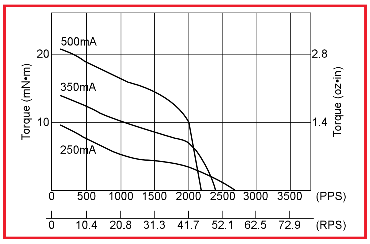
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48R1)



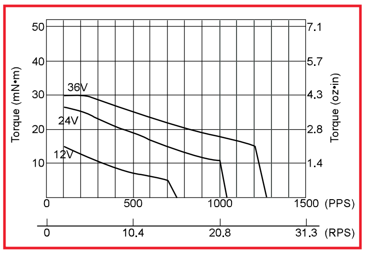
Coil Resistance: 72Ω

Bipolar Constant Current (48Q1)



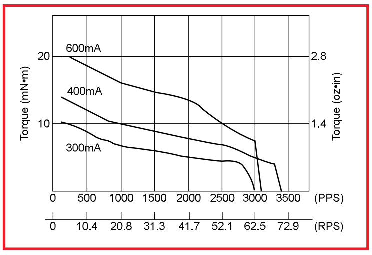
Coil Resistance: 16Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



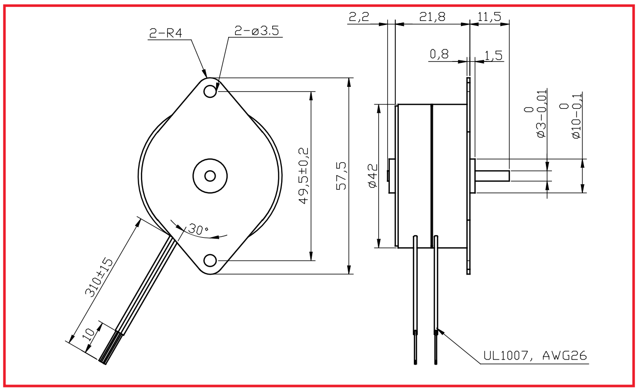
Coil Resistance: 70Ω

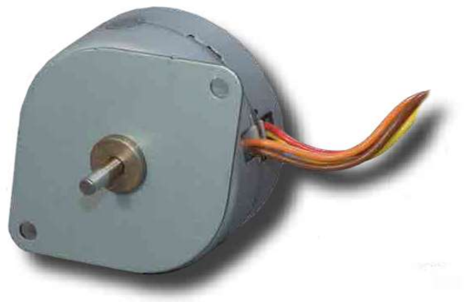
Unipolar Constant Current (48D1)



Coil Resistance: 12Ω Supply Voltage: 24V

*Torque curves are for reference only and are not guaranteed
All specifications are based on full-step constant voltage operation.
Magnet type: Anisotropic



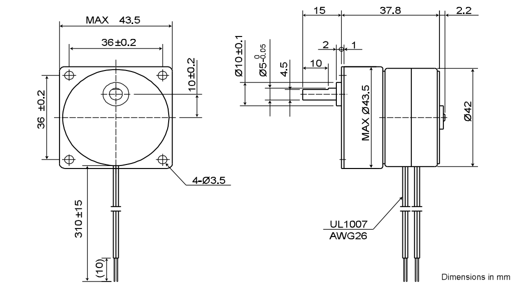


Specifications

Specification	Unit	PF42-24				PF42-48			
Type of Winding		Unipolar		Bipolar		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)				Full step (2-2)			
Step Angle	°	15 ±5%				7.5 ±5%			
Steps Per Revolution*		24				48			
Winding		C	D	P	Q	C	D	P	Q
Rated Voltage	V	12	5	12	5	12	5	12	5
Resistance	Ω	70	12	76	14	70	12	76	14
Inductance	mH	35	5.9	74	14	41	6.1	87	16
Holding Torque	mN·m	28	28	41	41	45	45	54	54
Rotor Inertia	kg·m^2	16.8 x 10^{-7}				12.8 x 10^{-7}			
Starting Pulse Rate*	pps	180				310			
Slewing Pulse Rate*	pps	250				320			
Operating Temp. Range	°C	-10 to +50							
Temperature Rise*	K	55							
Weight	g	160							

Dimensions of Geared Model

PF42 w/H Gear Head



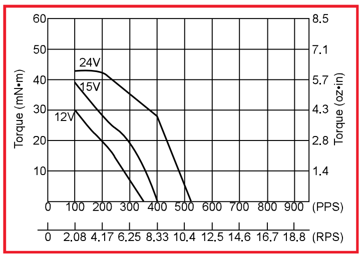
Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20	1/25
Ordinary Torque	200mN·m			250mN·m					
Destruction Torque	600mN·m			750mN·m					

Gear Ratio	1/30	1/50	1/60	2/125	1/75
Ordinary Torque	300mN·m				
Destruction Torque	900mN·m				

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	400mN·m						
Destruction Torque	1200mN·m						

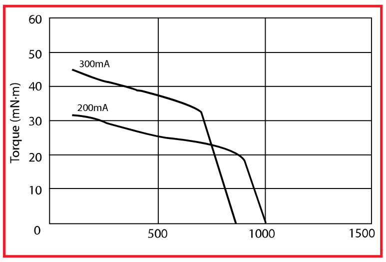
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48P1)



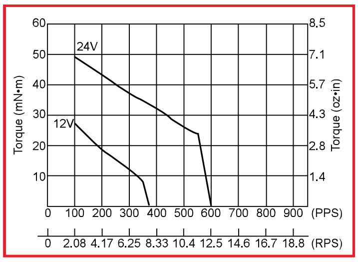
Coil Resistance: 76Ω

Bipolar Constant Current (48Y1)



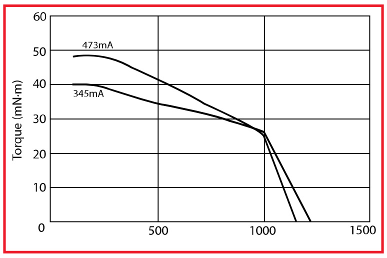
Coil Resistance: 20Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



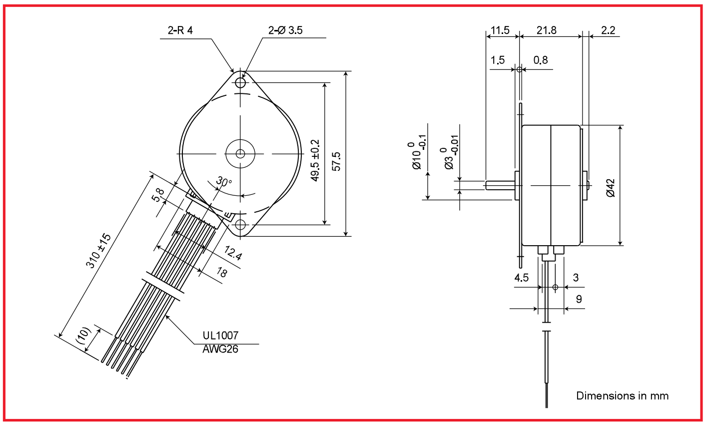
Coil Resistance: 70Ω

Unipolar Constant Current (48I1)



Coil Resistance: 20Ω Supply Voltage: 24V

All tin-can motor specifications are based on full-step constant voltage operation
Magnet type: Anisotropic
*Torque curves are for reference only and are not guaranteed

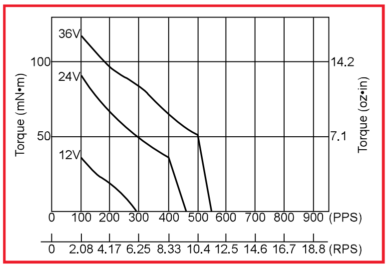


Specifications

Specification	Unit	PFC42H-48			
Type of Winding		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)			
Step Angle	°	7.5 ±5%			
Steps Per Revolution*		48			
Winding		C	D	P	Q
Rated Voltage	V	12	5	12	5
Resistance	Ω	70	12	70	12
Inductance	mH	39	6.6	80	13
Holding Torque	mN·m	50	50	70	70
Rotor Inertia	kg·m²	27 x 10^{-7}			
Starting Pulse Rate*	pps	290			
Slewing Pulse Rate*	pps	320			
Operating Temp. Range	˚C	-10 to +50			
Temperature Rise*	K	55			
Weight	g	160			

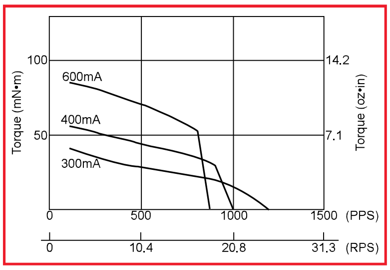
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48P1)



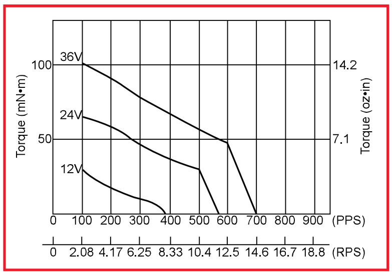
Coil Resistance: 70Ω

Bipolar Constant Current (48Q1)



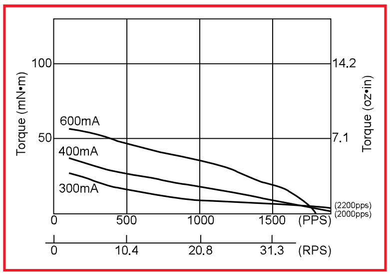
Coil Resistance: 12Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



Coil Resistance: 70Ω

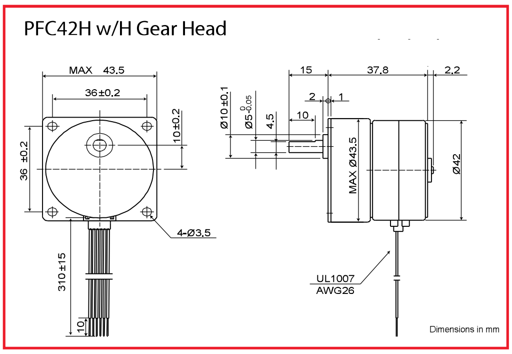
Unipolar Constant Current (48D1)



Coil Resistance: 12Ω Supply Voltage: 24V

All tin-can motor specifications are based on full-step constant voltage operation.
Magnet type: Anisotropic
*Torque curves are for reference only and are not guaranteed

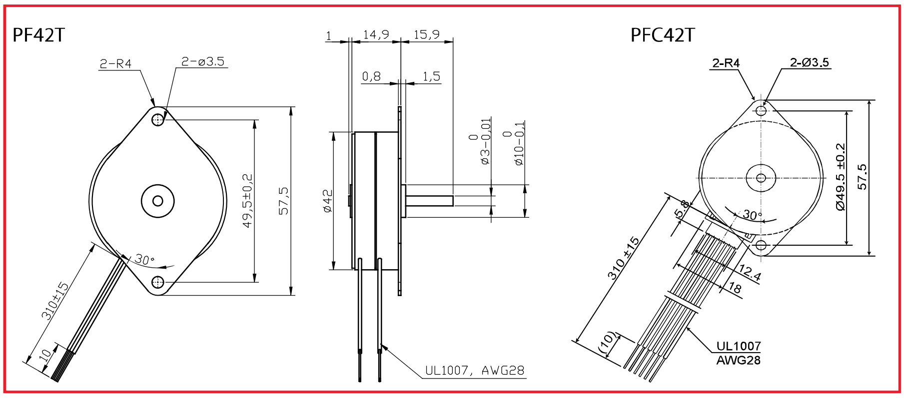
Dimensions of Geared Model



Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20	1/25
Ordinary Torque	200mN·m				250mN·m				
Destruction Torque	600mN·m				750mN·m				

Gear Ratio	1/30	1/50	1/60	2/125	1/75
Ordinary Torque	300mN·m				
Destruction Torque	900mN·m				

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	400mN·m						
Destruction Torque	1200mN·m						

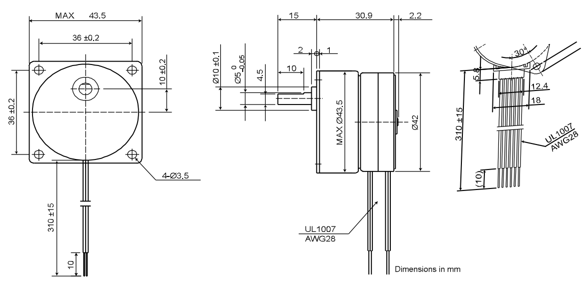


Specifications

Specification	Unit	PF(C)42T-48				PF(C)42T-96			
Type of Winding		Unipolar		Bipolar		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)				Full step (2-2)			
Step Angle	°	7.5 ±5%				3.75 ±5%			
Steps Per Revolution*		48				96			
Winding		C	D	P	Q	C	D	P	Q
Rated Voltage	V	12	5	12	5	12	5	12	5
Resistance	Ω	60	9.5	64	12	60	95	64	12
Inductance	mH	25	4	51	12	29	4.6	59	13
Holding Torque	mN·m	34	34	42	42	30	36	49	49
Rotor Inertia	kg·m²	14.8 x 10^{-7}				14.8 x 10^{-7}			
Starting Pulse Rate*	pps	345				450			
Slewing Pulse Rate*	pps	550				590			
Operating Temp. Range	˚C	-10 to +50							
Temperature Rise*	K	70							
Weight	g	105							

Dimensions of Geared Model

PF(C)42T w/H Gear Head



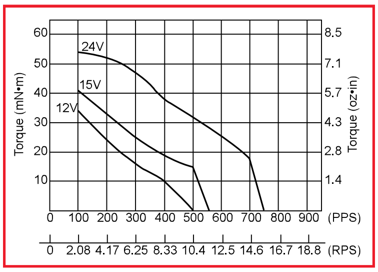
Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20	1/25
Ordinary Torque	200mN·m			250mN·m					
Destruction Torque	600mN·m			750mN·m					

Gear Ratio	1/30	1/50	1/60	2/125	1/75
Ordinary Torque	300mN·m				
Destruction Torque	900mN·m				

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	400mN·m						
Destruction Torque	1200mN·m						

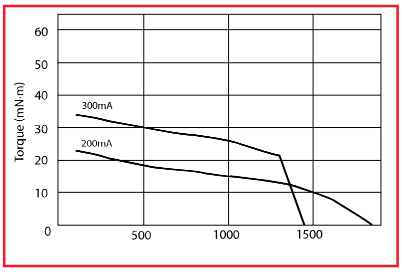
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48P1)



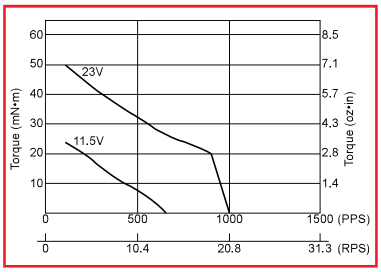
Coil Resistance: 64Ω

Bipolar Constant Current (48271)



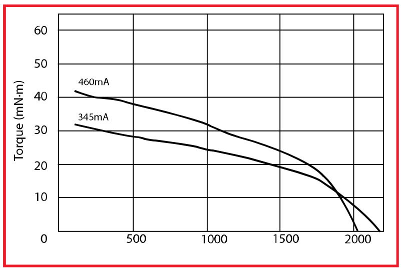
Coil Resistance: 19Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



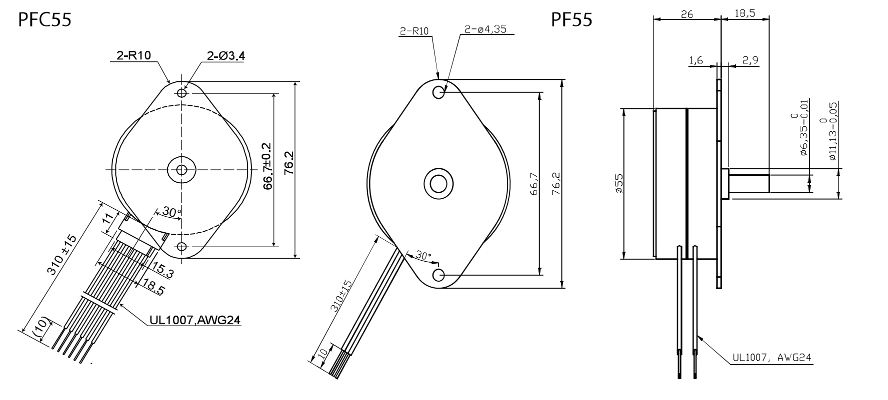
Coil Resistance: 60Ω

Uniplar Constant Current (48071)



Coil Resistance: 20Ω Supply Voltage: 24V

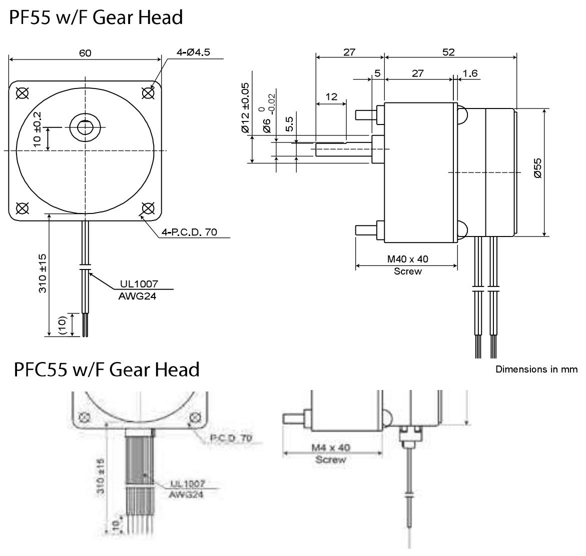
All tin-can motor specifications are based on full-step constant voltage operation.
Magnet type: Anisotropic
*Torque curves are for reference only and are not guaranteed



Specifications

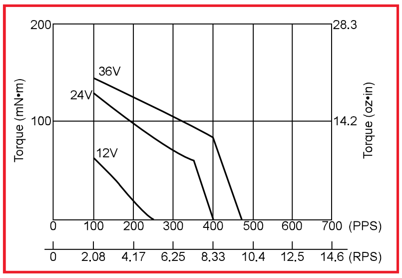
Specification	Unit	PFC55-48			
Type of Winding		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)			
Step Angle	°	7.5 ±5%			
Steps Per Revolution*		48			
Winding		C	D	P	Q
Rated Voltage	V	12	5	12	5
Resistance	Ω	36	5	40	6.75
Inductance	mH	37	4.6	84	12
Holding Torque	mN·m	120	120	150	150
Rotor Inertia	kg·m²	40 x 10^{-7}			
Starting Pulse Rate*	pps	280			
Slewing Pulse Rate*	pps	300			
Operating Temp. Range	˚C	-10 to +50			
Temperature Rise*	K	55			
Weight	g	300			

Dimensions of Geared Model



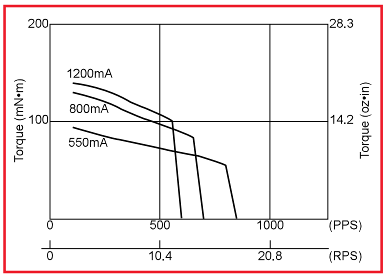
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48P1)



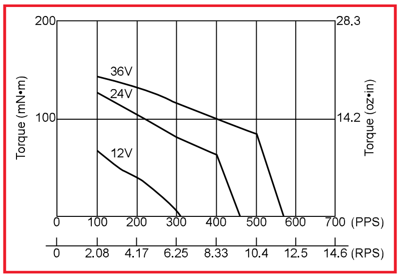
Coil Resistance: 40Ω

Bipolar Constant Current (48Q1)



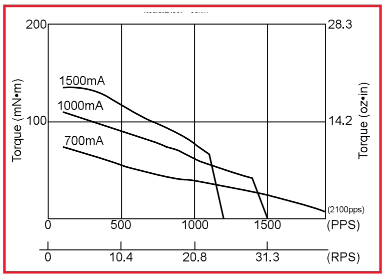
Coil Resistance: 6.75Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



Coil Resistance: 36Ω

Unipolar Constant Current (48D1)



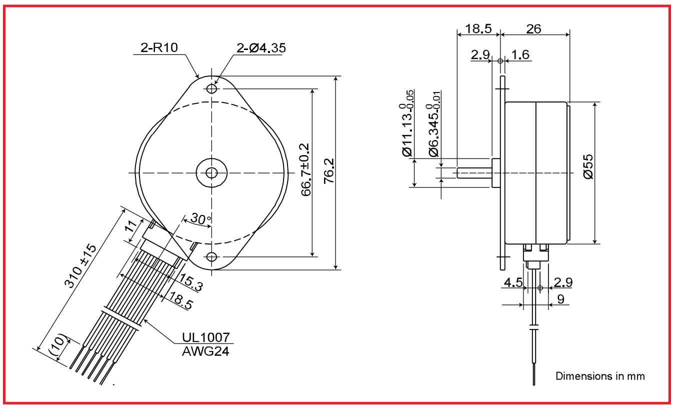
Coil Resistance: 5Ω Supply Voltage: 24V

Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20
Ordinary Torque	400mN·m							
Destruction Torque	1200mN·m							

Gear Ratio	1/25	1/30	1/50	1/60
Ordinary Torque	700mN·m			
Destruction Torque	2100mN·m			

Gear Ratio	2/125	1/75	3/250	1/100	1/125	1/150	1/250	1/300
Ordinary Torque	1000mN·m							
Destruction Torque	3000mN·m							

All tin-can motor specifications are based on full-step constant voltage operation
Magnet type: Anisotropic
*Torque curves are for reference only and are not guaranteed

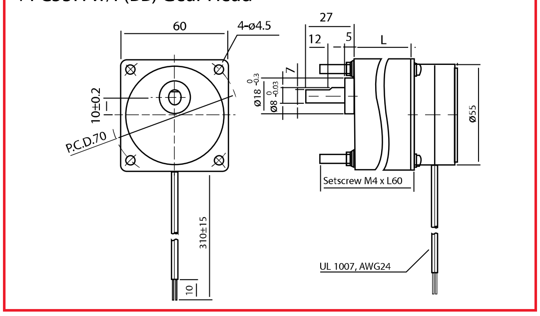


Specifications

Specification	Unit	PFC55H-48			
Type of Winding		Unipolar		Bipolar	
Excitation Mode*		Full step (2-2)			
Step Angle	°	7.5 ±5%			
Steps Per Revolution*		48			
Winding		C	D	P	Q
Rated Voltage	V	12	5	12	5
Resistance	Ω	36	5	36	5
Inductance	mH	30	4.4	65	9.3
Holding Torque	mN·m	150	150	180	180
Rotor Inertia	kg·m²	97 x 10^{-7}			
Starting Pulse Rate*	pps	210			
Slewing Pulse Rate*	pps	230			
Operating Temp. Range	˚C	-10 to +50			
Temperature Rise*	˚C	55			
Weight	g	300			

Dimensions of Geared Model

PFC55H w/F(BB) Gear Head



Gear Ratio	1/3	1/5	2/15	1/10	2/25	1/15	1/20
Ordinary Torque	400mN·m		500mN·m			600mN·m	800mN·m
Destruction Torque	1200mN·m		1500mN·m			1800mN·m	2400mN·m

Gear Ratio	1/25	1/30	1/50	1/60
Ordinary Torque	900mN·m	1100mN·m	1600mN·m	
Destruction Torque	2700mN·m	3300mN·m	4800mN·m	

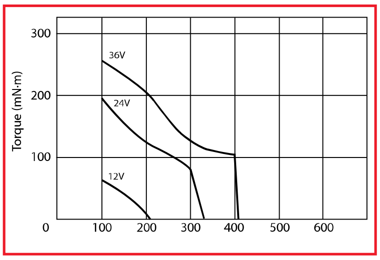
Reduction Ratio	L
1/3 to 1/15	32
1/20 to 1/180	42

Gear Ratio	1/75	1/100	1/125	1/150	1/180
Ordinary Torque	2500mN·m				
Destruction Torque	7500mN·m				

See page 19 for PFC55H with F gearhead ratios

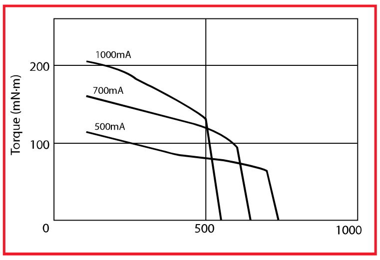
Torque Curve (pull-out torque)*

Bipolar Constant Voltage (48011)



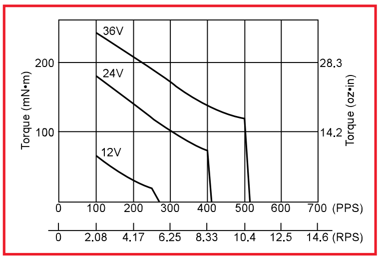
Coil Resistance: 40Ω

Bipolar Constant Current (48S1)



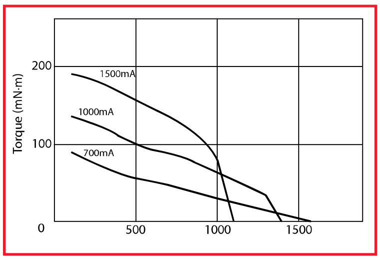
Coil Resistance: 8Ω Supply Voltage: 24V

Unipolar Constant Voltage (48C1)



Coil Resistance: 36Ω

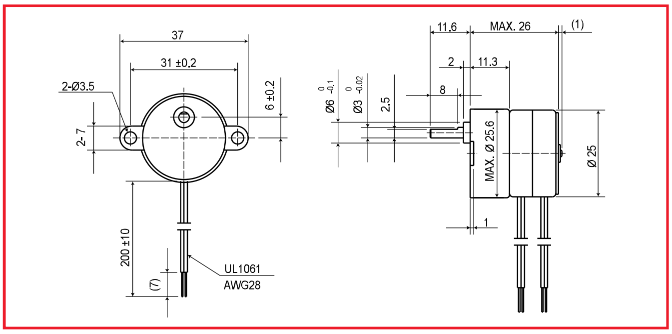
Unipolar Constant Current (48D1)



Coil Resistance: 5Ω Supply Voltage: 24V

All tin-can motor specifications are based on full-step constant voltage operation
Magnet type: Anisotropic
*Torque curves are for reference only and are not guaranteed

PF25 w/P Gearhead



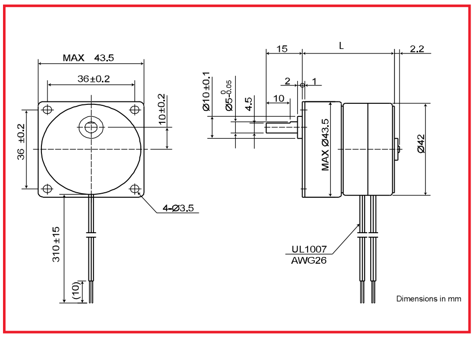
Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20
Ordinary Torque	20mN·m				50mN·m			

Gear Ratio	1/25	1/30	1/50	1/60	1/75	2/125
Ordinary Torque	70mN·m					

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	100mN·m						

PF(C)42/42H/42T w/H Gearhead

	L
PF42/ PFC42H	37.8
PF42T/ PFC42T	31



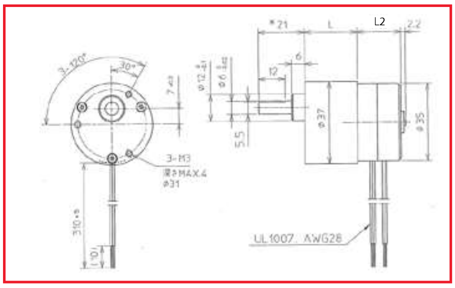
Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20	1/25
Ordinary Torque	200mN·m				250mN·m				

Gear Ratio	1/30	1/50	1/60	2/125	1/75
Ordinary Torque	300mN·m				

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	400mN·m						

PF35/35T w/M Gearhead

	L2
PF35	19.8
PF35T	14.2



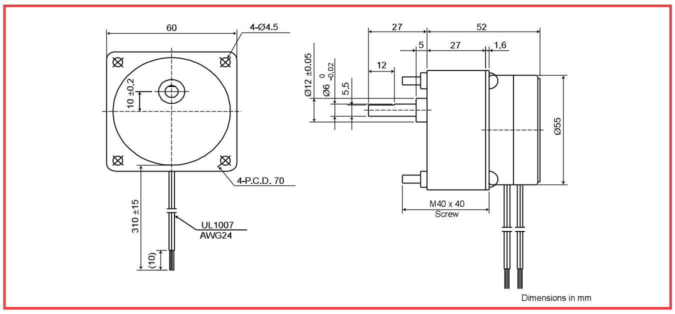
see page 13 for L specifications

Gear Ratio	1/5	1/6	1/10	1/12	1/15	1/18	1/25	1/30
Ordinary Torque	100mN·m			200mN·m				

Gear Ratio	1/40	1/50	1/60	1/75	1/90	1/100	1/120
Ordinary Torque	300mN·m						

Gear Ratio	1/125	1/150	1/180	1/200	1/250	1/300
Ordinary Torque	600mN·m					

PF(C)55/55H w/F Gearhead



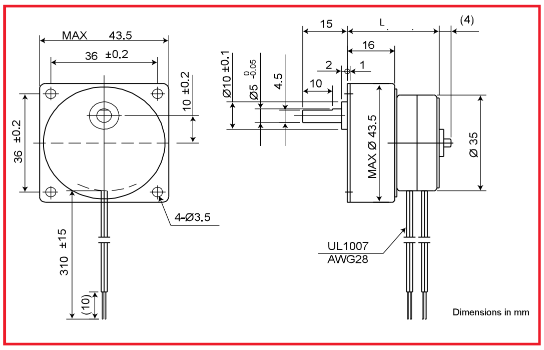
Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20
Ordinary Torque	400mN·m							

Gear Ratio	1/25	1/30	1/50	1/60
Ordinary Torque	700mN·m			

Gear Ratio	2/125	1/75	3/250	1/100	1/125	1/150	1/250	1/300
Ordinary Torque	1000mN·m							

PF35/35T w/H Gearhead

	L
PF35	36.6
PF35T	31



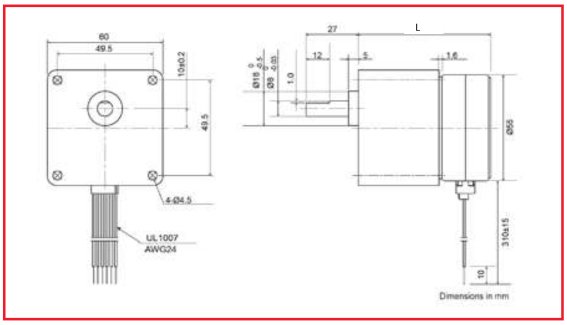
Gear Ratio	6/25	1/5	3/25	1/10	2/25	1/15	3/50	1/20	1/25
Ordinary Torque	200mN·m				250mN·m				

Gear Ratio	1/30	1/50	1/60	2/125	1/75
Ordinary Torque	300mN·m				

Gear Ratio	1/100	1/120	1/125	1/150	1/200	1/250	1/300
Ordinary Torque	400mN·m						

PF(C)55/55H w/F(BB) Gearhead

F(BB) gearhead provides ball-bearing support for all stages, ensuring long service life



Gear Ratio	1/3	1/5	2/15	1/10	2/25	1/15	1/20
Ordinary Torque	400mN·m		500mN·m			600mN·m	800mN·m

Gear Ratio	1/25	1/30	1/50	1/60
Ordinary Torque	900mN·m	1100mN·m	1600mN·m	

Gear Ratio	1/75	1/100	1/125	1/150	1/180
Ordinary Torque	2500mN·m				

Reduction Ratio	L
1/3 to 1/15	32
1/20 to 1/180	42