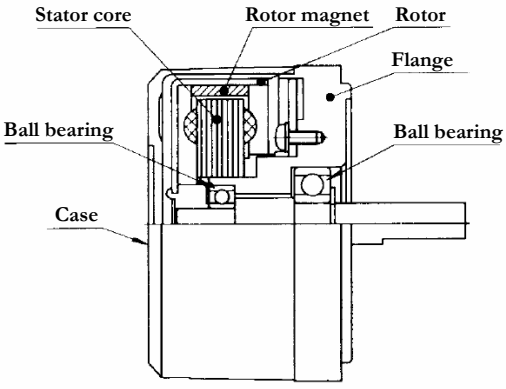
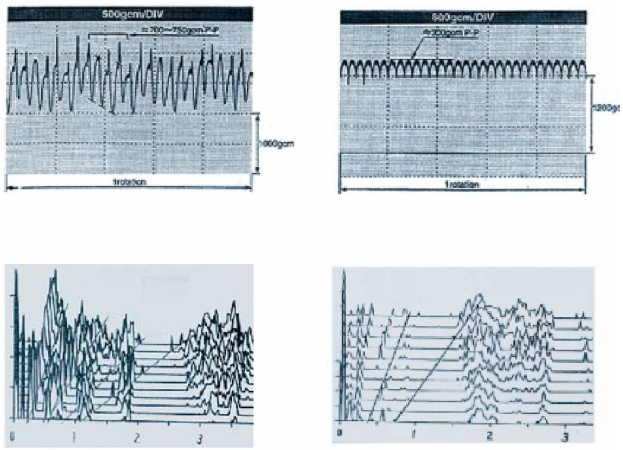
BLDC motor

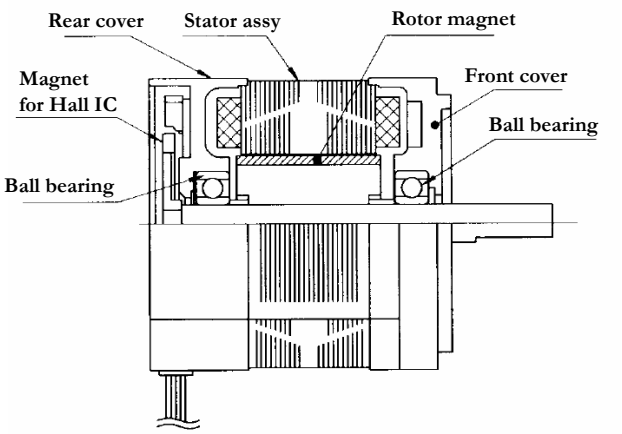
Construction & Features

Flange Size is **Same** as Induction Motor
FLAT & **LIGHT** WEIGHT
Strong Starting Torque： More Compact Design.
Strong Torque in Slow Speed ：Lower Gear Noise & Extended Gear Life
Excellent Efficiency: Energy **Saving**
Reasonable Price
Low Vibration & **Low** Noise：**12S-10P**



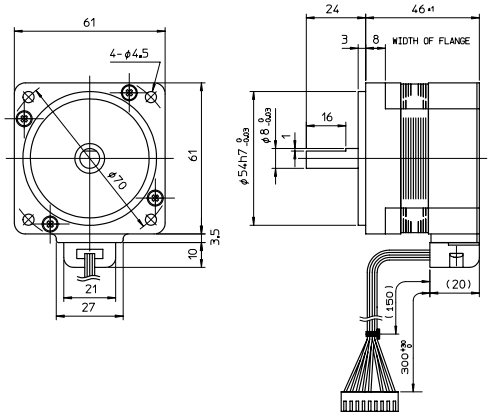


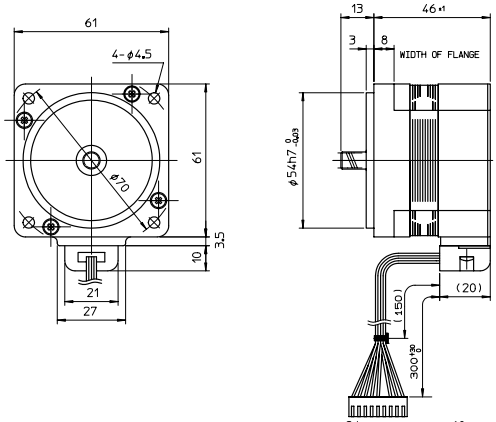
Quick Response: Inner Rotor Type
Small & **High** Power: Neodymium Magnet
40W & 60W are **Same** Size
Low Vibration & **Low** Noise: 12S-14P
Motor Cable: **Fixed** on Motor



BLDC motor FH series

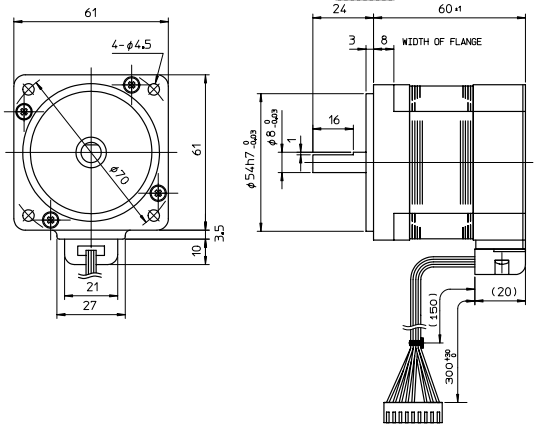
20W

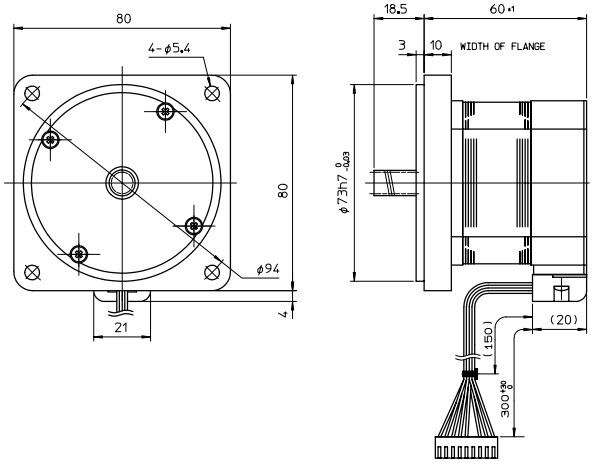




Helical gear specification of output shaft	
Module	0.5
Pressure angle	20 deg
Number of teeth	10
Outer diameter	6.76
Direction of handed teeth	Right

40, 60W



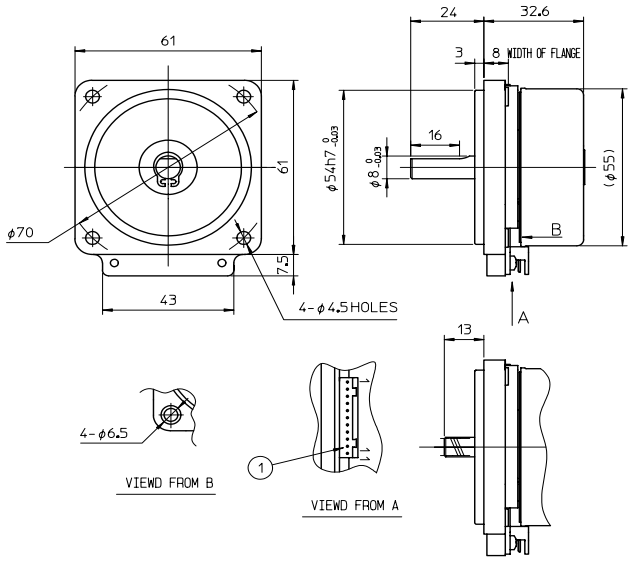


Helical gear specification of output shaft	
Module	0.7
Pressure angle	20 deg
Number of teeth	10
Outer diameter	9.4
Direction of handed teeth	Right

BLDC motor

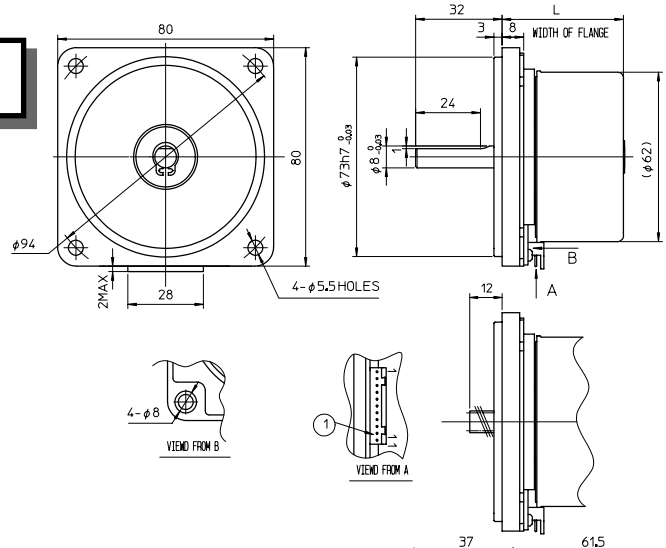
FY series

6W



Helical gear specification of output shaft	
Module	
Pressure angle	
Number of teeth	
Outer diameter	
Direction of handed teeth	
Mating GH	

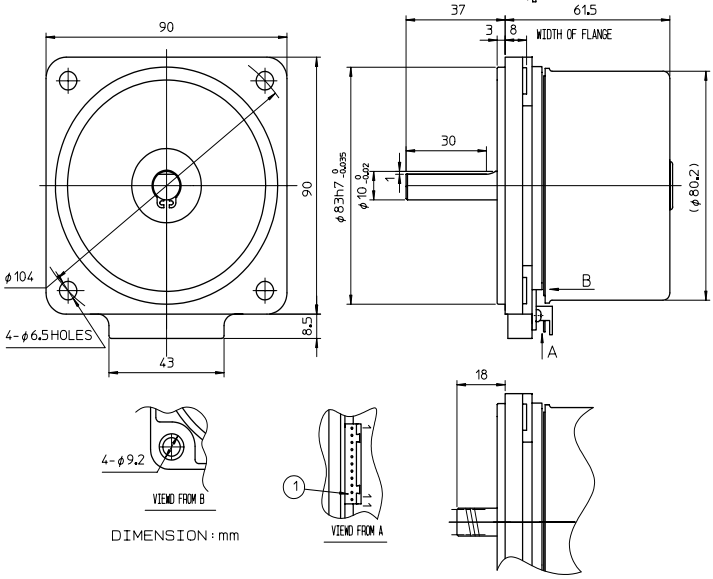
15、25W



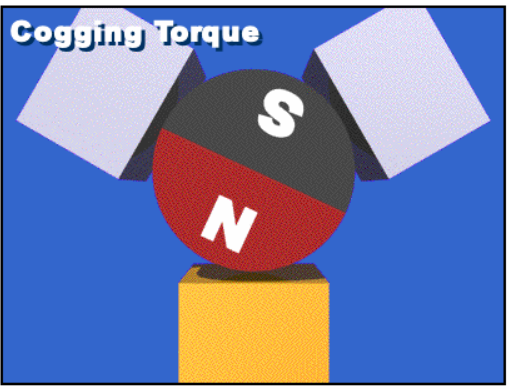
	L
15W	39
25W	45

Helical gear specification of output shaft	
Module	0.5
Pressure angle	20 deg
Number of teeth	10
Outer diameter	6.98
Direction of handed teeth	Right
Mating GH	8H_FBN

40W

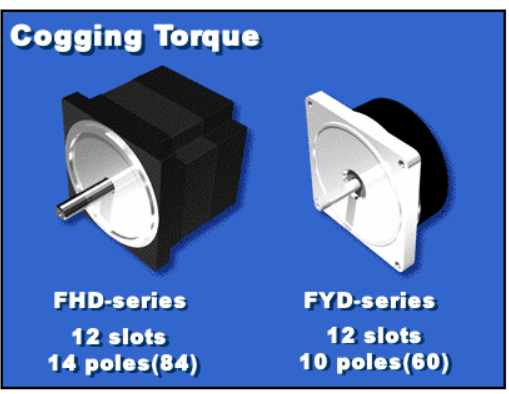


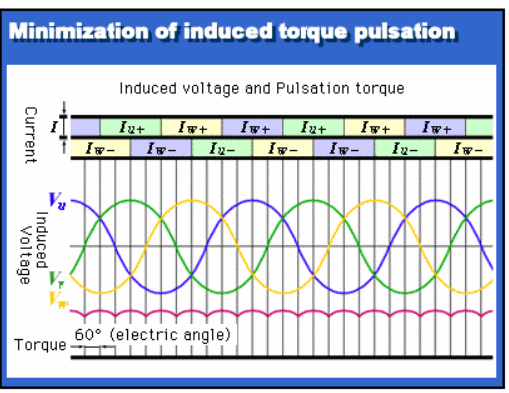
Helical gear specification of output shaft	
Module	0.6
Pressure angle	20 deg
Number of teeth	12
Outer diameter	9.6
Direction of handed teeth	Right
Mating GH	9H_FBN



Cogging torque is an unevenness felt when you turn the output shaft of a motor by hand. This torque is generated by a **pulling force** between the magnet and iron core of the motor.
The more balancing points of the pulling force, the smaller the **cogging torque**.
The number of balancing points is decided by the least common multiple of the number of slots and number of poles.
To minimize cogging torque, our FHD series employs **12 slots and 14 poles** (least common multiple: 84), and our FYD series employs **12 slots and 10 poles** (least common multiple: 60).
To improve characteristics and to make high grade motor drive systems on Blushless DC motors, not only the drive system but the basic motor characteristics must also be studied well and improved.
Therefore, Japan Servo achieved improvement such as minimizing the pulsation torque the motor generates and which, we think, obstructs our improvement of motor characteristics (like low noise operation, smooth rotation, and minimized unevenness of rotation).
For the same purpose, several new ideas were proposed and applied: **"Slewed slots"** were formed on the stator core lamination, and/or a special pattern was applied to the rotor magnetization.
But these ideas **caused the loss** of certain motor characteristics. So, by these ideas, such motors were never able to have better characteristics and better efficiency at the same time.
Then we researched further the 3 phase excitation Brushless DC motors, to **minimize the pulsation torque** in an ideal & reasonable manner; especially regarding the **combination of the number of Stator slots and the number of Rotor poles**.
The bottom chart shows the relation between general construction and pulsation torque on Permanent magnet field type, 3 phase (excitation) Brushless DC motors
The pulsation torque in permanent magnet field type Brushless motors, there are the cogging torque that is generated from the permanent magnet in the rotor and the shape of stator, and the pulsation torque (inducted voltage pulsation torque) arising from the torque constant variation caused by rotor location change.

Number of slots	Number of poles	Least common multiple
3	2	6
6	4	12
6	8	24
12	8	24
12	10	60
12	14	84
12	16	48





Minimization of Cogging Torque

Number of slots	Number of rotor poles (the least common multiple)
9	8, (72) 10 (90)
12	8, (24) 10, (60) 14, (84) 16 (48)
15	12, (60) 14, (210) 16, (240) 18 (90)

Here is an explanation of our research to **minimize Cogging torque**.
We started the study on the combination of the number of stator slots and the number of rotor poles.
To realize 3 phase (excitation) motors, the following are required.

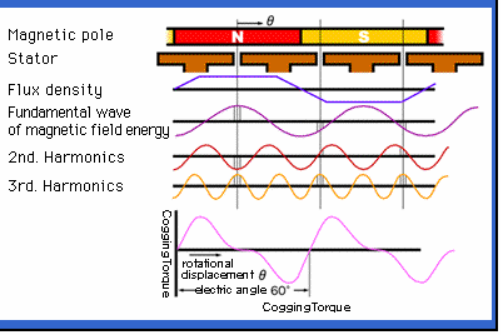
1. **The number of slots must be a multiple of 3.**
2. **Windings must be separated by 120 deg electric angle.**

Minimization of Cogging Torque

Item \ Motor construction		12-slots 8-poles	12-slots 10-poles	12-slots 14-poles
Induced Voltage	Calculated (gf·cm)	584	238	67
	Measured (gf·cm)	458	204	82
Pulsation Rate	Calculated (PPR)	24	60	84
	Measured (PPR)	24	60	84

The first table shows the calculation results of the combinations, which meet the above conditions and minimize cogging torque.
We have found that there is no combination suitable from cases of 6 or fewer stator slots, and the combination **ratio of 3 to 2** of the "**number of slots**" to "**number of poles**", employed rather popularly, is not suitable enough to minimize cogging torque.
So Japan Servo decided to use **"12" stator slots** for our products, after many studies on shape, productivity, and characteristics.
Under this condition, the simulation by calculation and test results are shown in the second table.
From these results, we found and confirmed that the combinations of "**12-slots & 10-poles**" and "**12-slots & 14-poles**" are excellent.

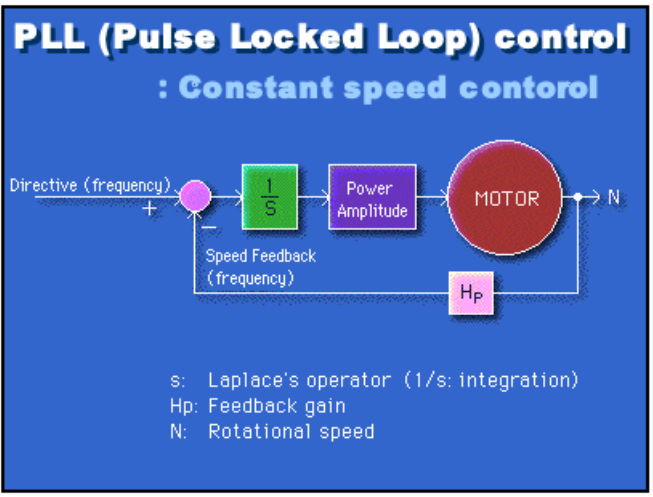
Minimization of induced torque pulsation



The current flows constantly for the 120 deg period (called the 120 deg current flow method).
The torque wave form can be shown as full-wave rectified voltage on each phase, and has a pulsation of the 60 deg period.
The last table shows induced voltage, calculated pulsation rate and test results.
From these results, it is confirmed that the combination of "**12-slots & 10-poles**" and "**12-slots & 14-poles**" are **excellent**.
So, Japan Servo designed and announced the FYD series and BH series (12-slots, 10-poles combination) and FHD series (12-slots, 14-poles combination).

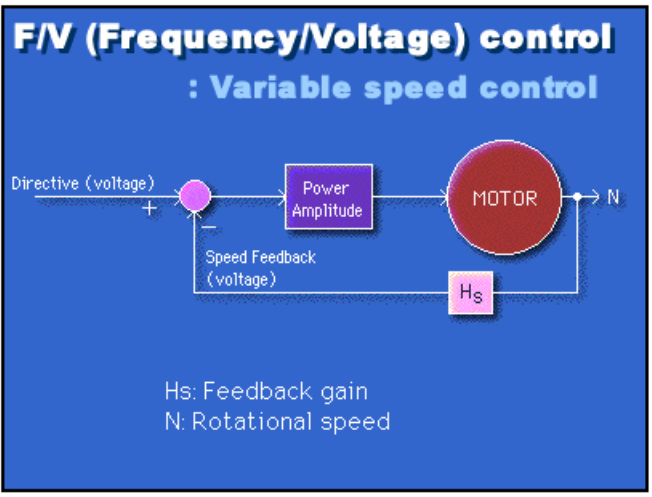
Minimization of induced torque pulsation

Item \ Motor construction		12-slots 8-poles	12-slots 10-poles	12-slots 14-poles
Induced Voltage	Calculated(V) Rate (%)	3.42 (100.0)	3.65 (106.7)	3.62 (105.8)
	Measured(V) Rate (%)	3.5 (100.0)	4.0 (114.3)	4.0 (114.3)
Pulsation Rate	Calculated(V) Rate (%)	33.1 (100.0)	16.4 (49.5)	12.6 (38.1)
	Measured(V) Rate (%)	32.0 (100.0)	18.0 (56.0)	16.0 (50.0)



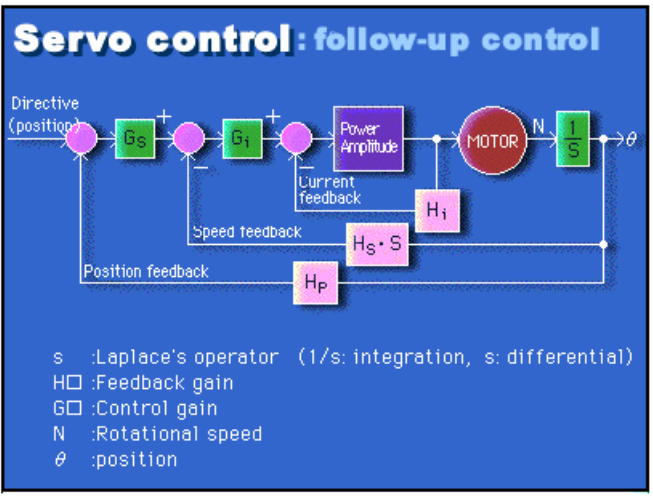
PLL (Pulse Locked Loop) control

This is a control method by phase comparing the feed back frequency signal proportional to the motor speed with the directive frequency. Accurate speed control is achievable and suitable for constant speed control.



F/V (Frequency/ Voltage) control

The speed is controlled by comparing the feedback signal voltage which is proportional to the speed with the set voltage. This is quite suitable for speed adjustment in a rather wide range.



Servo control

This is a control method by position, speed, and current feedback.
It is quite suitable for "follower drive" and "position control". Excellent response to the directives is obtained, but the control is rather complicated and costs more.

Naming rules

Model coding for "set"

FHD 6 P 20 S – D3

Name of Series
FYD=Outer Rotor
FHD=Inner Rotor

Size of drive motor
(mounting surface dimensions)
(motor core size for FHD-series)
6=61×61mm
8=80×80mm
9=90×90mm

Type of Driver
P=Palm mini plus type driv
B=On-board type driver
J= "J" Book type driver

Motor Output in Watts
6= 6W , **15**=15W
20=20W , **25**=25W
40=40W , **60**=60W

Output Shaft type
S=Plain shaft
PF=Pinion shaft
(strengthened type)
PE=Pinion shaft
(highly strengthened type)

Power Supply
D3=DC24V
D5=DC48V

Model coding for "motor"

FH 6 PF 20 N – D3

Name of Series
FY =Outer Rotor
FH =Inner Rotor

Size of drive motor
(mounting surface dimensions)
(motor core size for FHD-series)
6=61×61mm
8=80×80mm
9=90×90mm

Output Shaft type
S=Plain shaft
PF=Pinion shaft
(strengthened type)
PE=Pinion shaft
(highly strengthened type)

Motor Output in Watts
6= 6W , **15**=15W
20=20W , **25**=25W
40=40W , **60**=60W

Options
N=Pinion shaft for low noise gear
No marking=The others

Power Supply
D3=DC24V
D5=DC48V

Model coding for "driver"

FHD 6 20 P – D3

Name of Series
FYD=Outer Rotor
FHD=Inner Rotor

Size of drive motor
(mounting surface dimensions)
(motor core size for FHD-series)
6=61×61mm
8=80×80mm
9=90×90mm

Motor Output in Watts
6= 6W , **15**=15W
20=20W , **25**=25W
40=40W , **60**=60W

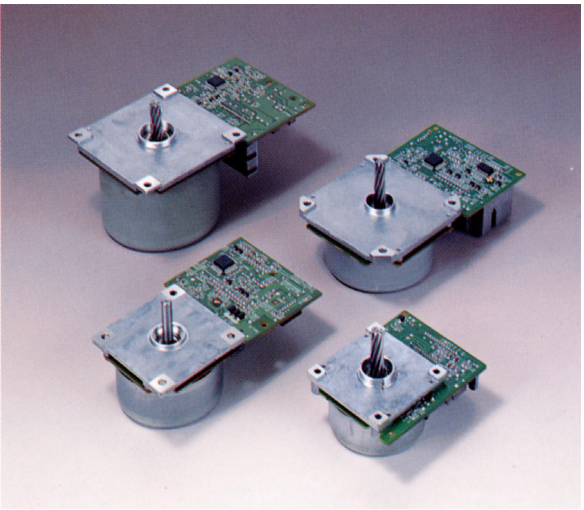
Type of Driver
P=Palm mini plus type driver
B=On-board type driver
J= "J" Book type driver

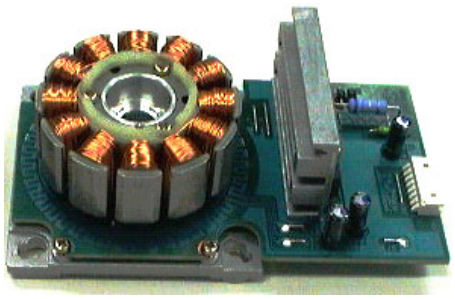
Power Supply
D3=DC24V
D5=DC48V

Output	Voltage	Shaft type	Model name			Mating GH
			Motor & Driver	Motor	Driver	
20W	DC24V	Straight shaft	FHD6P20S-D3	FH6S20-D3	FHD620PD3	N/A
		Pinion shaft	FHD6P20PF-D3	FH6PF20N-D3	FHD620PD3	6H_EBN
40W	DC24V	Straight shaft	FHD6P40S-D3	FH6S40-D3	FHD640PD3	N/A
		Pinion shaft	FHD6P40PE-D3	FH6PE40N-D3	FHD640PD3	8F_EBN
60W	DC48V	Straight shaft	FHD6P60S-D3	FH6S60-D3	FHD660JD5	N/A
		Pinion shaft	FHD6P60PE-D3	FH6PE60N-D3	FHD660JD5	8F_EBN

Output	Voltage	Shaft type	Model name			Mating GH
			Motor	Driver Parm mini type	Driver Simple type	
6W	DC24V	Straight shaft	FY6S6-D3	FYD66PD3	FYD66SD3	N/A
		Pinion shaft	FY6PF6N-D3	FYD66PD3	FYD66SD3	6H_FBN
15W	DC24V	Straight shaft	FY8S15-D3	FYD815PD3	FYD815SD3	N/A
		Pinion shaft	FY8PF15N-D3	FYD815PD3	FYD815SD3	8H_FBN
25W	DC24V	Straight shaft	FY8S25-D3	FYD825PD3		N/A
		Pinion shaft	FY8PF25N-D3	FYD825PD3		8H_FBN
40W	DC24V	Straight shaft	FY9S40-D3	FYD940PD3		N/A
		Pinion shaft	FY9PF40N-D3	FYD940PD3		9H_FBN

BLDC motor **BH series**

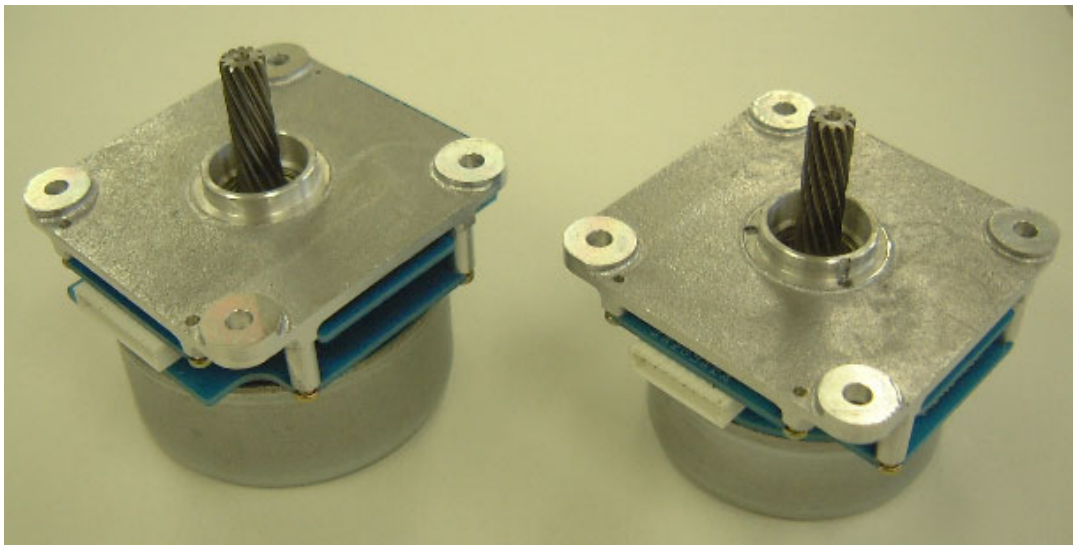




Fully Customized motor and driver
Compact & High Power
Performance
  Low Vibration & Noise for 12S-10
  Torque Ripple -50% Less Compare to Competitor's one.
Quality
  High Quality and Accuracy are made by In-house Machining and assembly.
Driver is Fixed on Motor
Without Casing
Order Made products
MOQ 1K/M or more.

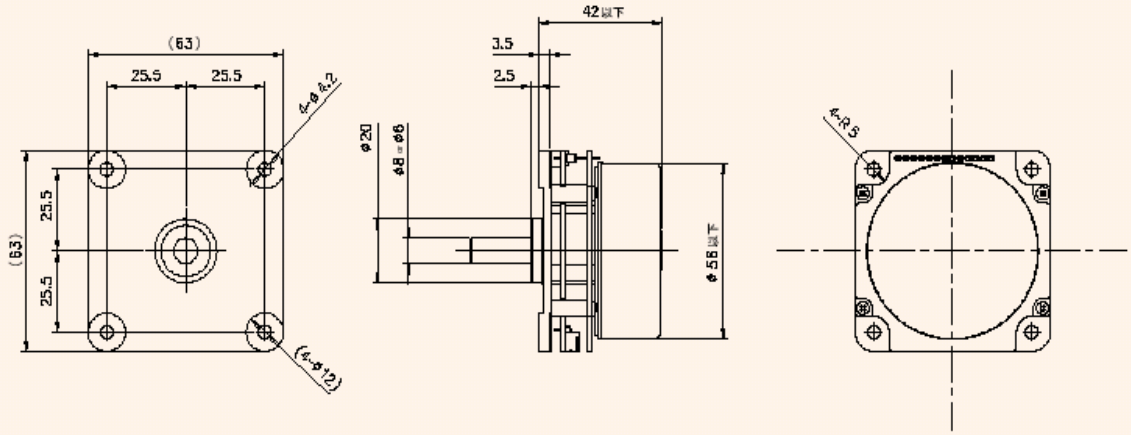
		BH55		BH60		BH70	BH80	
Output(W)(REF)	1	7 to 10	7 to 15	10 to 20	20 to 30	20 to 35	20 to 40	40 to 80
Voltage(Power)(V)	2	24	24	24	24	24	24	24
Voltage(Signal)(V)		5	5	5	5	5	5	5
Speed(r/min)(REF)		500 to 2400	500 to 2400	500 to 2400	500 to 2400	500 to 2400	500 to 2400	500 to 2400
controlled method	3	PLL	PLL	PLL	PLL	PLL	PLL	PLL
		Interenal	External	External	External	External	External	External
Rotor diameter(Max)		56	56	63	63	75	84	84
Material of Magnet		Rubber	Plastics	Rubber	Rubber	Plastics	Rubber	Rubber
Motor length(mm)	4	34MAX.	40MAX.	37MAX.	45MAX.	40MAX.	45MAX.	57MAX.
material of PCB	5	FR-1	FR-1	FR-1	FR-1	FR-1	FR-1	FR-1

Note1: Output is reference. Various rotation speeds are possible.(500 to 2500r/min)
Note2: We can order to DC36V TYPE.
Note3: Manufacturing of Internal CLK / External CLK is possible for each size.
Note4: This is in the case our standard bracket (ADC) is used.
  Concerning the bracket of press plate,
  it is possible to manufacture according to the castomer's request.
Note5: PCB is possible to be made according to your indicated form as custom-made way.
  In the case of a custom made PCB, art-work charge is required separately.



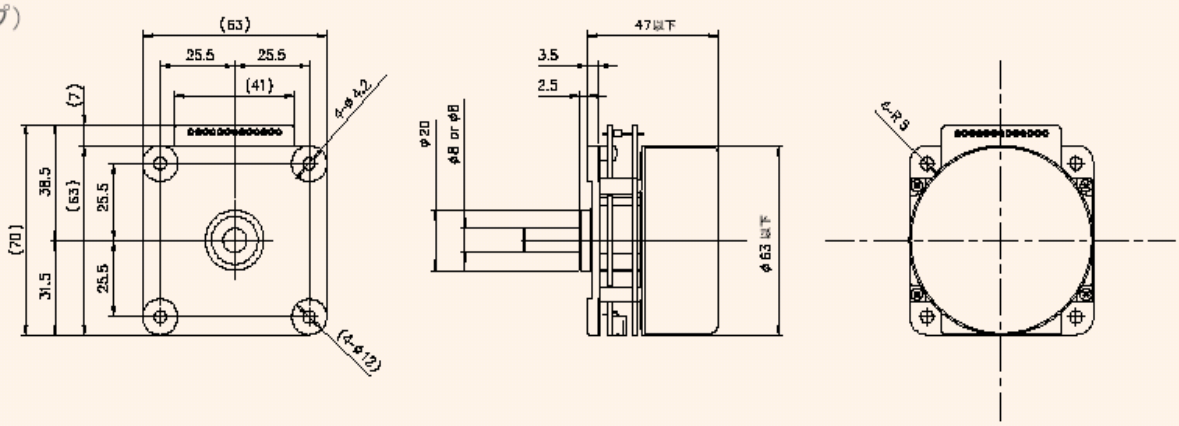
BH55

（省スペースタイプ）



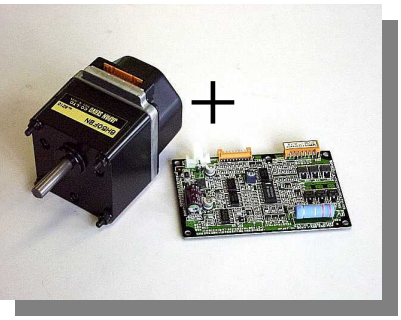
BH60

（省スペースタイプ）



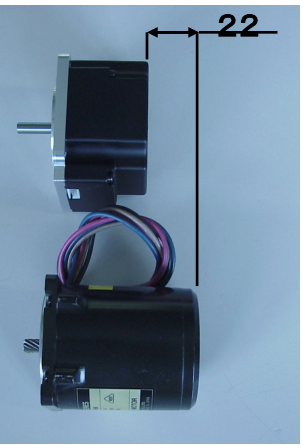
BLDC motor with built-in driver

FYD Series Motor
+ Simple Type Driver



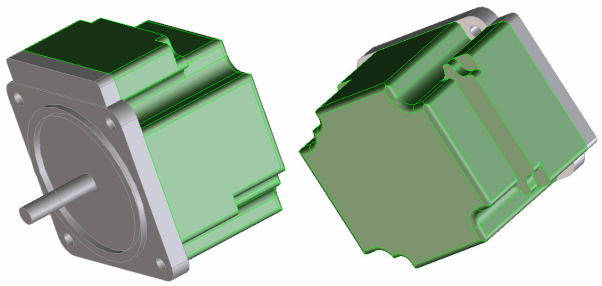
Fixed speed BLDC motor and driver electronics in one small package

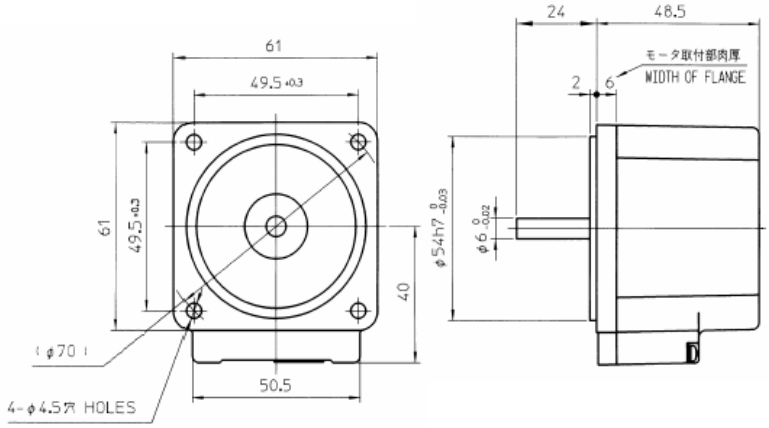
Motor Size：sqr61*34
Driver Size： 70*105*18



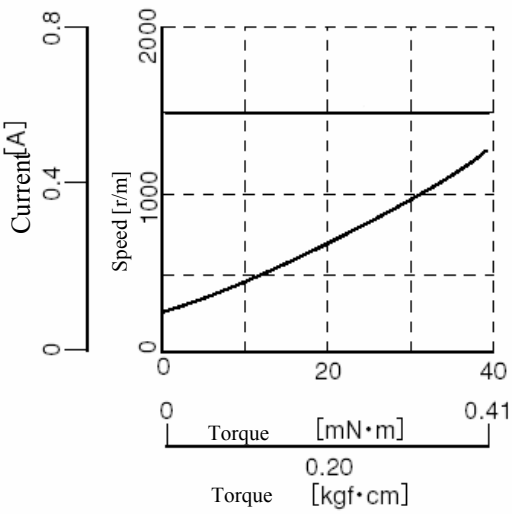
FYD6U6S-D3（Out Put6W）
Motor Size: sqr61*48.5L

IH6S6N（Out Put6W）
Motor Size: sqr 61*75L





FYD6U6S-D3／FYD6U6PF-D3



- Driver : Constant Speed Control
- Power Supply : DC24V
- Speed : 1500[r/min]
- Out Put : 6 [W]
- I/O : RUN、F/RIN、SPEED OUT
- Other : With Rotor Cover