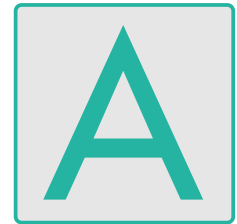


# ORIENTAL MOTOR GENERAL CATALOG



## Speed Control Motors

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# Product Line and Features of Speed Control Motors

Speed control motors can easily set and adjust the speed with the use of a potentiometer. The control system consists of a speed feedback system, a motor, a speed control pack (or a driver) and a potentiometer.

The motor for the speed control system may be either a brushless DC motor or a standard AC motor.

## ■ Features

- **High speed up to 3000 r/min (FBLII series) or 2000 r/min (HBL series)**

With standard AC speed control motors, speed is usually limited to 1600r/min at 60Hz.

- **Constant torque**

These DC brushless motor systems offer constant torque over the entire speed range.

## ■ Electronic-Input Control

Most speed control motors use power relays to control the motor and control pack. However, as the control pattern becomes more complex, the relays cannot follow the sequence and also require maintenance.

The electronic-input type, on the other hand, uses either a photocoupler or a C-MOS type input circuit. Requiring no external relays, the motor can be connected directly to a programmable controller (PLC), featuring the following advantages.

- **Maintenance Free**

As the motor requires no power relays, there is no need for periodic service or replacement of relays. This makes the machine highly reliable.

- **Easy connection**

With no power relays, connection is easy, and the time required to set up the motor is greatly reduced. Moreover, they can make the time needed for circuit design shorter than that required for setting a relay sequence.

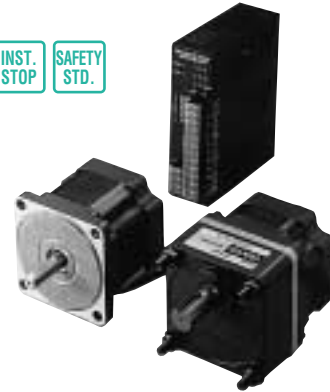
**Maintenance-free speed control motors that can be operated directly from a programmable controller (PLC).**

## FBLII Series A-120 page.

- Speed control range: 300 r/min ~ 3000 r/min
- Output power: 75W, 120W

These products combine a compact, powerful, constant torque motor with a slim-line driver. They offers compact size, high output and precise, flexible control. Connections are simple because of the snap connectors.

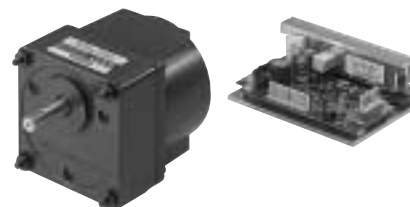
The **GFB** type high torque gearheads are also available.



## HBL Series A-132 page.

- Speed control range: 300 r/min ~ 2000 r/min
- Output power: 10W ~ 100W

The **HBL** Series are DC 24V or DC 48V-driven brushless DC speed control motors consisting of slim, powerful motors and compact drivers.



(The gearhead for 10W, 25W and 40W is sold separately.)

## SC Series

A-142 page.

- Speed control range: 90 r/min ~ 1400 r/min (50Hz)  
90 r/min ~ 1600 r/min (60Hz)
- Output power: 6W~60W
- Induction motor type, Reversible motor type.

Multi-functional operation including speed control, acceleration / deceleration is made possible by the combination of a control pack and a speed control motor. The control pack can be installed in a control panel.



Motor

Control Unit



(The gearhead shown is sold separately.)

## US Series

A-156 page.

- Speed control range: 90r/min ~ 1400 r/min(50Hz)  
90r/min ~ 1600 r/min(60Hz)
- Output power: 6W ~ 90W
- Induction motor type

Unit consisting of a compact control unit and a speed control motor. One-step connectors make for easy wiring.



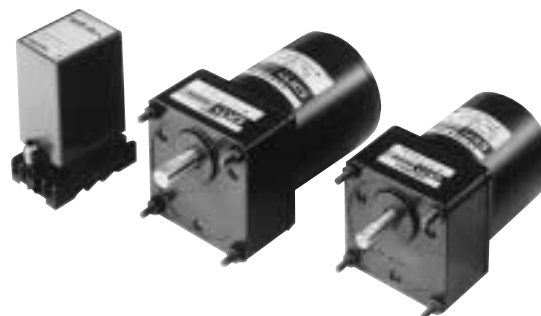
(The gearhead shown is sold separately.)

## Component Type

A-170 page.

- Speed control range: 90 r/min ~ 1700 r/min
- Output power: 6W ~ 40W
- Induction motor type

The combination of a motor with a control pack allows for highly versatile operation, tailored to your needs.



(The gearhead shown is sold separately.)

# Guide for Speed Control Motor Selection

## ■ Selection Procedure

### 1. Selecting a motor and control pack

First, determine :

- Required functions (Instantaneous stop, Acceleration/Deceleration etc.)
- Power supply voltage (AC/DC)
- Required motor output power

### 2. Computing the gearhead ratio

The following equation is used to determine the gear ratio of the gearhead using the higher limit of required speed if a speed range between A [r/min] to B [r/min] is to be achieved.

$$i_x = \frac{1300 \text{ [r/min]}}{B \text{ [r/min]}} \text{ [AC speed control motors*]}$$

$$i_x = \frac{3000 \text{ [r/min]}}{B \text{ [r/min]}} \text{ [FBLII series]}$$

$i_x$ : Speed reduction ratio

A: Lower limit of the required shaft speed range

B: Higher limit of the required shaft speed range

\*AC speed control motors have the highest torque and the largest continuous duty region at around 1300r/min.

Use a gearhead with the gear ratio “i” closest to, but still below, the calculated value.

### 3. Corresponding motor speed range

With the speed-reduction ratio of the selected gearhead ( $i$ ), the corresponding upper and lower value for the speed range at motor shaft  $N_H$  and  $N_L$ , respectively, are determined as follows:

$$N_H = B \times i \text{ [r/min]}$$

$$N_L = A \times i \text{ [r/min]}$$

### 4. Corresponding minimum motor torque

The torque required at the motor shaft to drive the load with the gearhead attached is determined by the following equation:

$$T_M = \frac{T_L}{i \cdot \eta} \text{ [oz-in]}$$

$T_M$ : Torque required at the motor output shaft

$T_L$ : Load torque

$i$ : Gear ratio

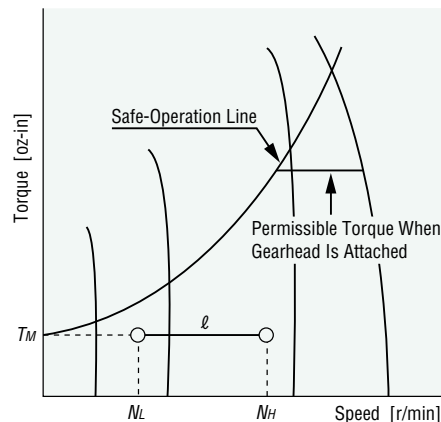
$\eta$ : Gearhead efficiency

### 5. Selecting the right motor

The main parameters for motor selection in a given application are the values for the torque required at the motor output shaft, the required speed range  $N_L$ - $N_H$  and the torque-speed characteristics of the motor.

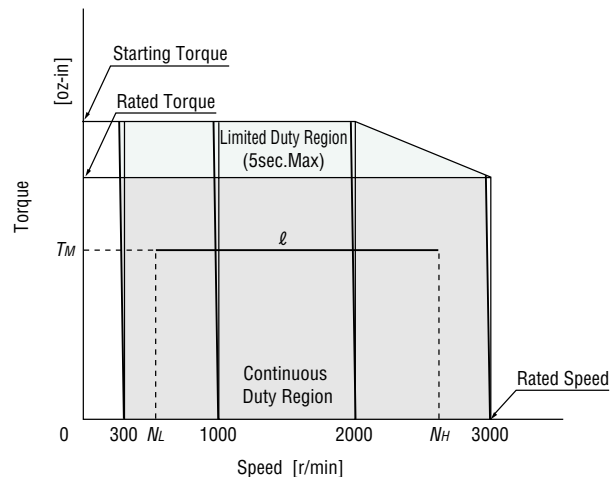
### ● AC speed control motor

To determine whether a motor is suitable, a line ( $\ell$ ) is entered into the torque-speed characteristics curve that connects the value for  $N_L$  and  $N_H$  as the coordinates to the abscissa ( $T_M$ ), as shown in the figure below. If this line is entirely to the left of the “safe-operation line”, continuous operation of the motor is generally possible. (If the line “ $\ell$ ” is partly or entirely to the right of the “safe-operation line”, but still within the range below the stall torque, the motor may be suitable as long as the motor temperature is kept below the 194°F (90°C) limit by such methods as forced-air cooling or intermittent operation of the unit. On the other hand, if  $\ell$  is far to the left of the “safe-operation line”, the motor under consideration is oversized and, therefore, not economically suitable for the application.)



### ● FBLII series

Determine if the line ( $\ell$ ) is entirely inside the “continuous duty region”.



### 6. Selecting the right gearhead

Find the maximum permissible torque of the gearhead, using the required speed reduction ratio ( $i_x$ ) in the gearhead data provided with every speed control motor. Any combination of a suitable motor with a gearhead whose maximum permissible torque is higher than the load torque can be used for the application. The final selection must be carried out according to other criteria (e.g. temperature rise, size, etc.)

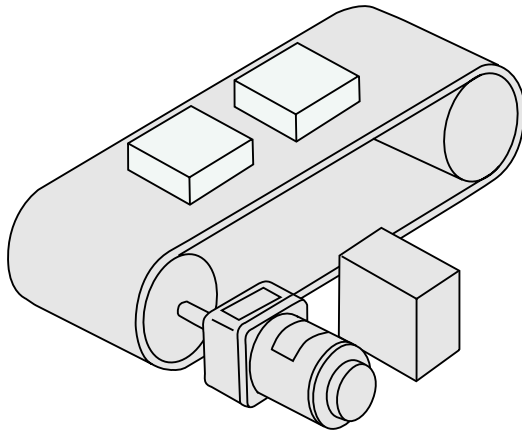
## ■ Sample Calculation for Selecting a Speed Control System

### Conditions

#### ● Belt Conveyor with Uni-directional Rotation

The speed of feed can be set in the range between 50 in/min and 200 in/min in order to match the work being moved by the manual speed adjustment.

- Drum diameter: 5 inch DIA.
- Drive torque: 30 lb-in (= 480 oz-in)
- Power supply: Single-Phase 115 VAC, 60 Hz



### 1. Motor and Control Pack

Select a product from the unit type speed control motor **US** series, for easy wiring.

### 2. Gearhead Output Shaft Speed

Gear shaft speed when the belt conveyor is moving at 50 in/min is:

$$\frac{\text{Belt conveyor speed}}{\text{Drum outer diameter}} = \frac{50}{5\pi} \doteq 3.18 \text{ [r/min]}$$

Gear shaft speed when the belt conveyor is moving at 200 in/min is:

$$= \frac{200}{5\pi} \doteq 12.7 \text{ [r/min]}$$

### 3. Gear Ratio of Gearhead

Find the gear ratio using the highest gear shaft speed as the standard.

$$\frac{\text{Motor shaft speed}}{\text{Gear shaft speed}} = \frac{1300}{12.7} \doteq 102 \rightarrow \boxed{100}$$

The gear ratio is therefore 100 : 1.

### 4. Motor Shaft Speed

$$\begin{aligned} \text{Gear shaft speed} \times \text{Gear ratio} &= 3.18 \times 100 = 318 \text{ [r/min]} \\ &= 12.7 \times 100 = 1270 \text{ [r/min]} \end{aligned}$$

### 5. Required Motor Torque

The efficiency of a gearhead with a gear ratio of 100:1 is 0.66. The required motor torque is:

$$\frac{\text{Drive torque}}{\text{Gear ratio} \times \text{Efficiency}} = \frac{480}{100 \times 0.66} \doteq 7.3 \text{ [oz-in]} (52.6 \text{ mN} \cdot \text{m})$$

### 6. Motor Selection

These calculations indicate that the best combination from those listed on the torque-speed curves for the **US** series (page A-156) is:

Motor : **US425-401U**  
Gearhead : **4GN100KA**

In this example, an AC speed control motor was chosen, but depending on the required motor torque, motor size limitations, and required speed, the **FBLI** and **HBL** Series motors may sometimes be better choices. Follow the same procedure to select one of these motors. The only additional step is to check that the load inertia falls within the selected motor's specifications.

## ■ Characteristics of the **FBL II** and **HBL** Series

### ● Constant Torque Over a Wide Range of Speeds

These motors provide a constant level of torque over a wide range of speeds (300 ~ 3000 r/min for the **FBL II** series and 300 ~ 2000 r/min for the **HBL** series).

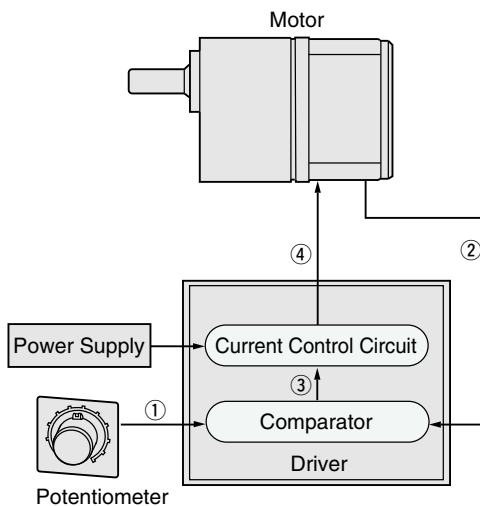
They both have continuous operation areas and short-term operation areas (about 5 seconds), so they are extremely effective at accelerating inertial loads.

### ● Power Beyond Their Size

Brushless DC motors are used, which produce more power than AC speed control motors of the same size.

### ● Closed-Loop Speed Control System

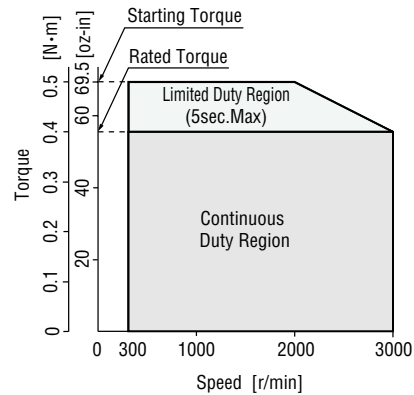
#### Basic Configuration



- ① The speed setting voltage is supplied by a potentiometer.
- ② The motor speed is sensed and the speed signal voltage is supplied.
- ③ The difference between the speed setting voltage and speed signal voltage is the output.
- ④ A current determined by the output from the comparator is supplied to the motor so it reaches the set speed.

## ● **FBL II** Series Torque-Speed Characteristics

### **FBL5120AW**-□



The figure above illustrates the characteristics of an **FBL II** series motor. Except for a speed control range of 300 ~ 2000 r/min, the characteristics are the same for the **HBL** series. Rated torque and instantaneous maximum torque are constant from 300 r/min to 3000 r/min. The torque does not drop at low speeds, as it does for AC speed control motors. Unlike AC speed control motors, which have a limit to continuous use because of the motor's temperature rise, brushless DC motors can be used continuously at rated torque from high speeds to low.

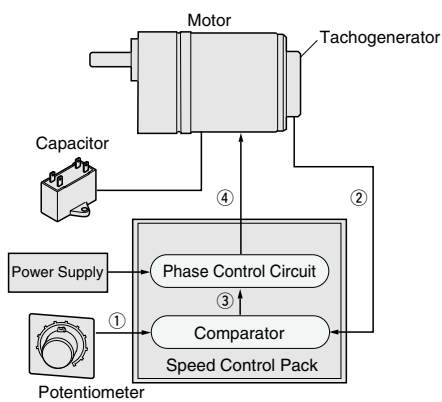
In addition to their continuous use areas, brushless DC motors also have short-term use areas. In the short-term use area, an instantaneous maximum torque that is about 1.3 times the rated torque can be output. This is extremely effective for accelerating inertial loads. If operated for more than about 5 seconds in the short-term use area, the driver's overload protection function engages and the motor is automatically stopped.

## ■ Characteristics of AC Speed Control Motors

The most commonly used of all general-purpose compact AC motors is the induction motor. Speed Control motors are equipped with a tachogenerator as a speed sensor, which, together with the specially designed control pack, allows speed control over a wide range of 90 ~ 1600 or 1700 r/min (for 60Hz). A speed control motor's speed can be set and adjusted by a speed potentiometer. The phase controlled lower voltage, which is applied to the motor, helps to keep motor temperature rise low in low speed or light load operations.

## ● Closed-Loop Speed Control System

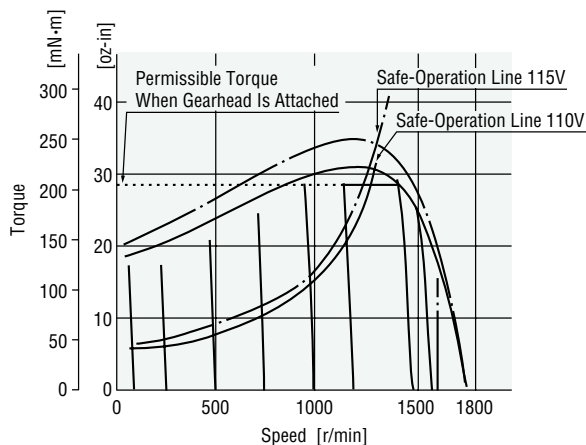
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- ④ A voltage determined by the output from the comparator is supplied to the motor so it reaches the set speed.

## ● Safe-Operation Line and Continuous Duty Region

### Torque-Speed Characteristics



The speed-torque characteristic line shown in the figure above is typical for all AC speed control motors. Up to a certain maximum torque, the "stall torque", an increase of load has almost no influence on the motor speed. Exceeding this value for maximum torque will lead to sudden stalling of the motor.

## ● Safe-Operation Line

Input power to the speed control motor varies with the load and the speed. The greater the load, and the lower the speed, the higher the motor's temperature will rise.

The graph left displays the relationship between the speed and the torque characteristics of the AC speed control motor. The line is referred to as the safe-operation line and the shaded area is called the continuous operation area.

The safe-operation line, measured by motor's temperature, indicates its operational limit for continuous usage with the temperature level below the permissible maximum (In case of using the reversible motor, it is measured by 30 minute operation).

Whether the motor can be operated continuously or not is judged by measuring the temperature of the motor case. When the temperature of the case is below 194°F(90°C), the motor is capable of continuous operation.

When using a gearhead, be aware that it is necessary to operate below the maximum permissible torque.

If the actual torque required should exceed the maximum permissible torque, it may cause possible damage to the motor and/or may shorten its life.