Orientalmotor

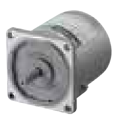
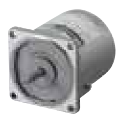
# AC Motor Utilization

## 1. Select a Combination of Features

By combining mechanisms and circuits, AC motors can expand its performance characteristics to cover a wide range of applications.

*Depending on the product, the type of gearhead and circuit combination may vary.

**Select Motor Type**

| Operate continuously in a certain direction | Operate in forward and reverse directions instantly | Hold the load when stopped |
|---|---|---|
|  |  |  |
| Induction Motor | Reversible Motor (Simple Brake) | Motor with Electronic Brake |

**Combine Mechanisms**

| Slow down, increase torque | Reduce speed, increase torque, save space | Convert to linear motion |
|---|---|---|
|  |  |  |
| Parallel Shaft Gearhead | Orthogonal Shaft Gearhead | Linear Head |

**Combine Circuits**

Stop instantly

Brake Pack





We will explain the roles and operation principles of "gearhead", "electromagnetic brake", and "brake pack" respectively.

## 2. Speed Reducer Mechanism- Gearheads

The gearhead is a mechanism that decreases the rotation speed of the AC motor and increases the generated torque. It is attached to the tip of a pinion shaft type motor.

### Role of the Gearhead

The gearhead has the role of decreasing the rotation speed, increasing the torque, and reducing the overrun of the motor.

### • Reduce Rotation Speed

The rotation speed of the AC motor is determined by the power supply frequency, the number of motor poles, and the magnitude of the load.

By combining a gearhead with a motor, it is possible to reduce the motor's rotation speed by the reduction ratio of the gearhead.

$$\text{Speed at gearhead output shaft} = \frac{\text{Speed at motor output}}{\text{Gear ratio}}$$

For example, when the motor shaft rotation speed is 1300 r / min, if you use a gearhead with a reduction ratio of 1/50, the rotation speed of the output shaft of the gearhead will be 26 r / min.

### • Increase Generated Torque

The torque of an AC motor has specification values for each product. By combining a gearhead with a motor, the generated torque can be increased by the reduction ratio of the gearhead.

$$\text{Torque at gearhead output shaft} = \text{Torque at motor output} \times \text{Gear ratio} \times \text{Gearhead transmission efficiency}$$

Although it is easy to multiply the torque by the reduction ratio, we need to consider the loss of power due to gear friction. Therefore, when calculating, consider the transmission efficiency of the gearhead.

In the case of a parallel shaft gearhead with high gear ratio, multiple stages of gears must be used, so loss will increase.

| Product Name \ Gear Ratio | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [illegible] | | | [illegible] | | | | | | | | [illegible] | | | | | | | | [illegible] | | | | |
| [illegible] | | | [illegible] | | | | | | | [illegible] | | | | | | | | [illegible] | | | | | |
| [illegible] | | | [illegible] | | | | | | [illegible] | | | | | | [illegible] | | | | | | [illegible] | | |

For example, if the torque of the motor shaft is 0.2 N · m, using the gearhead with the reduction ratio of 1/50 and the transmission efficiency of 86%, the torque of the output shaft of the gearhead will be 8.6 N · m

### • Reduce the Overrun A mount

By combining a gearhead with a motor, it is possible to reduce the overrun amount by the reduction ratio of the gearhead.

$$\text{Overrun at gearhead output shaft} = \frac{\text{Overrun at motor output shaft}}{\text{Gear ratio}}$$

When a gearhead with a reduction gear ratio of 1/50 is combined with an induction motor, a reversible motor, or an electromagnetic brake motor, the guideline (reference value) of the overrun amount of the output shaft of the gearhead is as shown in the table below.

| Motor type | Overrun amount of motor shaft | Reduction ratio of gear head | Overrun amount of gearhead output shaft |
|---|---|---|---|
| Induction motor | 30 to 40 revolutions | 1/50 | 0.6 to 0.8 turn |
| Reversible motor | 5 to 6 turns | | 0.1 to 0.12 turn |
| Motor with electromagnetic brake | 2 to 3 turns | | 0.04 to 0.06 rotation |

## How to Read the Gearhead Specifications

### • Allowable Torque at Gearhead Shaft

Depending on the combination of the motor and the gearhead, the magnitude of allowable torque is different. Calculate the necessary torque from the mechanism and confirm that it is within the allowable value.

N·m

| Product Name ① | Rotational Speed ② r/min | 300 | 250 | 200 | 166 | 120 | 100 | 83 | 60 | 50 | 41 | 30 | 25 | 20 | 16.6 | 15 | 12.5 | 10 | 8.3 | 6 | 5 | 4.1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reduction Ratio ③ | **5** | **6** | **7.5** | **9** | **12.5** | **15** | **18** | **25** | **30** | **36** | **50** | **60** | **75** | **90** | **100** | **120** | **150** | **180** | **250** | **300** | **360** |
| **4IK25SW-□、4IK25J□□-□** | | 0.86 | 1.0 | 1.3 | 1.5 | 2.1 | 2.6 | 3.1 | 4.3 | 4.9 | 5.9 | 8.2 | 9.8 | 12.3 | 14.7 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| **4IK25GC□-□** | | 0.92 | 1.1 | 1.4 | 1.7 | 2.3 | 2.8 | 3.3 | 4.6 | 5.3 | 6.3 | 8.8 | 10.6 | 13.2 | 15.9 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |

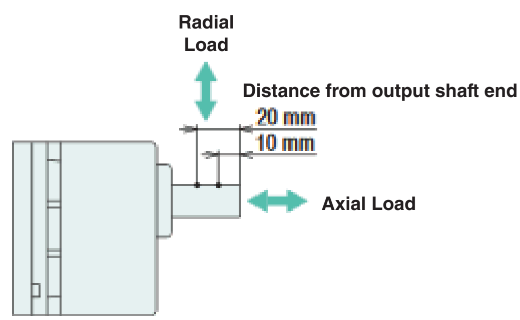
④ ⑤

① Product Name
It is a combination type name of a motor and a gearhead. Depending on the product, it may be listed as a single item.
② Rotational Speed
It is a value obtained by dividing the synchronous rotation speed of the motor by the reduction gear ratio of the gearhead. Actual rotation speed can be up to 30% less depending on load size.
③ Reduction Ratio
It is the reduction gear ratio of the gearhead.
④ Rated Torque
It is a value obtained by multiplying the rated torque of the motor by the reduction ratio of the gearhead and the transmission efficiency of the gearhead. If it exceeds a certain reduction ratio, it is limited because the gearhead exceeds the allowable torque.
⑤ Maximum Permissible Torque
It is the upper limit value of the load torque applied to the gearhead. If it exceeds this load, the gearhead may be damaged.

### • Allowable Radial Load/ Axial Load of Gearhead

Radial load is a load applied in a direction perpendicular to the output shaft. Axial load is a load applied in a direction parallel to the output shaft.

For each gearhead, the allowable radial load / axial load differs. Calculate the load from the mechanism and confirm that it is within the allowable value.



| Product Name | Gear Ratio | Max. Permissible Torque N·m | Permissible Radial Load N | | Permissible Radial Load N |
|---|---|---|---|---|---|
| | | | 10mm from output shaft end | 20mm from output shaft end | |
| 4GN■ | 5~25 | 6 | 300 | 350 | 100 |
| | 30~360 | | 450 | 550 | |

Radial load is always applied to the output shaft when using chains, gears, belts, etc. for the transmission mechanism from the gearhead output shaft.

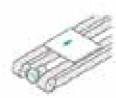
### • Allowable Moment of Inertia of Gearhead

Moment of inertia is a value that represents difficulty of moving or stopping the object. The size of allowable inertia varies for each type of motor. Calculate the moment of inertia from the mechanism and confirm that it is within the allowable value.

| Number of phases | Frame Size | Output Power | Permissible Inertia at the Motor Shaft J ($\times 10^{-4}$ kg·m$^2$) |
|---|---|---|---|
| Single-phase | 80mm | 25W | 0.31 |

### Types of Gearhead

We offer three types of gearheads. Benefits other than speed reduction can be obtained by using gearheads properly according to load and equipment.

| Type | Features | Application example |
|---|---|---|
|  Parallel Shaft Gearhead | It is a gearhead whose output shaft is arranged parallel to the motor shaft. The torque of the motor can be efficiently transmitted to the output shaft. |  |
|  Right-Angle Gearhead (Hollow Shaft/ Solid Shaft) | The output shaft is arranged in the direction orthogonal to the motor shaft by 90°. There are hollow shaft type and solid shaft type. By using the orthogonal shaft gearhead, the motor can be installed perpendicularly to the driven shaft such as a conveyor, so that space saving of the device can be achieved. |  |
|  Linear Heads | It adopts a rack and pinion mechanism and converts the rotational motion of the motor into a linear motion. There are horizontal drive type and vertical drive type. It can be used as a driving source for linear motion. |  |

* The gearhead to be combined varies depending on the product.

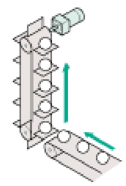
## 3. Load Holding Function- Electromagnetic Brake

When you want to hold the load of the AC motor, use a motor with electromagnetic brake.

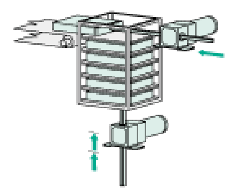
### Role of Electromagnetic Brake

Our electromagnetic brake motor is equipped with a non-excitation type electromagnetic brake. A non-excitation type electromagnetic brake is a mechanism that can hold a load when the power is turned off.

### Application Examples:



It is possible to prevent the fall of the workpiece at power failure

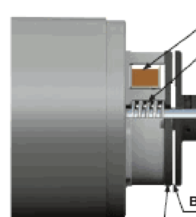


Ideal for vertical linear head drive

### Operation Principle of Electromagnetic Brake

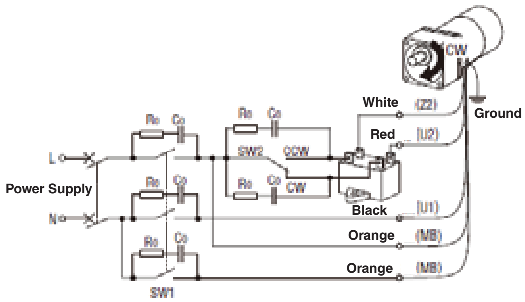
### Structure

Friction brakes are built in the rear of the motor with an electromagnetic brake. The load is held by the friction created when the brake lining is pressed against the brake hub.The brake lining is integrated with an iron armature. The figure below shows the state of the electromagnetic brake when the motor is running.




During motor operation, current flows through the magnet coil. The iron armature is attracted to the magnet coil which becomes an electromagnet when energized. As a result, the brake lining and the brake hub separate from each other, and the motor output shaft becomes free. While the motor is stopped, the coil spring pushes out the armature. As a result, the brake lining and the brake hub come into contact and hold the load.

When operating a motor with an electromagnetic brake, connect the power line with the electromagnetic brake wires. The electromagnetic brake wires are connected to the excitation coil inside the electromagnetic brake. As long as there is no power connection, the motor shaft remains locked.

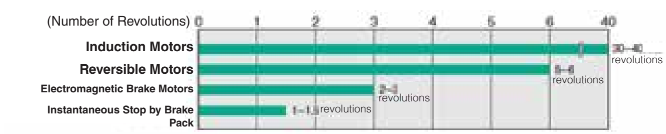



## 4. Instantaneous Stop Function- Brake Pack

When you want to hold the load of the AC motor, use a motor with electromagnetic brake.

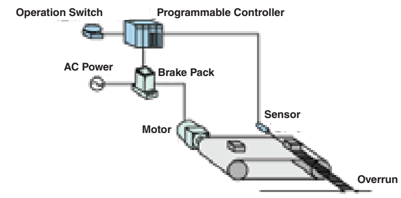
### Role of a Brake Pack

A brake pack is a product with a brake circuit. You can dynamically stop the motor and reduce the overrun amount. The below figure compares the overrun amount (reference value) of each AC motor wit no load. By using a brake packs, the overrun amount can be reduced to about 1 to 1.5 revolutions.




### Simple Positioning with a Brake Pack

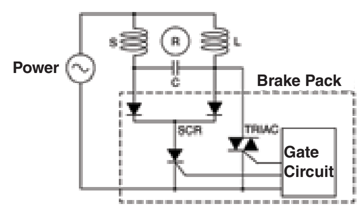
Brake packs can be controlled by a PLC or similar I/O devices. It can also be used for simple positioning using an external sensor.




### Operation Principle of Brake Packs

The AC motor rotates using the rotating magnetic field generated by AC power. The brake pack generates a fixed magnetic field and applies a large braking current to the motor. The motor stops because the magnetic field is no longer rotating. After supplying the braking current, commercial power is also cut off.

### Internal Configuration of Brake Pack




**R:** Rotor

**L:** Main Winding

**S:** Auxiliary Winding

**SCR:** Silicon Controlled Rectifier
(switch type electrical component, and passes current in one direction)

**TRIAC:** Triodeswitc
(switch type electrical component, and passes current in both directions)

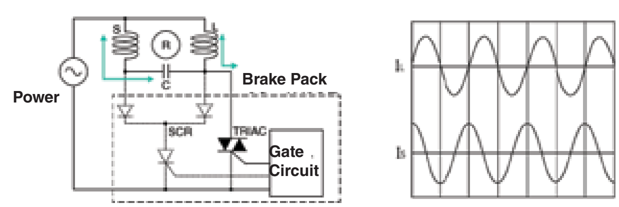
SCR is a circuit that flows the braking current. Only current from one direction flows.

TRIAC is a supply circuit for commercial power. Current flows from both directions.

### When Driving an AC Motor

When operating an AC motor, the TRIAC circuit is used.

When the trigger signal is given to TRIAC, AC power is supplied to the AC motor. In the case of a single-phase motor, a current that is out of phase due to the capacitor flows in the auxiliary winding against the current flowing in the main winding. This generates a rotating magnetic field and causes the motor to rotate.

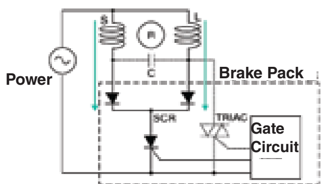


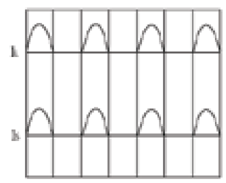
## When Stopping the AC Motor Instantaneously

To stop the AC motor instantaneously, the SCR circuit is used to shut off the TRIAC circuit. When a trigger signal is given to the SCR, braking current flows to the AC motor. The braking current is a current in one direction.

Because this braking current is half-wave rectified, only the in-phase current flows. In addition, since the SCR circuit does not go through the capacitor, there is no phase shift between the main and auxiliary windings.

After applying the braking current, the TRIAC signal is turned off to shut off the commercial power supply.



During instantaneous stop, a large braking current greater than the operating current flows. The braking current only flows for less than a second, so heat generation does not increase.

However, if driving and braking are repeated in a short time, the heat generation of the AC motor and the brake pack may increase, and the continuous duty rating may be limited.