## Connection Diagrams
The figure below is a connection diagram for a configuration based on a single-phase 100–120 V supply voltage, with the sink/source selector switch set to the sink side.

### Timing Chart

#### 2-wire Mode

- **Rotation direction switching/Stop method selection**
  - **CW**: Instantaneous Stop
  - **CCW**: Deceleration Stop

- **Bi-directional operation**
  - **CW**: Instantaneous Stop
  - **CCW**: Deceleration Stop

#### 3-wire Method

- **Stop method selection**
  - **CW**: Instantaneous Stop
  - **CCW**: Deceleration Stop

### Applicable Crimp Terminals
- **Power Supply Connection Terminal (M3.5):** Round shape terminal with insulator
  - **Protective Earth Terminal (M4):** Round shape terminal with insulator

- **I/O Terminals**
  - Use the terminals specified below for connection using crimp terminals. Please note that the applicable crimp terminal will vary depending on the size of the wire. The following terminals can be used with wires of AWG26 to 22.
  - [Manufacturer: Phoenix Contact]
  - **AI 0.25-6**: Applicable cable size
    - AWG26–24 (0.14–0.2 mm²)
  - **AI 0.34-6**: Applicable cable size
    - AWG22 (0.35 mm²)

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  - AWG22 (0.35 mm²)
I/O Signal Circuits
The input signal circuit can be switched between the sink mode and source mode using the sink/source selector switch on the driver. The factory setting is the sink mode.

Input Circuit
Common to the CW (START/STOP), CCW (RUN/BRAKE), DEC-STOP (CW/CCW), EXT-ERROR, ALARM-RESET and operation-data selection inputs.

Sink Input
X0, X1, X2, X3, X5
M0, M1, M2
X0: EXT-ERROR input
X1: CW input
X2: CCW input
X3: DEC-STOP input
X5: ALARM-RESET input
M0, M1, M2: Operation data selection

Source Input
C0, C1
X0, X1, X2, X3, X5
M0, M1, M2
X0: EXT-ERROR input
X1: CW input
X2: CCW input
X3: DEC-STOP input
X5: ALARM-RESET input
M0, M1, M2: Operation data selection

Output Circuit
Common to the SPEED-OUT, ALARM-OUT1 and ALARM-OUT2 outputs.

Sink Output
Internal Circuit
Shielded Cable
Insert a resistor to keep the current to 10 mA or less.

Y0: SPEED-OUT output
Y1: ALARM-OUT1 output
Y2: ALARM-OUT2 output
* Supply a current of 5 mA or more to the SPEED-OUT output.

Source Output
Internal Circuit
Shielded Cable
Insert a resistor to keep the current to 10 mA or less.

Y0: SPEED-OUT output
Y1: ALARM-OUT1 output
Y2: ALARM-OUT2 output
* Supply a current of 5 mA or more to the SPEED-OUT output.

When a Controller with a Built-in Clamp Diode is Used
When you want to use the controller with a built-in clamp diode, pay attention to the sequence of turning on or off the power.

Power ON: Controller ON → Driver ON
Power OFF: Driver OFF → Controller OFF

If the driver power is turned on first when connected as shown above, or the controller power is turned off with the driver power turned on, current will be applied, as indicated by the arrows in the diagram. This may cause the motor to run.

When the power is turned on or off simultaneously, the motor may run temporarily due to differences in power capacity. The controller power must be turned on first, and driver power must be turned off first.

SPEED-OUT Output
Pulse signals of 30 pulses (pulse width: 0.2 ms) are output per each revolution of the motor output shaft in synchronization with the motor operation.

By measuring the frequency of SPEED outputs, the motor speed can be calculated.

\[
\text{Motor Shaft Speed (r/min)} = \frac{1}{T} \times 60
\]

ALARM-OUT1 Output
When any of the driver’s protection functions is actuated, the ALARM-OUT1 output will turn OFF and the digital operator will display an alarm code. The motor will decelerate to a stop.

ALARM-OUT2 Output
The ALARM-OUT2 output will turn OFF when the driver’s overload protection function or overload warning function is actuated. Actuation of any other protection function will not turn this output OFF.

The overload warning function is actuated based on a preset load factor relative to the rated torque. The ALARM-OUT2 output will turn OFF once the set load factor is exceeded.

(A desired load factor can be set at 10% intervals between 50 and 100%.)

<table>
<thead>
<tr>
<th>Type of Protection Function</th>
<th>ALARM-OUT1 Output</th>
<th>ALARM-OUT2 Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Operation</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Overload Protection Function</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Other Protection Function</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Overload Warning Function</td>
<td>ON</td>
<td>OFF</td>
</tr>
</tbody>
</table>

* A maximum error of approx. 20% may generate when the motor is operated at the rated speed under the rated load.
Operating Methods

One of the following two operating methods (a and b) can be set by switching between the digital-operator setting mode and external-input signal setting mode.

a) Operate the motor using the RUN and STOP keys on the digital operator
b) Operate the motor using external input signals

Speed Setting Methods

One of the following four methods (1 to 4) can be used to set speeds:

1. Set speeds using the internal potentiometer
   Set speeds using the potentiometer provided on the driver’s front panel.

2. Set speeds using the digital operator
   The digital operator can be used to set speeds in units of 1 r/min. Up to eight speed data can be set.

3. Set speeds using an External Potentiometer (sold separately)
   To set speeds at a location away from the driver, connect an optional external potentiometer as shown below.

Set speeds using external DC voltage
Set the external-voltage selection switch on the driver in accordance with the external DC voltage to be supplied. Detach the digital operator and set the switch to either 5 V or 10 V. Thereafter, connect an external DC power supply as shown below. Connect the positive and negative terminals of the power supply correctly.

Multi-Speed Operation

Two-Speed Operation
The speed set by the internal potentiometer and another set by an external potentiometer can be combined for two-speed operation by switching the operation-data selection input M0.

Note:
The speed in the graph represents the speed of a motor alone. The gear output shaft speed of the combination type is calculated by dividing the graph speed by the gear ratio.
Eight-Speed Operation
A multi-speed operation using up to eight speeds can be performed by setting desired speeds in operation data No. 1 to 8 and then switching the speed using external input signals.

<table>
<thead>
<tr>
<th>Operation Data</th>
<th>M0 Input</th>
<th>M1 Input</th>
<th>M2 Input</th>
<th>Speed Setting Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>Internal potentiometer/Digital operator</td>
</tr>
<tr>
<td>No. 2</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>External potentiometer/Digital operator</td>
</tr>
<tr>
<td>No. 3</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>Digital operator</td>
</tr>
<tr>
<td>No. 4</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>Digital operator</td>
</tr>
<tr>
<td>No. 5</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>Digital operator</td>
</tr>
<tr>
<td>No. 6</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>Digital operator</td>
</tr>
<tr>
<td>No. 7</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>Digital operator</td>
</tr>
<tr>
<td>No. 8</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>Digital operator</td>
</tr>
</tbody>
</table>

Parallel Operation
Two or more motors can be operated at the same speed using a single external potentiometer or external DC power supply. The diagram below applies to a single-phase power supply specification. For a three-phase power supply specification, change the power-supply line to a three-phase type. Also note that the diagram does not show the motor or operation control part.

Using an External Potentiometer
As shown in the diagram, use a common power-supply line and a common speed-control line for each driver and set speeds using the external potentiometer VRx.

The resistance of the external potentiometer is determined using the formula below:

Resistance when n numbers of drivers are connected: \( VRx = \frac{20}{n} \) (kΩ), \( n / 4 \) (W)

Example: When two drivers are connected

\( VRx = \frac{20}{2} = 10 \) (kΩ), \( 2 / 4 = 1 / 2 \) (W)

Accordingly, the resistance is calculated as 10 kΩ, 1/2 W.

To adjust the speed difference between motors, connect a 1.5 kΩ, 1/4 W resistor to the VM terminal on the first driver, and connect a 5 kΩ, 1/4 W variable resistor (VRn) to the VM terminal on each of the remaining drivers.

Up to five drivers can be operated in parallel using an external potentiometer.

Using External DC Voltage
As shown in the diagram, use a common power-supply line and a common speed-control line for each driver and connect all drivers to a 5 or 10 VDC power supply.

The power-supply capacity of the external power supply is determined using the formula below:

Power-supply capacity when n numbers of drivers are connected: \( I = 1 \times n \) (mA)

Example: When two drivers are connected

\( I = 1 \times 2 = 2 \) (mA)

Accordingly, the power-supply capacity is calculated as 2 mA or more.

To adjust the speed difference between motors, connect a 1.5 kΩ, 1/4 W resistor to the VM terminal on the first driver, and connect a 5 kΩ, 1/4 W variable resistor (VRn) to the VM terminal on each of the remaining drivers.

Using the Digital Operator
When multiple drivers are connected where the same data are set digitally in each driver, the operations of multiple motors can be controlled via a single set of external input signals using the wiring circuit shown below.
Installation of the Hollow-Shaft Flat Gearhead

- **Installing the Load Shaft**
  - Install the load shaft to the hollow output shaft by aligning the center of the hollow shaft with that of the load shaft.
  - The hollow output shaft has a key groove. Machine a matching key groove on the load shaft side and use the supplied key to affix the two shafts across the grooves.
  - A recommended tolerance of the load shaft is h7.
  - If the motor will receive large impacts due to frequent instantaneous stops or carry a large overhung load, use a stepped load shaft.

- **Stepped Load Shaft**
  - Install a hexagonal socket head bolt over a stopper ring, spacer, flat washer and spring washer, and tighten the bolt to affix the load shaft.

- **Straight Load Shaft**
  - Install a hexagonal socket head bolt over a stopper ring, spacer, flat washer and spring washer, with a spacer also inserted underneath the load shaft, and tighten the bolt to affix the load shaft.

Notes:
- When installing the load shaft to the hollow output shaft, be careful not to damage the hollow output shaft or bearing.
- To prevent seizure, apply a coat of molybdenum disulfide grease on the exterior surface of the load shaft and interior surface of the hollow output shaft.
- Do not attempt to modify or machine the hollow output shaft. Doing so may damage the bearing and cause the hollow-shaft flat gearhead to break.

- **Recommended Load Shaft Installation Dimensions**

<table>
<thead>
<tr>
<th>Model</th>
<th>BLF230</th>
<th>BLF460</th>
<th>BLF5120</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner Diameter of Hollow Shaft (h8)</td>
<td>φ12</td>
<td>φ15</td>
<td>φ20</td>
</tr>
<tr>
<td>Recommended Tolerance of Load Shaft (h7)</td>
<td>φ12</td>
<td>φ15</td>
<td>φ20</td>
</tr>
<tr>
<td>Nominal Diameter of Stopper Ring</td>
<td>φ12</td>
<td>φ15</td>
<td>φ20</td>
</tr>
<tr>
<td>Applicable Bolt</td>
<td>M4</td>
<td>M5</td>
<td>M6</td>
</tr>
<tr>
<td>Spacer Thickness</td>
<td>3 (0.12)</td>
<td>4 (0.16)</td>
<td>5 (0.20)</td>
</tr>
<tr>
<td>Outer Diameter of step part</td>
<td>20 (0.79)</td>
<td>25 (0.98)</td>
<td>30 (1.18)</td>
</tr>
</tbody>
</table>
  | Determine the spacer thickness in conformance with the table. If the spacer is thicker than the specified dimension, the bolt will project from the surface and interfere with the safety cover.

- **Installing the Hollow Shaft**
  - **Installing from the Front Face**
    The output shaft boss (h8) can be used to align the shaft.

  - **Installing from the Rear Face**
    The output shaft boss (h8) can be used to align the shaft.

  - **Mounting Hole Cutout**

  - **Mounting Hole Dimensions**

<table>
<thead>
<tr>
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<th>BLF230</th>
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<tbody>
<tr>
<td>Nominal Bolt Size</td>
<td>φA</td>
<td>φB H8</td>
<td>φC</td>
</tr>
<tr>
<td>M5</td>
<td>70 (2.76)</td>
<td>94 (3.70)</td>
<td>104 (4.09)</td>
</tr>
<tr>
<td>M6</td>
<td>34 (1.34)</td>
<td>38 (1.50)</td>
<td>50 (1.97)</td>
</tr>
<tr>
<td>M8</td>
<td>5.5 (0.22)</td>
<td>6.5 (0.26)</td>
<td>8.5 (0.33)</td>
</tr>
<tr>
<td>25 (0.98)</td>
<td>30 (1.18)</td>
<td>35 (1.38)</td>
<td></td>
</tr>
<tr>
<td>29 (1.14)</td>
<td>39 (1.54)</td>
<td>44 (1.75)</td>
<td></td>
</tr>
</tbody>
</table>

Note:
When installing the hollow-shaft flat gearhead from the rear face, provide dimension E to prevent the mounting plate from contacting the motor.