**Connection and Operation**

- Names and Functions of Driver Parts

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**Power Input Display**

<table>
<thead>
<tr>
<th>Color</th>
<th>Function</th>
<th>When Activated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Power supply indication</td>
<td>Lights when power is on</td>
</tr>
</tbody>
</table>

**Current Adjustment Potentiometers**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Potentiometer Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN</td>
<td>Motor run current potentiometer</td>
<td>For adjusting the motor running current.</td>
</tr>
<tr>
<td>STOP</td>
<td>Motor stop current potentiometer</td>
<td>For adjusting the motor current at standstill.</td>
</tr>
</tbody>
</table>

**Function Select Switches**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Switch Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1P/2P</td>
<td>Pulse input mode switch</td>
<td>Switches between 1-pulse input and 2-pulse input.</td>
</tr>
<tr>
<td>OFF/SD</td>
<td>Smooth drive function switch</td>
<td>Enables or disables the smooth drive function.</td>
</tr>
<tr>
<td>R2/R1</td>
<td>Resolution select switch</td>
<td>Switches the basic step angle between R1 and R2.</td>
</tr>
</tbody>
</table>

**Input/Output Signals**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Input/Output</th>
<th>Pin No.</th>
<th>Signal Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td></td>
<td>1 Pulse signal (CW pulse signal)</td>
<td>Operation command pulse signal (The motor will rotate in the CW direction when in 2-pulse input mode.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 Rotation direction signal (CW pulse signal)</td>
<td>Rotation direction signal (The motor will rotate in the CW direction when in 2-pulse input mode.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 All windings off signal</td>
<td>Cuts the output current to the motor and allows the motor shafts to be rotated manually.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 Step angle select signal</td>
<td>Switches to step angle set in DATA1 and DATA2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 Excitation timing signal</td>
<td>Outputs signals when the excitation sequence is at STEP 0.</td>
</tr>
</tbody>
</table>

**Step Angle Setting Switches**

<table>
<thead>
<tr>
<th>Indication</th>
<th>Switch Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA1</td>
<td>Step angle setting switch</td>
<td>Each switch can be set to the desired resolution from the 16 resolution levels.</td>
</tr>
<tr>
<td>DATA2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATA1</th>
<th>DATA2</th>
<th>Microsteps/Step 1</th>
<th>Resolution 1</th>
<th>Step Angle 1</th>
<th>DATA1</th>
<th>DATA2</th>
<th>Microsteps/Step 2</th>
<th>Resolution 2</th>
<th>Step Angle 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>500</td>
<td>0.72˚</td>
<td>0</td>
<td>0</td>
<td>2.5</td>
<td>200</td>
<td>1.8˚</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1000</td>
<td>0.36˚</td>
<td>1</td>
<td>1</td>
<td>1.25</td>
<td>400</td>
<td>0.9˚</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>3</td>
<td>1250</td>
<td>0.288˚</td>
<td>2</td>
<td>1.6</td>
<td>800</td>
<td>0.45˚</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2000</td>
<td>0.18˚</td>
<td>3</td>
<td>2</td>
<td>1000</td>
<td>0.36˚</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>5</td>
<td>2500</td>
<td>0.144˚</td>
<td>4</td>
<td>3.2</td>
<td>1600</td>
<td>0.225˚</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>6</td>
<td>4000</td>
<td>0.09˚</td>
<td>5</td>
<td>4</td>
<td>2000</td>
<td>0.18˚</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>7</td>
<td>5000</td>
<td>0.072˚</td>
<td>6</td>
<td>6</td>
<td>3200</td>
<td>0.1125˚</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>8</td>
<td>10000</td>
<td>0.036˚</td>
<td>7</td>
<td>10</td>
<td>5000</td>
<td>0.072˚</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>9</td>
<td>12500</td>
<td>0.0296˚</td>
<td>8</td>
<td>12.8</td>
<td>6400</td>
<td>0.05625˚</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>40</td>
<td>A</td>
<td>20000</td>
<td>0.018˚</td>
<td>9</td>
<td>20</td>
<td>10000</td>
<td>0.036˚</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>B</td>
<td>25000</td>
<td>0.0144˚</td>
<td>A</td>
<td>25.6</td>
<td>12800</td>
<td>0.028125˚</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>80</td>
<td>C</td>
<td>50000</td>
<td>0.0072˚</td>
<td>B</td>
<td>40</td>
<td>20000</td>
<td>0.018˚</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>100</td>
<td>D</td>
<td>62500</td>
<td>0.00576˚</td>
<td>C</td>
<td>50</td>
<td>25000</td>
<td>0.0144˚</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>125</td>
<td>E</td>
<td>62500</td>
<td>0.00576˚</td>
<td>D</td>
<td>51.2</td>
<td>25600</td>
<td>0.0140625˚</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>200</td>
<td>F</td>
<td>100000</td>
<td>0.0036˚</td>
<td>E</td>
<td>100</td>
<td>50000</td>
<td>0.0072˚</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>250</td>
<td></td>
<td>125000</td>
<td>0.00286˚</td>
<td>F</td>
<td>102.4</td>
<td>51200</td>
<td>0.00703125˚</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- The step angle is calculated by dividing the basic step angle by the number of microstep. The above figures are based on a basic step angle of 0.72˚.
- With the high-resolution type, the basic step angle and resolution are 0.36˚ and 1000 (microsteps/step 1), respectively.
- If you are using a geared type, the step angle divided by the gear ratio becomes the actual step angle.
- The number of microstep that can be switched by the “Step Angle Select” signal are limited to those selected in step angles 1 and 2.
- Do not change the “Step Angle Select” signal input or step angle setting switch while the motor is operating. It may cause the motor to misstep and stop.

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Specifications, Characteristics C-140 / Dimensions C-153 / Connection and Operation C-159 / Motor and Driver Combinations C-163
**Description of Input/Output Signals**

Indication of Input/Output Signal "ON"/"OFF"

| Input (output) "ON" indicates that the current is sent into the photocoupler (transistor) inside the driver. Input (output) "OFF" indicates that the current is not sent into the photocoupler (transistor) inside the driver. The input/output remains "OFF" if nothing is connected.

**Pulse (CW) and Rotation Direction (CCW) Input Signal**

- **Input Circuit and Sample Connection**
  - Open-Collector Output
  - Pin No: 1, 3
  - Resistor: 220 Ω
  - Current: 10~20 mA

- **Pulse Waveform Characteristics**
  - **1-Pulse Input Mode**
    - Pulse ON: 90%
    - Pulse OFF: 10%
    - Pulse width: 2 μs
    - Pulse OFF time: 2 μs max.
  - **2-Pulse Input Mode**
    - Pulse ON: 90% (CW)
    - Pulse OFF: 10% (CCW)
    - Pulse width: 2 μs
    - Pulse OFF time: 2 μs max.

**Notes on Wiring**
- Use twisted-pair wires of AWG24 to AWG22 and keep wiring as short as possible (within 2 m (6.6 ft.).)
- Use twisted-pair wires of AWG22 or thicker for the power supply lines. When assembling the controller, use the hand-operated crimp tool or the crimped driver lead wire set (sold separately). The crimp tool is not provided with the package. It must be purchased separately.
- Do not run the signal lines in the same duct as power lines or bundle them with power lines.
- Incorrect connection of DC power input will lead to driver damage. Make sure that the polarity is correct before turning power on.

**Input Signal Connection**

Signals can be connected directly when 5 VDC is supplied. If the signals are used at a voltage exceeding 5 VDC, be sure to provide an external resistor to prevent the current exceeding 20 mA from flowing. Internal components will be damaged if a voltage exceeding 5 VDC is supplied directly without using an external resistor.

Example: If the voltage is 24 VDC, connect a resistor (R1) of 1.5 to 2.2 kΩ and 0.5 W or more.

**Output Signal Connection**

Use output signals at 24 VDC or less and 10 mA or less. If these specifications are exceeded, the internal components may be damaged. Check the specification of the connected equipment.

When the current is above 10 mA, connect an external resistor R1.

**Power Supply**

Use a power supply that can supply sufficient input current. When power supply capacity is insufficient, a decrease in motor output can cause the following malfunctions:
- Motor does not operate properly at high-speed
- Slow motor startup and stopping

**Pulse Signal Characteristics**

- Keep the pulse signal at the "photocoupler OFF" state when no pulses are being input.
- In 1-pulse input mode, leave the pulse signal at rest ("photocoupler OFF") when changing rotation directions.
- In 2-pulse input mode, do not input a CW pulse and CCW pulse simultaneously.

**All Windings Off (A.W.OFF) Input Signal**

- Inputting this signal puts the motor in a non-excitation (free) state.
- This signal is used to move the motor shaft with external force or manual home position is desired. The photocoupler must be "OFF" when the motor is operating.

**All Windings Off (A.W.OFF) Input Signal**

- Switching the "All Windings Off" signal from "photocoupler ON" to "photocoupler OFF" does not alter the excitation sequence. When the motor shaft is manually adjusted with the "All Windings Off" signal input, the shaft will shift up to ±3.6˚ (Geared type: ±3.6˚/gear ratio) from the position set after the "All Windings Off" signal is released.
**Step Angle Select (C/S) Input Signal**
- You may select two step angles (resolutions) from 16 available step angles (resolutions) with the step angle setting switches DATA1 and DATA2.
- When the signal is at "photocoupler OFF," a step angle set by DATA1 is selected; at "photocoupler ON," DATA2 is selected.

Example: Changing the step angle from 0.072˚ to 0.72˚.

**Automatic Current Cutback Release (C.D.INH) Input Signal**
- When this signal is in the "photocoupler ON" state, the automatic current cutback function is disabled. When this signal is in the "photocoupler OFF" state, the automatic current cutback function will be activated after the motor stops (after approximately 100 msec).
- The photocoupler must be "OFF" except when the running current is adjusted.

**Excitation Timing (TIMING) Output Signal**
- The "Excitation Timing" signal is output to indicate when the motor excitation is in the initial stage (step "0" at power up).
- The "Excitation Timing" signal is output simultaneously with a pulse input each time the excitation sequence returns to step "0." The excitation sequence will complete one cycle for every 7.2˚ rotation of the motor output shaft.
- Microsteps/step 1: Signal is output once every 10 pulses.
- Microsteps/step 10: Signal is output once every 100 pulses.

**Timing Chart**
- The minimum switching time to change direction (1-pulse input mode), and switching time to change CW, CCW pulse (2-pulse input mode) 10 μs is shown as a response time of circuit. The motor may need more time than that.
- Depends on load inertia, load torque and starting frequency.
- Never input a pulse signal immediately after switching the "All Windings Off" signal to the "photocoupler OFF" state. The motor may not start.
- Wait at least 5 seconds before turning on the power again.

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Specifications, Characteristics C-140 / Dimensions C-153 / Connection and Operation C-159 / Motor and Driver Combinations C-163
**Adjusting the Current**

- **Adjusting the Motor Current**
  Use the "RUN" potentiometer to decrease the current and suppress the temperature rise in the motor/driver, or when there is sufficient motor torque and you want to suppress vibration by lowering the current.
  
  Use the "STOP" potentiometer to readjust the current at motor standstill in relation to the holding-brake force of the motor.

  **Factory settings**
  - Running current: Rated current
  - Current at motor standstill: 50% of rated current

  Follow the procedure below to adjust the motor current.

- **Connecting an Ammeter**
  Connect a DC ammeter as illustrated below.
  Connect a DC ammeter in series to the blue motor lead wire and motor connector pin No. 1. Set all driver input signals to the "photocoupler OFF" state.
  Disconnect the red motor lead wire from connector pin No. 2, and black motor lead wire from connector pin No. 5.

  ![Diagram of ammeter connection](image)

  **Automatic Current Cutback Release Signal**

  ![Diagram of motor connection](image)

  **Holding Torque**

  \[
  \text{Holding Torque} = \frac{\text{Maximum Holding Torque [Nm (oz-in)]} \times \text{Current at Standstill [A]}}{\text{Motor Rated Current [A]}}
  \]

  **Notes:**
  - Be sure to use the motor at the rated current or below.
  - Adjusting the running current will also change the current at standstill.

- **Adjusting the Motor Running Current**
  To adjust the motor running current, follow the procedure below:

  1. Set the automatic current cutback release signal to the "photocoupler ON" state. Keep other signals in the "photocoupler OFF" state.
  2. Turn on the power to the driver.
  3. Use the "RUN" potentiometer to adjust the motor running current.
  4. When the power is turned on, the value measured by the ammeter represents the total current in two phases through the blue motor lead wire. The current for one phase is equivalent to one-half the ammeter value. (Example: To set the current to 1.0 A/phase, adjust the current level until the ammeter reads 2.0 A.)
  5. When the running current has been adjusted, set the automatic current cutback release signal to the "photocoupler OFF" state.

  **Notes:**
  - Be sure to use the motor at the rated current or below.
  - Adjusting the running current will also change the current at standstill.

- **Adjusting the Current at Motor Standstill**
  To adjust the current at motor standstill, follow the procedure below:

  1. Set the automatic current cutback release signal to the "photocoupler OFF" state. Keep other signals in the "photocoupler OFF" state.
  2. Turn on the power to the driver.
  3. Use the "STOP" potentiometer to adjust the motor current at standstill.
  4. When the power is turned on, the value measured by the ammeter represents the total current in two phases through the blue motor lead wire. The current for one phase is equivalent to one-half the ammeter value. (Example: To set the current to 0.5 A/phase, adjust the current level until the ammeter reads 1.0 A.)

  **Notes:**
  - Always set the running current first, turn off the driver power and turn it back on, and then set the current at standstill. Setting the running current after current at standstill may change the current setting at standstill.
  - Setting the current at motor standstill too low may affect the starting of the motor or the position-holding action.