Heater Element Burnout Detector

Accurate Detection of Heater Element Burnout Regardless of Heater Capacities

- Accurately detects a burned heater element or elements incorporated by a molding machine or packing machine and outputs an alarm signal.
- Precisely singles out the burned element even if one heater element among several heater elements has been burned out.
- Applicable to small- to large-capacity heater elements.
- All K2CU-F large-capacity, built-in current transformer models work with both single-phase and three-phase heaters.
- Voltage fluctuation compensation function eliminates false alarms due to variations in the supply voltage.

Ordering Information

K2CU-F F Model with Gate Input Terminals

<table>
<thead>
<tr>
<th>Control supply voltage</th>
<th>Control supply voltage</th>
<th>Operating current</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 VAC</td>
<td>With voltage fluctuation compensation</td>
<td>4 to 10 A</td>
</tr>
<tr>
<td>200 VAC</td>
<td>K2CU-F10A-EG</td>
<td>K2CU-F20A-EG</td>
</tr>
<tr>
<td>220 VAC</td>
<td>K2CU-F10A-EG</td>
<td>K2CU-F20A-EG</td>
</tr>
</tbody>
</table>

K2CU-F Large-capacity, Built-in Current Transformer Models

<table>
<thead>
<tr>
<th>Control supply voltage</th>
<th>Control supply voltage</th>
<th>Operating current</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 VAC</td>
<td>With voltage fluctuation compensation</td>
<td>4 to 10 A</td>
</tr>
<tr>
<td>110 VAC</td>
<td>K2CU-F10A-C</td>
<td>K2CU-F20A-C</td>
</tr>
<tr>
<td>200 VAC</td>
<td>K2CU-F10A-EG</td>
<td>K2CU-F20A-EG</td>
</tr>
<tr>
<td>220 VAC</td>
<td>K2CU-F10A-EG</td>
<td>K2CU-F20A-EG</td>
</tr>
</tbody>
</table>

K2CU-P Small-capacity, Plug-in Models

<table>
<thead>
<tr>
<th>Control supply voltage</th>
<th>Control supply voltage</th>
<th>Operating current</th>
</tr>
</thead>
<tbody>
<tr>
<td>100/ 200 VAC</td>
<td>With voltage fluctuation compensation</td>
<td>0.25 to 0.5 A</td>
</tr>
<tr>
<td></td>
<td>K2CU-P0.5A-A</td>
<td>K2CU-P1A-A</td>
</tr>
<tr>
<td></td>
<td>Without voltage fluctuation compensation</td>
<td>0.25 to 0.5 A</td>
</tr>
<tr>
<td></td>
<td>K2CU-P1A-A</td>
<td>K2CU-P2A-A</td>
</tr>
</tbody>
</table>

110/ 220 VAC

<table>
<thead>
<tr>
<th>Control supply voltage</th>
<th>Control supply voltage</th>
<th>Operating current</th>
</tr>
</thead>
<tbody>
<tr>
<td>With voltage fluctuation compensation</td>
<td>K2CU-P0.5A-B</td>
<td>K2CU-P1A-B</td>
</tr>
<tr>
<td>Without voltage fluctuation compensation</td>
<td>K2CU-P1A-B</td>
<td>K2CU-P2A-B</td>
</tr>
</tbody>
</table>
## Specifications

### Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>K2CU-F</th>
<th>K2CU-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control supply voltage</td>
<td>100, 110, 200, 220 VAC</td>
<td>100/200, 110/220 VAC</td>
</tr>
<tr>
<td>Rated frequency</td>
<td>50/60 Hz</td>
<td></td>
</tr>
<tr>
<td>Carry current</td>
<td>1.25 times as large as each model's max. op. curr.</td>
<td>2.5 A for K2CU-P0.5A-A/-B; 5 A</td>
</tr>
<tr>
<td>Operating voltage range</td>
<td>85% to 110% of control supply voltage</td>
<td>85% to 110% of control supply voltage</td>
</tr>
<tr>
<td>Voltage fluctuation compensation range</td>
<td>85% to 110% of control supply voltage</td>
<td>85% to 110% of control supply voltage</td>
</tr>
<tr>
<td>Operating current</td>
<td>4 to 10 A, 8 to 20 A, 16 to 40 A, 32 to 80 A (cont. var.)</td>
<td>0.25 to 0.5 A, 0.5 to 1 A, 1 to 2 A, 2 to 4 A (cont. var.)</td>
</tr>
<tr>
<td>Releasing current</td>
<td>105% max. of operating current</td>
<td>110% max. of operating current</td>
</tr>
<tr>
<td>Operate time</td>
<td>0.5 s max. (when current changes from 150% to 0%)</td>
<td></td>
</tr>
<tr>
<td>Gate input voltage range (for models with gate input terminals)</td>
<td>5 to 30 VDC</td>
<td>---</td>
</tr>
<tr>
<td>Control output</td>
<td>2 A at 220 VAC, SPDT (cos φ = 0.4)</td>
<td>---</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Input: 0.5 VA max.</td>
<td>Input: 1 VA max.</td>
</tr>
<tr>
<td></td>
<td>Power supply: 5 VA max.</td>
<td>Power supply: 4 VA max.</td>
</tr>
</tbody>
</table>

### Characteristics

| Setting accuracy                          | ±7% max.                                    |
| Repeat accuracy                           | ±3% max.                                    |
| Influence of temperature                  | ±10% max. (at 20°C±30°C)                    |
| Influence of voltage                      | Models without voltage fluctuation compensation: ±3% max. of the value measured at the control supply voltage, on condition that the voltage fluctuation is 85% to 110% of the control supply voltage. Models with voltage fluctuation compensation: ±5% max. of the logical value, on condition that the voltage fluctuation is 85% to 110% of the control supply voltage. (see note) |
| Influence of frequency                    | ±3% max. (±5% of rated frequency)           |
| Insulation resistance                     | 10 MΩ min. (at 500 VDC) between electric circuits and mounting panel |
| Dielectric strength                       | 2,000 VAC, 50/60 Hz for 1 min between electric circuits and mounting panel |
| Overcurrent                               | 20 times of max. set value of operating current for 2 s |
| Vibration resistance                      | Destruction: 16.7 Hz, 1-mm double amplitude for 10 min each in X, Y, and Z directions |
| Shock resistance                          | Destruction: 100 m/s² (approx. 10G)         |
| Ambient temperature                       | Operating: −10°C to 55°C (with no icing)    |
| Ambient humidity                          | Operating: 45% to 85%                       |
| Weight                                    | K2CU-F: approx. 390 g; K2CU-P: approx. 300 g |

**Note:** The logical value is an operating value within a range of 0.85 to 1.1 with a voltage fluctuation of 85% to 110%, based on the value at the control supply voltage measured as 1.
**Operation**

**K2CU-F A- GS Series**

When power is supplied to the heater (when the SSR is ON), a current flows through the wires to the heater elements. At the same time, a voltage is imposed on the gate circuit and the K2CU-F/C0106A-GS begins monitoring the current flowing through the heater wires.

The current flowing to the heater wires is detected by the detector sections through each Current Transformer (CT) incorporated by the K2CU-F/C0106A-GS.

The current signals transmitted by the two CTs are sent to the current-voltage converters, smoothing circuits, and comparators as shown in the diagram.

The signal generated by the reference voltage generator is sent to the setting circuit to provide a reference value. The reference value is sent to the comparators. Each comparator compares its heater element current input and the reference value. If the input is lower than the reference value, a signal is sent to the output circuit.

There are two detector sections operating independently. If either of the input signals from the CTs is lower than the reference value, the output relay and alarm indicator will be activated.

The K2CU-F/C0106A-GS incorporates a voltage fluctuation compensation function which automatically corrects the reference value if the supply voltage fluctuates.

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**Note:**

1. The dotted lines indicate the line conductors passing through the windows of the current transformers.

2. The current flowing into the gate circuit (between G+ and G−) is as follows:
   - Approximately 1.4 mA at 5 VDC
   - Approximately 3.4 mA at 12 VDC
   - Approximately 6.7 mA at 24 VDC

3. When using a K2CU which has the model number suffix “GS” (a model that incorporates gate input terminals), the control output of the temperature controller must be a voltage output type.
K2CU-F Series
When power is supplied to the heater (when the contactor is ON), a current flows through the wires to the heater elements. At the same time, a voltage is imposed on the power circuit of the K2CU-F.

The current flowing to the heater wires is detected by the detector sections through each Current Transformer (CT) incorporated by the K2CU-F.

The current signals transmitted by the two CTs are sent to the current-voltage converters, smoothing circuits, and comparators as shown in the diagram.

The signal generated by the reference voltage generator is sent to the setting circuit to provide a reference value. The reference value is sent to the comparators. Each comparator compares its heater element current input and the reference value. If the input is lower than the reference value, a signal is sent to the output circuit.

There are two detector sections operating independently. If either of the input signals from the CTs is lower than the reference value, the output relay and alarm indicator will be activated.

The K2CU-F incorporates a voltage fluctuation compensation function which automatically corrects the reference value if the supply voltage fluctuates.

Note: The dotted lines indicate the line conductors passing through the windows of the current transformers.

K2CU-P Series
The K2CU-P operates basically in the same way as the K2CU-F.

The comparator compares external current signals and the reference value and outputs the result of the comparison to the output circuit.
Setting of Operating Current

Use the potentiometer on the front panel to set the operating current.

Rotate the knob to set the desired current value at which the Heater Burnout Detector should operate. Do not exceed the maximum and minimum positions.

The K2CU-F’s scale is divided into 12 graduations including subgraduations and the K2CU-P’s scale is divided into 5 graduations.

The knobs of the K2CU-F and K2CU-P as shown in the illustrations are set to 32 A and 0.7 A respectively.

Heater Connection and Current

The following table shows the different connections possible. The formula under each illustration indicates the electrical current value of the heater elements under normal and abnormal conditions.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Normal condition</th>
<th>Abnormal condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 V 1 kW</td>
<td>200 V 0 A</td>
</tr>
<tr>
<td>Three phase</td>
<td>Delta network</td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 V 8.7 A</td>
<td>200 V 7.5 A</td>
</tr>
<tr>
<td></td>
<td>(5 A x (\frac{2}{3}))</td>
<td>(5 A x (\frac{2}{3}) x (\frac{1}{3}))</td>
</tr>
<tr>
<td>Star network</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 V 2.9 A</td>
<td>200 V 2.9 A</td>
</tr>
<tr>
<td></td>
<td>(5 A x (\frac{1}{3}))</td>
<td>(5 A x (\frac{1}{3}) x (\frac{2}{3}))</td>
</tr>
<tr>
<td>V network</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 V 5 A</td>
<td>200 V 2.5 A</td>
</tr>
<tr>
<td></td>
<td>(5 A x 5 A)</td>
<td>(5 A x 5 A x (\frac{1}{2}))</td>
</tr>
</tbody>
</table>

Note: Values in this table are correct when a 200 VAC, 1 kW heater is used on a single-phase or three-phase current.
Operation Check
K2CU-F A- GS

The operation of the heater burnout detector can be easily checked as follows:

In a Single-phase Circuit
Set the operating current to be 0.6 to 0.55 times the heater current.
Close the SW2 with switch SW1 turned on. Confirm that the alarm indicator remains off.
Turn off SW1 and confirm that the alarm indicator comes on, and that the output relay operates.

In a Three-phase, Delta Network
Set the operating current to be 0.6 times the heater current.
Close the SW3 with switches SW1 and SW2 turned on. Confirm that the alarm indicator remains off.
Turn off SW2 and confirm that the alarm indicator comes on, and that the output relay operates.
Turn on SW1 set the operating current to be 0.9 times the heater current, and confirm that the alarm indicator goes off and the output relay releases.
Turn off SW1 and confirm that the alarm indicator comes on, and that the output relay operates.

In a Three-phase, Star Network
Set the operating current to be 0.9 times the heater current.
Close the SW2 with switch SW1 turned on. Confirm that the alarm indicator remains off.
Turn off SW1 and confirm that the alarm indicator comes on, and that the output relay operates.
In a Three-phase, V Network 1
Set the operating current to be 0.3 to 0.35 times the heater current. Close the SW₂ with switch SW₁ turned on. Confirm that the alarm indicator remains off. Turn off SW₁ and confirm that the alarm indicator comes on, and that the output relay operates.

In a Three-phase, V Network 2
Set the operating current to be 0.6 times the heater current (of the phase connected between terminals 1 and 2, or the one passed through the window of the window-type Current Transformer of the heater burnout detector). Close the SW₂ with switch SW₁ turned on. Confirm that the alarm indicator remains off. Turn off SW₁ and confirm that the alarm indicator comes on, and that the output relay operates.

K2CU-F, K2CU-P
The operation of the heater burnout detector can be easily checked as follows:

In a Single-phase Circuit
Set the operating current to be 0.55 to 0.6 times the heater current. Close the contactor with switch SW₁ turned on. Confirm that the alarm indicator remains off. Turn off SW₁ and confirm that the alarm indicator comes on, and that the output relay operates.
In a Three-phase, Delta Network
Set the operating current to be 0.6 times the heater current.
Close the contactor with switches SW₁ and SW₂ turned on. Confirm that the alarm indicator remains off.
Turn off SW₂ and confirm that the alarm indicator comes on, and that the output relay operates.
Turn on SW₁ set the operating current to be 0.9 times the heater current, and confirm that the alarm indicator goes off and the output relay operates.
Turn off SW₁ and confirm that the alarm indicator comes on, and that the output relay operates.

In a Three-phase, Star Network
Set the operating current to be 0.9 times the heater current.
Close the contactor with switch SW₁ turned on. Confirm that the alarm indicator remains off.
Turn off SW₁ and confirm that the alarm indicator comes on, and that the output relay operates.

In a Three-phase, V Network 1
Set the operating current to be 0.3 to 0.35 times the heater current.
Close the contactor with switch SW₁ turned on. Confirm that the alarm indicator remains off.
Turn off SW₁ and confirm that the alarm indicator comes on, and that the output relay operates.

In a Three-phase, V Network 2
Set the operating current to be 0.6 times the heater current (of the phase connected between terminals 1 and 2, or the one passed through the window of the window-type Current Transformer of the heater burnout detector).
Close the contactor with switch SW₁ turned on. Confirm that the alarm indicator remains off.
Turn off SW₁ and confirm that the alarm indicator comes on, and that the output relay operates.
Test Circuit
To check the operation in detail, use the following circuit.

Note: Determine the value of R according to the specifications of the K2CU to be used. The dotted line indicates the connection at a supply voltage of 100 or 110 VAC.

Dimensions
Note: All units are in millimeters unless otherwise indicated.
**Installation**

**External Connections**

**K2CU-F A- GS**

**Single-phase Heater**

- Power source
- Temperature controller
- Control voltage
- SSR
- K2CU-F
- Temperature sensor
- Heater

**Three-phase Heater**

- Power source
- Temperature controller
- Control voltage
- SSR
- K2CU-F
- Temperature sensor
- Heater

**Mounting Holes**

- Two, 6-dia. or M5 mounting holes
- 6.5 mm max.

**Note:**

1. Install the K2CU-F on a flat surface.
2. When solderless terminal lugs are desired, use ones having an outer diameter of 6.5 mm maximum.
Three-phase, V-connected Heater

With External Current Transformer

**Note:** Pass two out of the three line conductors through the current transformers of the heater burnout detector twice as shown.
K2CU-P Small-capacity, Plug-in Models

Small-capacity Heater

With External Current Transformer

Note: 1. The dotted lines which pass through the heater burnout detector indicate the line conductor passing through the round “window” of the window-type Current Transformer.
2. Y: External relay for self-holding circuit
   BZ: Alarm buzzer
   L: Alarm indicator
3. To use an 100 (110) VAC control power supply with K2CU-P, connect it to terminal 7 instead of 6.

Precautions

K2CU-F A- GS
Use the K2CU-F A- GS (with gate input terminals) in combination with a temperature controller that has PID with feed-forward circuitry to control the heater temperature, in which case, the heater element(s) must be turned ON or OFF for 0.1 s or longer.

K2CU-F
When a single-phase heater is used, pass the two lines through the openings of the heater burnout detector. When a three-phase heater is used, pass two (phases) of the three lines through the openings. In either case, if only one line passes through, an alarm signal will always be produced.

With three-phase power supply

With single-phase power supply

Pass the lines through the openings only once. If they are passed more than once, the actual operating current will be less than the set current. The lines can be passed in either direction.

To use the heater burnout detector at a current less than the current range that can be set, the lines must be passed more than once. Determine the number of times the lines should be passed by the following equation:

\[(\text{Operating current}) \times n = \text{Current setting range}\]

where,
\n\n- \(n\): number of times the lines loop through the window

All K2CU-F models incorporate a voltage fluctuation compensation function.

K2CU-P
The K2CU-P can be used only in single-phase circuits.

Do not pull out the K2CU-P from the socket when the K2CU-P is energized. Especially when using it in combination with a Current Transformer commercially available, this practice causes the secondary circuit of the transformer to open, which is very dangerous.
**General**

Refer to “External Connections” before using the K2CU with external CTs.

When a temperature controller is used in combination with the K2CU (except for the K2CU-F/C0106/C0106A/C0106GS), the heater element(s) must be turned ON or OFF for 1 s or longer (although the heater element(s) can be turned ON for 0.5 s according to the specifications).

The K2CU cannot be used with a phase-control circuit, inverter circuit, frequency-count circuit, cycle-control unit, or a motor load.

**Mounting**

Securely mount the K2CU as horizontally as possible although there is no particular limitation of mounting directions.

**Connection**

Solderless-type terminal must be connected to the terminals securely.

Wire the terminals correctly by referring to the external connections. The terminals have no polarity. Be sure to connect 100 (or 110) V to the 100-V (or 110-V) terminals and 200 (or 220) V to the 200-V (or 220-V) terminals of the K2CU-P or the K2CU-P may malfunction.

The control power source for the K2CU (except for the K2CU-F/C0106/C0106A/C0106GS) must be supplied from the load side via a contactor.

Be sure to impose a voltage between the 0-V terminal and 100-V (or 110-V) terminal or the 0-V terminal and 200-V (or 220-V) terminal of the K2CU-P, otherwise the K2CU-P will not operate.

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**Operating Current Setting when Several Heaters are Used**

The following table shows relative values of changes in the current when any one of several heaters connected in parallel has burned out. The current value under normal condition is 1. Use this table as a guideline in determining the operating current.

<table>
<thead>
<tr>
<th>Connection</th>
<th>n = 1</th>
<th>n = 2</th>
<th>n = 3</th>
<th>n = 4</th>
<th>n = 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td><img src="image3.png" alt="Diagram" /></td>
<td><img src="image4.png" alt="Diagram" /></td>
<td><img src="image5.png" alt="Diagram" /></td>
<td><img src="image6.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Current in burned-out phase</td>
<td>0</td>
<td>0.5</td>
<td>0.67</td>
<td>0.75</td>
<td>0.8</td>
</tr>
<tr>
<td>Current in other phases</td>
<td>0.87</td>
<td>0.92</td>
<td>0.95</td>
<td>0.96</td>
<td>0.97</td>
</tr>
<tr>
<td><img src="image7.png" alt="Diagram" /></td>
<td><img src="image8.png" alt="Diagram" /></td>
<td><img src="image9.png" alt="Diagram" /></td>
<td><img src="image10.png" alt="Diagram" /></td>
<td><img src="image11.png" alt="Diagram" /></td>
<td><img src="image12.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Current in burned-out phase</td>
<td>0.58</td>
<td>0.77</td>
<td>0.84</td>
<td>0.88</td>
<td>0.91</td>
</tr>
<tr>
<td>Current in other phases</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

**Note:**

1. This table shows the respective change rates in current when any one of several heaters connected in parallel has burned out.
2. The current value under the normal condition is 1.
3. The values in this table are logical values. Actually, these values may vary slightly because of influence of unbalanced loads (heaters). It is therefore recommended to test the actual current values and the load condition before determining the operating current, especially when the current under the normal condition and that under an abnormal condition do not significantly differ.
ALL DIMENSIONS SHOWN ARE IN MILLIMETERS.
To convert millimeters into inches, multiply by 0.03937. To convert grams into ounces, multiply by 0.03527.

In the interest of product improvement, specifications are subject to change without notice.