BE1-87G
Percentage-Differential Relay

Washington State University
Hands-On Relay School

Basler Electric

www.basler.com
Differential Protection

PROTECTED ZONE (PHASE A)
1-∅ Generator Application

Figure 1-1. Typical Single-Phase Application Scheme
Figure 1-3. Style Number Identification Chart

NOTES

1. If TARGET is B, OUTPUT must be E.
2. All BE1-87G relays are supplied in an S1 case.
Current-Sensing Inputs

- Range 1: 5-A nominal; 10 A contin; 250 A for 1 s
- Range 2: 1-A nominal; 2 A contin; 50 A for 1 s
- Burden: < 0.05 Ω per input
- Frequency: 45–65 Hz

Stabilizing Reactor

- Range 1: 65 A for 1 s (70°C)
- Range 2: 13 A for 1 s (70°C)
• Minimum Differential (Operate) Current
  0.1, 0.15, 0.2, 0.4, 0.5, 0.8, 1.6 A
• Accuracy
  For IR \leq 4 \text{ A}: \pm 5\% \text{ of operate pickup or } \pm 25 \text{ mA (whichever is greater)}
  For IR > 6 \text{ A (20 A max.)}: \pm 8\% \text{ of operate pickup or } \pm 150 \text{ mA (whichever is greater)}
• Dropout
  > 90\% \text{ of operate characteristic}
• Timing
  < 30 \text{ ms at 10 times pickup setting}; 70 \text{ ms maximum}
• Minimum Differential (Operate) Current
  0.02, 0.03, 0.04, 0.08, 0.10, 0.16, 0.32 A
• Accuracy
  For IR \leq 0.8\,\text{A}: \pm 5\% \text{ of operate pickup or } \pm 25\,\text{mA (whichever is greater)}
  For IR > 1.2\,\text{A (4 A max)}: \pm 8\% \text{ of operate pickup or } \pm 150\,\text{mA (whichever is greater)}
• Dropout
  > 90\% \text{ of operate characteristic}
• Timing
  \text{< 30 ms at 10 times pickup setting; 70 ms maximum}
Contact-Outputs Ratings

• Resistive Ratings
  › 120 Vac: Make, break, and carry 7 Aac continuous
  › 250 Vdc: Make and carry 30 Adc for 0.2 s, carry 7 Adc continuous, and break 0.3 Adc
  › 500 Vdc: Make and carry 15 Adc for 0.2 s, carry 7 Adc continuous, and break 0.3 Adc

• Inductive Ratings
  › 120 Vac, 125 Vdc, 250 Vdc:
    Break 0.3 A (L/R = 0.04)
    (L/R of 0.04 is about 15.1 X/R at 60 Hz, inductive)
Two Types of Targets

Internally operated or current operated targets

Internally operated—electronically latching
  • Manual-reset targets indicate that a setpoint contact has energized.
  • Select internally operated targets if the relay has normally closed output contacts.

Current-operated
  • Require a minimum trip circuit current of 200 mA
    › Continuous rating of 3 amperes
    › Two-minute rating of 7 amperes
    › One-second rating of 30 amperes
**Power-Supply Options**

Wide-range, isolated, low-burden, switching
Input power (source voltage) is NOT polarity sensitive

<table>
<thead>
<tr>
<th>Type</th>
<th>Input Voltage Nominal</th>
<th>Range</th>
<th>Burden (Nominal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K (midrange)</td>
<td>48 Vdc</td>
<td>24 to 150 Vdc</td>
<td>3.8 W</td>
</tr>
<tr>
<td>J (midrange)</td>
<td>125 Vdc</td>
<td>25 to 150 Vdc</td>
<td>4.0 W</td>
</tr>
<tr>
<td></td>
<td>120 Vac</td>
<td>90 to 132 Vac</td>
<td>17.1 VA</td>
</tr>
<tr>
<td>L (low range)</td>
<td>24 Vdc</td>
<td>12 to 32 Vdc*</td>
<td>3.9 W</td>
</tr>
<tr>
<td>Y (midrange)</td>
<td>48 Vdc</td>
<td>24 to 150 Vdc</td>
<td>3.8 W</td>
</tr>
<tr>
<td></td>
<td>125 Vdc</td>
<td>25 to 150 Vdc</td>
<td>4.0 W</td>
</tr>
<tr>
<td>Z (high range)</td>
<td>250 Vdc</td>
<td>68 to 280 Vdc</td>
<td>4.1 W</td>
</tr>
<tr>
<td></td>
<td>240 Vac</td>
<td>90 to 270 Vac</td>
<td>28.4 VA</td>
</tr>
</tbody>
</table>

*Type L begins operation at 14 Vdc;
Once operating, voltage can be reduced to 12 Vdc
Front-Panel Controls

Figure 2-1. Controls and Indicators

- **A**: Switch position
- **B**: AMPS
- **C**: PUSH TO ENERGIZE OUTPUT
- **D**: UPPER CONNECTION PLUG MUST BE IN PLACE PRIOR TO INSERTING OR REMOVING LOWER CONNECTION PLUG
- **E**: POWER

**CAUTION:**

- Upper connection plug must be in place prior to inserting or removing lower connection plug.

**BE1-87G Generator Differential Relay**
- Style No. G2E A1J A0C0F
- Serial No. H123456789101
Figure 3-2. Stabilizing Reactor Impedance Characteristic, Sensing Input Range 1
Figure 5-3. Operating Characteristics, Relay Style x1x-xxxx-xxxxx
Figure 4-17. Typical DC Control Connections
AC Connections

Figure 4-18. Single-Phase Sensing Connections
Internal Connections

Figure 4-15. Internal Connections/Terminal Assignments, Single-Phase Relay
NOTE

Input reactance might be too great for solid-state test sets at large operate currents.

Bypass the internal stabilizing reactor by placing jumper across terminals in Figure 5-1.
Follow test routine in the instruction manual, at page 5-2.

Figure 5-2. Operational Test Setup
External Wiring

Figure 1-2. Typical Three-Phase Application Scheme
Three-Phase Testing

Sense 1–10
I₁ (At) 9–8 \( \angle 0° \)
I₂ (Bt) 15–14 \( \angle 240° \)
I₃ (Ct) 19–18 \( \angle 120° \)
I₄ (An) 6–8 \( \angle 180° \)
I₅ (Bn) 12–14 \( \angle 60° \)
I₆ (Cn) 16–18 \( \angle 300° \)
DC 3(+)–4(–)

Mimics field wiring and normal current flow
Testing Differential: Method 1

Set selector switch to D
Apply 0.1 amps to terminals 9-6
Ramp up current to terminals 8-6
Relay should pick up around 0.4 amps
Testing Differential: Method 2

Set selector switch to D
Apply 1.0 amps to terminals 9-8 at $180^0$
Apply 1.0 amps to terminals 6-8 at $0^0$ and ramp up
Relay should pick up at around 1.4 amps – a difference of 0.4 amps
Emulates current flow through generator increasing on neutral side and not on terminal side
Investigate!

Try changing angles (if you can)—does relay respond differently at $30^0$, $90^0$, $180^0$, etc.? Is there a maximum torque angle?
Ramp up, ramp down—where does relay drop out? (Should drop out above 90%)
Start at larger current, 5 or 10 amps, and ramp up one
Does relay respond differently if fed from one side, or both?
If miss-wired, what can happen? (What if field wiring is like method 1?)
Questions?