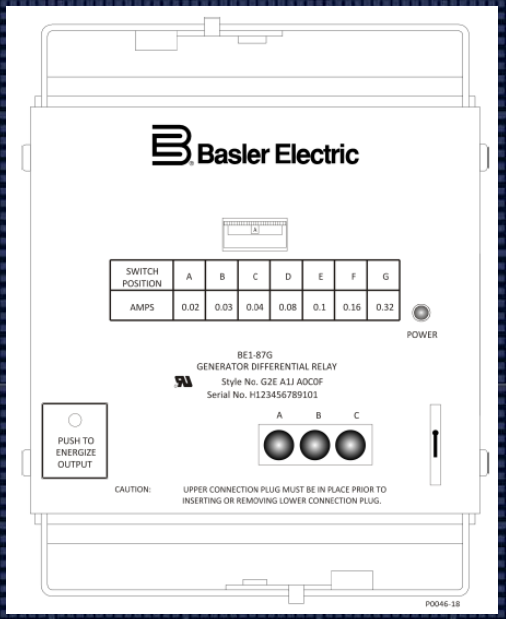
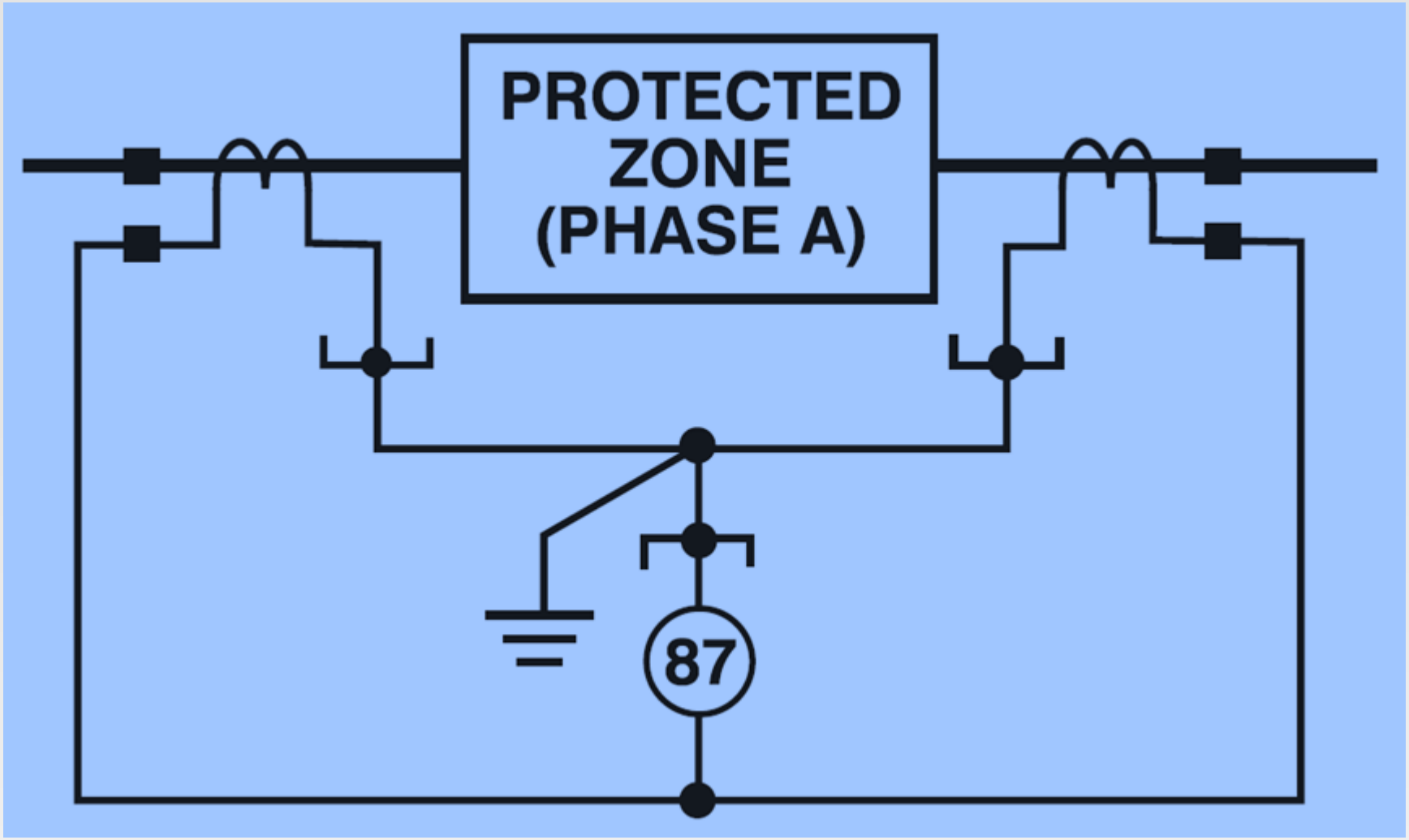


BE1-87G
Percentage-Differential Relay

Washington State University
Hands-On Relay School

Basler Electric

Differential Protection



1-Ø Generator Application

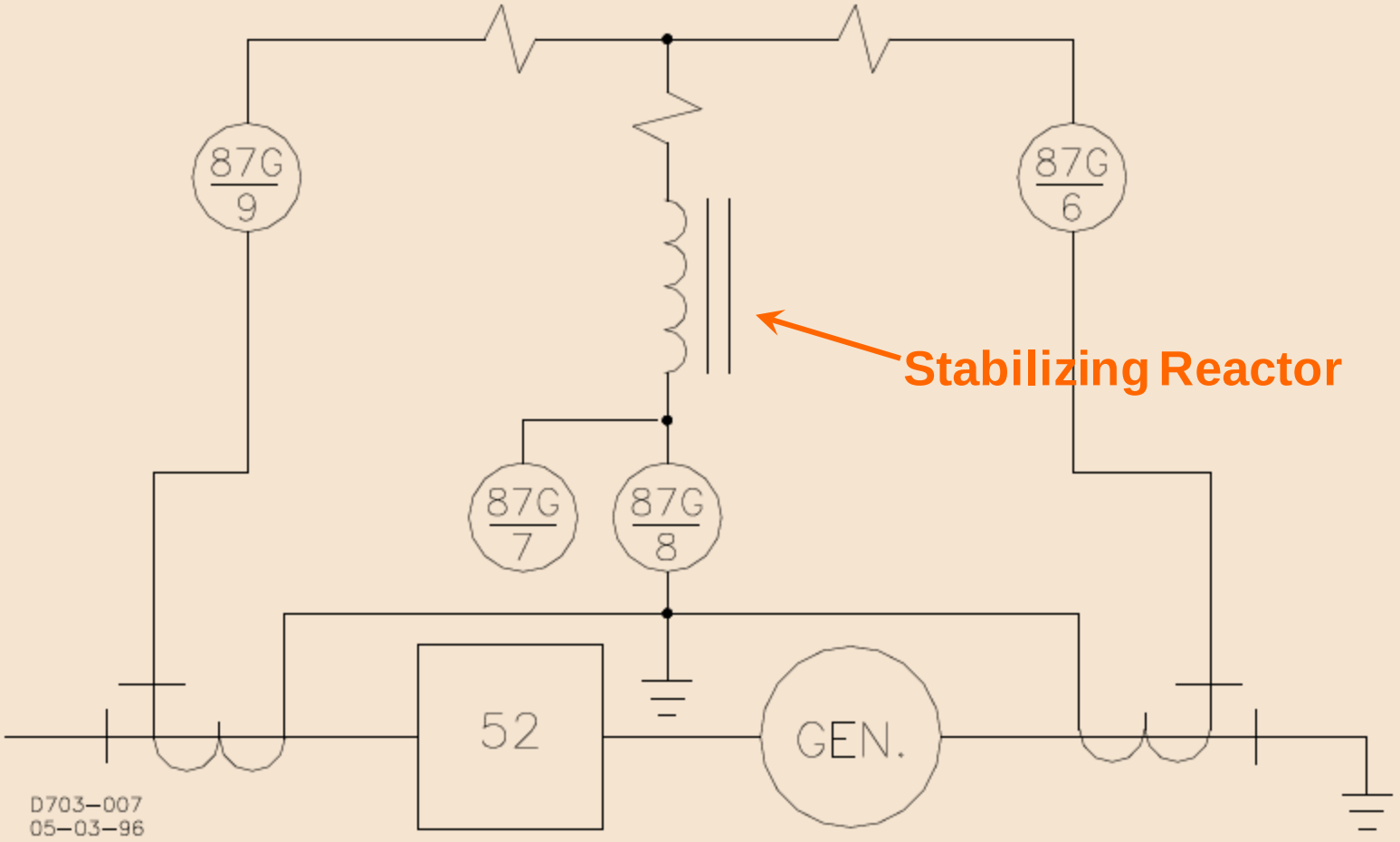


Figure 1-1. Typical Single-Phase Application Scheme

Style Chart

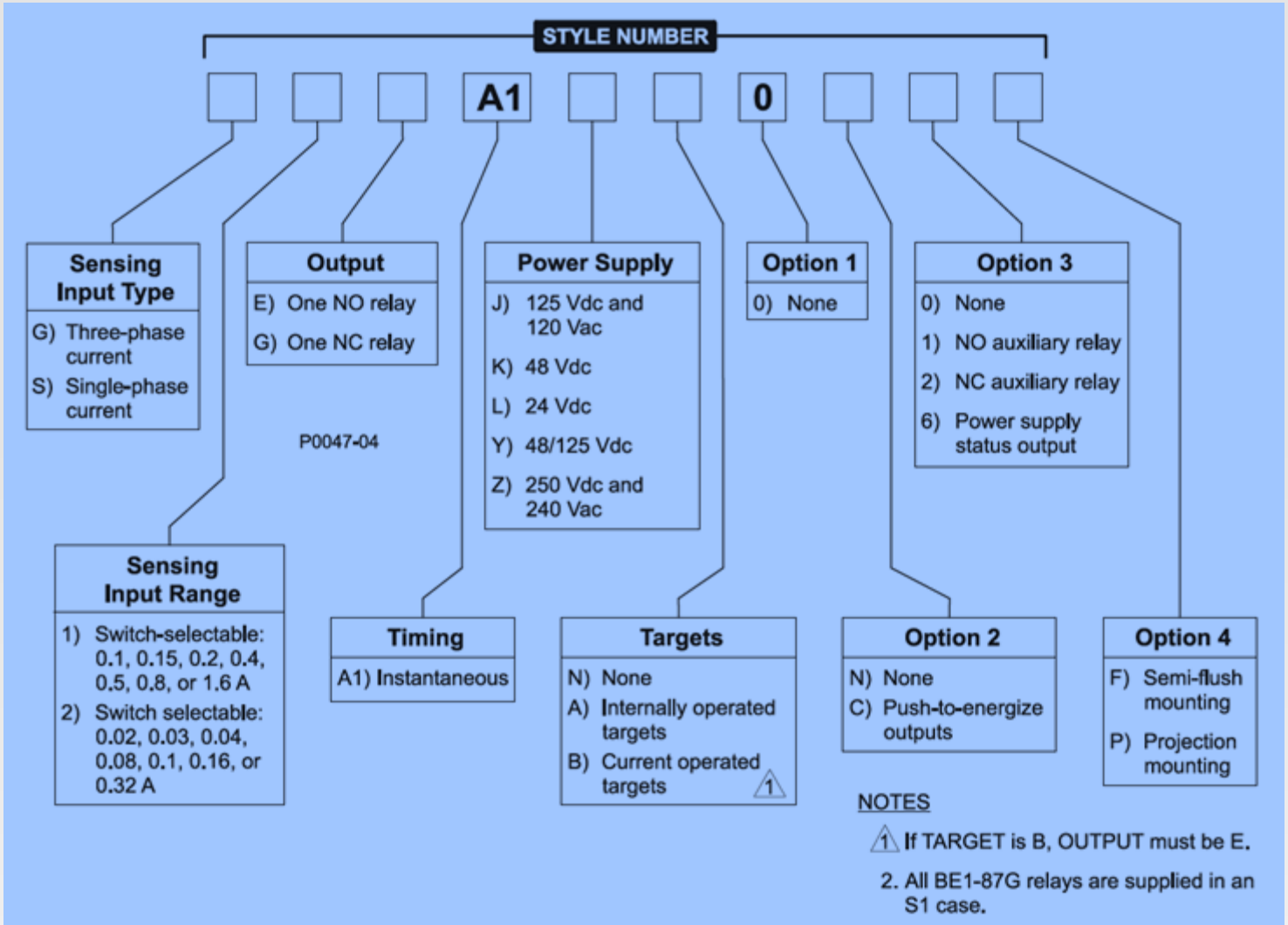


Figure 1-3. Style Number Identification Chart

Input Ratings

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)

Sensing-Range 1

- Minimum Differential (Operate) Current
- 0.1, 0.15, 0.2, 0.4, 0.5, 0.8, 1.6 A
- Accuracy
- For IR ≤ 4 A: ±5% of operate pickup or ±25 mA (whichever is greater)
- For IR > 6 A (20 A max.): ±8% of operate pickup or ±150 mA (whichever is greater)
- Dropout
- > 90% of operate characteristic
- Timing
- < 30 ms at 10 times pickup setting; 70 ms maximum

Sensing-Range 2

- Minimum Differential (Operate) Current
- 0.02, 0.03, 0.04, 0.08, 0.10, 0.16, 0.32 A
- Accuracy
- For IR ≤ 0.8 A: ±5% of operate pickup or ±25 mA (whichever is greater)
- For IR > 1.2 A (4 A max): ±8% of operate pickup or ±150 mA (whichever is greater)
- Dropout
- > 90% of operate characteristic
- Timing
- < 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

Page 1-5

Input power (source voltage) is NOT polarity sensitive

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

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

Front-Panel Controls

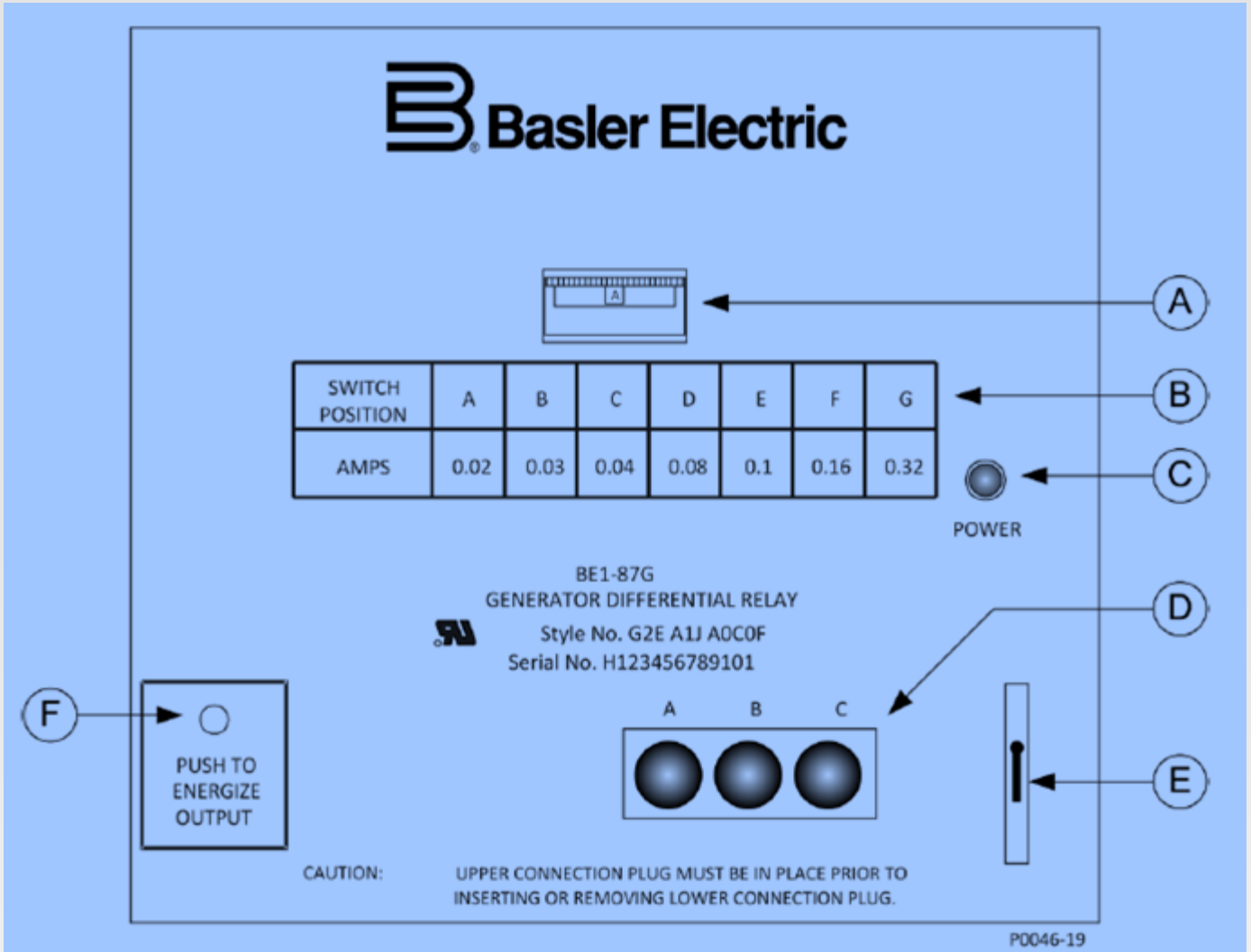


Figure 2-1. Controls and Indicators

Stabilizing Reactor

Pg 3-2

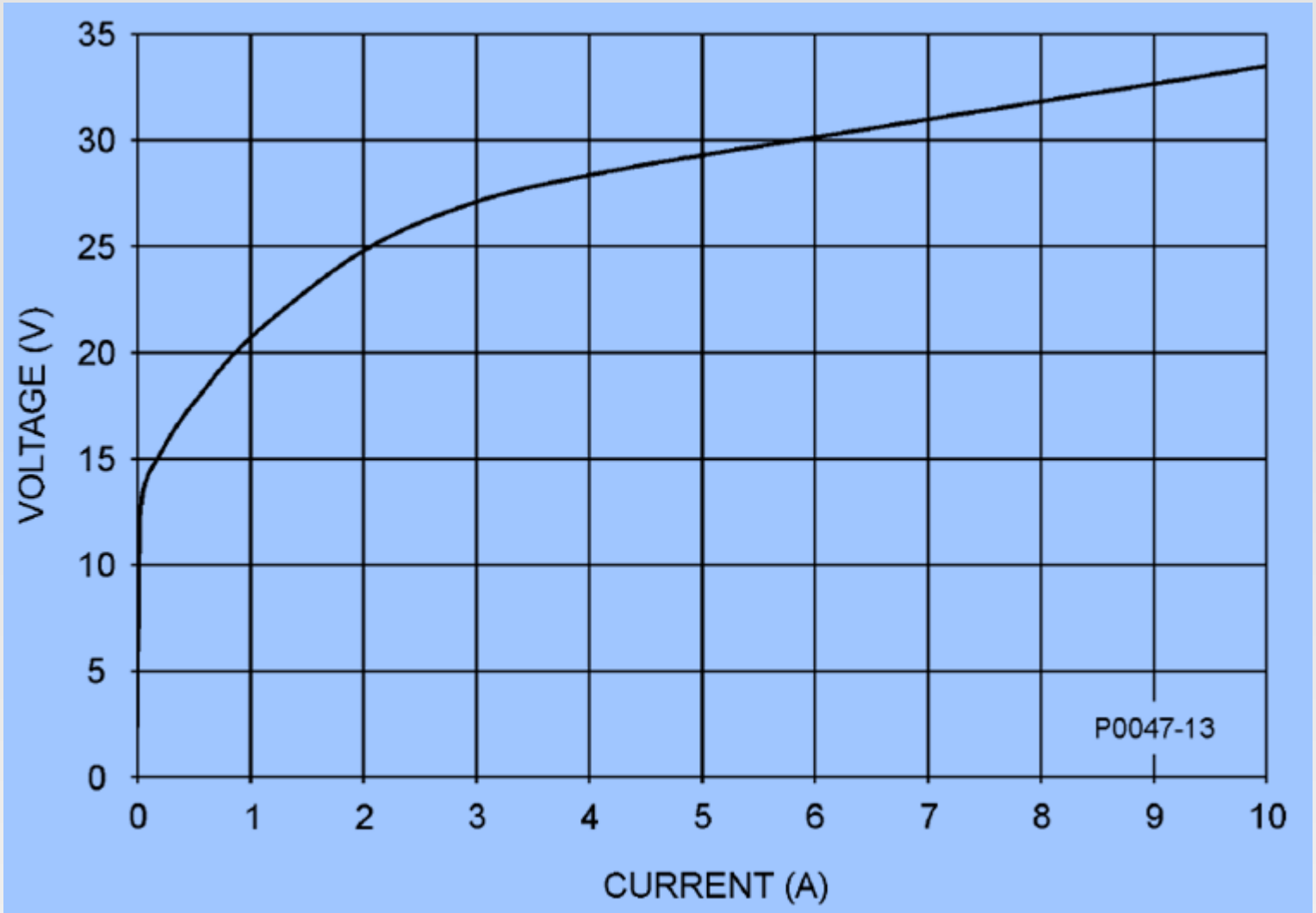


Figure 3-2. Stabilizing Reactor Impedance Characteristic, Sensing Input Range 1

Operate / Restraint Characteristic

Pg 5-4

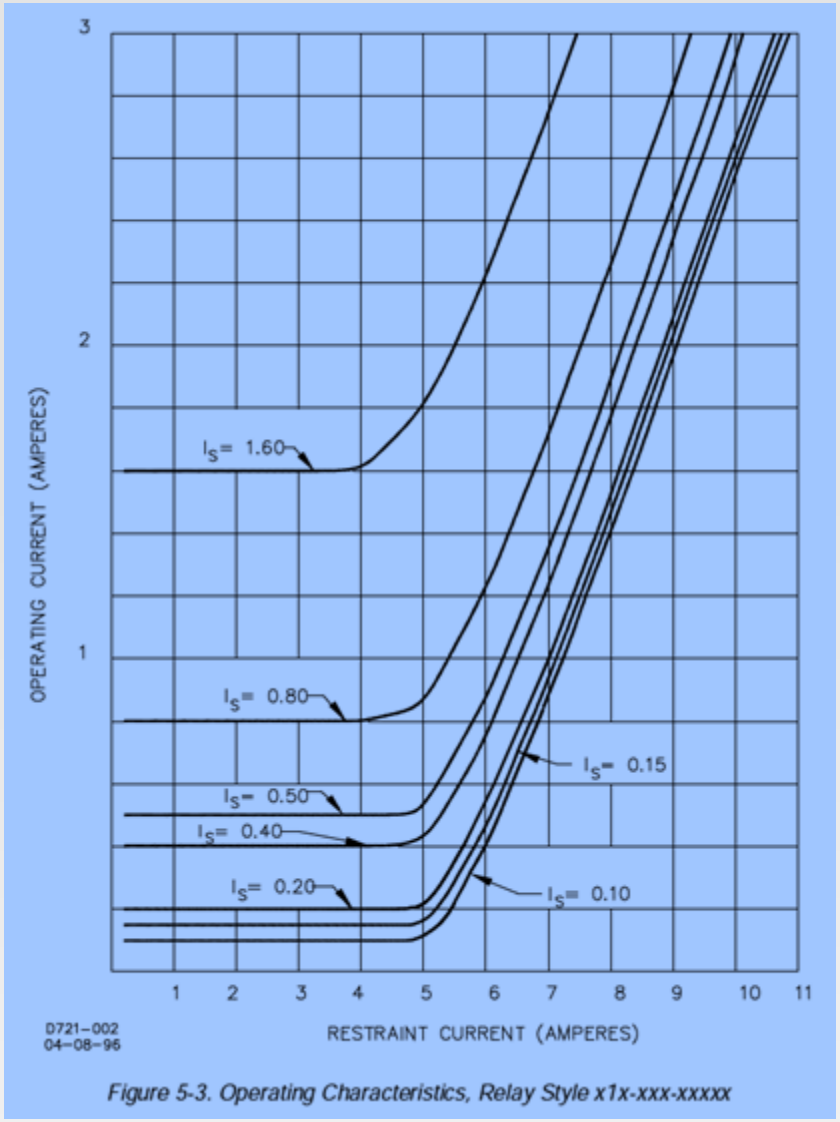


Figure 5-3. Operating Characteristics, Relay Style x1x-xxx-xxxxx

DC Connections

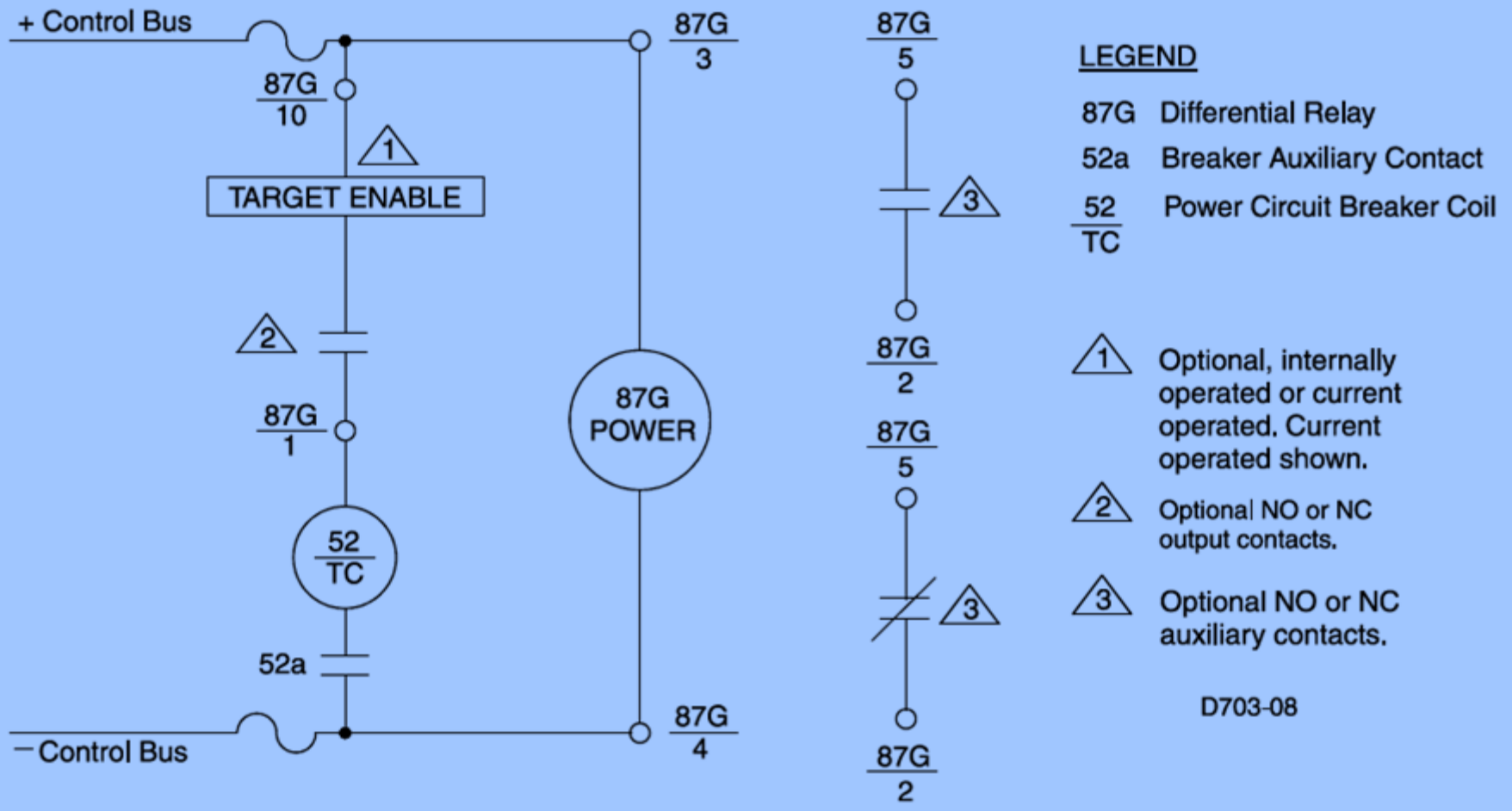


Figure 4-17. Typical DC Control Connections

AC Connections

Pg 4-20

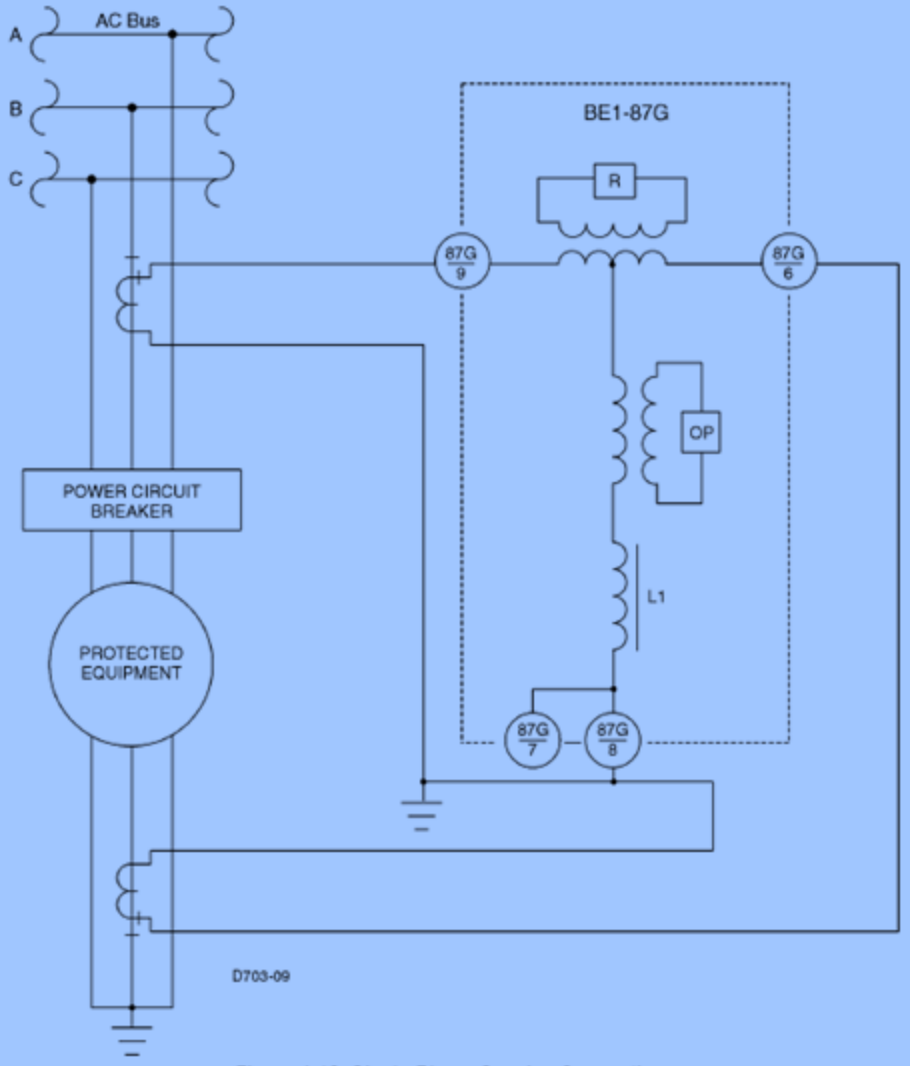


Figure 4-18. Single-Phase Sensing Connections

Internal Connections

Pg 4-12

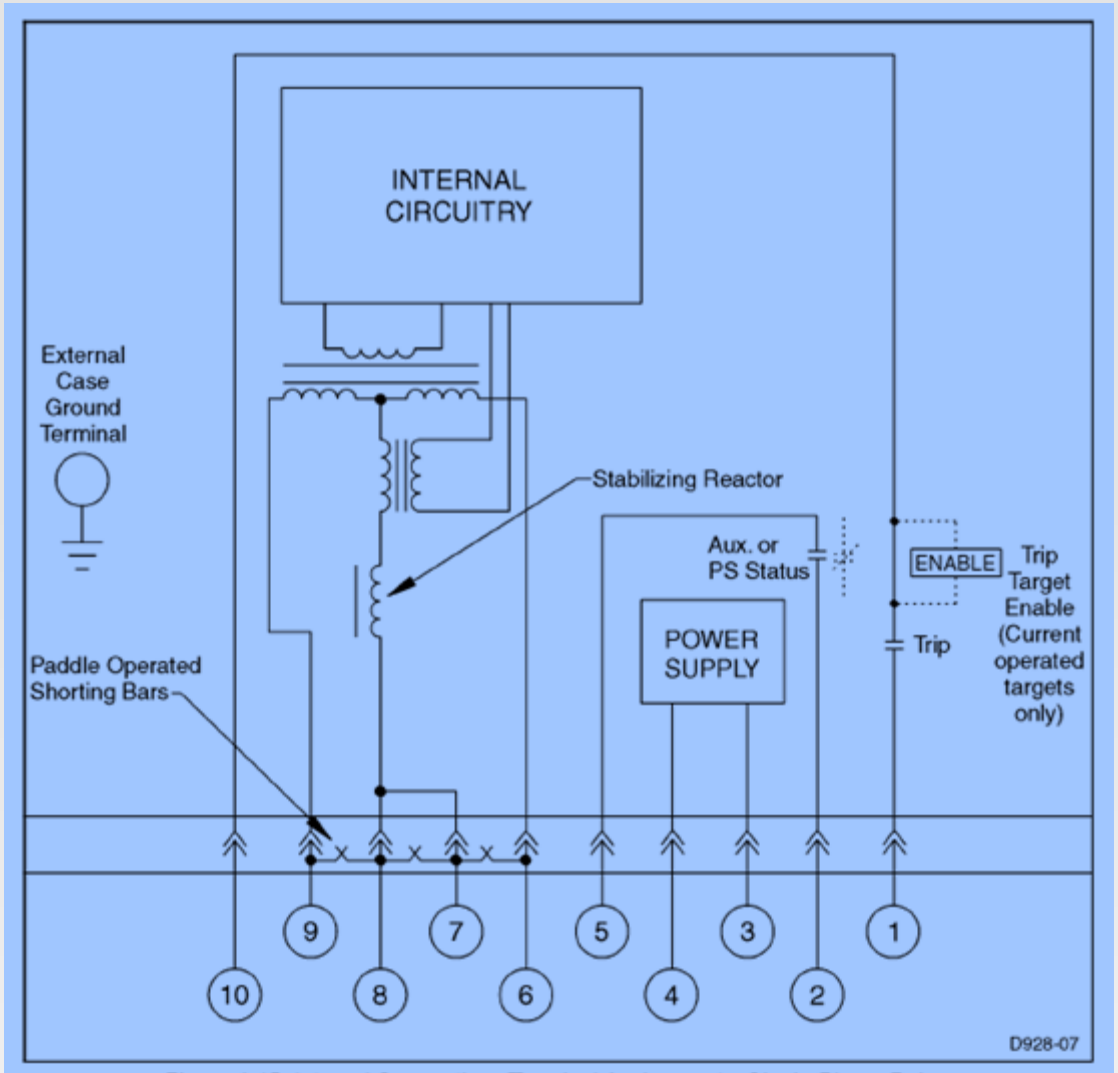


Figure 4-15. Internal Connections/Terminal Assignments, Single-Phase Relay

Single-Phase Bypass

Pg 5-1

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

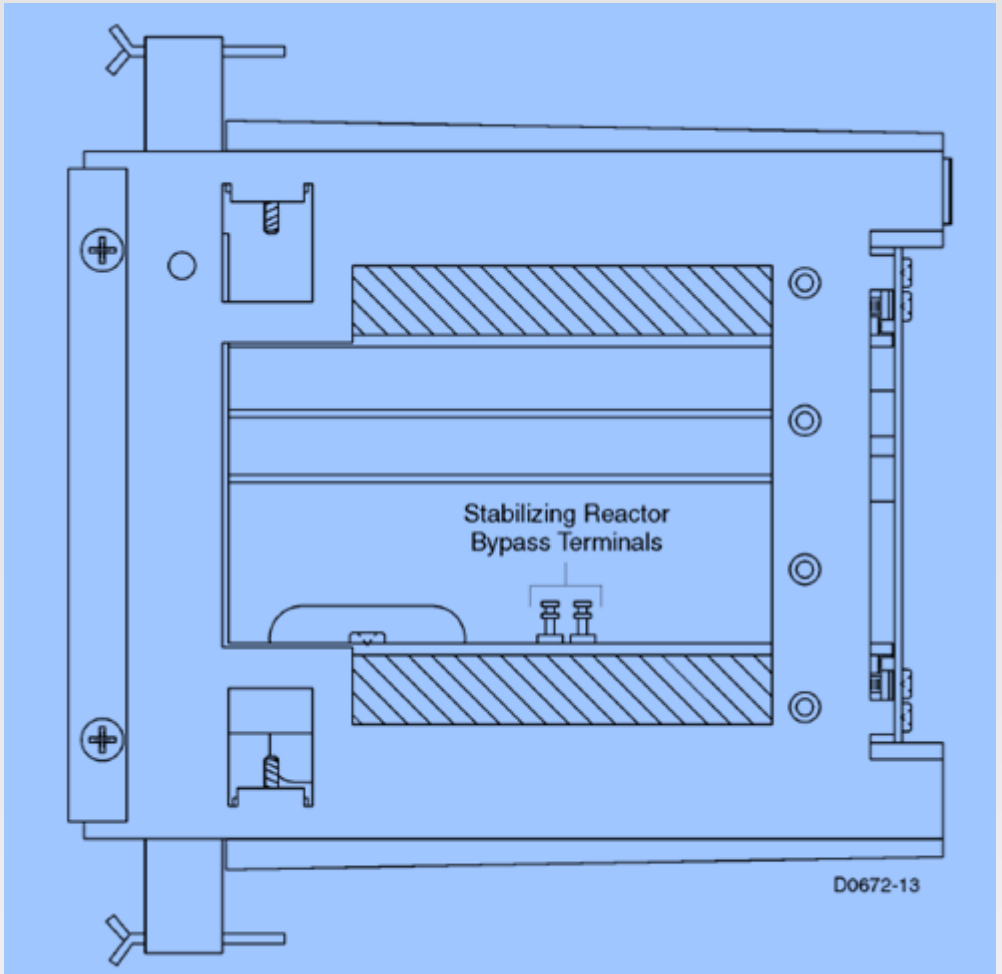


Figure 5-1. Location of Stabilizing Reactor Bypass Terminals (Single-Phase Relays)

Single-Phase Testing

Pg 5-2

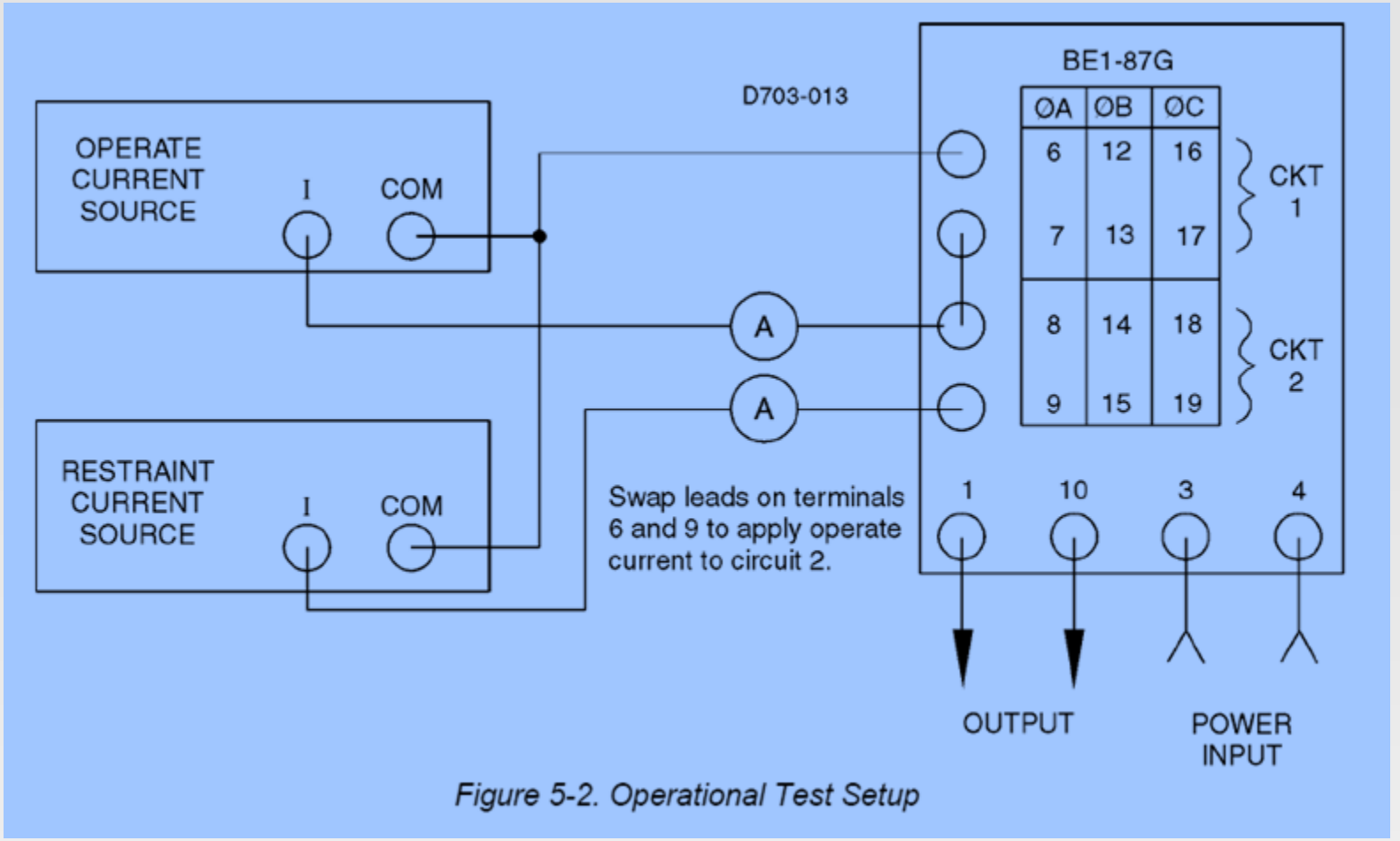


Figure 5-2. Operational Test Setup

Follow test routine in the instruction manual, at page 5-2

External Wiring

Pg 1-2

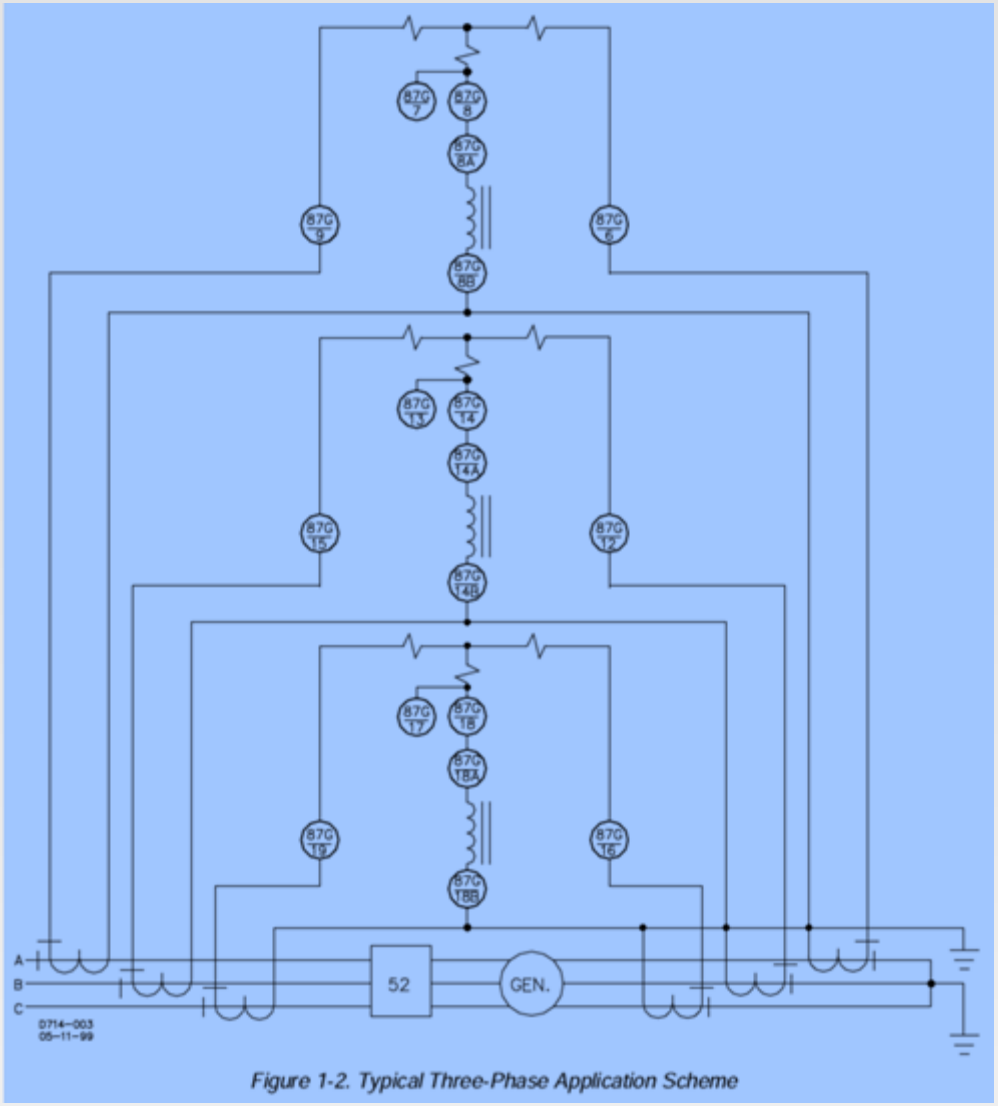


Figure 1-2. Typical Three-Phase Application Scheme

Three-Phase Internal Connections

Pg 4-15

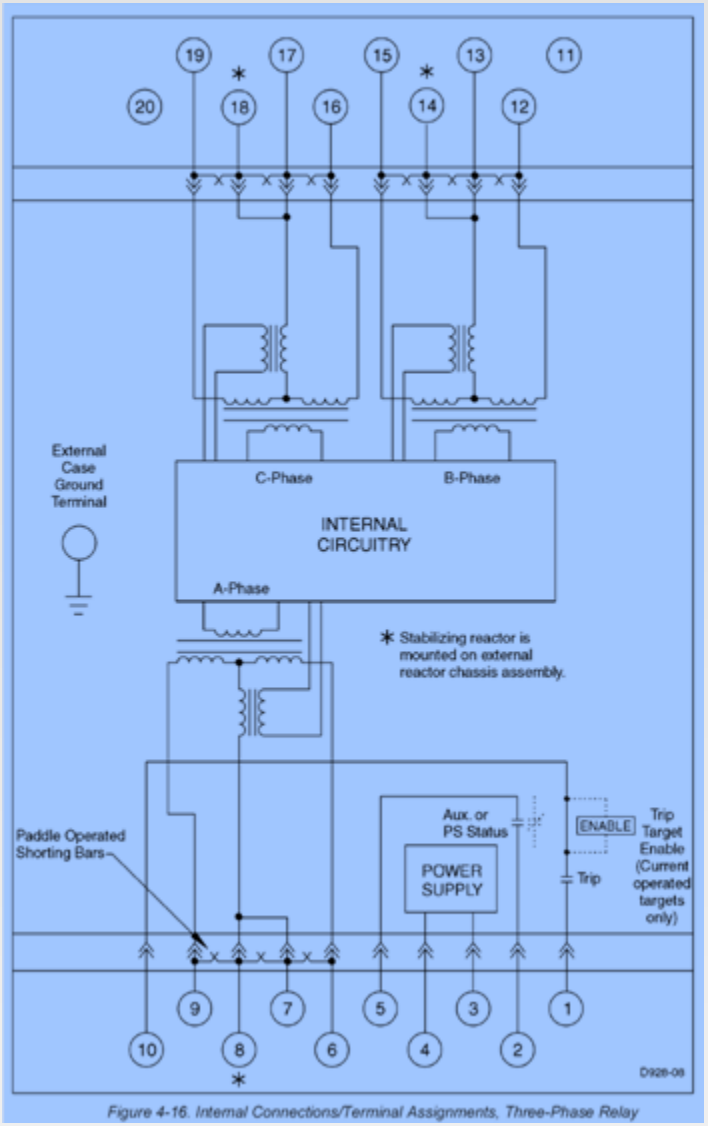
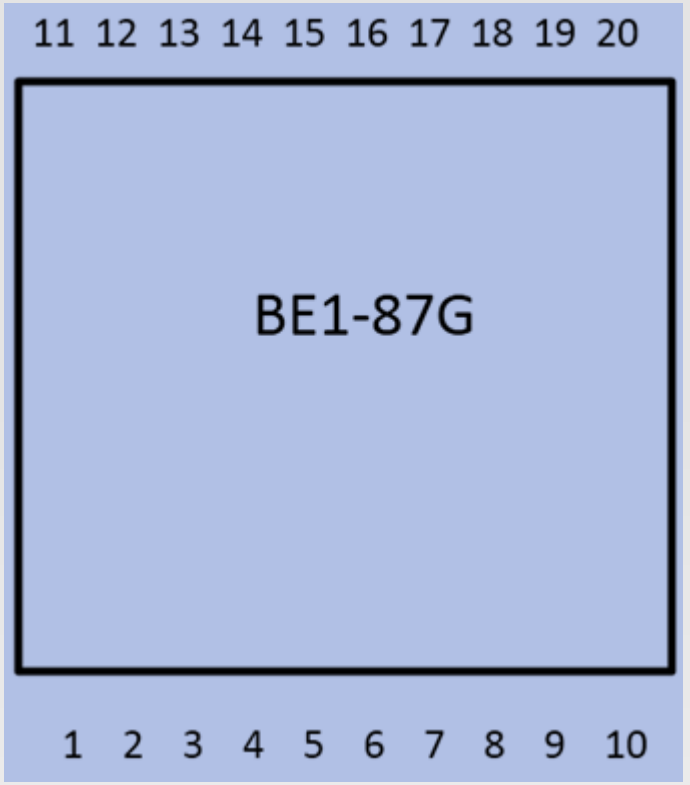


Figure 4-16. Internal Connections/Terminal Assignments, Three-Phase Relay

Three-Phase Testing

Sense 1–10
I1 (At) 9–8 ∠0°
I2 (Bt) 15–14 ∠240°
I3 (Ct) 19–18 ∠120°
I4 (An) 6–8 ∠180°
I5 (Bn) 12–14 ∠60°
I6 (Cn) 16–18 ∠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?