

October 1993  
Supersedes Descriptive Bulletin 41-359S,  
Pages 1-4, dated September 1990  
Mailed to: E, D, C/41-300B

Single Phase  
Device Number: 87T

## CIRCUIT SHIELD<sup>®</sup> Type 87T Transformer Differential Relay



### Application

The Type 87T transformer differential relay provides high speed phase and ground protection for two and three winding power transformers.

The relay has ratio matching taps and incorporates a second harmonic restraint function where large transformer magnetizing inrush is present. The proportion of second harmonic to fundamental, for restraint, is factory set at 15%; this value is easily adjusted to other amounts as the application may require.

The percentage differential operating characteristic prevents operation until the differential current is greater than a certain percentage of the through current. The characteristic accommodates current transformer errors, particularly those resulting from CT saturation at high current faults external to the protected zone. The adjustability of the percentage characteristic (the slope) also aids in this regard, and allows tailoring of the operating characteristic to other requirements of the application such as load tap changer variations. Minimum pickup is also adjustable, and in some applications allows a sensitivity as low as 13% of tap. The high continuous rating of the input circuits (at least twice tap value) permits selection of the ratio tap much lower than the actual continuous current. This provides considerable improvement in the sensitivity as measured in terms of the rating of the power transformer.

An unrestrained instantaneous element adjustable from approximately 8 to 20 times tap is included as a standard feature. This element is factory set at 10 times tap.

### Features

- Harmonic Restraint
- Ratio Matching Taps
- Adjustable Slope
- Adjustable Sensitivity
- Adjustable Instantaneous
- Seismic Capability to 6g ZPA
- Transient and EMI Immunity
- 2 Year Warranty

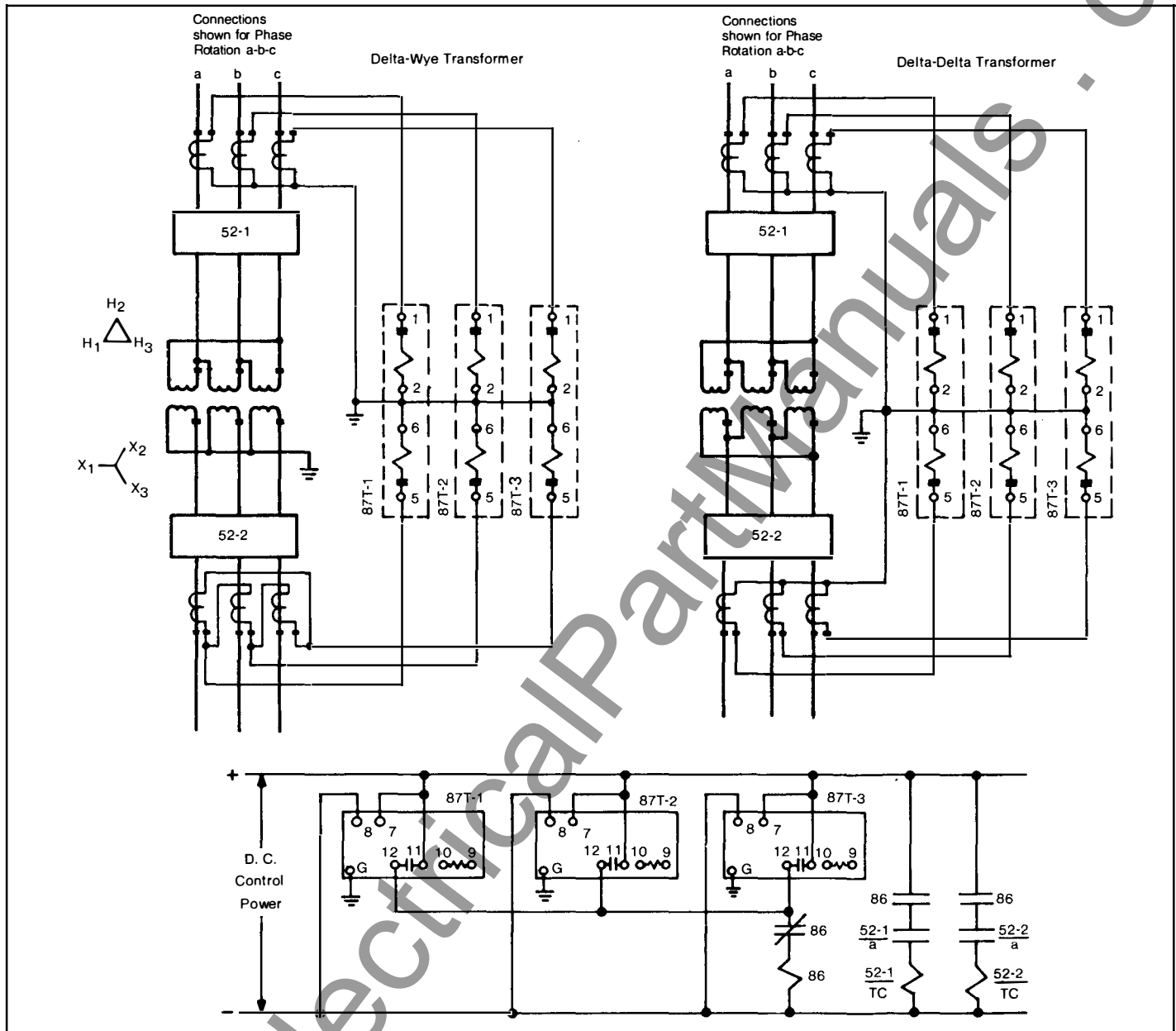


Figure 1. Typical Connections for the Protection of Power Transformers

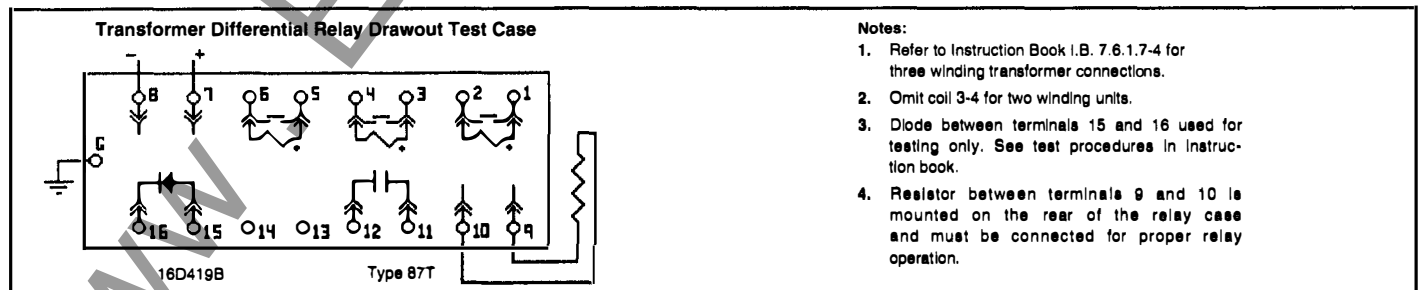


Figure 2. Internal Connections

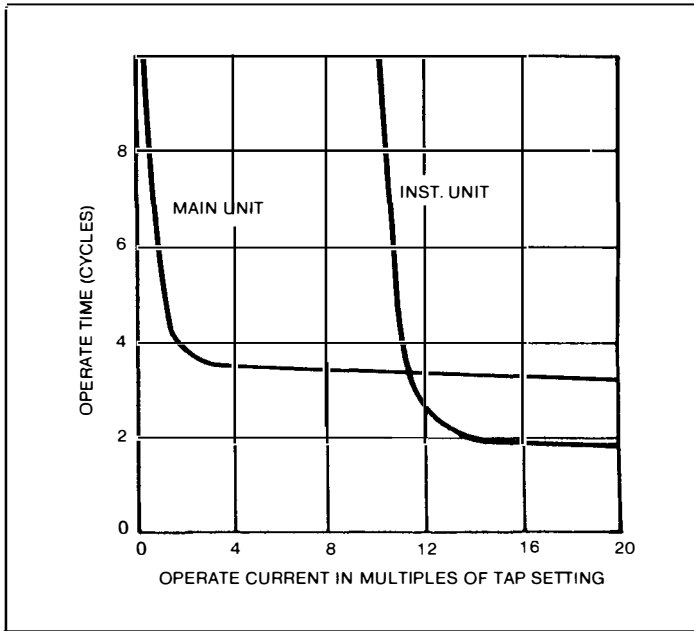


Figure 3. Operating Time

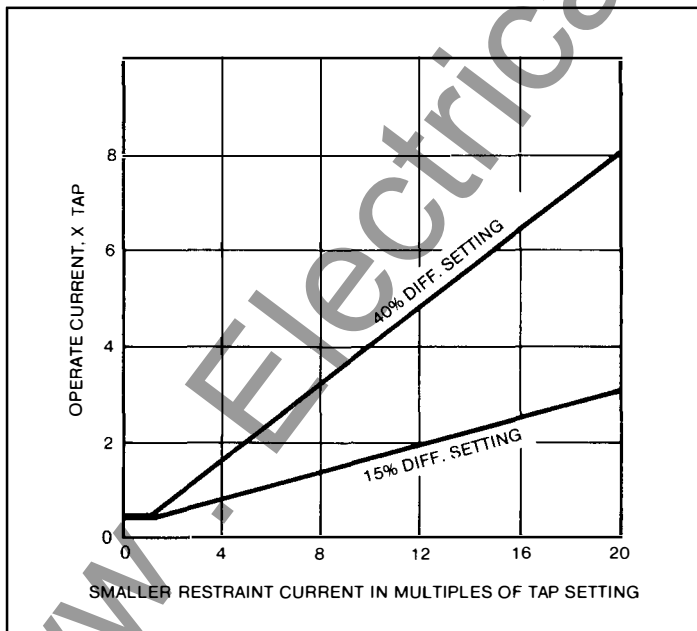


Figure 4. Percentage Differential Characteristics

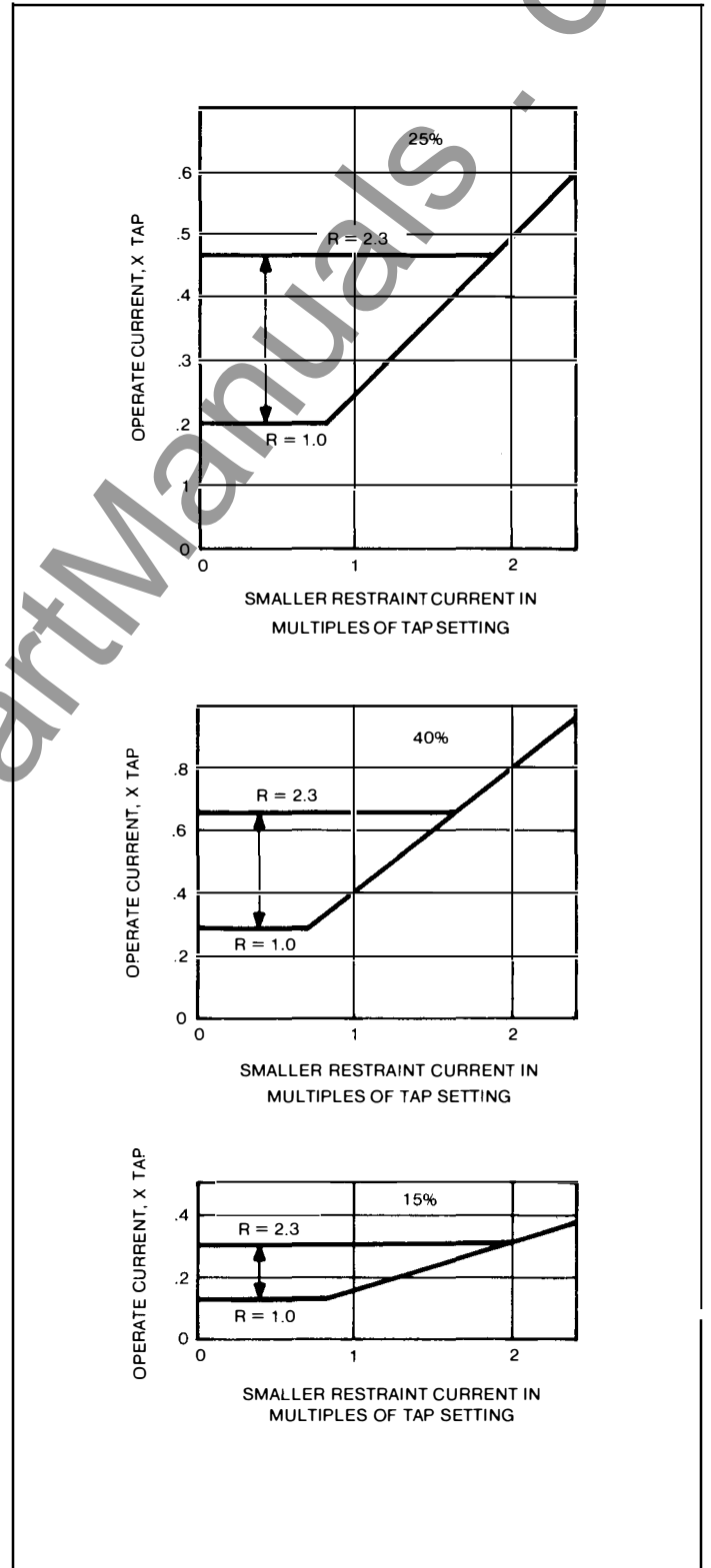


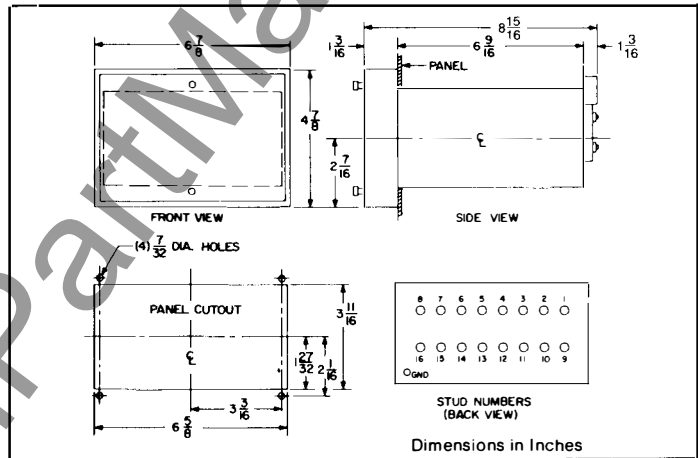
Figure 5. Percentage Differential Characteristics at Low Currents for 25, 40 and 15% Settings  
R = Restraint Setting (adjustable from 1.0 to 2.3)

**Specifications**

- Ratio Matching Taps:** See Table 1
- Input Circuits:** Any Tap:  
**Continuous** See Table 1  
**One Second** 200 Amperes, any tap
- Burden:** See Table 1
- Percentage Restraint Element:**  
**Sensitivity Slope** Adjustable 13 to 65% of tap setting.  
 Adjustable 15 to 40% (based on smaller restraint).
- Harmonic Restraint Element:** Restraint on 2nd harmonic only. Internally adjustable - factory set at 15% 2nd harmonic relative to fundamental.
- Instantaneous Element:** Internally adjustable 8 to 20 times tap.  
 Factory set at 10 times tap.
- Control Power:** Models available for:  
 125 Vdc @ 0.05A; 110 Vdc @ 0.05 A  
 48 Vdc @ 0.05A; 230 Vdc @ 0.05 A
- Output Circuit Rating:** 30 Amperes, Tripping  
 5 Amperes, Continuous  
 1 Ampere Break, Resistive  
 0.3 Ampere Break, Inductive  
 0.1 Ampere Break, Inductive (250 Vdc)
- Temperature Range:** Minus 20°C to Plus 70°C
- Seismic Capability:** More than 6g ZPA either AXIS biaxial multifrequency vibration without damage or malfunction ANSI/IEEE C37.98.
- Transient Immunity:** More than 2500 V, 1 MHz bursts at 400 Hz repetition rate, continuous (ANSI C37.90.1 SWC); Fast transient test; EMI Test.
- Weight:** Unboxed - 5.5 lbs. (2.5 kg)  
 Boxed - 6.2 lbs. (2.8 kg)  
 - 0.26 cubic feet

Tap	Continuous Current Rating- Amps	Burden	
		Ohms	P.F.
2.9	10	0.050	1.0
3.2	10	0.050	1.0
3.6	10	0.040	1.0
4.0	10	0.040	1.0
4.5	10	0.040	1.0
5.0	10	0.040	1.0
8.7	17	0.040	1.0

**Table 1: Relay Input Data**



**Figure 6. Outline and Drilling**

**How To Specify**

Transformer differential relays shall be Asea Brown Boveri Type 87T or equal. Relay shall have ratio matching taps, adjustable slope, adjustable sensitivity, and harmonic restraint. Relay shall be capable of withstanding 6g ZPA seismic stress without malfunctioning. Built-in means shall be provided to allow operational tests without additional equipment.

**How To Order**

For a complete listing of available transformer differential relays see TD 41-025. To place an order, or for further information contact the nearest ABB Representative.

**Further Information**

- List Prices: PL 41-020
- Technical Data: TD 41-025
- Instruction Book: IB 7.6.1.7-4
- Other Protective Relays:  
 Application Selector Guide, TD 41-016

September, 1990  
 Supersedes Section 7.6.0.3, Type 87T on  
 pages 1 and 4, dated January 1, 1990  
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Single Phase with Harmonic Restraint  
 Taps: 2.9-8.7A

## CIRCUIT SHIELD<sup>®</sup> Type 87T Transformer Differential Relay

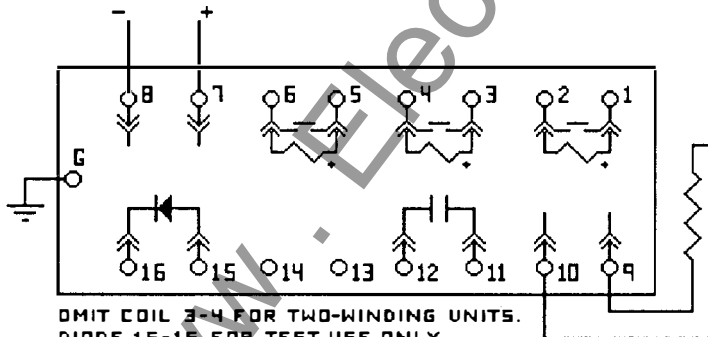
Type	Application	Slope	Freq.	Control Voltage	Catalog Number Drawout Test Case
87T	2 Winding Transformer	15-40%	60 Hz	125 Vdc 250 Vdc 48 Vdc	419T2441 419T2451 419T2431
			50 Hz	125 Vdc 48 Vdc 110 Vdc	419F2441 419F2431 419F2401
			60 Hz	125 Vdc 48 Vdc	419T3441 419T3431
	3 Winding Transformer	15-40%	60 Hz	125 Vdc 48 Vdc 110 Vdc	419F3441 419F3431 419F3401
			50 Hz	125 Vdc 48 Vdc 110 Vdc	419F3441 419F3431 419F3401

Internal Connections: 16D419B

Type 96 DC-DC Inverters available for applications using 24 or 32 Vdc control.

### Internal Connection Diagram

16D419B Type 87T  
 Transformer Differential Relay  
 Drawout Test Case



OMIT COIL 3-4 FOR TWO-WINDING UNITS.  
 DIODE 15-16 FOR TEST USE ONLY.  
 EXTERNAL RESISTOR SUPPLIED WITH RELAY.