

THREE-PHASE PAD-MOUNTED DISTRIBUTION TRANSFORMERS

1. GENERAL

- 1.1. This specification covers the electrical and mechanical characteristics of 45-10,000 kVA Three-Phase Step-Down Pad-Mounted Distribution Transformers. KVA ratings for transformers with secondary voltages not exceeding 700V are 45-3,750 kVA, while KVA ratings for transformers with secondary voltages greater than 700V are 1,000-10,000 kVA. Product is per Cooper Power System's catalog section 210-12.
- 1.2. All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following ANSI and NEMA standards.

C57.12.00 - IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

C57.12.26 - IEEE Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors (34500GrdY/19920 Volts and Below; 2500 kVA and Smaller).

C57.12.28 - Pad-Mounted Equipment - Enclosure Integrity.

C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVA and Smaller) - High Voltage: 34500GrdY/19920 Volts and Below; Low-Voltage: 480 Volt 2500 kVA and Smaller. (*issued in March 2005 - combines C57.12.22 and C57.12.26*)

C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.

C57.91 - Guide for Loading Mineral-Oil-Immersed Transformers.

2. RATINGS

- 2.1. The transformer shall be designed in accordance with this specification and the kVA rating shall be 45, 75, 112.5, 150, 225, 300, 500, 750, 1000, 1500, 2000, 2500, 3000, 3750, 5000, 7500, 10,000 (range may also be specified).
- 2.2. The primary voltage, configuration, and the basic lightning impulse insulation level (BIL) shall be _____, {make a selection from Table 1} Dual voltages are also available.



PART 1 - Table 1 - Transformer Voltage Ratings (volts), Configuration, and BIL Levels

Primary Voltage	BIL (kV)		Secondary Voltage	BIL (kV)
2400 Delta	60		208Y/120	All 30 kV
4160 Delta	60		480Y/277	
4800 Delta	60		575Y/332	
7200 Delta	75		600Y/347	
12000 Delta	95		690Y/398	
12470 Delta	95		240 Delta	
13200 Delta	95		480 Delta	
13800 Delta	95		240 Delta with 120 Mid-Tap	
14400 Delta	95		480 Delta with 240 Mid-Tap	
16430 Delta	125			
34500 Delta	150			
43800 Delta	250			
4160GrdY/2400	60		See left column for voltages over 700 V	
8320GrdY/4800	75			
12470GrdY/7200	95			
13200GrdY/7620	95			
13800GrdY/7970	95			
22860GrdY/13200	125			
23900GrdY/13800	125			
24940GrdY/14400	125			
34500GrdY/19920	150			
43800GrdY/25300	250			

1. For complete connector rating, see ANSI/IEEE 386.
2. Transformers are suitable for connectors with phase-to-ground or phase-to-ground/phase-to-phase high-voltage ratings as listed.
3. Arrester coordination may require higher BIL on multiple connections than indicated to achieve a minimum protection level of 20%.
 - 2.3. The secondary voltage, configuration, and the basic insulation level (BIL) of the secondary voltage shall be _____, {make a selection from Table 1}
 - 2.4. The transformer shall be furnished with full capacity high-voltage taps. The taps shall be +/- 2 - 2½% above and below nominal voltage . The tap changer switch shall be an externally operated switch with a hotstick-operable handle. The tap changer shall be clearly labeled to reflect that the transformer must be de-energized before operating the tap changer as required in Section 3.3 of ANSI C57.12.26. Taps shall be provided on the higher voltage of dual voltage primary units.
 - 2.5. The average winding temperature rise above ambient temperature, when tested at the transformer rating, shall not exceed 55°C and when tested at 112% of the base rating, shall not exceed 65°C.
 - 2.6. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 2. For target impedances, the tolerance on the impedance shall be +/- 7.5% of nominal value for impedance values greater than 2.5%. The tolerance on the impedance shall be +/- 10.0% for impedance values less than or equal to 2.5%.



PART 2 - Table 2 - Percent Impedance Voltage

KVA Rating (Low voltage < 700 V)	Impedance
75	1.10 - 5.75
112.5-300	1.40 - 5.75
500	1.70 - 5.75
750-3750	5.75 nominal

KVA Rating	Low voltage > 700 V (all nominal values)		
	≤150 kV BIL	200 kV BIL	250 kV BIL
1000 - 5000	5.75	7.00	7.50
7500 - 10000	6.50	7.00	7.50

3. HIGH VOLTAGE BUSHINGS AND TERMINALS

3.1. Bushing Style:

FOR 15/25 KV DEADFRONT, FOR CURRENTS BELOW 200 AMPS: The high voltage bushings shall be 15/25 kV 200A bushing wells with bushing well inserts installed. The bushings shall be externally removable and be supplied with a removable stud. (Examples: Cooper Power Systems catalog sections 800-32, 500-12, and 500-26)

FOR 35 KV DEADFRONT, FOR CURRENTS BELOW 200 AMPS: The high voltage bushing shall be a one-piece, 150 kV, 200-amp large interface load-break bushing. (Example: Cooper Power Systems catalog section 800-39)

FOR 15/25/35 KV DEADFRONT, FOR CURRENTS ABOVE 200 AMPS: The high voltage bushing shall be a 600A Deadbreak Primary One-Piece Bushing externally removable, 3Ø rated, integral design. 900 A can also be achieved using copper conductors. (Example: Cooper Power Systems catalog sections 800-45 and 800-47)

FOR UP TO 46 kV (250 KV BIL) DEADFRONT APPLICATIONS: The high voltage bushing shall be a CONNEX Plug-in Cable Termination System, size 3S. The male and female portions of the bushing shall be supplied with the transformer. This is only available in radial feed. (Example: see www.phoenixelectric-usa.com)

15/25/35 KV LIVEFRONT, 200 KV BIL MAX: The high voltage bushing shall be a porcelain bushing with a two, four, or six-hole spade or an eyebolt connector.

3.2. Bushing Configuration:

15/25 KV RADIAL FEED DEADFRONT: The transformer shall be provided with three (3) high voltage bushings in accordance with Figure 1 minimum dimensions (Figure 4a specific dimensions also available) of ANSI C57.12.34 for radial feed configurations. The bushing heights shall be in accordance with Figure 3 minimum dimensions (Figure 6 specific dimensions also available) of ANSI C57.12.34.



15/25 KV LOOP FEED DEADFRONT: The transformer shall be provided with six (6) high voltage bushings in accordance Figure 2 minimum dimensions (Figure 5a specific dimensions also available) of ANSI C57.12.34 for loop feed configurations. The bushing heights shall be in accordance with Figure 3 minimum dimensions (Figure 6 specific dimensions also available) of ANSI C57.12.34.

35 KV RADIAL FEED DEADFRONT: The transformer shall be provided with three (3) high voltage bushings in accordance with Figure 4b specific dimensions of ANSI C57.12.34 for radial feed configurations. The bushing heights shall be in accordance with Figure 6 specific dimensions of ANSI C57.12.34.

35 KV LOOP FEED DEADFRONT: The transformer shall be provided with six (6) high voltage bushings in accordance with Figure 5c specific dimensions of ANSI C57.12.34 for loop feed configurations. The bushing heights shall be in accordance with Figure 6 specific dimensions of ANSI C57.12.34.

250 KV BIL DEADFRONT: The transformer shall be provided with 3 bushings mounted 45° down from the horizontal, 60" from the ground, and 12" apart from each other.

15/25/35 KV LIVEFRONT, 150 KV BIL MAX: The transformer shall be provided with three (3) bushings in accordance with Figure 9 of ANSI C57.12.34 for radial feed configurations. The bushing heights shall be in accordance with Figure 10 of ANSI C57.12.34.

200 KV BIL LIVEFRONT: The transformer shall be provided with 3 bushings with phase-to-phase and phase-to-ground clearances adequate for 200 kV BIL.

4. SECONDARY VOLTAGE BUSHINGS AND TERMINALS

4.1. Bushing Style:

For voltages less than 700 Volts: The transformer shall be provided with tin-plated spade-type bushings for. The spacing of the connection holes shall be 1.75" on center, per ANSI C57.12.34 figure 13. The quantity of connection holes shall be 4, 6, 8, 10, 12, 16, 20 holes.

Standard/Possible Bushing Hole Quantities:

<u>KVA</u>	<u>208Y/120</u>	<u>480Y/277 and higher</u>
45-300	4 standard, 16 possible	4 standard, 16 possible
500	6 standard, 12 possible	4 standard, 16 possible
750-1500	10 standard, 20 possible	6 standard, 12 possible
2000-3750	out of product scope	10 standard, 20 possible

(Example: Cooper Power Systems catalog sections 800-14, 800-16, and 800-21)

Bushing supports shall be provided for units requiring 10 or more connection holes. Bushing supports shall be attached to the cabinet sidewalls; tank-mounted support mountings are not acceptable.

4.2. Bushing Configuration:



The transformer shall be provided with bushings in a staggered arrangement in accordance with Figure 11a minimum dimensions (Figure 12a specific dimensions also available) of ANSI C57.12.34.

For voltages greater than 700 Volts: Refer to section 3.1 for the bushing type. Secondary arrangements are available in radial live front and loop or radial deadfront with a porcelain X0 bushing.

5. TRANSFORMER PROTECTION AND SWITCHING

5.1. Overcurrent Protection:

Bayonet with or without current limiting fuses: (available up to 130 amps of full-load transformer current, up to 34.5 kV grounded wye, or 17.1 kV delta). The high-voltage overcurrent protection scheme provided with the transformer shall be an externally removable loadbreak expulsion Bay-O-Net fuse assembly with a flapper valve to minimize oil spillage. The bayonet fuses shall be in series with ELSP under-oil partial-range current-limiting back-up fuses with an interrupting rating of 50,000 A. (Example: Cooper Power Systems catalog sections 240-40, 240-45, 240-46, 240-47, 240-48, 240-49, and 240-50) *for voltages 23000GY and above and a delta connected secondary, bayonet fuses are not available*

Optional Accessory: An interlock shall be required between the load-break switch scheme specified and the bayonet fuses, such that the fuses may not be removed unless the transformer has been de-energized via the load-break switch scheme.

Magnex® Interrupter or equivalent: (available up to 42 amps of full-load transformer current, up to 35 kV), The high-voltage overcurrent protection scheme provided with the transformer shall be a three-phase trip Magnex® Interrupter. This externally resettable device may also be used as an on-off switch. The three-phase Magnex® Interrupter shall be in series with ELSP under-oil partial-range current-limiting back-up fuses with an interrupting rating of 50,000 A. (Example: Cooper Power Systems catalog sections 240-33 and 240-50)

Integral Vacuum Fault Interrupter (VFI): (available from 13 amps up to 712 amps of full-load transformer current, up to 34.5 kV, grounded wye or delta) The high-voltage or low-voltage overcurrent protection scheme provided with the transformer shall be an integral Vacuum Fault Interrupter (VFI). The VFI shall have a maximum interrupting rating of 12000A RMS symmetrical with resettable fault protection up through 35kV. The VFI shall also include a Tri-Phase electronic breaker control with over 100 minimum trip settings and 5 selectable time current curves. The minimum trip setting shall be XX amps, and curve profile shall be the EF, KF, TF, F, or H. (Example: see Cooper Power Systems bulletins 97055 and 02039 and catalog section S285-75-1 for the electronic control)

Optional VFI Accessories: SCADA board; Secondary ground fault protection; Motor operator assembly; visible break window.

5.2. Overvoltage Protection:

The overvoltage protection scheme provided with the transformer shall protect the high-voltage or low voltage winding.



With DEADFRONT bushings: (150 kV BIL, for voltages up to 22 kV delta and 35 kV grounded wye). Externally mounted, Distribution Class M.O.V.E. Deadfront elbow arresters shall be supplied. (Example: Cooper Power Systems Catalog section 235-55 and 235-65) *If primary bushings are 600 amp or 900 amp, T-OP II elbow connectors are required with load-reducing tap plug for arrester connection.*

UNDER OIL: (for voltages up to 35 kV). Internally mounted, Distribution Class MOV under-oil surge arresters shall be supplied. (Example: Cooper Power Systems Catalog Section 235-95)

Optional Accessory: Three (3) disconnect switches shall be included to disconnect the under-oil arresters from ground for transformer testing. (Example: Cooper Power Systems catalog section 800-51)

With LIVEFRONT bushings: (up to 200 KV BIL). Intermediate class, Distribution Class, Heavy Duty, Medium Duty, Riser Pole Duty, arresters shall be supplied beneath the high-voltage bushings. (Example: Cooper Power Systems catalog sections 235-42, 235-45, 235-52, 235-70, 235-71, 235-75)

5.3. Switching:

The primary switching scheme provided with the transformer shall be one (*only available option for radial feed*), two, three on/off, one four-position V-blade, one four-position T-blade loadbreak switch. Refer to Appendix 1 for the schematics of these switching options. (Example: Cooper Power Systems catalog sections 800-64 and 800-65)

Make-before-break option for four-position, sectionalizing switch: This switch option provides improved system reliability by eliminating momentary interruptions during switching operations.

6. GENERAL DESIGN

6.1. Core and coil

The core and coil shall be vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system. While under vacuum, the windings will be energized to heat the coils and drive out moisture, and the transformer will be filled with preheated filtered degassed insulating fluid. The core shall be manufactured from burr-free, grain-oriented silicon steel and shall be precisely stacked to eliminate gaps in the corner joints. The coil shall be insulated with B-stage, epoxy coated, diamond pattern, insulating paper, which shall be thermally cured under pressure to ensure proper bonding of conductor and paper.

6.2. Dielectric fluid

The dielectric coolant shall be listed less-flammable fluid meeting the requirements of National Electrical Code® Section 450-23 and the requirements of the National Electrical Safety Code (IEEE C2-1997), Section 15. The dielectric coolant shall be readily and completely biodegradable per EPA OPPTS 835.3100. The base fluid shall be 100% derived from edible seed oils with performance enhancing additives. The fluid shall result in zero mortality when tested on trout fry per OECD G.L. 203 and be non-bioaccumulating. The fluid shall be published under US EPA



Environmental Technology Verification (ETV) requirements, and tested for compatibility with transformer components. The fluid shall be Factory Mutual Approved, UL® Classified Dielectric Medium (UL-EOUV) and UL Classified Transformer Fluid (UL-EOVK), Envirotemp® FR3® fluid. (Example: see www.cooperpower.com/fr3)

6.3. Tank and Cabinet Enclosure

- 6.3.1. The high-voltage and low-voltage compartments, separated by a metal barrier, shall be located side-by-side on one side of the transformer tank. When viewed from the front, the low-voltage compartment shall be on the right. Each compartment shall have a door that is constructed so as to provide access to the high-voltage compartment only after the door to the low-voltage compartment has been opened. There shall be one or more additional fastening devices that must be removed before the high-voltage door can be opened. Where the low-voltage compartment door is of a flat panel design, the compartment door shall have three-point latching with a handle provided for a locking device. Hinge pins and associated barrels shall be constructed of corrosion-resistant material, passivated AISI Type 304 or the equivalent.
- 6.3.2. A recessed, captive, penta-head bolt that meets the dimensions per ANSI C57.12.28 shall secure all access doors.
- 6.3.3. The enclosure integrity of the tank and cabinet shall meet the requirements for tamper resistance set forth in ANSI C57.12.28 including but not limited to the pry test, pull test, and wire probe test.
- 6.3.4. The compartment depth shall be in accordance with C57.12.34, unless additional depth is specified.
- 6.3.5. The tank base must be designed to allow skidding or rolling in any direction. Lifting provisions shall consist of four lifting lugs welded to the tank.
- 6.3.6. The tank shall be constructed to withstand 7 psi without permanent deformation, and 15 psi without rupture. The tank shall include a 15 psig pressure relief valve with a minimum flow rate of 35 SCFM.
- 6.3.7. The tank and cabinet coating shall meet all the requirements of ANSI C57.12.28 including:
 - Salt Spray Test
 - Crosshatch Adhesion Test
 - Humidity Test
 - Impact Test
 - Oil Resistance Test
 - Ultraviolet Accelerated Weathering Test
 - Abrasion Resistance - Taber Abraser



- 6.3.8. The exterior of the unit shall be painted Munsell 7GY3.29/1.5 green in color. The cabinet interior and tank face shall be painted gray for ease of viewing the inside the compartment.
- 6.3.9. The tank shall be complete with an anodized aluminum laser engraved nameplate. This nameplate shall meet Nameplate B per ANSI C57.12.00.

7. ACCESSORIES

The following accessories shall be provided (non-standard options are in yellow):

- Bolted main tank cover (1000 kVA & below)
- Welded main tank cover with bolted handhole (1500 kVA & above)
- 1.0" upper fill plug
- 1.0" drain plug in LV compartment (500 kVA & below)
- 1.0" drain valve w/ sampling device in LV compartment (750 kVA & above)
- Automatic pressure relief valve
- Metal drip shield (when bayonets specified)
- 20" deep cabinet (2500 kVA & below)
- 24" deep cabinet (3000 kVA & above)
- Ground provisions per C57.12.34 section 9.11.
- Meet NEMA TR-1 sound levels
- Liquid level gauge
- Dial-type thermometer gauge
- Pressure vacuum gauge
- 1.0" drain valve w/ sampling device in (LV or HV) compartment (500 kVA & below)
- Upper fill valve
- Pressure vacuum bleeder
- 24" deep cabinet
- 30" deep cabinet
- 36" deep cabinet
- 40" deep cabinet
- Spare bayonet fusing
- Ground connectors
- Mr. Ouch warning & danger signs
- Danger high voltage warning signs
- Miscellaneous stenciling
- Touch-up paint
- Interphase barriers (for live front primary units only)
- Seismic zone 3 and 4 tank anchoring
- Complete 304 stainless steel tank and cabinet
- Rapid rise relay with seal-in panel
- Winding temperature indicator
- Watt-hour meter package – includes GE kV Vector Meter (digital demand register). Factory supplied wiring shall be internal to the cabinet, not in conduit. Communication connection shall be the OPTOCOM port. (Example: Cooper Power Systems reference section R210-70-1)



- Factory Mutual (FM) Approved transformer (for NEC Code-listed installations on, near, or inside of buildings)
- UL Listed and Classified transformer (for NEC Code-listed installations on, near, or inside of buildings) per UL XPLH
- UL Listed transformer (certifying compliance with ANSI standards only) per UL XPLH
- Increased efficiency criteria / evaluated losses:
 - Core loss evaluation (A-factor) _____ \$/watt
 - Winding loss evaluation (B-factor) _____ \$/watt
 - NEMA TP-1 Efficiency design (2500 kVA and below)

8. SHIPPING

Units 1000 kVA and below shall be palletized. Units 1500 kVA and larger shall be loaded and unloaded with overhead cranes, so a pallet is not to be provided for these transformers.

9. TESTING & TOLERANCES

9.1. All units shall be tested for the following:

- No-Load (85°C) losses at rated current
- Total (85°C) losses at rated current
- Percent Impedance (85°C) at rated current
- Excitation current (100% voltage) test
- Winding resistance measurement tests
- Ratio tests using all tap settings
- Polarity and phase relation tests
- Induced potential tests
- Full wave and reduced wave impulse test

9.2. In addition, the manufacturer shall provide certification upon request for all design and other tests listed in C57.12.00, including verification that the design has passed short circuit criteria per ANSI C57.12.00 and C57.12.90.

9.3. IF THE TRANSFORMER HAS EVALUATED LOSSES, The no-load losses of a transformer shall not exceed the specified no-load losses by more than 10%, and the total losses of the transformer shall not exceed the specified total losses by more than 6%.

10. DATA WITH PROPOSAL

The following data shall be submitted with the proposal:

- Core losses
- Winding losses
- Percent Impedance
- Typical record drawings
- Approval drawings (furnished at time of order)
- Final record drawings (furnished at time of shipment)



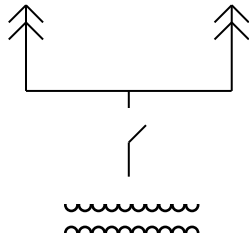
11. APPROVED MANUFACTURERS

Cooper Power Systems—Waukesha WI, or approved equal

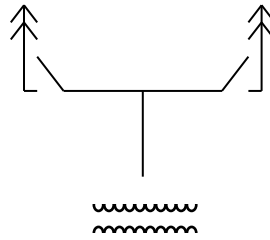


APPENDIX 1: Switching Options and Schematics

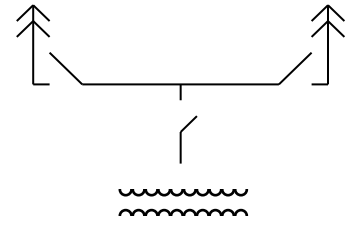
1 On/Off Switch



2 On/Off Switches

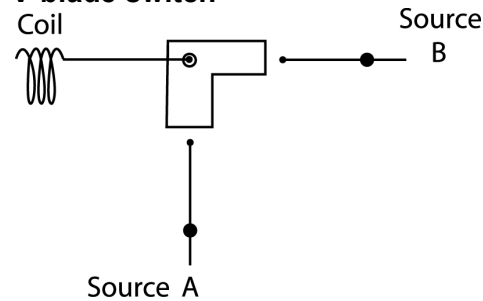


3 On/Off Switches



4-position sectionalizing switches:

V-blade switch

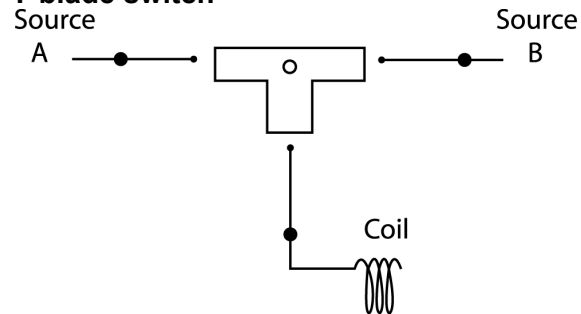


Description of positions:
 Feed from A & B
 Feed from A only

PART 3 - Feed from B only

Open — the loop is **open** and the transformer is de-energized

T-blade switch



Description of positions:
 Feed from A & B
 Feed from A only
 Feed from B only
 Open — the loop is **closed** and the transformer is de-energized

