

Distribution Transformers

Functional Specification Guide

Single-Phase Pad-mounted

PS201002EN

Functional Specification for Single-Phase Pad-Mounted Type Distribution Transformers 5–167 kVA

1.0 Scope

- 1.1 This specification covers the electrical and mechanical characteristics of Eaton's Cooper Power series 5–167 kVA Single-Phase Step-Down Pad-Mounted Distribution Transformers. Product is per catalog data CA201002EN.

2.0 Applicable Standards

- 2.1 All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following ANSI[®], IEEE[®], Department of Energy, and NEMA[®] standards.

IEEE Std C57.12.00[™]–IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE Std C57.12.38[™] - IEEE Standard for Pad-Mounted-Type, Self-Cooled, Single-Phase Distribution Transformers 250kVA and Smaller: High Voltage, 34,500 GrdY/19920V and Below; Low Voltage, 480/240V and Below

IEEE Std C57.12.28[™]–IEEE Standard Pad-Mounted Equipment–Enclosure Integrity

IEEE Std C57.12.35[™]–IEEE Standard Bar Coding for Distribution Transformers and Step-Voltage Regulators

IEEE Std C57.12.90[™]–IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE Std C57.91[™]–IEEE Guide for Loading Mineral-Oil-Immersed Transformers and Step-Voltage Regulators

IEEE Std C57.154[™] IEEE Standard for the Design, Testing, and Application of Liquid-Immersed Distribution, Power, and Regulating Transformers using High-Temperature Insulation Systems and Operating at Elevated Temperatures

NEMA TR 1 (R2000)–Transformers, Regulators and Reactors, Audible Sound Levels for Liquid-Immersed Power Transformers

10 CFR Part 431–Department of Energy–Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule.

3.0 Ratings

3.1 The transformer shall be designed in accordance with this specification and shall have an Average Winding Rise (AWR) of one of the following:

65°C, 65/75°C, 75°C

The applicable AWR rating shall be specified on the inquiry.

3.2 The transformer shall be designed in accordance with this specification and shall have one of the following kVA ratings:

5, 10, 15, 25, 37.5, 50, 75, 100, 167

The applicable kVA rating shall be specified on the inquiry.

Table 1
Transformer and Connector High-Voltage Ratings and Electrical Characteristics for dead-front transformers

Transformer		Electrical Characteristics of the Completely Assembled High-voltage Connectors ¹			
		High-voltage Rating		BIL (kV)	60-Hz dry 1 minute withstand (kV)
High-voltage Ratings (V)	Minimum BIL (kV)	Phase-to-Ground (kV)	Phase-to-Ground /Phase-to-Phase (kV)		
<i>Single High-Voltage</i>					
4160GrdY/2400	60	8.3	8.3/14.4	95	34
8320GrdY/4800	75	8.3	8.3/14.4	95	34
12000GrdY/6930	95	8.3	8.3/14.4	95	34
12470GrdY/7200	95	8.3	8.3/14.4	95	34
13200GrdY/7620	95	8.3	8.3/14.4	95	34
13800GrdY/7970	95	8.3	8.3/14.4	95	34
16340GrdY/9430 ²	95	(8.3 or 15.2) ²	(8.3/14.4 or 15.2/26.3) ²	(95 or 125) ²	(34 or 40) ²
22860GrdY/13200	125	15.2	15.2/26.3	125	40
23900GrdY/13800	125	15.2	15.2/26.3	125	40
24940GrdY/14400	125	15.2	15.2/26.3	125	40
34500GrdY/19920	150	21.1	21.1/36.6	150	50
<i>Series - Multiple High-Voltage</i>					
4160GrdY/2400					
x 12470GrdY/7200	95	8.3	8.3/14.4	95	34
4160Grdy/2400					
x 13200GrdY/7620	95	8.3	8.3/14.4	95	34
8320GrdY/4800					
x 24940GrdY/14400	125	15.2	15.2/26.3	125	40
12470GrdY/7200					
x 24940GrdY/14400	125	15.2	15.2/26.3	125	40
13200GrdY/7620					
x 24940GrdY/14400	125	15.2	15.2/26.3	125	40

1. For complete connector rating, see IEEE Std 386™
- 2.
- 2 The required connector rating should be specified

The applicable voltage rating and BIL shall be specified on the inquiry. Dual voltage primaries shall utilize an externally operable switch. Unit must be de-energized prior to changing voltages. The applicable multiple voltage rating shall be specified on the inquiry.

3.3 The secondary voltage shall be one of the following. The basic insulation level (BIL) of the secondary voltage shall be 30 kV.

240/120 (3-Bushings)
 480/240 (3-Bushings)
 120 (2-Bushings)

277 (2-Bushings)
120/240 (4-Bushings—Very uncommon for pad-mounted transformers)

The applicable secondary voltage shall be specified on the inquiry

- 3.4 When specified on inquiry, the transformer shall be furnished with full capacity high-voltage taps. The tap-changer shall be clearly labeled to reflect that the transformer must be de-energized before operating the tap-changer. The tap-changer shall be operable on the higher voltage only for transformers with dual voltage primaries. The unit shall have one of the following tap configurations:

No Taps
Two—2 ½% taps above and below rated voltage (split taps)
Four—2 ½% taps below rated voltage (four below)
NEMA[®] taps (14400, 13800, 13200, 12470, 12540)
Non-standard tap configuration

The applicable tap configuration shall be specified on the inquiry

4.0 Construction

- 4.1 The core and coil shall be vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system. While under vacuum, 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.
- 4.2 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 Std C2™-2002 standard), Section 15. The dielectric coolant shall be non-toxic*, non-bioaccumulating and be readily and completely biodegradable per EPA OPPTS 835.3100. The base fluid shall be 100% derived from edible seed oils and food grade performance enhancing additives. The fluid shall not require genetically altered seeds for its base oil. The fluid shall result in zero mortality when tested on trout fry*. The fluid shall be certified to comply with the 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.
*Per OECD G.L. 203
- 4.3 All transformer components shall be certified to comply with industry standards when tested in Envirotemp[™] FR3[™] fluid. Certified test reports for each transformer component shall be provided upon request.

- 4.4 In addition to the regular locking provision, all access doors or hood shall be secured by a recessed, captive, penta head bolt that meets the dimensions set forth in Rural Utilities Service (RUS) Drawing A3759 or IEEE C57.12.38.
- 4.5 The transformer shall be of sealed tank construction of sufficient strength to withstand a pressure of 7 psig without permanent distortion, and 15 psig without rupturing or affecting cabinet security.
- 4.6 The exterior of the unit shall be painted Munsell 7GY3.29/1.5 green unless otherwise specified.
- 4.7 The tank shall include a pressure relief device as a means to relieve pressure in excess of pressure resulting from normal operation. The venting and sealing characteristics shall be as follows:
- Cracking pressure: 10psig \pm 2psig
Resealing pressure: 6psig minimum
Zero leakage from reseal pressure to -8psig
Flow at 15 psig: 35 SCFM minimum
- 4.8 The tank shall be complete with an anodized aluminum laser engraved nameplate. Nameplate shall conform to IEEE Std C57.12.00™, nameplate A.

4.9 High Voltage Bushings and Terminals

- 4.9.1 The high voltage bushings provided shall be externally clamped bushing wells. These wells shall be removable to allow for field replacement of the bushings without opening the tank.
- 4.9.2 The bushing configuration shall be per IEEE C57.12.38 Figure 1 (15 & 25 kV Class) and Figure 2 (35 kV Class) for ANSI® Type I units, or per Figure 3 (15 & 25 kV Class) and Figure 4 (35 kV Class) for ANSI® Type II units, or Eaton's Cooper Power series unique Shrub Plus configuration which offers an ANSI® Type I high voltage bushing configuration and ANSI® Type II low voltage bushing configuration.

The applicable bushing configuration shall be specified on the inquiry.

- 4.9.3 A cable accessory parking stand shall be provided and shall be located such that the separable insulated connectors that are designed for operation after the transformer is in place can be operated with hot-line tools.

4.10 Low Voltage Bushings and Terminals

- 4.10.1 The configuration of the secondary bushings shall be per IEEE C57.12.38 Figure 1 (This specifies a horizontal or ANSI® Type I bushing arrangement) or Figure 3 (This specifies an angled or ANSI® Type II bushing pattern), or Eaton's Cooper Power series unique Shrub Plus configuration which offers an

ANSI® Type I high voltage bushing configuration and ANSI® Type II low voltage bushing configuration. These bushings shall be removable to allow for field replacement without opening the tank.

The applicable bushing configuration shall be specified on the inquiry.

4.10.2 Transformer shall have threaded stud-type line and neutral terminals per Tables 2 and 3 below.

Table 2
Stud-type line and neutral terminals

LV bushing stud sizes	
Thread size Note 2	Minimum L Note1/Note 2
0.62-11 UNC-2A	31.75 (1.25)
1.000-14 UNS-2A	44.45 (1.75)
1.250-12 UNF-2A	63.5 (2.5)

NOTE 1 – Dimension “L” is in millimeters. Dimensions in parentheses are in inches. The tolerance is $\pm 2\text{mm}$ (0.079 in).

NOTE 2 – Dimension “L” shall be the length of threads prior to any jam nuts, ground straps, or secondary connectors. Longer stud lengths may be required for user-supplied secondary connectors. Larger thread size or length, or both, may be required if materials other than copper are used. Stud thread sizes are in inches only

Table 3

Transformer kVA size	Required stud size for LV rating of:			
	120 120/208Y	240 240/120 120/240	277	480 480/240 240/480
10	0.625-11	0.625-11	0.625-11	0.625-11
15	0.625-11	0.625-11	0.625-11	0.625-11
25	0.625-11	0.625-11	0.625-11	0.625-11
37.5	0.625-11	0.625-11	0.625-11	0.625-11
50	1.00-14	0.625-11	0.625-11	0.625-11
75	1.00-14	0.625-11	0.625-11	0.625-11
100	1.00-14	1.00-14	0.625-11	0.625-11
167	1.250-12	1.00-14	1.00-14	0.625-11

NOTE 1 – Dimension “L” is in millimeters. Dimensions in parentheses are in inches. The tolerance is $\pm 2\text{mm}$ (0.079 in).

NOTE 2 – Dimension “L” shall be the length of threads prior to any jam nuts, ground straps, or secondary connectors. Longer stud lengths may be required for user-supplied secondary connectors. Larger thread size or length, or both, may be required if materials other than copper are used. Stud thread sizes are in inches only

4.11 Overcurrent Protection

4.11.1 The protection scheme provided with the transformer shall consist of the following checked attributes. If for any reason a special protection scheme is required it shall be clearly stated on the inquiry.

- Standard** – Over-current protection shall be provided by a Bay-O-Net expulsion fuse with a flapper valve to minimize oil spillage. The Bay-O-Net assembly shall be used in series with an internally mounted isolation link.
- Protected Plus (CLF)** – Primary overcurrent protection shall be provided by a Bay-O-Net expulsion fuse mounted in series with a partial range under-oil current-limiting fuse such that the maximum interrupting rating is 50,000 A. This fusing scheme eliminates the requirement for the isolation link mounted in series with the Bay-O-Net assembly.
- Secondary Protected Plus (Breaker)** – Secondary over-current and transformer overload protection shall be provided by a breaker installed on the secondary side of the transformer. This breaker shall have the capability to energize and de-energize the secondary service by one hotstick operation. This device shall be used in conjunction with an expulsion fuse on the primary side of the transformer.
- Protected Plus (MagneX Interrupter)** – Primary and secondary over-current and transformer overload protection shall be provided by a breaker installed on the primary side of the transformer. This breaker shall have the capability to energize and de-energize the transformer by one hotstick operation. This device may be used in series with a current-limiting fuse to provide 50,000 A interrupting capability.
 - MagneX Interrupter
 - MagneX in series with current limiting fuse
- VFI Protected (ANSI® I Only)** – The transformer primary shall include a Vacuum Fault Interrupter (VFI) to offer loop sectionalizing capability. The VFI shall have a maximum interrupting rating of 12,000 A_{RMS} with resettable fault protection through 35 kV. The VFI shall also include a tri-phase electronic breaker control with over 100 minimum trip settings and 5 selectable time current curves. The trip settings and curve shall be as checked below.

Trip Setting _____A (Default settings: 80 A minimum trip, instantaneous trip: off)

Time-Current Curve: EF TF KF F H

4.12 Overvoltage Protection

4.12.1 The protection scheme provided with the transformer shall consist of the following checked attributes. If a special protection scheme is required it shall be clearly stated on the inquiry.

- [] **Standard** – No overvoltage protection is provided with the transformer.
- [] Primary overvoltage protection shall be provided by an internally mounted, heavy-duty distribution class MOV arrester or externally mounted M.O.V.E. distribution-class MOV elbow arrester.
 - [] Internally mounted M.O.V.E. distribution-class MOV elbow arrester (STD when primary OCP is desired)
 - [] Externally mounted under-oil VariSTAR surge arrester
- [] Secondary overvoltage protection shall be provided by an externally mounted, high-energy, ANSI approved light-duty distribution-class arrester.
 - [] Storm Trapper H.E. (High Energy) low-voltage distribution-class surge arrester

5.0 Labeling

5.1 A temporary bar code label shall be attached to the exterior of the transformer in accordance with IEEE Std C57.12.35™.

6.0 Finish Performance Requirements

6.1 The tank coating shall meet all requirements in IEEE Std C57.12.28™ including:

- Crosshatch adhesion
- Humidity
- Impact
- Insulating fluid resistance
- Ultraviolet accelerated weathering (QUV)
- Abrasion resistance–taber abraser
- Gravelometer

6.2 The enclosure integrity of the tank and cabinet shall meet the requirements for tamper resistance set forth in IEEE Std C57.12.28™ including but not limited to the pry test, pull test, and wire probe test.

7.0 Production Testing

7.1 All units shall be tested for the following:

- No-Load losses at rated current*
- Total losses at rated current**
- Percent Impedance at rated current
- Excitation current (100% voltage) test

- Ratio tests using all tap settings
- Polarity and phase relation tests
- Induced potential tests
- Full wave and reduced wave impulse test

*No load losses will be reported at 95°C or 20°C for 75°C AWR units, and 85°C or 20°C for 65°C and 65/75°C AWR units.

**Total losses and impedance values will be reported at 95°C for 75°C AWR units, and 85°C for 65°C AWR units.

7.2 The manufacturer shall provide the guaranteed average, no-load, and load losses for the unit when specified. These losses will be subject to the tolerance specified in Table 4.

Table 4
Tolerance for Transformer Losses

No-Load Losses (%)	Total Losses (%)
10	6

7.3 Transformers manufactured for sale in the United States shall conform to efficiency levels for liquid immersed distribution transformers, as specified in the Department of Energy ruling “10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule; April 18, 2013.” Manufacturer shall comply with the intent of all regulations set forth in noted ruling.

8.0 Approved Manufacturers

8.1 Eaton’s Cooper Power Systems Division

9.0 Accessories

9.1 The following checked accessories shall be provided:

- Stainless steel hardware
- Stainless steel tank, sill, door
- Stainless steel pedestal (bottom 1.5” of tank), sill, door
- Stainless steel nameplate**
- Temporary service entrance (2.25” hole) in the sill
- Fault indicator provision
- Mounting cleats
- Lifting bolts
- Tank ground connector
- Internal high voltage arrester
- Arrester disconnect switch

- ½" drain valve with sampling device
- 1" drain valve with sampling device
- Bushing wells with removable studs
- Load break bushing inserts
- Rotatable feed thru load break inserts
- 2-position, on/off load break switch
- 4-position V-blade load break switch
- 4-position T-blade load break switch
- Bay-O-Net drip shield
- Oil site gauge (glass window with ball float)
- Oil level gauge (dial-type)
- Thermometer (dial-type) without contacts
- Pressure/vacuum gauge (dial-type)
- Barrier between high voltage and low voltage
- Poly-pad combination shipping/mounting pad (10-75 kVA)
- Internal fault detector**

Any additional accessories will be specified on the inquiry.

10.0 Shipping

10.1 The unit shall be banded, blocked, or bolted to a wood pallet or poly-pad.

10.2 When applicable, units shall be double stacked to reduce shipping cost and storage space.

11.0 Data With Proposal

11.1 The following data shall be submitted with the proposal when specified:

- Core losses
- Winding losses
- Percent Impedance

12.0 Service

12.1 The manufacturer of the transformer shall have regional service centers located within 2 hours flight time of each state within all contiguous 48 states. Service personnel shall be factory trained in commissioning and routine service of quoted transformers.