

Distribution Transformers

Functional Specification Guide

Single-Phase Overhead

PS201001EN

Functional Specification for Single-Phase Overhead 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 Overhead Type Distribution Transformers.

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 C57.12.20™—IEEE Standard for Overhead-Type Distribution Transformers 500kVA and Smaller: High Voltage, 34500V and Below; Low Voltage, 7970/13800Y V and below

IEEE Std C57.12.31™—IEEE Standard for Pole 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

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:

55°C, 55/65°C, 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.

- 3.3 The primary voltage and the basic insulation level (BIL) shall be in accordance with Table 1.

Table 1
Ratings for Single-Phase Transformers
(Single Ratio)

Transformer High-voltage		Minimum kVA Rating For Low-voltage Rating of:	
Rating (V)	BIL (kV)	120/240 ¹ (V)	277 or 240/480 ¹ (V)
2400/4160Y	60	5	5
4800/8320Y	75	5	5
7200/12470Y	95	5	5
12470GrdY/7200	95	5	5
7620/13200Y	95	5	5
13200GrdY/7620	95	5	5
12000	95	5	5
13200/22860Y ²	125	5	5
13200	95	5	5
13800GrdY/7970	95	5	5
13800/23900Y ²	125	5	5
13800	95	5	5
14400/24940Y ²	125	5	5
24490GrdY/14400 ²	125	5	5
16340	95	5	5
34500GrdY/19920 ^{3,4}	150	5	5

1. Low-voltage rating of 120/240 volts or 240/480 volts is suitable for series, multiple, or three-wire service.
2. Suitable for wye-connection on systems where ground conditions permit the use of 18-kV arresters.

3. Suitable for wye-connection on systems where ground conditions permit the use of 27-kV arresters.
4. When specifying 125kV BIL, adequate grounding and surge protection studies should be made

The applicable voltage rating shall be specified on the inquiry

Transformers with GrdY high voltage (example: 12470GrdY/7200) will be manufactured with one (1) high voltage bushings. Transformers with Y high voltage (example: 7200/12470Y) will be manufactured with two (2) high voltage bushings.

OR

The transformer shall have a dual voltage primary capable of being reconnected with an externally operable, de-energized switch. The voltage provided and the basic insulation level (BIL) shall be in accordance with Table 2.

Table 2
Ratings for Single-Phase Transformers
(Series Multiple)

Transformer High-voltage		Minimum kVA Rating For Low-voltage Rating of:	
Rating (V)	BIL (kV)	120/240 (V)	277 or 240/480 ¹ (V)
2400/4160Y x 7200/12470Y	95 x 95	5	5
4160GrdY/2400 x 12470GrdY/7200	95 x 95	5	5
2400/4160Y x 7620/13200Y	95 x 95	5	5
4160GrdY/2400 x 13200GrdY/7620	95 x 95	5	5
4800/8320Y x 7200/12470Y	95 x 95	5	5
8320GrdY/4800 x 12470GrdY/7200	95 x 95	5	5
4800/8320Y x 7620/13200Y	95 x 95	5	5
8320GrdY/4800 x 13200GrdY/7620	95 x 95	5	5
7200/12470Y x 14400/24940Y	125 x 125	5	5
12470GrdY/7200 x 24940GrdY/14400	125 x 125	5	5

Transformer High-voltage		Minimum kVA Rating For Low-voltage Rating of:	
Rating (V)	BIL (kV)	120/240 (V)	277 or 240/480 ¹ (V)
7620/13200Y x 14400/24940Y	125 x 125	5	5
13200GrdY/7620 x 24940GrdY/14400	125 x 125	5	5

1. Low-voltage rating of 120/240 volts or 240/480 volts is suitable for series, multiple, or three-wire service.

The applicable multiple voltage rating shall be specified on the inquiry.

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

120/240 (5-100kVA-3 Bushings, 167kVA-4 Bushings)

240/480 (5-100kVA-3 Bushings, 167kVA-4 Bushings)

120 (2 Bushings)

277 (2 Bushings)

The applicable secondary voltage shall be specified on the inquiry.

- 3.5 The transformer may 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 as required in IEEE Std C57.12.20. 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

NEMA[®] Taps (14400, 13800, 13200, 12780, 12540)

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™), 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 Transformers 75kVA and below shall be manufactured with interlaced windings in order to provide superior surge suppression (Interlaced windings above 75kVA are not required for superior surge suppression due to greater volts/turn at the higher kVA's)
- 4.4 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.
- 4.5 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 ± 2 psig
Resealing pressure: 6 psig minimum
Zero leakage from reseal pressure to -8 psig
Flow at 15 psig: 35 SCFM minimum
- 4.6 The tank provided shall have a recessed tank bottom which offers protection when sliding over rough surfaces.
- 4.7 The tank shall have an internal mark, which indicates the proper oil level per - IEEE Std C57.12.20™.
- 4.8 The tank shall be provided with a mild steel cover ring with stainless steel cover ring loops and a stainless steel bolt. A bronze nut shall also be provided to eliminate corrosion problems and avoid galling.
- 4.9 The tanks shall be complete with an anodized aluminum laser engraved nameplate. Nameplate shall conform to IEEE Std C57.12.00™, nameplate A.
- 4.10 The tank shall include arrester mounting pads, grounding provisions, ANSI® support lugs (hanger brackets) and lift lugs.

The quantity of hanger brackets (one set or two) shall be specified on the inquiry.

4.11 High Voltage Bushings and Terminals

4.11.1 The high-voltage bushings provided shall be in accordance with Table 3.

4.11.2

Table 3
Electrical Characteristics of Bushings

BIL withstand (kV)	Creepage distance (minimum) mm (in)	Minimum 60-Hz dry 1-minute withstand (kV)	Minimum 60-Hz wet 10-second withstand (kV)
30	-	10	6
45	-	15	13
60	-	21	20
75	-	27	24
95	255 (10)	35	30
95 ^a	380 (15)	42	36
125	380 (15)	42	36
150	432 (17)	60	50

^aFor 16.34kVA rating onl

4.11.3 The bushing terminals provided shall be tin plated to accommodate both aluminum and copper conductors. The size of these terminals shall be in accordance with Table 4.

Table 4
High-Voltage Terminal Sizes for Single-Phase Transformers

Size of Terminal Opening Inches Millimeters	AWG Size of Conductor Terminal will Accommodate	kVA Range for High-Voltage Rating of:	
		5 kV And below	7.2 kV to 34.5kV
5/16 7.9 5/8 15.9	No 8 Solid to No 2 Stranded No 6 Solid to No 4/0-19 Stranded	10-167 250-500	10-500 -----

4.11.4 The color of the bushings shall match Light Gray Number 70, Munsell Notation 5BG7.0/0.4.

The number of high voltage bushings (one or two) shall be specified on the inquiry

4.12 Low Voltage Bushings and Terminals

4.12.1 The low-voltage bushings provided shall be in accordance with Table 5.

- 4.12.2 The bushing terminals provided shall be tin plated to accommodate both aluminum and copper conductors. The size of the terminals shall be in accordance with Table 5.

**Table 5
Low-Voltage Terminal Sizes for Single-Phase Transformers**

Size of Terminal Opening		AWG Size of Conductor Terminal will Accommodate	Transformer Low Voltage Rating (volts)		
			120/240	240/480	277
Inches	Millimeters				
5/16	7.9	No 8 Solid to No 2 Stranded	-	-	-
5/8	15.9	No 6 Solid to No 4/0-19 Stranded	10-15	10-25	10-25
13/16	20.6	No 2 Solid to 350 kcmil-19 Stranded	25-50	37 ½ - 100	37 ½ - 100
15/16	23.8	No 1/0 Solid to 500 kcmil-37 Stranded	75	-	-
1-1/4	31.8	No 2/0 Solid to 1000 kcmil-61 Stranded	100	-	-
Spade H		- - -	167-250	167-500	167-250

- 4.12.3 The internal secondary leads shall be permanently embossed with the letters A, B, C, and D per IEEE Std C57.12.00™ and IEEE Std C57.12.20™. This marking can be used as a means to locate such leads with respect to one another for internal reconnection.

4.13 Overcurrent Protection

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

- Standard**—No overcurrent protection is required with the transformer.
- Protected**—Primary overcurrent protection shall be provided by an internally mounted cartridge fuse.
- Protected Plus**—Secondary overcurrent 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 (5-75 kVA).
- Protected Plus (MagneX)** – Primary overcurrent 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 **Magnex in series with current limiting fuse**

4.14 Overvoltage Protection

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

Primary overvoltage protection shall be provided by:

- Direct Connected UltraSIL Polymer-Housed VariSTAR Surge Arrester
Normal Duty
- Direct Connected UltraSIL Polymer-Housed VariSTAR Surge Arrester
Heavy Duty
- Direct Connected UltraSIL Polymer-Housed Evolution Surge Arrester
- Internal, under-oil VariSTAR arrester

Secondary overvoltage protection shall be provided by an internally or externally mounted, high-energy, low-voltage distribution-class MOV arrester.

- Storm Trapper H.E. (High Energy) low-voltage distribution-class surge arrester
Internally mounted
- Storm Trapper H.E. (High Energy) low-voltage distribution-class surge arrester
Externally mounted

4.15 Combined Overcurrent and Overvoltage Protection

- 4.15.1 The combined overcurrent and overvoltage protection scheme provided with the transformer shall consist of the following checked attributes. If a special protection scheme is required it will be clearly stated on the inquiry.

- Completely Self Protected**—Primary overvoltage protection shall be provided by an externally mounted, UltraSIL Polymer-Housed Evolution MOV arrester. Primary overcurrent protection shall be provided by an internally mounted weak link fuse. Secondary overcurrent 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. (5-75 kVA)

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 Transformer shall be painted Munsell Notation 5BG7.0/0.4, ANSI 70 Gray. The coating system shall meet or exceed IEEE Std C57.12.31™ standard coating system requirements for pole -mount equipment, including the following performance tests:

1. Salt spray test per ASTM B117 / D1654
2. Cross hatch adhesion test ASTM D3359
3. Humidity test per ASTM D4585 / D3363
4. Impact test per ASTM D2794 / B1117
5. Ultraviolet accelerated weathering (QUV) test per ASTM G154 / D523
6. Abrasion resistance Taber abraser test per ASTM D4060 / B1117

6.2 Certified test data shall be furnished upon request.

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. No load losses will be reported at 75°C or 20°C for 55°C and 55/65°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. Total losses and impedance values will be reported at 75C for 55°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 tolerances listed in Table 6.

Table 6
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:

- 15 kV insulated cover
- PVC bird guard(s)
- Handwheel bird guard(s)
- Non-PCB decal
- Primary voltage decal
- Secondary voltage Decal
- Extra creep bushing(s)
- Stainless steel hardware
- Stainless steel tank
- Stainless steel cover
- Stainless steel cover band
- Internal Fault Detector
- Vacuum pressure gauge
- Fluid level gauge
- Temperature gauge
- Drain valve with sampling device
- Tank ground connector
- Ground strap

Any additional accessories will be specified on the inquiry.

10.0 **Shipping**

- 10.1 The unit shall be sufficiently banded or blocked to a wood pallet.

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 overhead 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.

Envirotemp™ and FR3™ are licensed trademarks of Cargill, Incorporated.