



NEMA 8TP PS4-2021

Purchasing Specifications Guide Dry Type Transformers Low-Voltage ($\leq 1.2kV$)

Published by:

National Electrical Manufacturers Association

1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209

www.nema.org

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Overview

This document was produced by manufacturers of electrical transformers to assist customers in developing clear purchasing specifications for the type and rating of the transformer indicated above. While comprehensive, it is not intended to be exhaustive or cover every possible feature that a customer may wish to include in an order. NEMA Members encourage customers to review this document and, where applicable, use the content to guide the development of their own purchasing specification materials.

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- a. **Power Rating.** The transformer capacity should be selected based upon an analysis of the existing load to be served combined with any future load growth.

Please define the rated capacity in units of kVA or MVA, which can be determined by multiplying the line current by the phase to neutral voltage. If the transformer is a single-phase design, the figure derived from the above equation is the rated capacity in VA (or kVA/MVA). If the transformer is a three-phase design, multiply the figure by 3 for the total capacity.

- b. **Frequency.** Specify the correct frequency for the transformer.
- c. **Primary taps.** Taps are used to match the transformer input voltage with the system voltage to maintain proper output voltage on the secondary. The most common tap configurations are (two above and four below at 2.5%), (two above and below at 2.5 %.), (one above and below at 5%). The manufacturer will notify the customer when design limitations prevent certain tap configurations. Taps shall be changed via removable links unless otherwise specified.
- d. **Single-Phase vs. Three-Phase.** Specify which phase is required.
- e. **Step-up vs. Step-down.** Specify the transformer's intended function.
- f. **Winding Connections/Vector Group.** Please provide the following information:
1. Specify a combination of Wye, Delta, and/or Zig-Zag. Common combinations and applications are below, but others exist as well:
 - a. Delta-Wye: the most common winding connection used widely for distribution and Industrial & Commercial applications.
 - b. Other common combinations and applications
 1. Wye-Wye: used in utility transformers and some special applications
 2. Wye-Delta: used in generator step-up, high voltage transmission step-down, and grounding transformers
 3. Delta-Delta: special applications (i.e., large, low-voltage transformers when a neutral phase is not required)
 4. Zig-Zag: used in grounding transformers
 5. Delta – Zig-Zag or Wye – Zig-Zag: used in phase-shifting and power flow control applications
 2. Specify terminal type (i.e., bushing or spade-type).
 3. Specify whether a stabilizing winding is required (3-phase only). Stabilizing delta windings are normally only considered for transformers having wye connections on the primary and all secondary connections. They are not necessarily required when four or five-leg core construction is used.
- g. **Standards.** Please list the standards that the transformer(s) must meet. As a minimum, we recommend NEMA ST 20, which covers dry-type transformers up to 1.2 kV class.
- h. **Temperature Rise.** Specify the average temperature rise rating for the transformer. The most common rating for resin encapsulated is 150°C. Other common optional ratings are 115°C and 80°C. For solid cast transformers, the most common rating is 115°C.
- i. **Winding Conductor.** Specify whether aluminum or copper windings are required.

- j. **Electrostatic Shield.** Specify if electrostatic shielding is required between the primary and secondary winding to attenuate common and transverse mode electrical noise. Indicate if a separate terminal is required for shield lead. The shield should extend the full length of the winding.
- k. **Insulation.** The standard basic insulation (impulse) level for dry-type transformers with winding voltages up to 1.2 kV is 10 kV BIL. Higher levels may be specified as required.
- l. **Terminals.** Please specify all the electrical characteristics and physical details required for the terminals, including specific locations as required (i.e., top front, high voltage front, low voltage back, etc.). Most of the terminals for low voltage transformers are standardized for each current rating. The Purchaser should specify if special terminals are required (manufacturer, type, and ratings (Current, Voltage, and BIL).
- m. **Accessories.** Please specify all the accessories required. The following list of options should be helpful:
 - 1. Enclosure type. Though most transformers are built with enclosures, some applications do not require them. Where necessary, please specify the following:
 - a. Indoor vs. Outdoor
 - b. NEMA 250 Designation
 - c. Material
 - d. Paint color
 - e. Stainless steel if required. (Specify grade as required)
 - f. Hinged doors
 - g. Lights
 - 1. Interior
 - 2. Exterior

The most common designations for LV dry-type transformers are listed below and are well suited for most applications. Specify floor, ceiling, or wall-mounted as required.

NEMA Designation	Description
Type 1	Standard indoor enclosure
Type 2	Indoor enclosure with protection from dripping
Type 3R	Indoor or outdoor use resistant to rain, snow, and sleet.
Type 4	Similar to Type 3R but resistant to hose-directed water or splashing water and windblown dust.
Type 4X	Same as Type 4 but with an added degree of protection from corrosive atmospheric agents. Often constructed of stainless steel.

- 2. Air Terminal Compartment (ATC) - Primary or Secondary
 - a. Flanged throat for connections (primarily for outdoor use)
 - b. Full height or not
 - c. Space heaters required with or without thermostats
 - d. Metering requirements
 - e. Cable entry location
 - f. Close coupling to switches
- 1. Grounding Pads and Material – Specify whether ground pads are required and, if so, what material.

2. Cooling Provisions
 - a. Fans/Blowers required
 - b. Provisions for future fans
 - c. Remote alarm contact
 - d. Power supply controlled by a transformer
 - e. Lockable fan control switch
 - f. Fans controlled by winding temperature

1. Current Transformers
 - a. Primary
 1. Quantity
 2. Multi-ratio?
 3. Metering – accuracy class
 - b. Secondary
 1. Quantity
 2. Multi-ratio?
 3. Metering – accuracy class

2. Potential Transformers – Please specify whether potential transformers are required

3. Alarms – Please specify whether alarms are required.

4. Control Devices
 - a. Nameplate Material
 - b. Labels
 - c. Monitors
 - d. Winding temperature indicators

5. Control Cabinet –Specify the location, wiring connections, and contents of control cabinet. Include any special terminal block connection requirements. Also, specify whether any of the following special options are required:
 - a. Branch circuit protection
 - b. Rigid conduits:
 1. Galvanized
 2. Liquid-tight
 - c. Space heater
 - d. Ammeter
 - e. Thermostat
 - f. Indicator light

6. Tap Changer
 - a. Off-load
 - b. On-load

7. Protection
 - a. Snubber circuits
 - b. Lightning arresters

When identifying required accessories, please also provide the following information for each accessory:

1. Approved accessory manufacturers
2. Approved models/types of accessories for each application

- 3. Required features for each accessory
- 4. Minimum requirements
 - a. Contacts
 - b. Communications ports
 - c. Accuracy (i.e., meters, potential or current transformers, etc.)
 - d. Longevity (design life)
 - e. Others if applicable
- 5. Location where accessory shall be mounted/installed
- 6. Wiring required
 - f. What needs to be connected
 - g. Type of wire to be used
 - h. Type of terminals to be used
 - i. Type of crimped lugs to be used
 - j. Others if applicable
- 7. Specific optional features required for each accessory (as applicable)

n. **Types of Cooling:** Please specify the cooling media using the following letter combinations based on IEEE C57.12.01:

Description	Cooling Class
Ventilated self-cooled	AN
Ventilated forced air-cooled	AF
Ventilated self-cooled/forced air-cooled	AN/AF
Non-ventilated self-cooled	ANAN
Sealed self-cooled	GNAN

- o. **Sound Levels.** Please reference the appropriate standards and tables to indicate sound level requirements: ST-20 or CSA C22.2 No. 47-13. If specific sound pressure levels are required, specify in dBA. If special sound levels are required, we recommend requesting a sound test and report.
- p. **Impedance.** Please specify the acceptable impedance range, which may be identified through a system fault or arc flash study.
- q. **Short-Circuit Withstand Characteristics and Capabilities.** Please reference the short-circuit withstand capabilities outlined in NEMA ST 20 Section 4.2.13.
- r. **Overload Profiles.** Please specify the overload criteria as a % of rated load, duration, and frequency (i.e., 120% of load for 4 hours, once every six hours).
- s. **Rating Plate.** Please reference NEMA ST 20 Section 3.25, which contains a list of information to be included on the nameplate. Also, specify any further information that the customer would like to appear on the nameplate beyond what is required in the Standard.
- t. **Ambient conditions.** Provide the following information for the specific application:
 - 1. Elevation above sea level
 - 2. Atmospheric contamination

3. Ambient temperature (minimum and maximum)
 4. Other relevant environmental factors
 5. Location – indoor or outdoor
- u. **Seismic requirements.** Provide the following information:
1. G-force level required
 2. Maximum lean angle on bushings
 3. Seismic certifying body
- v. **Special Requirements.** Provide the following information, if applicable:
1. Transport requirements
 2. Geomagnetically induced current withstand requirements
 3. Harmonics requirements (K Factor or Non-Linear Load Factor per IEEE C57.110)
- w. **Tests and test levels.** Factory tests should include all standard production tests as specified in NEMA ST 20, Section 4.1, Table 4-1
1. The following optional tests may also be provided: Temperature
 2. Sound Level
 3. Standard Impulse (BIL) test on all windings
- x. **Supply-voltage Wave Shape.** If the supply voltage is not approximately sinusoidal, specify what the transmission supply voltage wave shape is and what the maximum voltage and current distortion is that the transformer can be exposed to or needs to be designed for. Reference IEEE 519 and explain its applicability to the design, and if there will be conditions exceeding the IEEE 519 limits.

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