

I. PART 1 – GENERAL

1. SCOPE

- A. Ultra low loss isolation transformer with a higher efficiency than that required by US Department of Energy 10 CFR Part 431 (DOE 2016), optimized for energy efficiency over a wide load range.
 - 1. Losses 30% lower than required by NEMA TP-1. Certification of DOE 2016 minimum limits at 35% load, and meeting or providing a greater than DOE 2016 efficiency requirements, based on a Weighted Average Efficiency as noted under Part 2 Products, Para. D Key Requirements, Sub-Para. 3 of this specification.
 - 2. Rated for K-13 load profile to supply without de-rating or significant degradation in efficiency, any typical application where non-linear loads, such as computer equipment, are present.
 - 3. Optional harmonic mitigating model with low zero phase sequence impedance

2. APPLICABLE DOCUMENTS AND REFERENCES

- A. US Department of Energy 10 CFR Part 431 (DOE 2016), Energy Efficiency Program for Certain Commercial and Industrial Equipment
- B. ANSI/NEMA ST 20 – Dry Type Transformers for General Applications.
- C. ANSI/NEMA TP-1 – Guide for Determining Energy Efficiency for Distribution Transformers.
- D. ANSI/NEMA TP-2 – Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.
- E. IEEE C57.110-1998 – IEEE Recommended Practice for Establishing Transformer Capability When Supplying Non-Sinusoidal Load Currents.
- F. IEEE-1100 – IEEE Recommended Practice for Powering and Grounding Electronic Equipment.
- G. CSA C9 – Dry-Type Transformers.
- H. CAN/CSA-C802.2 – Minimum Efficiency Values for Dry-Type Transformers.

3. SUBMITTALS

- A. Submit product specifications including the following:
 - 1. Data sheets including
 - a. construction details with enclosure dimensions,
 - b. kVA rating, primary and secondary nominal voltages, voltage taps, unit weight,
 - c. basic performance characteristics with insulation class, temperature rise, core and coil materials,
 - d. impedances,
 - e. audible noise levels
 - 2. Dimensional drawings,
 - 3. Inrush current (typical 3 cycle recovery)
 - 4. Short circuit current data
 - 5. Efficiency data
 - a. No load and full load losses per NEMA ST20,
 - b. Efficiency data at 10%, 25%, 35%, 50%, 65% and 100% of nominal linear load (see Part 2 Products, Section 2 Verification, Para. B Weighted Average Performance Verification)
 - c. efficiency data at 35% of nominal linear load tested per NEMA TP-2,
 - d. weighted average efficiency per formula noted in Part 2 Products, Para. D Key Requirements, Sub-Para. 3.

- B. Submit copy of non-linear test program description and sample test report for approval before manufacturing. Type testing with copies of calculations will be acceptable.
- C. Submit certified copies of the standard production tests required by NEMA standards ST-20 and TP2 for each transformer for approval before shipment.
- D. Submit certified type test results for non-linear load testing for each size of transformer ordered on the project for approval before shipment.

II. PART 2 PRODUCTS

1. REQUIREMENTS

- A. Acceptable Product and Manufacturer:
 - 1. ULLTRA™ Isolation Transformer made by MIRUS International Inc.
 - 2. Alternates or substitutions will be permitted upon verification that the alternative offering meets or exceeds all specification requirements, including document submittal requirements and that they are submitted in sufficient time to receive written approval by the engineer at least 10 days before bid closing.
- B. Voltage and kVA Requirements:
 - 1. Primary Voltage: [480] [600] [other] Volts
 - 2. Secondary Voltage: [120/208] [other] Volts
 - 3. kVA rating: [15] [30] [45] [75] [112.5] [150] [225] [300] [500] [750] [other] kVA
 - 4. System Frequency: 60 [50] [other] Hertz
- C. Basic Requirements:
 - 1. Three-phase isolation transformer built to NEMA ST20 and relevant NEMA, UL, CSA and ANSI/IEEE standards.
 - 2. UL listed, and CSA approved.
 - 3. Common core construction.
 - 4. Convection air-cooled.
 - 5. Copper Windings only, Aluminum Windings are not acceptable.
 - 6. Insulation Class: 220°C system, (15 kVA and 30 kVA transformers have 200°C insulation class).
 - 7. Temperature rise: 115°C, [80°C] in a 40 degrees C maximum ambient.
 - 8. K-rating: K-13 at 150°C rise. K-9 for Low Load model.
 - 9. Maximum magnetizing inrush current: < 8x full load rms
 - 10. Taps: for 15kVA and all 208V primary: $\pm 1 \times 5\%$ (1FCAN, 1FCBN); for 30kVA up to 300kVA: $+ 2 \times 2.5\%$, $- 4 \times 2.5\%$ (2FCAN, 4FCBN); for 500kVA to 750kVA: $\pm 2 \times 2.5\%$ (2FCAN, 2FCBN).
 - 11. Sound levels 3dB below NEMA Std. ST-20: max. 42dB up to 45 kVA, 47 dB from 75 to 150 kVA, 52 dB from 225 to 300 kVA, 57dB for 500 kVA, and 61 dB for 750 kVA.
 - 12. Enclosure: NEMA 3R, ventilated, sprinkler-proof. [Other]. Colour: Grey
 - 13. Anti-vibration pads shall be used between the core and the enclosure.
 - 14. Single electrostatic shield: 60dB attenuation.
- D. Key Requirements:
 - 1. Secondary neutral connection rated at 200% of the rated secondary phase current
 - 2. No Load losses shall not exceed:

[Select the below text if specifying Wide Load Range Transformer]

15 kVA: 75 watts,
30 kVA: 115 watts,
45 kVA: 150 watts,
75 kVA: 225 watts,
112.5kVA: 320 watts,
150 kVA: 400 watts,
225 kVA: 560 watts,
300 kVA: 710 watts

[Select the below text if specifying Low Load Range Transformer]

15 kVA: 50 watts,
30 kVA: 90 watts,
45 kVA: 120 watts,
75 kVA: 170 watts,
112.5kVA: 250 watts,
150 kVA: 310 watts,
225 kVA: 430 watts,
300 kVA: 530 watts

Submit for approval before shipment certified type test results for maximum no load losses for each size of transformer ordered on the project.

3. Linear load efficiency at 35% shall not be less than DOE 2016 Energy Efficiency Requirements. A Weighted Average Efficiency Index Abstract must be provided for each transformer capacity rating and design that highlights the overall efficiency rating of the transformer based on the following calculations:

[Select the below text if specifying Wide Load Range Transformer]

Weighted Average Efficiency =
 $(0.01 \times \eta_{10\%}) + (0.03 \times \eta_{25\%}) + (0.22 \times \eta_{35\%}) + (0.50 \times \eta_{50\%}) + (0.22 \times \eta_{65\%}) + (0.02 \times \eta_{100\%})$

[Select the below text if specifying Low Load Range Transformer]

Weighted Average Efficiency =
 $(0.05 \times \eta_{10\%}) + (0.35 \times \eta_{25\%}) + (0.52 \times \eta_{35\%}) + (0.05 \times \eta_{50\%}) + (0.03 \times \eta_{65\%}) + (0.00 \times \eta_{100\%})$

The calculated Weighted Avg. Efficiency shall exceed the DOE 2016 35% loading efficiency level for the appropriate transformer sizing.

The following minimum efficiency levels shall be met for the above weighted average:

15 kVA: 97.9%
30 kVA: 98.25%
45 kVA: 98.39%
75 kVA: 98.6%
112.5kVA: 98.74%
150 kVA: 98.81%
225 kVA: 98.95%
300 kVA: 99.02%

4. Positive & negative sequence impedance at 60Hz:
2.0% to 3.5% (up to 75 kVA), 2.5% to 5% (112.5 kVA to 150 kVA), 3.0% to 6% (225 kVA to 300 kVA), 4.5% to 7% (500kVA) 5% to 8% (750 kVA to 1000kVA).

E. Other Requirements:

1. [OPTION] For harmonic mitigating model (ULL-H1E), zero sequence impedance and reactance at 60Hz shall not exceed:
 $Z_0 < 0.95\%$, $X_0 < 0.3\%$ for sizes up to 150 kVA, $Z_0 < 1.0\%$, $X_0 < 0.5\%$ for sizes 225 kVA and 300 kVA, $Z_0 < 1.5\%$, $X_0 < 0.5\%$ for 500 kVA and $Z_0 < 2.0\%$, $X_0 < 1.0\%$ for 750 kVA.
2. [OPTION] Dual electrostatic shields.

3. [OPTION] Over-Temperature switch[es] wired to internal terminal strip. Temperatures specified for use with class 220°C insulation systems. Standard configuration is N.C. opening [N.O. closing] on high temperature. Number of switches: [one switch: 170°C or 200°C on center coil] [two switches: 170°C and 200°C on center coil] [six switches: one 170°C and one 200°C on each of the 3 coils.]
4. [OPTION] Submit for approval before shipment certified production test results with serial numbers for linear load efficiency at 35% load for one of each size of transformer manufactured for the actual project.
5. [OPTION] Submit for approval before shipment certified production test results with serial number for non-linear load testing up to the lesser of either full load or 225kVA for one of each size of transformer manufactured for the project.

2. VERIFICATION

A. Non-linear Load Testing Capability:

1. Manufacturer must have a non-linear load testing program operating in the production environment. A detailed description of the program and a sample non-linear test report must be submitted to the Engineer in enough time for him to issue his written approval at least 10 days before bid closing. The non-linear load bank shall consist of three single-phase power electronic rectifier loads that present the same current harmonics (fundamental plus 3rd, 5th, 7th, 9th, 11th, etc.) as the 120VAC personal computer power supply loads present in workplaces today. The non-linear load bank shall be capable of presenting current distortion levels up to 100% and a load of up to 75 kVA on each phase-to-neutral leg to test a 225-kVA transformer at full load and larger transformers at a reduced load. Dual watt meters and CT sets shall be used to monitor transformer input and output power with revenue class accuracy. Measurements shall include input and output power, kVA, and efficiency plus input and output current and voltage distortion and k-factor. This information shall be presented in graphical form.

B. Weighted Average Performance Verification:

1. Manufacturer must submit in writing type testing to verify 35% loading efficiency requirements per DOE 2016 for each transformer capacity and rating to be supplied on the project. In addition, weighted average test verification and computation, as well as, individual load efficiency testing and calculation data shall be submitted via certified documentation during the submittal process. Failure to provide verifiable data along with the submittal materials will warrant disapproval of the submittal. Additional verification via actual test data may be required by the customer/engineering firm at their sole discretion.

3. WARRANTY

- A. Transformer shall carry a 25-year pro-rated warranty, which shall be standard for the product line.

III. PART 3 EXECUTION

1. INSTALLATION

- A. The installing contractor shall install the ultra low loss transformer per the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual and comply with all applicable codes.

2. ACCEPTANCE

- A. [OPTION] Manufacturer's representative shall visit site, verify installation, and submit to owner a letter stating equipment and installation meets intent of specification and manufacturer's warranties and guarantees are in effect.

***** END OF SECTION *****