



Typical Specification

1.2kV Class Energy Efficiency Dry-Type Harmonic Mitigating Transformers

**Compliant to DOE 10, CFR Part 431
(effective as of January 1st, 2016),
NRCan-EE act SOR/2018-201 amend.14
(effective as of April 30th, 2019)
and
ON Reg.404-12 sch.6
(effective as of January 1st, 2018)**

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1 **GENERAL**

1.1 SCOPE

- A This section defines dry-type low voltage, super low loss transformers designed to (where applicable) meet the following regulations:
 - i DOE 10 CFR Part 431 January 1st, 2016 efficiency levels defined in the U.S. Department of Energy, Energy Conservation Program; Distribution Transformers Energy Conservation Standards DOE 10 CFR Part 431 as published in the Federal Register No. 2013-08712 / Vol. 78, No. 75 / Thursday, April 18, 2013 / Rules and Regulations, and
 - ii NRCan (Natural Resources Canada), Energy Efficiency Act SOR/2018-201, amendment 14 effective April 30th, 2019.
 - iii Ontario Green Energy Act, revised by ON Reg.404-12 effective January 1st, 2018
- B The transformers shall be designed, constructed and 'K-rated' in accordance with UL, CSA and NEMA standards as per their temperature capability.

1.2 NON LINEAR LOADS DEFINITION

- A Non-Linear loads and K-factor are defined as per UL 1561 & further explained in IEEE 519 Harmonic Spectrum for Switching Power supply, IEEE C57.110 and IEEE 1100.

1.3 RELATED DOCUMENTS

- A Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section

1.4 REFERENCES

- A NEMA ST-20 Dry-Type Transformer for General Applications.
- B IEEE C57.110 Recommended Practice for establishing transformer capability when feeding non-sinusoidal load currents.
- C DOE 10 CFR Part 431 Efficiency Standards; (before DOE referred to as TP1), CSA C802.2 as referenced in the Canadian Energy Efficiency Regulations SOR/94-651.
- D UL 1561, CSA C9-02 and C22.2 No. 47.
- E Natural Resources Canada, Canada Energy Efficiency Act, Energy Efficiency Regulations, SOR/2018-201 amendment 14 April 30th, 2019.
- F Ontario Green Energy Act, revised by ON Reg.404-12 schedule 6 effective January 1st, 2018, last amendment O.Reg.318/17, August 1, 2017

1.5 ENERGY EFFICIENCY LEVELS

- A DOE 2016 Low Voltage Energy Efficiency levels as per DOE 10 CFR Part 431 – effective Jan. 1, 2016.
- B NRCan 2019 effective as of April 30th, 2019 and ON Reg.404-12 – effective as of Jan. 1, 2018 (in Ontario)

1.6 TESTING & QUALITY CONTROL:

- A Production tests: each unit according to:
 - NEMA ST-20, CSA C9 & C22.2 No. 47
 - DOE 10 CFR Part 431 sub part K and NEMA TP2
- B Test each model design and submit report on request
- C Standard production tests to include:
 - Applied potential test

- Induced voltage test
 - Impedance voltage and load loss test
 - Voltage ratio test
 - No load and excitation current test
- D Additional type test should be made available on request include:
- Short circuit test, BIL – basic impulse insulation level test
 - Partial discharge test
 - Sound level test
 - Temperature rise test

1.7 SUBMITALS

- A Submit shop drawing and product data for approval and final documentation in the quantities listed according to the Conditions of the contract. Customer name, customer location and customer order number shall identify all transmittals.
- B Product Data including kVA rating, average winding temperature rise, detailed enclosure dimensions, primary & secondary nominal voltages, primary voltage taps, no load & full load losses, impedances, unit weight, warranty.

1.8 STORAGE AND HANDLING

- A Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions.
- B Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.

1.9 WARRANTY

- A The transformer shall carry a 10 year limited warranty.
(For details, refer to the manufacturers published warranty)

2 **PRODUCTS**

2.1 GENERAL CONSTRUCTION:

- A Three phase transformers shall be ventilated type. Convection air cooled. All three phase transformers shall be constructed with three coils and a single core. The primary side of each transformer shall, if applicable, be provided with taps that meet or exceed NEMA standards.
- B Transformers shall be designed, constructed and rated in accordance with UL, CSA and NEMA standards. If shipping to Europe, transformer will carry a CE mark
- C Scott-T designs no acceptable

2.2 HARMONIC MITIGATION REQUIREMENTS

- A Single output Harmonic Mitigating Isolation Transformers with low zero sequence output impedance are designed to reduce the voltage distortion created by the 3rd and other triplen harmonic currents:
- i 3rd, 9th & 15th harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes. Simply trapping these currents in the delta primary winding is NOT acceptable.
 - ii For 5th, 7th, 17th & 19th harmonics provide the appropriate primary-secondary phase shift in order to cancel these harmonic currents with those of other loads fed from the same primary supply.

- iii The Harmonic Mitigation shall be obtained by electromagnetic means only. No capacitors or electronics shall be used.
 - iv Evidence of relevant application experience must be available upon request.
- B Dual output Harmonic Mitigating Transformers are designed to eliminate the harmful effects of all the low frequency, odd order harmonic currents from the 3rd through 21st:
- i 3rd, 9th & 15th harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes. Simply trapping these currents in the delta primary winding is NOT acceptable.
 - ii 5th, 7th, 17th & 19th harmonics will be cancelled in the flux of the secondary winding at low impedance with loads distributed in both outputs.
 - iii The Harmonic Mitigation shall be by electromagnetic means only. No capacitors or electronics shall be used.
 - iv Evidence of relevant application experience must be available upon request.

2.3 VOLTAGE AND kVA REQUIREMENTS:

- A Primary Voltage: Three Phase - [208], [480], [600], [other] Volts
- B Secondary Voltage: Three Phase - [208Y/120], [480Y/277], [600Y/347], [other] Volts
- C kVA Rating: Three Phase – [15], [30], [45], [75], [112.5], [150], [225], [300], [500], [750], [1000], [1250], [1500], [other] kVA
- D System Frequency: 60, [50], [other] Hertz

2.4 KEY REQUIREMENTS:

- A Positive & negative sequence impedance at 60Hz:
2.0% to 6.0% (up to 300kVA), 3.5% to 7% (500kVA and up)
- B Zero sequence impedance/reactance at 60Hz:
 - i <0.95% and <0.3% respectively for sizes up to 150kVA:
 - ii <1.0% and <0.5% respectively for 225kVA and 300kVA;
 - iii <1.5% and <1.0% for 500kVA
- C Non-Linear load profile: Standard K13 rating for non-linear loads, 60Hz.
- D Efficiencies:
 - i Meets efficiency levels defined (where applicable) in accordance with U.S. Department of Energy, DOE 10 CFR Part 431 in effect on January 1st, 2016 and
 - ii NRCAN (Natural Resources Canada), Energy Efficiency Act SOR/2018-201, amendment 14 effective April 30th, 2019 and
 - iii Ontario Green Energy Act, revised by ON Reg.404-12 effective January 1st, 2018
 - iv Energy efficiency levels defined at 35% of full rated load
 - v Efficiencies, no-load losses, load losses and impedance values will be calculated at temperature reference of 75°C at Unity Power Factor (UPF).
- E Electrostatic shield for common noise attenuation.
 - i 60 dB Common Mode electrical noise attenuation.
 - ii 10 dB Transverse Mode electrical noise attenuation.
- F Load compatibility: up to K20 load profile, Crest Factor up to 5.
- G Secondary Windings: Single [Dual]
- H Primary to secondary phase-shift:
 - i Single output units - upstream cancellation of 5th & 7th harmonics: [0°] [30°]. Windings configured to provide primary-to-secondary phase shift of -30° or 0° (as specified on drawing).
 - ii Dual output units - upstream cancellation of 11th & 13th harmonics: [0°] [15°]. Windings configured to provide primary-to-secondary phase shift of 0° & -30° or -15° & -45° (as specified on drawing).
- I Reduction of fundamental current imbalance from secondary to primary of transformer.

- J Primary to secondary voltage distortion reduction shall be certified and tested with a non-linear Test Bench.
- K Non-linear performances shall be certified and tested with a non-linear test bench.
- L In-rush currents not to exceed 15 x RMS.

2.5 BASIC REQUIREMENTS:

- A Insulation Class: 220°C
- B Temperature Rise: 150°C [130°C], [115°C], [80°C], [other].
- C Taps: To NEMA ST 20 [2 x ± 5% (1FCAN, 1FCBN)], [4 x ± 2.5% (2FCAN, 2FCBN)], [2 x +2.5%, 4 x -2.5% (2FCAN, 4FCBN)], [none], [other].
- D Secondary neutral connections rated at 200% of the rated secondary phase current.
- E Core construction: high grade non-aging, fully processed silicon steel laminations or better
- F Coil conductors: continuous copper [aluminum] windings, with terminations brazed, welded or bolted.
- G Impregnation: vacuum pressure impregnated core & coils.
- H Excitation current: 5% of full load current rating (max.)
- I Sound level: as per NEMA ST-20.
- J Enclosure: ventilated, Type 3R, [other]; Enclosure Finish: ANSI 61 Grey suitable for UL50 outdoor applications [other].
- K Transformers shall terminate in mounting pads or mechanical lugs. Primary and secondary terminations are to have terminals on the same side of the transformer mounted on separate insulated supports, with the HV terminations in the upper half of the enclosure and LV terminations in the lower half. Mechanical type lugs shall be included on primary, secondary and neutral customer terminations on all aluminum and copper units up to and including 270 amp ratings. Contractors shall provide all necessary lugs not already provided with transformer.
- L Anti-vibration pads/isolators shall be used between the transformer core and coil and the enclosure.
- M UL listed, CSA approved, [CE Mark].
- N 10 kV BIL for both MV and LV coils of all 3 PH transformers.
- O Built to NEMA ST-20 and in accordance with all applicable UL, CSA and ANSI/IEEE standards.
- P Ground core & coil assembly to enclosure with a flexible copper grounding strap or equivalent. Cannot block ventilation slots per N.E.C. 2014. Mounting:
 - i Ventilated units up to 750 lbs.: Suitable for wall, floor or ceiling mounting (drip plate required).
 - ii Ventilated units over 750 lbs.: Suitable for floor mounting only.
- Q Transformers shall be designed and seismically qualified according to the International Building Code (IBC) 2018, and the American Society of Civil Engineers ASCE 7-16 specifications. Compliance must be demonstrated by testing. (Applicable to floor mounted units only.)

Transformers can be designed to be approved for O.S.H.P.D California.

OPTIONS:

- Electrostatic shielding: [double] [triple]
- Vibration Isolators
- Low Sound level: [-3 dB], [-5 dB], [-8 dB], [other]
- Enclosures: [Type 3R – Stainless Steel], [Type 3R – Enhanced], [Type 4], [Type 4X Stainless Steel], [Type 12], [other].
- Over-Temperature switches wired to internal terminal strip. Temperatures specified for use with class 220°C insulation systems. Standard configuration is N.C. opening on high temperature. Optional configuration is N.O. closing on high temperature. Installation options: [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].
- Strip Heater

- Marine Duty (meet ABS requirements)
- SPD (Surge Protection Device)

2.6 ACCEPTABLE PRODUCT AND MANUFACTURER:

- A ***HPS Sentinel® H3*** brand transformers or similar manufactured by: Hammond Power Solutions Inc. (Canada: 1-888-798-8882 / U.S.: 1-866-705-4684)
- B Substitutions are permitted, subject to meeting all requirements of this specification and also a written approval from the Consulting Engineering firm at least 10 days prior to bid closing.

3 **EXECUTION**

3.1 INSTALLATION

- A The installing contractor shall install the HPS Energy Efficient Harmonic Mitigating Transformer per the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual in compliance with all applicable national and local codes.
- B Transformers cannot be back (reverse) fed unless specifically designed for and marked accordingly.
- C Make sure that the transformer is levelled.
- D Check for damage and loose connections.
- E Mount transformer to comply with all applicable codes.
- F Install optional vibration isolation pads between transformer enclosure and the mounting surface as needed.
- G Install seismic restraint where indicated on the drawing.
- H Coordinate all work in this section with all work of other sections.
- I Prior to putting transformer into service, verify secondary voltages and if necessary adjust primary taps.