

**PART 1 – GENERAL****1.1 Harmonic Mitigating Isolation Transformer with efficiency per NEMA Std. TP-1 over a wide load range.**

- .1 Transformer efficiency shall satisfy requirements at not just 35% load as required by NEMA Std. TP-1, but also over the operating range from 35 to 65% load.
- .2 Treatment of triplen (3<sup>rd</sup>, 9<sup>th</sup>, and 15<sup>th</sup>) harmonic load currents: Secondary winding configuration must cancel fluxes due to zero sequence harmonic currents without coupling them to the primary winding.
- .3 Treatment of 5<sup>th</sup>, 7<sup>th</sup>, 17<sup>th</sup> & 19<sup>th</sup> harmonics: Supply transformers with phase shifts of 0 and –30 degrees as indicated on the drawings. Harmonic currents from one transformer non-linear load will subtract from those of another transformer with opposite phase shift when they meet on their primary side common feeder
- .4 Harmonic mitigation shall be by electromagnetic means only. No capacitors or electronics shall be used.
- .5 Evidence of relevant application experience must be available upon request.
- .6 Non-linear Load Testing Capability: 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 at least 10 days prior to bid closing to allow sufficient time for written approval. The non-linear load bank shall consist of three single-phase power electronic rectifier loads that present the same current harmonics (fundamental plus 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup>, 9<sup>th</sup>, 11<sup>th</sup>, 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 75kVA on each phase-to-neutral leg in order to test a 225 kVA transformer at full load and larger transformers at a reduced load. Dual wattmeters 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.

**1.2 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 [other] Hertz

**1.3 Submittals:**

- .1 Submit specifications, data sheets, dimensional drawings, non-linear test program description and sample test report for approval before manufacturing
- .2 Submit certified copies of the standard production tests required by NEMA standards ST-20 and TP2 for each transformer for approval before shipment.
- .3 Submit certified type test results for linear load efficiency from 35 to 65% load for each size of transformer ordered on the project for approval before shipment.
- .4 Submit certified type test results for non-linear load testing up to the lesser of either full load or 225kVA for each size of transformer ordered on the project for approval before shipment
- .5 Do not commence manufacturing or shipping without the appropriate technical approval from the engineer and scheduling approval from the purchaser

**1.4 Applicable Standards (Latest Edition):**

- .1 NEMA ST-20 – Dry Type Transformers for General Applications
- .2 NEMA TP1 – Guide for Determining Energy Efficiency for Distribution Transformers
- .3 NEMA TP2 – Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- .4 CSA C9 – Dry-Type Transformers
- .5 CAN/CSA-C802.2 – Minimum Efficiency Values for Dry-Type Transformers

**PART 2 – PRODUCT****2.1 Key Requirements:**

- .1 Positive & negative sequence impedance at 60Hz:  
2.8% to 3.5% (up to 75 kVA), 3.2% to 4.5% (112.5 to 300 kVA), 5.0% to 6.0% (500kVA), 6 to 6.75% (750kVA).
- .2 Zero sequence impedance and reactance at 60Hz:  $\leq 0.95\%$  and  $0.3\%$  for up to 150 kVA,  $\leq 1.0\%$  and  $0.5\%$  for 225 kVA and 300 kVA,  $\leq 1.5\%$  and  $1.0\%$  for 500kVA,  $\leq 2.0\%$  and  $1.5\%$  for 750 kVA.
- .3 Load compatibility: K factor up to 20, Crest factor up to 4.5
- .4 Secondary neutral connection rated at 200% of the rated secondary phase current
- .5 Linear Load Efficiency: Comply to NEMA Std. TP-1 requirement for efficiency at 35% load and for the operating range from 35% to 65% linear load: 97.0% at 15 kVA, 97.5% at 30 kVA, 97.7% at 45 kVA, 98.0% at 75 kVA, 98.2% at 112.5kVA, 98.3% at 150 kVA, 98.5% at 225 kVA, 98.6% at 300 kVA, 98.7% at 500 kVA, 98.8% at 750 kVA. Submit for approval before shipment certified type test results for linear load efficiency from 35 to 65% load for each size of transformer ordered on the project.
- .6 Non-linear Load Testing: Submit for approval before shipment certified type test results for non-linear load testing up to the lesser of either full load or 225kVA for each size of transformer ordered on the project.

**2.2 Basic Requirements:**

- .1 Three-phase, common core construction. Convection air-cooled
- .2 Copper Windings
- .3 Insulation Class: 220°C system, (15kVA and 30kVA transformers have 200°C insulation class)
- .4 Temperature rise: 130°C [115°C] [other]
- .5 Taps:  $2 \times \pm 2.5\%$  (2FCAN, 2FCBN) for 30 kVA and larger,  $1 \times \pm 5\%$  for 15 kVA and all 208V primary
- .6 Sound level per NEMA Std. ST-20: max. 45dB up to 45 kVA, 50 dB from 75 to 150 kVA, 55 dB from 225 to 300 kVA, 60dB for 500 kVA, and 64 dB for 750 kVA.
- .7 Enclosure: NEMA 3R, ventilated, sprinkler-proof. [Other]. Colour: Grey
- .8 Anti-vibration pads shall be used between the core and the enclosure
- .9 Single electrostatic shield: 60dB attenuation
- .10 UL listed and CSA approved
- .11 Built to NEMA ST-20 and in accordance with all applicable UL, CSA and ANSI/IEEE standards
- .12 Warranty: 10 year pro-rated, with standard limited liability clauses

**2.3 Other Requirements:**

- .1 [OPTION] [Provide with second electrostatic shield.]
- .2 [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]
- .3 [OPTION] Submit for approval before shipment certified production test results with serial numbers for linear load efficiency from 35 to 65% load for one of each size of transformer manufactured for the actual project.
- .4 [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.

**2.4 Acceptable Product and Manufacturer:**

- .1 HARMONY-1E™ Nema TP1 Compliant Harmonic Mitigating Transformer by MIRUS International Inc.
- .2 No alternates or substitutions will be permitted unless they meet all the requirements of this specification, 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.

**PART 3 – EXECUTION****3.1 Installation**

- .1 The installing contractor shall install the Harmonic Mitigating Transformer per the manufacturer's recommended installation practices as found in the installation, operation, and maintenance manual and comply with all applicable codes.

**3.2 Acceptance**

- .1 [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.