SECTION 3

# NON-LINEAR LOAD ISOLATION® TRANSFORMERS

**Special winding techniques minimize eddy current losses. A double sized neutral handles excessive neutral currents. UL Listed for "K" Factor Loads 4, 13 & 20.**

# Non-Linear Load Isolation® Transformers

## FEATURES

- Available in K-factors of 4, 13 and 20. Consult factory for other K-factors.
- 150°C, 115°C and 80°C temperature rise units.
- 10-year limited warranty.
- UL Listed and CSA Certified.
- Available in 480V and 600V primary, 15 through 600 kVA.
- Primary taps: (2) 2 ½% ANFC, (4) 2 ½% BNFC.
- Aluminum windings

Non-linear loads generate high levels of harmonic currents. When supplying power to these loads, a special transformer design is necessary.

Typical non-linear loads include desktop computers, AC variable speed drives, HID lighting, electronic ballasts, inverters and welders. Of these non-linear loads, the major source of harmonic currents is the switch mode power supply found in desktop computers, data processors and other office equipment.

Acme non-linear load isolation transformers use special winding techniques to minimize eddy current losses generated by harmonic currents. A double-sized neutral conductor handles the excessive neutral current found in non-linear load applications.

The amount of harmonics produced by a given load is represented by the term “K” factor. The larger the “K” factor, the more harmonics are present. Linear loads have a “K” factor of 1; switch mode power supplies typically have a “K” factor as high as 20.

Acme non-linear load isolation transformers are shielded for cleaner power and carry the Acme exclusive 10-year limited warranty.

The following guide will help you select the proper transformer when the K-factor is unknown.*

## K-Factor/Type of Load

**K-1** Resistance heating
Incandescent lighting
Motors
Transformers, control/distribution

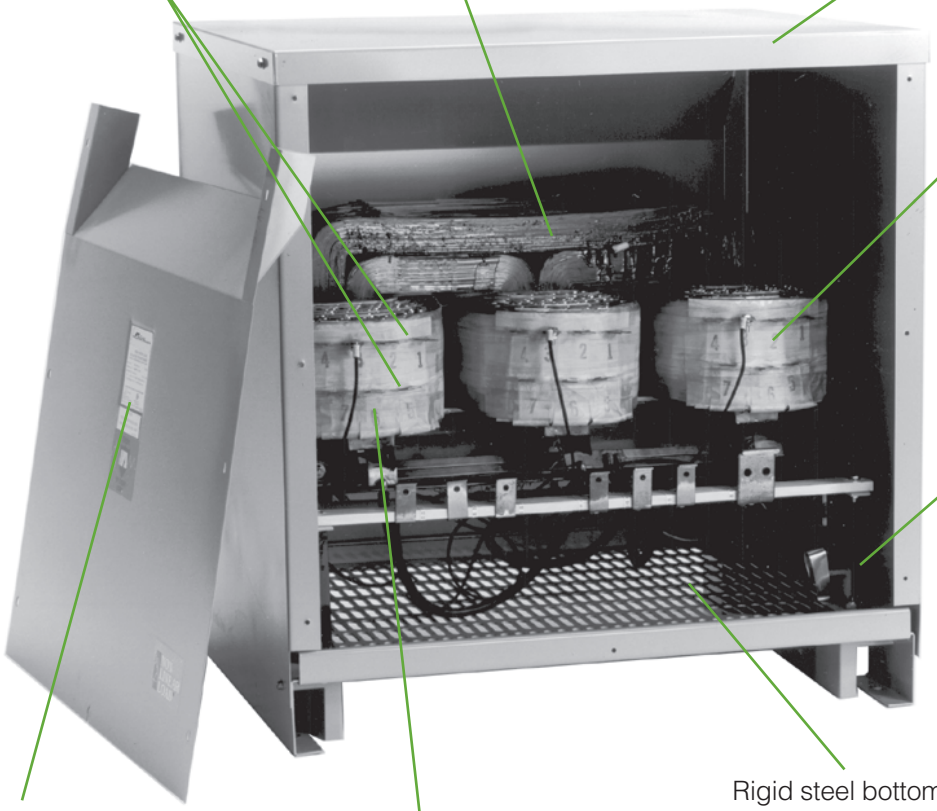
**K-4** Welders
Induction heaters
HID lighting
Fluorescent lighting
Solid state controls

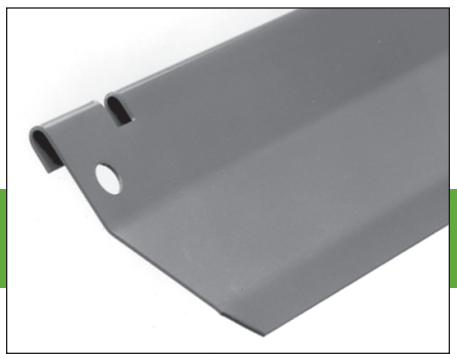
**K-13** Telecommunications equipment
Branch Circuits in classrooms and health care facilities

**K-20** Main frame computers
Variable speed drives
Branch circuits with exclusive loads of Data Processing equipment
Desktop computers

* These ratings are to be used as a guide only. They may vary from one load equipment manufacturer to another. A Spectrum Analysis is the best source.

**Note:** Non-sinusoidal and non-linear are synonymous terms relating to the same transformer type.



Weather shields are available from stock and are easily field-installed to make the transformer weather resistant.

Double-sized neutral conductor handles excessive neutral currents

## SELECTION CHARTS

THREE PHASE

### GROUP A, K FACTOR 20, 150°C RISE

#### 480 DELTA PRIMARY VOLTS — 208Y/120 SECONDARY VOLTS — 3Ø, 60 Hz

| kVA | CATALOG NO. | APPROX. DIMENSIONS ② Inches (Cm.) HEIGHT | WIDTH | DEPTH | APPROX. SHIP WEIGHT Lbs. (Kg.) | TYPE MTG. W – Wall F – Floor | WEATHER SHIELD P/N | Wiring Diagrams & Design Figures Begin on Page 122 |
|---|---|---|---|---|---|---|---|---|
| 15.0 | TPNS02533113S | 25.50 (64.8) | 24.40 (62.0) | 19.40 (49.3) | 325 (147.0) | F ① | WSA1 | 22–E |
| 30.0 | TPNS02533123S | 25.50 (64.8) | 24.40 (62.0) | 19.40 (49.3) | 420 (191.0) | F ① | WSA1 | 22–E |
| 45.0 | TPNS02533133S | 35.90 (91.2) | 31.90 (81.0) | 26.88 (68.3) | 575 (261.0) | F | WSA3 | 22–E |
| 75.0 | TPNS02533143S | 35.90 (91.2) | 31.90 (81.0) | 26.88 (68.3) | 620 (281.0) | F | WSA3 | 22–E |
| 112.5 | TPNS02533153S | 41.52 (105.5) | 32.90 (83.6) | 29.88 (75.9) | 1200 (544.0) | F | WSA4 | 22–E |
| 150.0 | TPNS02533163S | 41.52 (105.5) | 32.90 (83.6) | 29.88 (75.9) | 1700 (771.0) | F | WSA4 | 22–E |
| 225.0 | TPNS02533173S | 45.60 (115.8) | 39.50 (100.3) | 35.50 (90.2) | 2165 (982.0) | F | WSA5 | 22–G |

Notes: All TPNS models are TP1 compliant

### GROUP B,K FACTOR 13, 150°C RISE

#### 480 DELTA PRIMARY VOLTS — 208Y/120 SECONDARY VOLTS — 3Ø, 60 Hz

| kVA | CATALOG NO. | APPROX. DIMENSIONS ② Inches (Cm.) HEIGHT | WIDTH | DEPTH | APPROX. SHIP WEIGHT Lbs. (Kg.) | TYPE MTG. W – Wall F – Floor | WEATHER SHIELD P/N | Wiring Diagrams & Design Figures Begin on Page 122 |
|---|---|---|---|---|---|---|---|---|
| 15.0 | TPNS01533113S | 25.50 (64.8) | 24.40 (62.0) | 19.40 (49.3) | 325 (147.0) | F ① | WSA1 | 22–E |
| 30.0 | TPNS01533123S | 29.90 (75.9) | 28.15 (71.5) | 22.37 (56.8) | 360 (163.0) | F ① | WSA2 | 22–E |
| 45.0 | TPNS01533133S | 29.90 (75.9) | 28.15 (71.5) | 22.37 (56.8) | 440 (200.0) | F ① | WSA2 | 22–E |
| 75.0 | TPNS01533143S | 35.90 (91.2) | 31.90 (81.0) | 26.88 (68.3) | 600 (272.0) | F | WSA3 | 22–E |
| 112.5 | TPNS01533153S | 41.52 (105.5) | 32.90 (83.6) | 29.88 (75.9) | 870 (395.0) | F | WSA4 | 22–E |
| 150.0 | TPNS01533163S | 41.52 (105.5) | 32.90 (83.6) | 29.88 (75.9) | 1500 (680.0) | F | WSA4 | 22–E |
| 225.0 | TPNS11533173S | 45.60 (115.8) | 39.50 (100.3) | 35.50 (90.2) | 1550 (703.0) | F | WSA5 | 22–E |

Notes: All TPNS models are TP1 compliant

### GROUP C, K FACTOR 4, 150°C RISE

#### 480 DELTA PRIMARY VOLTS — 208Y/120 SECONDARY VOLTS — 3Ø, 60 Hz

| kVA | CATALOG NO. | APPROX. DIMENSIONS ② Inches (Cm.) HEIGHT | WIDTH | DEPTH | APPROX. SHIP WEIGHT Lbs. (Kg.) | TYPE MTG. W – Wall F – Floor | WEATHER SHIELD P/N | Wiring Diagrams Design Figures Begin on Page 122 |
|---|---|---|---|---|---|---|---|---|
| 15.0 | TPNS00533113S | 25.50 (64.8) | 24.40 (62.0) | 19.40 (49.3) | 325 (147.0) | F ① | WSA1 | 22–E |
| 30.0 | TPNS00533123S | 29.90 (75.9) | 28.15 (71.5) | 22.37 (56.8) | 345 (157.0) | F ① | WSA2 | 22–E |
| 45.0 | TPNS00533133S | 29.90 (75.9) | 28.15 (71.5) | 22.37 (56.8) | 430 (195.0) | F ① | WSA2 | 22–E |
| 75.0 | TPNS00533143S | 35.90 (91.2) | 31.90 (81.0) | 26.88 (68.3) | 560 (254.0) | F | WSA3 | 22–E |
| 112.5 | TPNS00533153S | 41.52 (105.5) | 32.90 (83.6) | 29.88 (75.9) | 875 (397.0) | F | WSA4 | 22–E |
| 150.0 | TPNS00533163S | 41.52 (105.5) | 32.90 (83.6) | 29.88 (75.9) | 1550 (703.0) | F | WSA4 | 22–E |
| 225.0 | TPNS10533173S | 45.60 (115.8) | 39.50 (100.3) | 35.50 (90.2) | 1600 (725.8) | F | WSA5 | 22–E |

Notes: All TPNS models are TP1 compliant

① Wall mounting brackets are available for these sizes, refer to page 133.

② Dimensions in this section may change and are not to be used for detailed construction purposes. Please contact the factory for certified dimensional drawings.

## GROUP H, K FACTOR 13, 115°C RISE

### 480 DELTA PRIMARY VOLTS — 208Y/120 SECONDARY VOLTS — 3Ø, 60 Hz

| kVA | CATALOG NO. | APPROX. DIMENSIONS ② Inches (Cm.) | | | APPROX. SHIP WEIGHT | TYPE MTG. W – Wall | WEATHER SHIELD | Wiring Diagrams & Design Figures |
|---|---|---|---|---|---|---|---|---|
| | | HEIGHT | WIDTH | DEPTH | Lbs. (Kg.) | F – Floor | P/N | Begin on Page 122 |
| 30.0 | TPNS01533121S | 29.90 (75.9) | 28.20 (71.6) | 22.40 (56.9) | 400 (181.0) | F ① | WSA2 | 22–E |
| 45.0 | TPNS01533131S | 35.90 (91.2) | 31.90 (81.0) | 26.90 (68.3) | 575 (261.0) | F | WSA3 | 22–E |
| 75.0 | TPNS01533141S | 35.90 (91.2) | 31.90 (81.0) | 26.90 (68.3) | 750 (340.0) | F | WSA3 | 22–E |
| 112.5 | TPNS01533151S | 41.50 (105.4) | 32.90 (83.6) | 29.90 (75.9) | 1120 (508.0) | F | WSA4 | 22–E |
| 150.0 | TPNS01533161S | 41.50 (105.4) | 32.90 (83.6) | 29.90 (75.9) | 1200 (544.0) | F | WSA4 | 22–E |

Notes: All TPNS models are TP1 compliant

## GROUP M, K FACTOR 13, 150°C RISE

### 208 DELTA PRIMARY VOLTS — 208Y/120 SECONDARY VOLTS — 3Ø, 60 Hz

| kVA | CATALOG NO. | APPROX. DIMENSIONS ② Inches (Cm.) | | | APPROX. SHIP WEIGHT | TYPE MTG. W – Wall | WEATHER SHIELD | Wiring Diagrams & Design Figures |
|---|---|---|---|---|---|---|---|---|
| | | HEIGHT | WIDTH | DEPTH | Lbs. (Kg.) | F – Floor | P/N | Begin on Page 122 |
| 15.0 | TPNS01792714S | 25.50 (64.8) | 24.90 (62.0) | 19.37 (49.2) | 320 (145.1) | F ① | WSA1 | 61-E |
| 30.0 | TPNS01792724S | 25.50 (64.8) | 24.90 (62.0) | 19.37 (49.2) | 366 (166.0) | F ① | WSA1 | 61-E |
| 45.0 | TPNS01792734S | 29.40 (74.7) | 28.15 (71.5) | 22.37 (56.8) | 522 (236.8) | F ① | WSA2 | 61-E |
| 75.0 | TPNS01792744S | 35.40 (89.9) | 31.90 (81.0) | 26.87 (68.2) | 667 (302.6) | F | WSA3 | 61-E |

Notes: All TPNS models are TP1 compliant

Notes: All TPNS models are TP1 compliant

**For Additional Low Temperature Rise 115° and 80° Degree Units and Copper Wound Units, Consult Factory**

**NON-LINEAR LOAD ISOLATION® WIRING DIAGRAMS (Refer to pgs 122-124)**

**NON-LINEAR LOAD ISOLATION® DESIGN FIGURES (Refer to pg 122)**

① Wall mounting brackets are available for these sizes, refer to page 133.

② Dimensions in this section may change and are not to be used for detailed construction purposes. Please contact the factory for certified dimensional drawings.

### 1. Linear loads
Loads where the current waveform conforms to the waveform of the applied voltage. Or loads where a change in current is directly proportional to a change in applied voltage. For example:

- Resistance heating
- Incandescent lighting
- Water heater

### 2. Non-linear loads
Loads where the current waveform does not conform to the waveform of the applied voltage. Or loads where a change in current is not proportional to a change in applied voltage. Examples are:

- Computer power supplies
- Motor drives
- Fluorescent lighting

Non-linear loads produce non-sinusoidal current or voltage waveforms.

### 3. Sinusoidal current or voltage
This term refers to a periodic waveform that can be expressed as the sine of a linear function of time.

### 4. Non-linear currents or voltages
A waveform of current or voltage which cannot be expressed as the sine of a linear function of time. A non-linear load would result in a non-sinusoidal current or voltage.

### 5. Harmonic
A sinusoidal waveform with a frequency that is an integral multiple of the fundamental 60 Hz frequency.

| | |
|---|---|
| 60 Hz | Fundamental |
| 120 Hz | 2nd Harmonic |
| 180 Hz | 3rd Harmonic |
| 240 Hz | 4th Harmonic |
| etc. | |

Current waveforms from non-linear loads appear distorted because the non-linear waveform is the result of adding harmonic components to the fundamental current.

### 6. Triplen harmonics
Odd multiples of the 3rd harmonic (3rd, 9th, 15th, 21st, etc.).

### 7. Harmonic distortion
Non-linear distortion of a system characterized by the appearance in the output of harmonic currents (voltages) when the input is sinusoidal.

### 8. Voltage harmonic distortion (VHD)
Voltage harmonic distortion is distortion caused by harmonic currents flowing through the system impedance. The utility power system has relatively low system impedance, and the VHD is very low. But, VHD on the distribution power system can be significant due to its relatively high system impedance.

### 9. Total harmonic distortion (THD)
The square root of the sum of the squares of all harmonic currents present in the load excluding the 60 Hz fundamental. It is usually expressed as a percent of the fundamental.

### 10. Root mean squared current (or voltage) RMS
**1:** The vector sum of the fundamental current and the total harmonic distortion.
**2:** Square root of the sum of the squared value of the fundamental current and the squared value of the total harmonic distortion.

### 11. Eddy currents
Currents flowing in a conducting material in the presence of a time varying magnetic field. These currents are in addition to the current drawn by the load.

### 12. Eddy current losses
Power dissipated due to eddy currents. Includes eddy current losses in the core, windings, case and associated hardware of a transformer.

### 13. Stray losses
A term used to express the difference between the measured alternating current losses on a transformer and the direct current (DC) losses ($I^2R$). Stray losses include eddy losses. Stray losses are usually expressed as a percent of the direct current (DC) losses.

### 14. Per unit value
**1:** Percent value divided by 100.
**2:** The ratio of two components of a system.

### 15. Harmonic spectrum "K" factor
The sum of the product of each harmonic current squared and that harmonic number squared for all harmonics from the fundamental (60 Hz) to the highest harmonic of any measurable consequence. When the "K" factor is multiplied by the stray losses of the transformer, the answer represents the losses in the transformer caused by harmonic currents. When these losses are added to the $I^2R$ losses of the transformer, the total load losses are known. The "K" factor for a linear load without harmonics is one (1).