

Harmonics

Causes, **Effects**, **Solutions**

Including:

- K-Factor Transformers
- Harmonic Mitigating Transformers
- Drive Isolation Transformers
- AC Line Reactors
- APEX Active Filter and PQS



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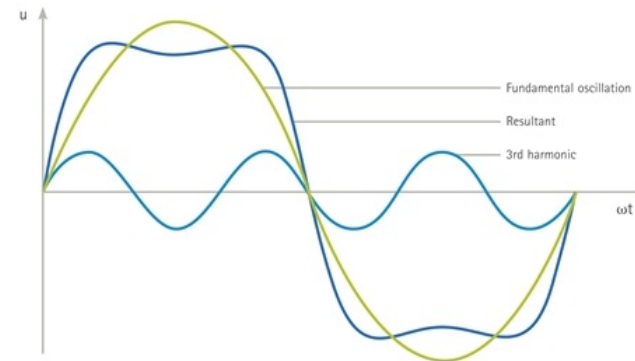


What are harmonics?

HARMONICS: A sinusoidal waveform with a frequency that is an integral multiple of the fundamental frequency.

When multiple harmonics are present, the resultant sinusoidal waveform becomes distorted, which affects the current (THID) and voltage (THVD) of the power system

60hz	Fundamental
120hz	2nd Harmonic
180hz	3rd Harmonic
240hz	4th Harmonic
etc...	



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Where Do Harmonics Originate?

Harmonics primarily originate in electronic power converters.

These can be found in **Non Linear Loads** such as:

1. Switch Mode Power Supplies
2. Electronic Ballasts
3. Variable Frequency Drives
4. Oven and Furnace Controls
5. Rectifier Circuits



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Problems Created By Harmonic Currents

Effects of Harmonics on the power system

1. **Overheated** Neutrals
2. **Overheated** Transformers
3. Malfunctioning of Equipment due to excessive voltage distortion
4. **Burned-out** Motors
5. Tripped Circuit Breakers
6. Blown Fuses

Effect of Harmonics on Transformers

1. **Increased temperature rise**
2. **Increased neutral current flow**
3. **Increased core losses**
4. Increased sound level
5. Decreased efficiency



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Harmonic Distortion Leads To Higher Costs

1. **Increased** utility current required resulting in
 - a) **LARGER** Wires
 - b) **LARGER** Transformers
 - c) **LARGER** Circuit Breakers
 - d) **HIGHER** Operating Costs
2. Overheating of components will lead to **premature component failure**
3. Reduces utility power factor – **high utility costs and possible fines**



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Solutions to Harmonic Problems

1. K - Rated Transformers
2. Harmonic Mitigating Transformers
3. Drive Isolation Transformers
4. AC Line and Load Reactors
5. Active Filter



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K-Rated Transformers

K-Factor is a measure of a transformer's ability to **tolerate** the **heating** effects of non-sinusoidal harmonic currents created by much of today's electronic equipment.

The stray losses of the transformer are multiplied by the K-Factor of the load resulting in increased **heating** of the unit.

K - Rated or Non-Linear transformers **do not eliminate harmonics!**

K1 – Resistance heating, incandescent lighting, motors, transformers

K4 – Welders, induction heaters, fluorescent lighting, solid state controls

K13 – Telecommunications equipment, branch circuits

K20 – Main frame computers, VFDs, data processing equipment



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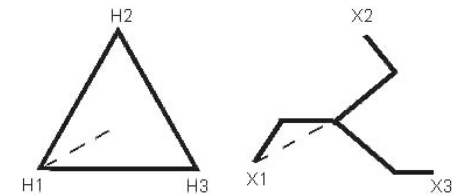
Harmonic Mitigating Transformers

How do they work?

They consist of a Delta primary and a Zig-Zag secondary. The Zig-Zag secondary causes a phase shift in the triplen harmonics which results in a canceling effect. This prevents the triplen harmonic losses from being coupled back into the primary and results in cooler operation and increased energy efficiency.

What is a Zig-Zag Winding

The secondary winding is wound in two separate sections. These sections are then connected to create a 120° phase shift.



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Harmonic Mitigating Benefits

- Unlike K-Rated transformers, Mitigating transformers actually treat the triplen harmonics in the zig-zag secondary winding
- Reduce supply voltage flat topping caused by non-linear loads
- Improve overall power factor of supply system
- Suitable for K-Factor loads
- Improved energy efficiency (Meet DOE 2016 at K-1 load)

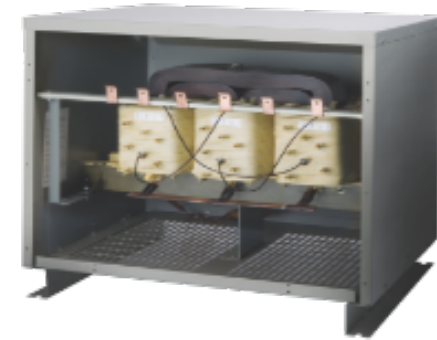


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Drive Isolation Transformers

- Transformer voltages and kVA unique to supplying power to SCR (Silicon Control Rectifier) motor drives.
- The isolation between the primary and secondary provides electrical isolation between the supply and the load.
- The transformer core is designed to handle the harmonic voltage without saturating, and the coils are braced to handle the mechanical forces that are introduced due to these harmonic currents.
- The coils are also designed to mitigate the impact of the harmonic currents.



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AC Line Reactors

- 3% or 5% Impedance Reactors with varying inductance
- Reduce tripping from voltage sags and peaks
- Reduce current surges from voltage transients/spikes
- Reduce harmonic peaks generated by the drive
- Up to 30% reduction in harmonic currents



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Encapsulated Line Reactors

- Line reactor may need to be added after installing of drive or measuring harmonics distortion
- Encapsulation allows reactors to be place outside of the wiring cabinet
 - Saves space in motor control cabinet
 - Saves money by not having to build new or change wiring layout
- Can be added at any point in time

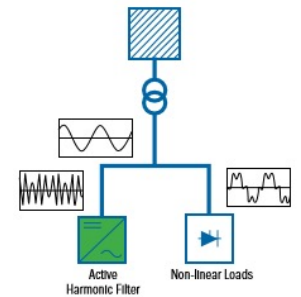


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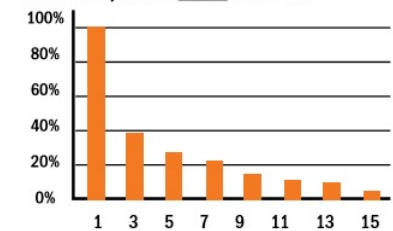


APEX Active Filter

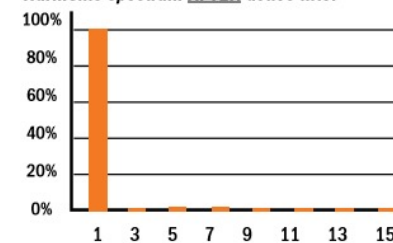
- Active harmonic filters connect parallel to loads.
- APEX Active Filter senses the harmonic distortions created by non-linear loads in the network and provide effective **real-time response to cancel the distortion.**
- Ensure compliance with the harmonic distortion limits specified in **IEEE 519**, power quality standards and recommendations.



Harmonic spectrum *before* active filter



Harmonic spectrum *AFTER* active filter



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APEX Active Filter

- 50A, 100A, 150A, or 200A Modules with **unlimited scalability**
- **Best in class 3-Level Topology** for higher efficiency and lower losses
- **Fully Selectable Harmonic Filtering** from 2nd to 50th Harmonics
- Real time response with **<50 micro seconds reaction time**
- **7" Color Touchscreen** (up to 7 modules)
- Power Factor Correction
- Voltage Balancing and Flicker Mitigation
- Smart Operation Mode automatically turns off modules under low load conditions, reducing operational losses and extending filter life
- Digital Inputs and Outputs
- Low Noise (60-68db)
- Low Losses (<2.5%)
- **AND MORE!**



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The Future of Power Quality



Power Quality Solutions

Drive Isolation
Harmonic Mitigating
K Factor



Line Reactor



Sinewave Filter
dV/dT Filter



Common Bus

Power Quality



Power Resistor



Braking Resistor



Braking Module



Active Filter



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Product Links

1. [K - Rated Transformers](#)
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Questions or Comments

Tech Service contact number:
800-334-5214 option 1



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