Harmonic Filters
for Single Phase Equipment

· Agriculture  · Call Centers  · Casino Slot Machines
  · Computer Centers  · Distributed Generation
  · Electronic Power Converter  · Oil & Gas  · On-Line UPS
  · Power Electronics Equipment  · Lighting
· Variable Speed Motor Drives  · Water Pumping  · Wind Turbines
What is Harmonic Distortion?

Harmonic distortion is the continuous deformation of the voltage or current waveforms and is generally caused by equipment that converts AC to DC, namely power electronics equipment. Harmonics are caused by common commercial and industrial loads such as:

- AC and DC motor drives,
- Motor soft starters,
- Welders,
- Computers,
- Slot machines
- UPS systems,
- Robotics, and
- Other power electronic loads.

AC to DC rectifiers do not draw current from the power source as a continuous sine wave, but rather in short, rapid bursts. These (non-linear) loads draw what appears to be a chopped up current waveform through the electrical system all the way back to the power source (transformer, utility system, generator). As more and more power electronics loads are added to the electrical system, the magnitude of harmonic distortion increases.

Because harmonics flow at frequencies higher than the normal 60Hz, special harmonic analyzers are required to measure the magnitude of harmonic distortion. Total Harmonic Distortion (THD) is normally expressed as a percentage with respect to the value of fundamental current or voltage.

Why are harmonics a problem?

Harmonic distortion increases the total rms current that flows from a power source (transformer) to a load, and the harmonic currents flow at frequencies which are higher than the supply frequency. Problems caused by harmonics include:

- Increased heating of transformer and motors,
- Increased power losses,
- Failure of power factor capacitors,
- Distorted system voltage,
- Reduced transformer life,
- Increased motor heating,
- Increased energy demand from power sources.

Arteche solves harmonics problems!

Generally speaking, the best place to solve harmonics problems is as close to their point of generation as possible. The most common solutions for harmonic distortion tend to divert harmonic energy to an alternative path to keep it off the common power system and away from the power sources. By solving harmonics close to the load, all points upstream of the harmonic filter will benefit and experience a higher level of power quality. The electric utility system will benefit regardless where the filters are connected in a customer's facility, however, in order for the facility electrical system to benefit, harmonic filtering equipment must be applied close to the non-linear loads. Arteche offers a complete range of harmonic mitigating equipment. We can recommend the best solutions to meet your power quality goals.
Harmonics in Single Phase Systems
Harmonic distortion from 1-phase power electronics equipment are typically worse than for 3-phase loads. Besides the higher total harmonic current distortion (THD-i), 1-phase systems also experience the cumulative effect of the 3rd, 9th and 15th harmonics on a shared neutral conductor (4-wire or 3-wire 120/240 systems). When harmonics flow on the neutral conductor;

- Neutral current increases
- Neutral to ground voltage increases at the load
- Fire hazard and liability increases
- NEC requires larger neutral conductors and K-factor transformers

The 3rd harmonic alone may be as high as 90% of the fundamental current. Since the neutral has no overcurrent protection, this can lead to severe overheating and a dangerous situation. Excessive 3rd harmonic (180hz) current can cause equipment interference, reduction of useful equipment life and has been known to cause electrical fires.

Arteche Offers Two Types of Single Phase Harmonic Filters
Our Single Phase Harmonic Filters solve problems caused by 1-phase power electronics loads such as switch mode power supplies, motor drives and power converters. We offer two basic types of filters to solve a wide variety of applications:

- 3rd Harmonic Filters,
- Low Pass Harmonic Filters.

Rather than absorb the unwanted harmonics at the distribution panel, switchboard or upstream supply transformer, our single phase harmonic filters can be applied right at the loads (single load or group of loads). Solving for harmonics near to the culprit loads reduces the burden on your upstream electrical system and keeps your facility electrical system cleaner, more efficient, more reliable and safer.

3rd Harmonic Filters
Our 3rd Harmonic Filters are ideal for plug-in type electronic equipment such as personal computers, laptops, slot machines and other office equipment. To accommodate multiple loads, they can either be supplied with duplex receptacles, or field wiring terminals for direct wiring into the branch circuit. Not only does our 3rd Harmonic Filter reduce third harmonic current by as much as 80%, it also reduces the 5th, 7th and 9th harmonics. 3rd Harmonic Filters typically reduce the triplen (harmonics which are multiples of 3) harmonic currents flowing on the neutral to a fraction of the phase current. 3rd Harmonic Filters are designed for use where shared neutrals are common, and where many single phase power electronics loads are present. They focus on removing most of the 3rd harmonic, which is considered the worst for single phase systems. Our 3rd Harmonic filters allow fundamental (50hz or 60hz) current to flow easily from the supply to the load, but insert very high impedance at the 3rd harmonic frequency, effectively blocking most of the 3rd harmonic current. 3rd Harmonic Filters can reduce 3rd harmonic currents by as much as 80 percent, while reducing some higher order harmonics by but 25% to 50%.

Low Pass Harmonic Filters
Arteche’s single phase Low Pass Harmonic Filter is generally considered the most effective of all passive harmonic filters. Often they are used in medium and high power applications such as:

- Electronic motor drives,
- Uninterruptible power supplies (UPS),
- Wind turbine inverters
- Photovoltaic power converters

Arteche Low Pass Harmonic Filters significantly reduce all frequencies of harmonic current, but allow the fundamental current to pass relatively unimpeded. While in 3-phase systems, our Low Pass Harmonic Filters achieve residual levels of total harmonic current distortion (THD-i) of 5% or less, the single phase version can achieve levels as low as 5% to 10% THD-i. The Low Pass Harmonic filter includes series impedance to protect the loads from transient over voltage, so no additional reactors are needed for motor drive applications.
3rd Harmonic Filters
Plug-In Style Filters

Typical Applications

- Office Buildings
- Computer Centers
- Schools & Universities
- Call centers
- Casinos

The basic function of 3rd harmonic filters is to impede the flow of third harmonic current (180Hz for 60Hz systems) in a circuit with little to no attenuation of the fundamental frequency (60Hz) current. The filter combines inductors and capacitors in a way that offers nearly infinite impedance to the unwanted harmonic (3rd) frequency. Separate versions of the 3rd harmonic filters are available for either 60Hz or 50Hz systems.

Easy to Select
Plug-In style 3rd Harmonic Filters are supplied with one or more duplex receptacles, based on their maximum ampere rating. Select the correct filter based on the total connected load. The Plug-In style 3rd Harmonic Filter has internal over current protection.

Consult factory if you need other ratings.

<table>
<thead>
<tr>
<th>Max. Load (Amps)</th>
<th>Number of Outlets</th>
<th>Catalog Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
<td>THF 60 0003 120 N1</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>THF 60 0005 120 N1</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>THF 60 0010 120 N1</td>
</tr>
<tr>
<td>15</td>
<td>8</td>
<td>THF 60 0015 120 N1</td>
</tr>
</tbody>
</table>

The harmonic spectrum (left) illustrates the magnitudes of individual harmonic currents for single phase loads for two conditions - without a filter (often more than 100% THD-i) and with a 3rd harmonic filter (often ≤ 30% THD-i).
Typical Applications

- Office Buildings
- Computer Centers
- Schools & Universities
- Call centers
- Casino slot machines
- Lighting circuits

Typical Performance - 3rd Harmonic Filters

The basic function of 3rd harmonic filters is to impede the flow of third harmonic current (180Hz for 60Hz systems) in a circuit with little to no attenuation of the fundamental frequency (60Hz) current. The filter combines inductors and capacitors in a way that offers nearly infinite impedance to the unwanted harmonic (3rd) frequency. Separate versions of the 3rd harmonic filters are available for either 60Hz or 50Hz systems.

The harmonic spectrum at the illustrates the typical magnitudes of individual harmonic currents for single phase loads for two conditions - without a filter (often more than 100% THD-i) and with a 3rd harmonic filter (often ≤ 30% THD-i).
This unique version of our single phase Low Pass Harmonic Filter is specially designed for Distributed Generation (D-G) applications where an inverter is used as a power source to feed both linear and non-linear loads. This filter serves as a buffer between the power source and the utility grid or between the power source and the loads and will typically enable the D-G equipment to comply with electric utility interconnect standards such as IEEE-1547. A front mounted D-G Interconnect Relay is available as an option for those applications where demanded by the local electric utility.

**Benefits of Arteche D-G Harmonic Filters**
- Filter harmonics
- Absorb transients
- Reduce KVA burden on D-G power sources

**Typical Applications**
- Wind Turbines
- Photovoltaic systems
- Micro Turbines
- Fuel Cells
- Generators
- UPS inverter output

Optional Features:
- Interconnect relay
- Capacitor cutout contactor
- Current sensing relay
- Various enclosure styles

**Selection is easy!**
Make the proper selection by determining the single phase line to line voltage and the load rating (KW, KVA, HP) of the D-G system.

### 240V 60Hz - Selection Table

<table>
<thead>
<tr>
<th>Max. Load (KVA)</th>
<th>Catalog Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>DGF 0005 216 N3R</td>
</tr>
<tr>
<td>7.5</td>
<td>DGF 007.5 216 N3R</td>
</tr>
<tr>
<td>10</td>
<td>DGF 0010 216 N3R</td>
</tr>
<tr>
<td>15</td>
<td>DGF 0015 216 N3R</td>
</tr>
<tr>
<td>20</td>
<td>DGF 0020 216 N3R</td>
</tr>
<tr>
<td>25</td>
<td>DGF 0025 216 N3R</td>
</tr>
<tr>
<td>30</td>
<td>DGF 0030 216 N3R</td>
</tr>
</tbody>
</table>

### 480V 60Hz - Selection Table

<table>
<thead>
<tr>
<th>Max. Load (KVA)</th>
<th>Catalog Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>DGF 0005 416 N3R</td>
</tr>
<tr>
<td>7.5</td>
<td>DGF 007.5 416 N3R</td>
</tr>
<tr>
<td>10</td>
<td>DGF 0010 416 N3R</td>
</tr>
<tr>
<td>15</td>
<td>DGF 0015 416 N3R</td>
</tr>
<tr>
<td>20</td>
<td>DGF 0020 416 N3R</td>
</tr>
<tr>
<td>25</td>
<td>DGF 0025 416 N3R</td>
</tr>
<tr>
<td>30</td>
<td>DGF 0030 416 N3R</td>
</tr>
</tbody>
</table>
Low Pass Harmonic Filters
For motor drives, UPS input, pumps
Single-Phase

Selection is easy!
Make the proper selection by determining the single phase line to line voltage and the maximum rating (HP) of the connected load.

| 240V 60Hz - Selection Table | 480V 60Hz - Selection Table |
|-----------------------------|
| Max. Load (KVA) | Catalog Number | Max. Load (KVA) | Catalog Number |
| 5 | LPF 0005 216 N3R | 5 | LPF 0005 416 N3R |
| 7.5 | LPF 007.5 216 N3R | 7.5 | LPF 007.5 416 N3R |
| 10 | LPF 0010 216 N3R | 10 | LPF 0010 416 N3R |
| 15 | LPF 0015 216 N3R | 15 | LPF 0015 416 N3R |
| 20 | LPF 0020 216 N3R | 20 | LPF 0020 416 N3R |
| 25 | LPF 0025 216 N3R | 25 | LPF 0025 416 N3R |
| 30 | LPF 0030 216 N3R | 30 | LPF 0030 416 N3R |

Arteche Low Pass Harmonic Filters reduce harmonic distortion to such low levels that the input current waveform is returned nearly to a perfect sine wave. The residual amount of input harmonic current distortion can be reduced to as low as 5% THD-I to 10% THD-i.

Typical Applications
- Agricultural
- Recreational water
- Dairy farm
- Residential water pumps
- Methane wells
- Motor drives/inverters

Photo shows internal components of single phase low pass harmonic filter.
We can solve all of your Power Factor Correction and Harmonic Distortion problems!

Analysis—Engineering—Products

- Low Voltage
- Medium Voltage
- High Voltage

### Harmonic Mitigation Solutions
That solve harmonic distortion right at the source!

<table>
<thead>
<tr>
<th>Type of Solution</th>
<th>Harmonic Mitigating Reactor</th>
<th>Tuned 5th Harmonic Filter</th>
<th>Low Pass (Wide Band) Harmonic Filter</th>
<th>Dynamic Harmonic Filter</th>
<th>12 or 18 Pulse Rectifier Conversion Kit</th>
<th>Active Harmonic Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration</td>
<td><img src="artechepq.com" alt="Diagram" /></td>
<td><img src="artechepq.com" alt="Diagram" /></td>
<td><img src="artechepq.com" alt="Diagram" /></td>
<td><img src="artechepq.com" alt="Diagram" /></td>
<td><img src="artechepq.com" alt="Diagram" /></td>
<td><img src="artechepq.com" alt="Diagram" /></td>
</tr>
<tr>
<td>Current Waveform</td>
<td><img src="artechepq.com" alt="Graph" /></td>
<td><img src="artechepq.com" alt="Graph" /></td>
<td><img src="artechepq.com" alt="Graph" /></td>
<td><img src="artechepq.com" alt="Graph" /></td>
<td><img src="artechepq.com" alt="Graph" /></td>
<td><img src="artechepq.com" alt="Graph" /></td>
</tr>
<tr>
<td>Harmonic Current Distortion</td>
<td>35% to 45% THD-I</td>
<td>15% to 25% THD-I</td>
<td>5% to 8% THD-I</td>
<td>15% to 25% THD-I</td>
<td>5% to 15% THD-I</td>
<td>5% THD-I</td>
</tr>
<tr>
<td>Basic Product Photo</td>
<td><img src="artechepq.com" alt="Image" /></td>
<td><img src="artechepq.com" alt="Image" /></td>
<td><img src="artechepq.com" alt="Image" /></td>
<td><img src="artechepq.com" alt="Image" /></td>
<td><img src="artechepq.com" alt="Image" /></td>
<td><img src="artechepq.com" alt="Image" /></td>
</tr>
</tbody>
</table>