

## Casino Does Not Gamble on Power Quality

### Background:

#### NEED TO REDUCE THIRD HARMONICS

A casino, located in Michigan, had 1000 slot machines and was planning an expansion that involved 500 additional slot machines. Their local electric utility measured voltage distortion of nearly 5% THD-v, plus the casino experienced interference on their CCTV security monitors. To improve the operation of their security systems and to meet the utility power quality requirements, they needed to solve the harmonics problems before adding 500 more harmonic producing slot machines.

### Problem:

#### HARMONICS CAUSED BY 1-PHASE POWER SUPPLY

Due to the accumulated effects of numerous switch-mode power supplies, (used in computers, video games and slot machines) the casino was experiencing several power quality issues:

- Harmonic voltage distortion was about 5% THD-v .
- Branch circuit current distortion was about 60% THD-i.
- 3rd harmonic current was as high as high as 50%.
- Neutral ground voltage measured several volts.
- UPS system fluctuations
- Surveillance camera distortion
- Corruption of access control data transmissions



### Solution:

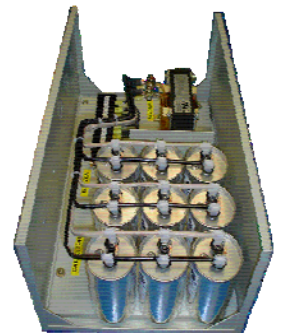
#### THIRD HARMONIC FILTER (THF)

The Third Harmonic Filter is a series connected filter that is specially designed to minimize third harmonic currents in 1-phase circuits. In addition to reducing the 3rd harmonic by as much as 80-90%, this filter can also reduce the 5th, 7th and 9th harmonics. The THF filter is ideal for 3-phase, 4-wire power systems as found in casinos, office buildings and other commercial applications.

Typical 3rd Harmonic Content	No Filter	With THF
	50-90%	10-20%

#### THF-60-0020-120-N1

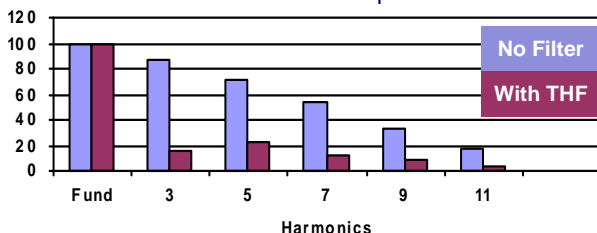
The THF-60-0020-120-N1 is a branch circuit current rated filter and proved to be effective and convenient for this application which had as many as eight slot machines supplied from a single branch circuit. THF filters can be hard wired into the circuit and should be selected based upon the current rating of the branch circuit protective device.



### Benefits:

#### THIRD HARMONICS REDUCED

- 3rd harmonic current was reduced to less than 10%.
- Reduced 3rd harmonic current on neutral.
- Reduced transformer load and temperature.



#### CONVENIENT RATINGS AND CONFIGURATIONS:

As shown above, the filter can be located in the pedestal beneath the slot machines and wired in series with the branch circuit conductors that supply several (typically 2-8) slot machines.

Filter Type	Ratings Available
Plug-In Style	5, 10, 15 Amps
Hard-Wire Style	20, 30, 40, 50, 60, 100 Amps

## Third Harmonic Filters

### Technical Explanation:

#### Harmonics in Single Phase Electrical Systems

Harmonic distortion caused by 1-phase power electronics equipment is more severe than typical 3-phase distortion. It is common to see the harmonic current distortion for a single power loads as high as 135% THD-i. Besides the higher total harmonic current distortion, 1-phase systems also experience the additive effect of the 3rd, 9th and 15th (triplen) harmonics on a shared neutral conductor (4-wire or 3-wire systems). Triplen harmonics from all phases add together in the shared neutral conductor and may cause heating of conductors and transformer, increased N-G voltage and excessive current through neutral conductor. For an individual single phase non-linear load, such as a computer, slot machine, etc, the 3<sup>rd</sup> harmonic alone may be as high as 90% of the fundamental current. Since 3rd harmonic currents from all three phases add together in the neutral, and since the neutral has no over current protection, this can lead to severe overheating and a dangerous situation.

Excessive 3rd harmonic current may cause equipment interference, reduction of useful equipment life and has been known to cause electrical fires.

When harmonics flow on the neutral conductor:

- Neutral current increases
- Neutral to ground voltage increases at the loads
- Fire hazard and liability increases
- Supply transformers may overheat

The current waveform associated with single phase electronic loads (such as computers, slot machines) shows current being consumed in short pulses and very high crest factor (peak current divided by RMS current). The peak KVA capability of all power sources must be evaluated when supplying harmonic producing single phase loads.

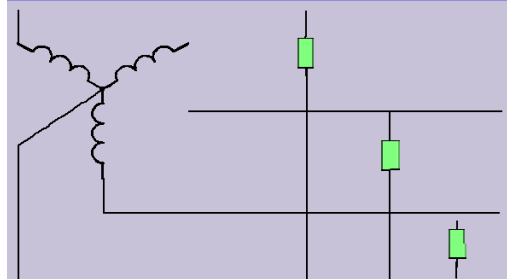
#### 3<sup>rd</sup> Harmonic Filters (THF)

Arteche Third Harmonic Filters solve problems caused by 1-phase power electronics loads such as computers, UPS, slot machines and other equipment having switch mode power supplies. Our 3<sup>rd</sup> Harmonic Filters are ideal for plug-in type equipment, but to accommodate multiple loads, they can either be supplied with power receptacles, or field wiring terminals for direct wiring into the branch circuit.

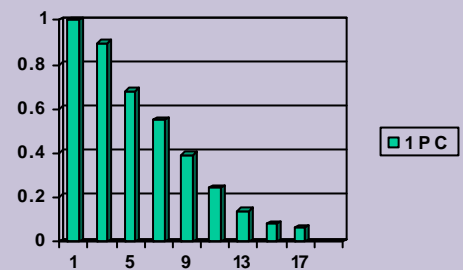
3<sup>rd</sup> Harmonic Filters typically reduce the triplen harmonic currents flowing on the neutral to a fraction of the phase current. 3<sup>rd</sup> Harmonic Filters are designed for use where shared neutrals are used, and where many single phase power electronics loads are present. They focus on 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 they restrict the flow of third harmonic current. Type THF 3rd Harmonic Filters can reduce 3rd harmonic current by as much as 80 percent, while reducing some higher order harmonics (5th to 9th) by 25% to 50%.

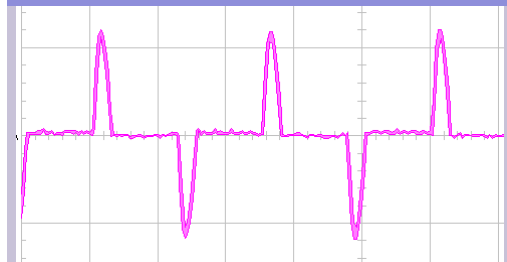
#### 3-phase, 4-wire system



#### Harmonic Spectrum - Computer



#### Current Waveform - Computer



#### 3rd Harmonics Summed in Neutral

