

# WE KNOW POWER

## A Comprehensive Approach to Harmonics Management

Over 3 Decades of Leadership

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# Do You have Harmonic Problems?

**IORA 3000 ACTIVE HARMONIC FILTERS**  
from the pioneer and leader in Harmonic solutions



Rated as one of the top 4 leading brands in India, CONSUL NEOWATT is actively taking on the challenges of the global markets with latest technology and a wide range of UPS, Servo Stabilizers, Harmonic Filters, Static Transfer Switch, Isolation Transformers, Inverters, Bi-directional Solar Inverter.

Apart from ISO 9001 and ISO 14000 certifications, CONSUL NEOWATT has a DSIR approved R&D centre to be a strong contender in the global arena.

Today, CONSUL NEOWATT has the power of over 250,000 installations, ranging from 1 KVA to several thousand KVA, providing expert and timely service from over 73 service locations with 250 Factory-trained Service Engineers across the country.

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We have supplied over 1000+ MW of power conditioning and power back up products till date.

## Product Range

- ✓ Online UPS upto 800Kva
- ✓ Servo Stabilizer 1-3500Kva
- ✓ Active Harmonic Filter
- ✓ Static Transfer Switch
- ✓ Isolation/Ultra/K-rated Transformer
- ✓ Inverters
- ✓ Bi-directional Solar Inverter
- ✓ Solar PCU.

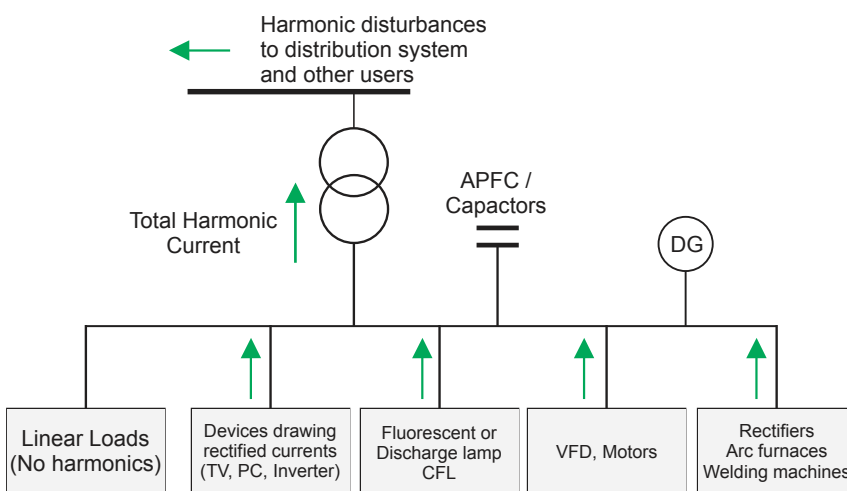
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# Harmonics Management

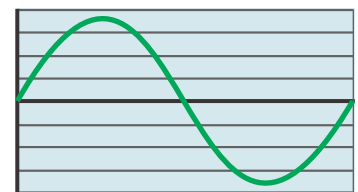
The Issues due to poor power factor caused by inductive loads like motors is well known and the solution to improve power factor and reduce maximum demand (kVA) using automatic power factor correcting capacitors (APFC) panels is well established. What is less understood is the reasons and effects due to harmonics generated by Non-linear loads and its effect on the consumer's internal power system and the grid.

Harmonics are produced by electronic loads which draw currents in a “chopped” manner and the current drawn by these non-linear loads are not sinusoidal in nature. The level of harmonics is usually expressed as a ratio called Total Harmonic Distortion,  $THD\% = (\text{rms value of all harmonics}) / (\text{rms value of the fundamental})$  in %. The harmonic currents passing through linear loads generate harmonic distortion in the voltage wave shape, which will depend on both the nature of the harmonic currents and the impedance of the grid and loads. The harmonics norms in India, consistent with international standards like IEEE 519, have been fixed by the Central Electricity Authority (CEA) in their Technical Standards for Connectivity to the Grid Regulations, 2007. The regulations stipulate that the total harmonic distortion for voltage at the connection point shall not exceed 5% with no individual harmonic higher than 3% and the total harmonic distortion for current drawn from the transmission system at the connection point shall not exceed 8%. Now Power Utilities have started levying penalties on consumers not only for low power factor but also when harmonics exceed the CEA norms.

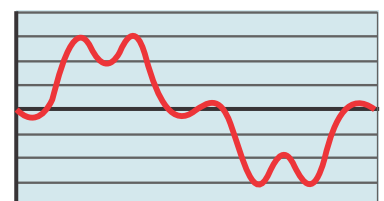
## Typical Power System with Linear and Non Linear Loads



## Sinusoidal Current Drawn by Linear Loads

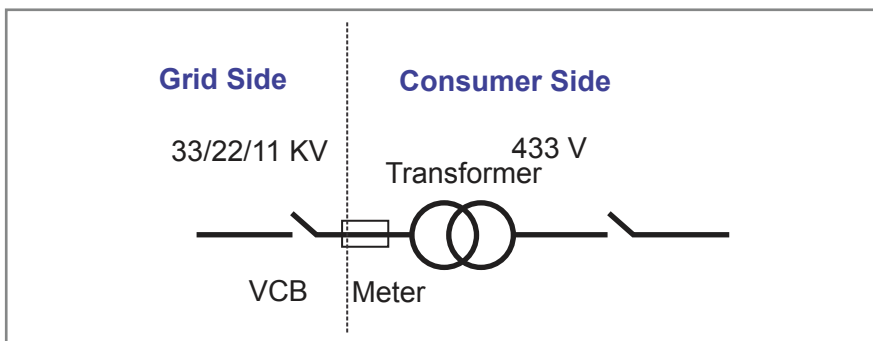


## Harmonic Current Drawn by Non-Linear Loads



The proliferation of non-linear loads is driven by increasing need for energy savings and to improve quality and productivity of life through automation. This unfortunately has come at the cost of harmonics which has many damaging effects on both sides of the meter – consumer side and grid side.

**Grid Side Issues:** Reduced ability to transfer power through existing T&D infrastructure and transformers along with higher T&D and distribution transformer losses. T&D capability in many parts of India has to be de-rated by 10 to 30% due to increasing level of harmonics from consumer side of meter.



**Consumer Side Issues:** Overheating of transformers and cables, reduction in available capacity of transformers and switchgear, excess neutral currents, power factor capacitor failures, spurious tripping, increased failure of electronic devices, capacity limits on stand-by generators and UPS systems, higher losses leading to higher power bills.

### Linear Load examples

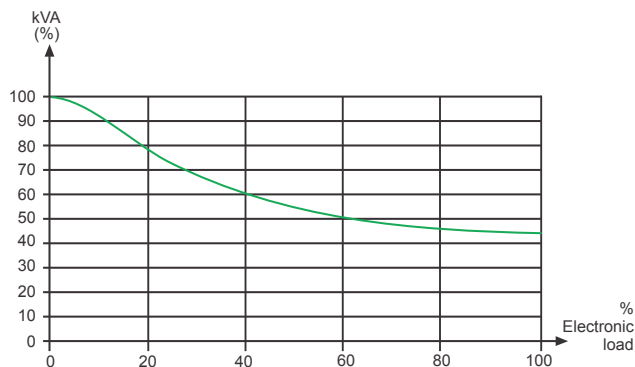
- Incandescent Lamps
- Motors
- Transformers
- Capacitors

### Non- Linear Load examples

- VFD for Motors, AHU
- UPS w/ SCR Rectifier
- Computers
- LED, CFL Lamps
- Discharge lamps (mercury, sodium, fluorescent)
- Rectifiers
- Induction Furnace

## Impact of Harmonics on Transformers:

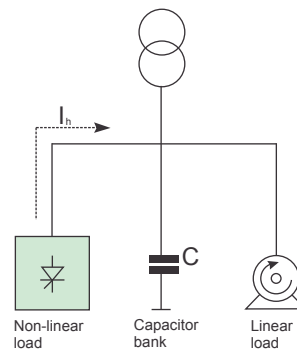
### De-rating required for a transformer supplying electronic (Non-Linear) loads



Harmonic currents flowing in transformers cause an increase in the “copper” losses due to the Joule effect and also due to skin effect and increased “iron” losses due to eddy currents. The harmonic voltages are responsible for “iron” losses due to hysteresis. It is generally considered that losses in windings increase as the square of the harmonic current distortion, THDi and that core losses increase linearly with the total harmonic voltage distortion, THDu. Even with 20% harmonic distortion, losses will increase 15% to 20%. If the transformer supplies an overall load comprising 20% of electronic loads, it must be de-rated by 20% apart from higher utility power bills due to the increase in losses.

## Impact of Harmonics on Capacitors

The harmonic voltages applied to capacitors cause the flow of currents proportional to the frequency of the harmonics. These currents cause additional losses and heating of capacitors reducing life. In many cases, capacitors need to be oversized for both voltage and current handling capability for sites with high harmonics. Also “resonance” phenomena can happen in some power systems due to the parallel resonant circuit between capacitor and upstream inductance of transformer and network line. This can cause magnification of harmonic currents further leading to early damage of capacitors.



### Capacitor failure due to harmonics overload



## Impact of Harmonics on Generators and UPS:

Generators supplying non-linear loads must be de-rated due to the additional losses caused by harmonic currents. The level of de-rating is approximately 30% for a generator where the overall load is made up of 30% of non-linear loads. It is therefore necessary to oversize the generator, in order to supply the same active power to loads. Similarly UPS not designed to handle highly non-linear loads like VFD Drives or computers may get overloaded and hence must be de-rated for normal and safe operations.

## Impact of Harmonics on sensitive electronic equipment:

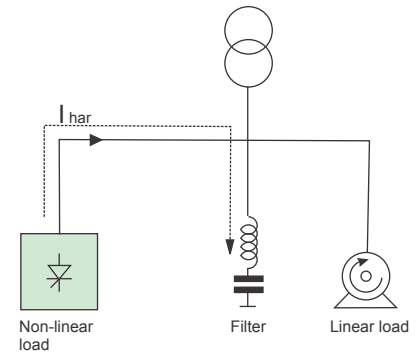
Distortion of voltage due to harmonics can cause failure and breakdown of sensitive equipment like power supplies, computer hardware, PLCs and control cards. Harmonics can cause disturbances in control circuits (low current levels). The level of distortion depends on the distance that the power and control cables run in parallel, the distance between the cables and the frequency of the harmonics.

## Harmonics Mitigation

For new sites, care can be taken to purchase non-linear electronic equipment with built-in filtering to reduce the harmonic currents drawn and consumers can also over-size power system components to handle the harmonics without premature failure. This can be very expensive resulting in higher CAPEX and OPEX and also will not be possible for an existing installation. The best option in both cases for harmonic mitigation is by use of harmonic filters: Either Passive or Active.

### Passive Harmonic Filtering

A passive harmonic filter is an LC circuit, tuned to each harmonic order to be filtered, and is installed in parallel with the non-linear load. This bypass circuit absorbs the harmonics, thus avoiding their flow in the distribution network. The passive filter is tuned to a harmonic order close to the order to be eliminated. Several parallel-connected branches of filters can be used if a significant reduction in the distortion of a number of harmonic orders is required. They are effective when the harmonic content and order is constant and also when used close to the Non-linear load producing the harmonics. When there are a number of loads producing harmonics and nature of load is not constant then passive filters are ineffective and are prone to failures.

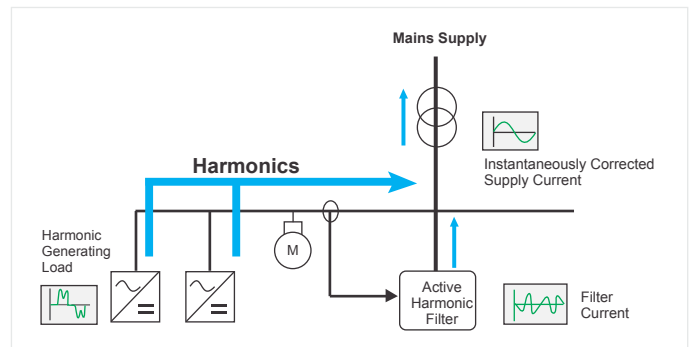


Due to voltage harmonic distortion, existing APFC may be drawing more harmonic current and amplifying the existing harmonics in the system. Here, De-tuned assemblies of custom designed iron-core reactors in series with the existing three-phase heavy duty capacitor modules can be installed. The series capacitor and reactor combination is tuned well below the first dominant harmonic (usually the 5th) thus preventing resonance and harmonic magnification.

One issue with passive filters is the capacitor degrades over time and there is a shift of the tuning frequency which leads to greater harmonic current absorption and accelerated deterioration and failure. Passive filters are old technology with higher losses and limitations.

### Active Harmonic Filtering

Active Harmonic Filter (AHF) is a highly sophisticated device which compensates the harmonics generated by nonlinear loads by generating the same harmonic components in opposite phase. The non-linear load current is sensed by a DSP (Digital Signal Processor) in the AHF and DSP calculates harmonic components of the current and reactive power. Counter harmonics and reactive power control is generated by the DSP



and fed to the IGBT power circuit. Instantaneously, currents are injected into the line, restoring the sine wave and in case of PF correction, the IGBTs inject fundamental current of proper phase shift to improve the PF. The AHF also reduces the voltage harmonic distortion due to the reduction of harmonic currents and also acts as a damping resistor to avoid resonance due to power factor capacitors seen in some power systems. Unlike passive harmonic filters, AHF can provide harmonic mitigation under varying load conditions and even handle different harmonics due to changes in loads up to their rated capacity. AHF is also smaller and more energy efficient than passive filters. AHF comes in 3-wire (commonly used in industrial environment) and 4-wire (used when single phase SMPS - Switched Mode Power supply) loads in a three phase system cause triplen harmonics in the Neutral conductors.

## Active Harmonic Filter – IORA 3000 from Consul Neowatt Power Solutions

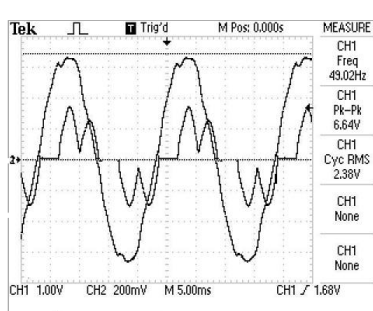
IORA 3000 is the State of the Art Active Harmonic Filter(AHF) controlled by a floating-point 32 bit DSP operating at high frequency. The high speed IGBTs in the AHF injects currentre storing the current to the required sinusoidal waveform and attenuating the harmonics at the point of installation. The IORA 3000 provides the most robust AHF solution in the market with built-in protections for reliability.

- High attenuation up to 96% of individual harmonics upto 50<sup>th</sup> Order to achieve compliance of regulations like CEA and IEEE 519.
- Programmable selective harmonic elimination
- PF (reactive power) compensation, leading as well as lagging
- Required PF is user settable to any value from 0.7 to unity
- Selection between PF and harmonic compensation
- Broadest Range of Ratings available: 30A, 60A, 75A,100A,200A,300A,400A and 600A in 3-wire and 30A, 60A in 4-wire.
- 4 units of same power rating can be used in parallel
- Modular Construction with tough Touch Screen TFT Display
- Remote monitoring and diagnostics available
- Self-current limited, if overloaded. Current limit is automatically modified if used at higher ambient temperature without shutting down.
- EMI compliance to IEC/ EN 62040-2 category C3

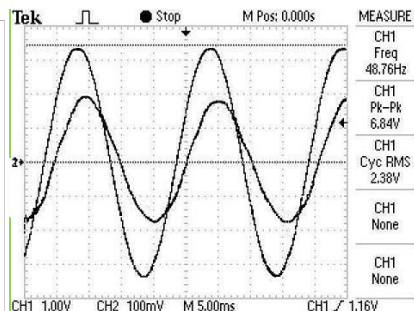


### Performance Results of Consul Neowatt 100A IORA 3000 AHF compensating both for Harmonics and reactive power

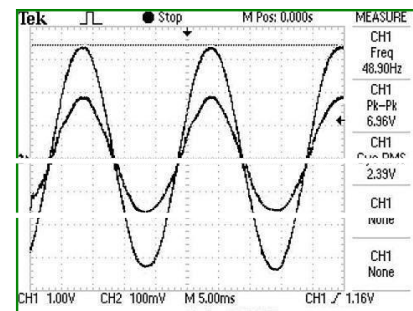
Parameter	A	V (P-N)	THD V	THD i	PF	kVA	kW	Filter A
Without AHF	165	220	5.2 %	25.5 %	0.85	109	92.5	--
With AHF (harmonics)	<b>150</b>	<b>218</b>	<b>3.5%</b>	<b>4.0 %</b>	<b>0.92</b>	<b>98</b>	<b>90</b>	<b>50</b>
With AHF (harmonic + pf)	<b>140</b>	<b>215</b>	<b>2.3%</b>	<b>3.9 %</b>	<b>1.00</b>	<b>90</b>	<b>90</b>	<b>94</b>



Without Active Filter



Harmonics compensation



Harmonics +pf compensation

## 300A AHF Supplied to a Textile Plant in Tamil Nadu



## Proven Track Record of solving harmonic problems

Consul Neowatt has supplied several hundred AHF systems solving harmonic issues in a wide range of industries including textiles, automotive, forging, foundries, data centers, IT parks, engineering and other manufacturing sectors and provided effective active harmonic filtering for several thousand amps of harmonic currents.

Consul Neowatt 300A IORA 3000 supplied to a textile plant and installed at the output of a distribution transformer helped reduce THDi from around 23% to around 5% and THDu from 5.5% to 2.5%, both well below the CEA guidelines.

Transformer Data								
kW Total	KVA	P.F	%THD Volt R	% THD Volt Y	%THD Volt B	%THD Amps R	%THD Amps Y	%THD Amps B
Before Harmonic Filter Installation								
689	717	0.96	5.4	5.0	5.7	<b>23.9</b>	<b>23.8</b>	<b>24.8</b>
After Harmonic Filter Installation								
658	665	0.96	2.7	2.4	2.6	5.8	4.3	6.1

## Consul Neowatt Power Solutions Pvt Ltd

**(CNPS)** is the only Indian company to manufacture and supply a full range of power electronics products, services and solutions—UPS, Inverter, Active Harmonic Filter, Solar PCU and Inverters, Servo Stabilizers, Isolation Transformers and Static Transfer switches. The company was formed by the merger between Consul Consolidated, a company with more than 30 year heritage in developing power conditioning and power back up products and Neowatt Energy Solutions, a leading power electronics technology company.

CNPS solutions and products are backed with more than 30 years of field experience in developing customized power products that meet the exacting standards of clients in supporting critical and sensitive equipment in various industrial and commercial applications. CNPS assists customers optimize their power protection & energy consumption through tailor made products & solutions developed by a World class R&D team in its DSIR approved R&D facility. CNPS ISO 9001 and 14001 state of the Art Manufacturing facilities are located in Chennai and Pune. CNPS products are backed by a nation-wide service network of over 250 company employed, factory trained service engineers based out of 75 locations to provide quick, reliable and local service.

Till date CNPS has completed over 250,000 installations across India, Africa and Middle East delivering over 1000 Megawatt of power conditioning and power back up products and solutions.

## Consul Neowatt Power Solutions Pvt Ltd

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