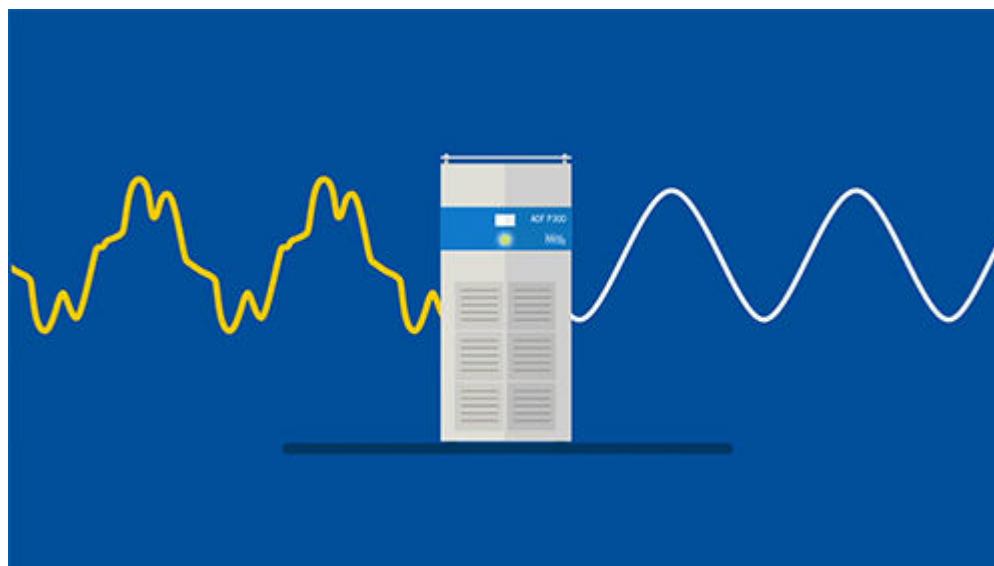


Introduction to SVG & AHF



**LIVELINE ELECTRONICS
KOLKATA**

WHAT IS POWER FACTOR

EVERYONE KNOWS

Real Power (kW) is the power that actually powers the equipment and performs useful, productive work. It is also called Actual Power or Working Power.

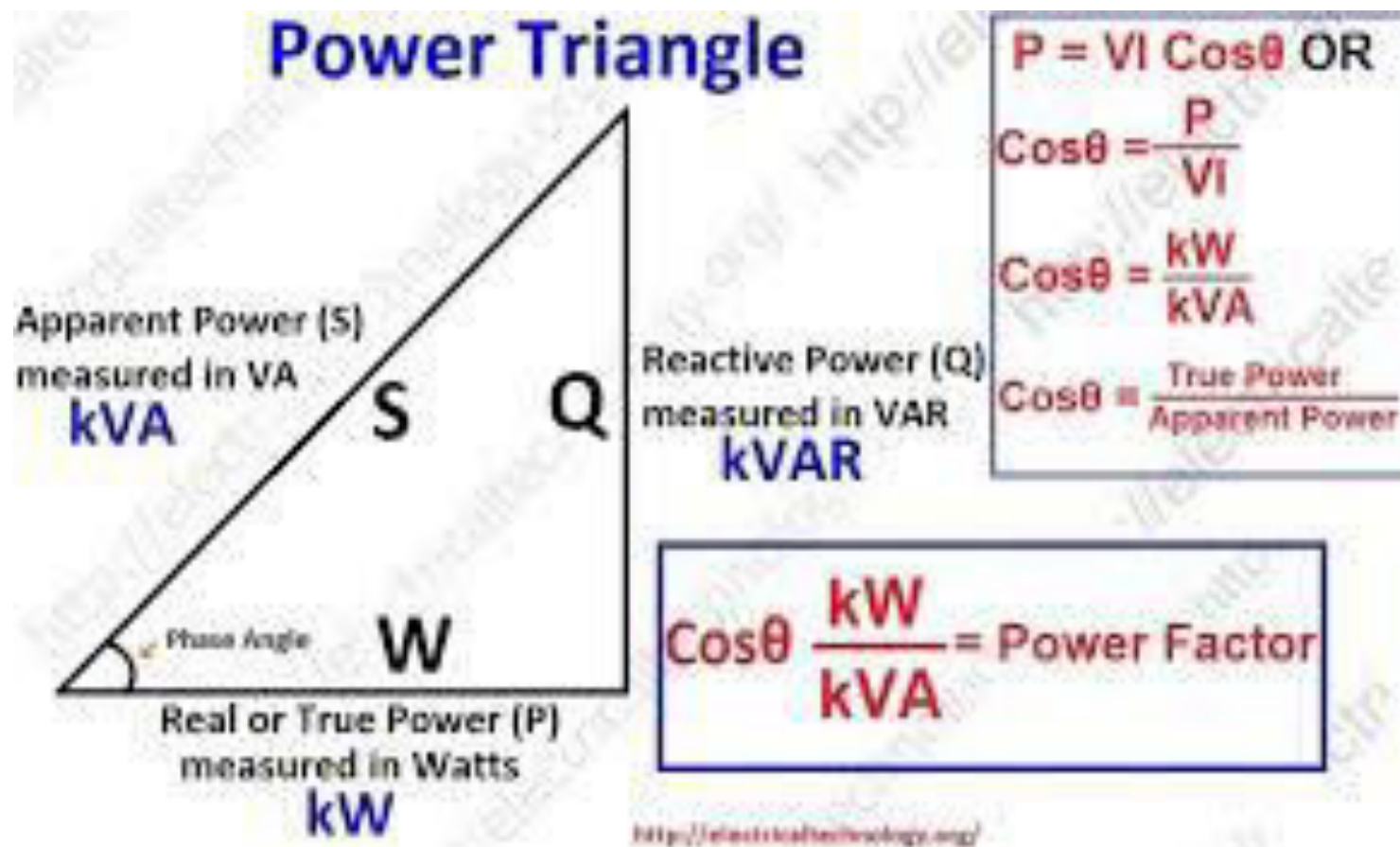
Reactive Power (kVAr) is the power required by some equipment (eg. transformers, motors and relays etc) to produce a magnetic field to enable real work to be done. It's necessary to operate certain equipment but you don't see any result for its use.

Apparent Power (kVA) is the vector sum of **Real Power** (kW) and **Reactive Power** (kVAr) and is the total power supplied through the mains that is required to produce the relevant amount of real power for the load.



WHAT IS POWER FACTOR

EVERYONE KNOWS

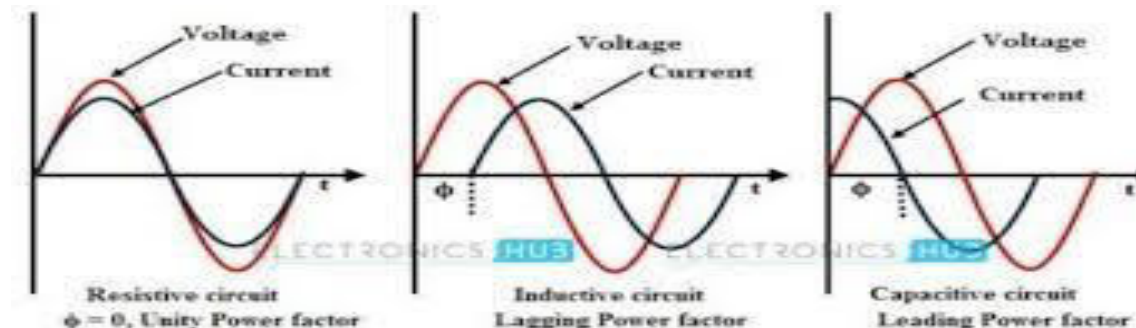
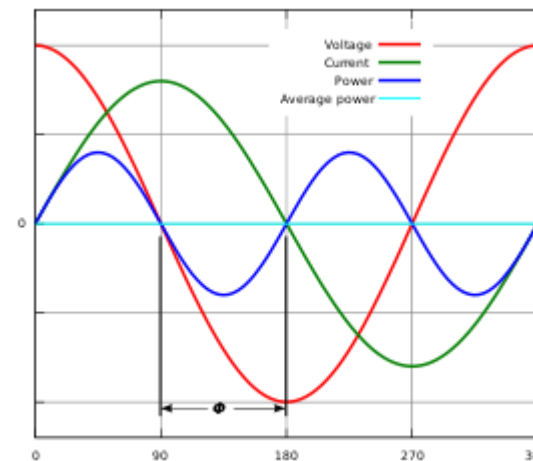


HOW DOES IT AFFECT

Causes more current to be drawn from the supply

Overloading of the electrical network, supply transformers, switchboards, motor switching devices and protection equipment, and cabling

Excessive voltage drop which may impact other electrical equipment



THE BENEFITS OF POWER FACTOR IMPROVEMENT

WHY SHOULD WE IMPROVE P.F?

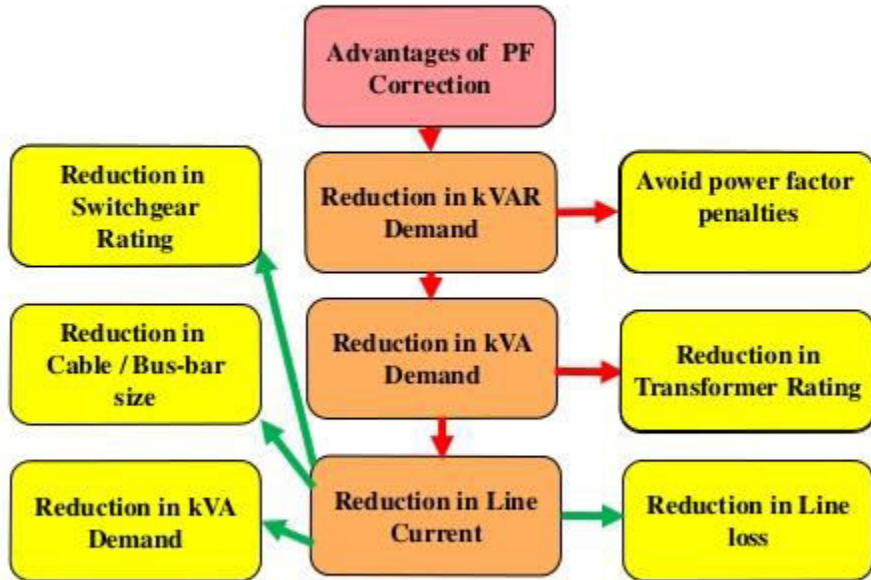


Figure: Advantages of PF Correction

19 March 2017



40%

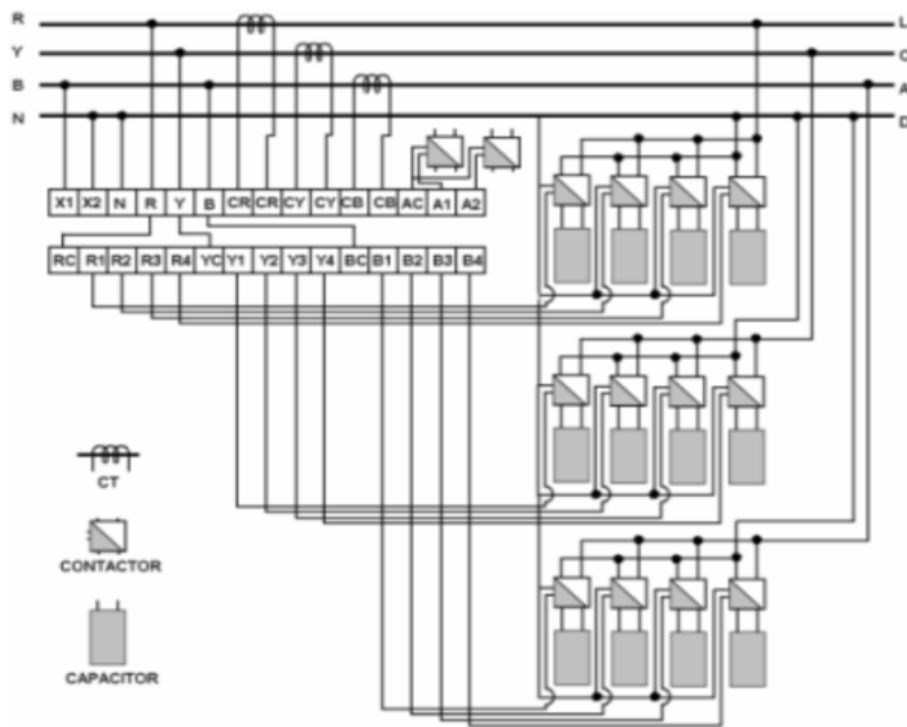
OF BUSINESS DOWNTIME STEMS FROM POWER QUALITY PROBLEMS

6

Power Factor	Increased Available Power
0.7	0%
0.8	+14%
0.85	+21%
0.9	+28%
0.95	+36%
1	+43%

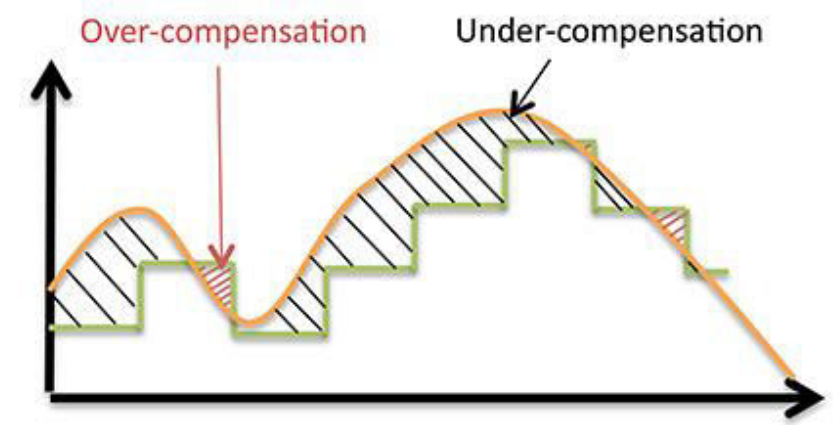
HOW TO IMPROVE PF

One of the most common way is to use capacitors and switch them into circuit as and when load PF is lower than the target. We call them APFC panel.



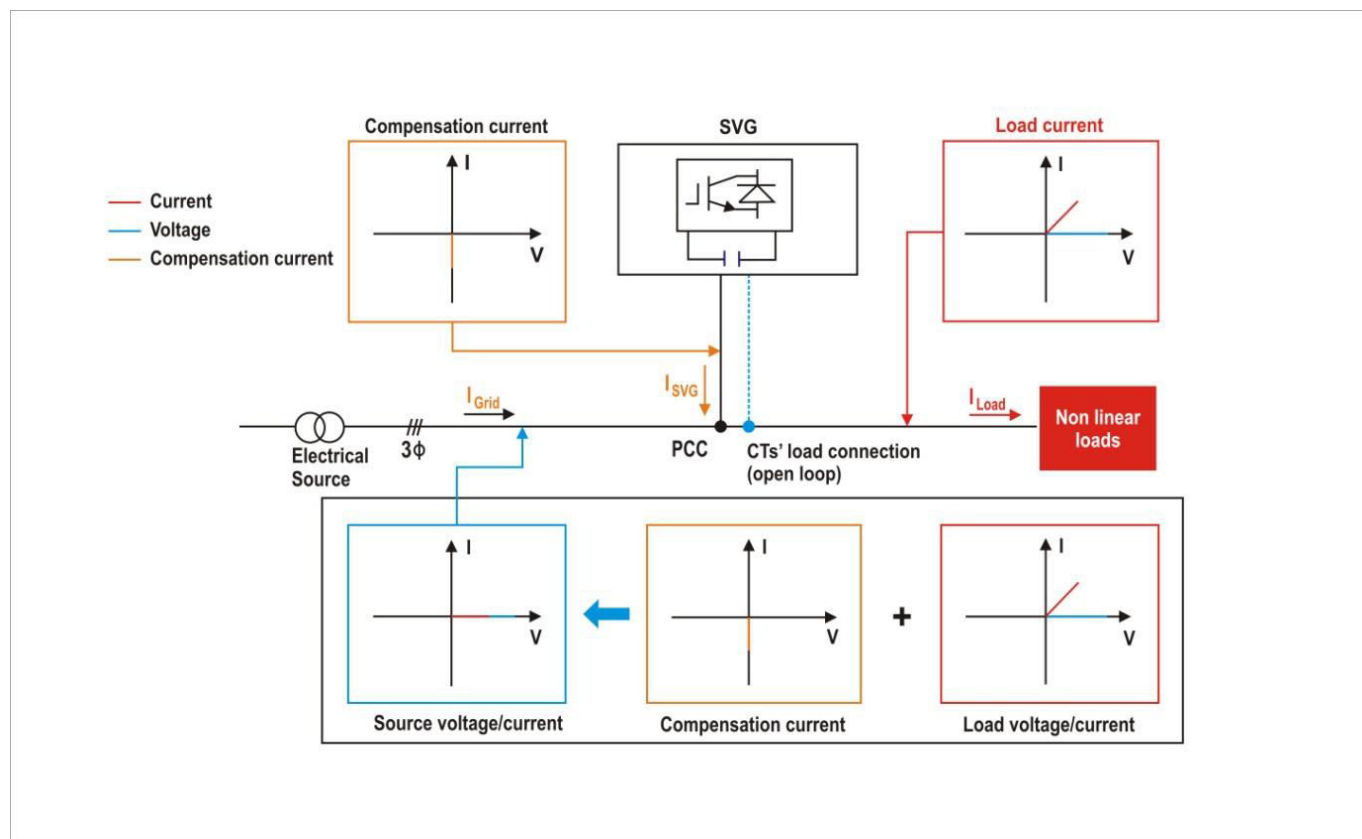
DEMERITS OF CAPACITOR PANELS

Over/under compensation	Capacitor switching transients	Cant handle leading PF	Step control
Slow to respond	Resonance issue	Generate PQ problems	Capacitor failures/burst
Electromechanical failure	Not suitable for dynamic loads	Can not handle unbalanced load	What if supply voltage is variable
Scalability and upgradability	Space	Installed capacity is not compensation capacity	



STATIC VAR GENERATOR - SVG

the most innovative approach to power factor correction



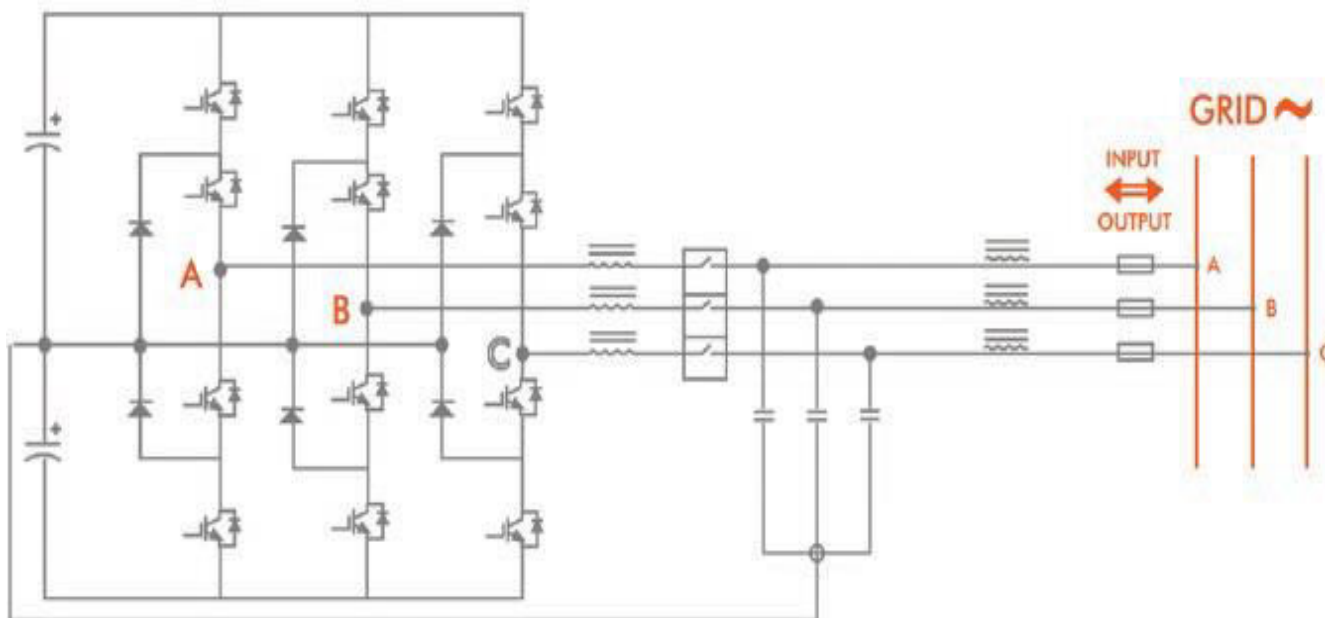
Typical block diagram of a SVG

Advantages:

- Reactive power compensation: Cos F always 1.00
- Continuous correction – step less control.
- No over compensation or under compensation
- Individual correction on all three phases.
- Capacitive and Inductive compensation
- Full correction in less than 10ms (1/2 a cycle).
- Suitable dynamic loads
- Optimised sizing – installed capacity equals compensation capacity
- Simple wall mount for 50kVAR and 100kVAR
- Rack mount options in 30/50/100kVAR sizes. one cabinet can
- Accommodate up to 600kVAR utilising any combination of sizes.
- Increase your capacity as your plant grows.

OPERATIONAL PHILOSOPHY - SVG

the most innovative approach to power factor correction



Multi level IGBT based converter

Advantages:

- Innovative multi level converter design
- Full digital with DSP
- 160 KHz sampling rate
- 80 KHz PWM switching for IGBT converter
- Causes Capacitive and Inductive power flow
- Low harmonics
- Ultra compact design enables modular construction and easy expansion

BENIFITS OVER APFC PANEL - SVG

Lets find out how its better than capacitor based correction

	CAPACITOR BASED APFC	STATIC VAR GENERATORS
TECHNOLOGY	Employ switching IN and OUT fixed value capacitor banks and there by achieves the desired PF at the grid end of the supply.	Uses scalable IGBT based inverter to produce infinitely variable step less output to achieve the desired set point.
RESPONSE TIME	Generally slow to respond and are an electro mechanical system and may take considerable time to achieve the desired result.	Takes 15msec to completely respond to the need and only 50 microsec to dynamically respond.
RESONANCE	Most likely to encounter resonance.	Being a inverter based control technique, has no such possibilities.

BENIFITS OVER APFC PANEL - SVG

Lets find out how its better than capacitor based correction

	CAPACITOR BASED APFC	STATIC VAR GENERATOR
DOES IT CORRECT ALL LOADS	Only corrects inductive load PF where it's lagging in nature.	Correct both an inductive (lagging) and capacitive (leading) load.
SIZE & SPACE	Generally sizes are big as it houses inductors, contactors and capacitors in one enclosure.	Very compact and typically requires less mounting area than a conventional system.
IMPACT OF GRID VOLTAGE	Greatly impacted by the grid voltage level. Low voltage on the grid results in poorer compensation performance from the capacitors.	Performance is virtually unaffected by low grid voltage levels.

BENIFITS OVER APFC PANEL - SVG

Lets find out how its better than capacitor based correction

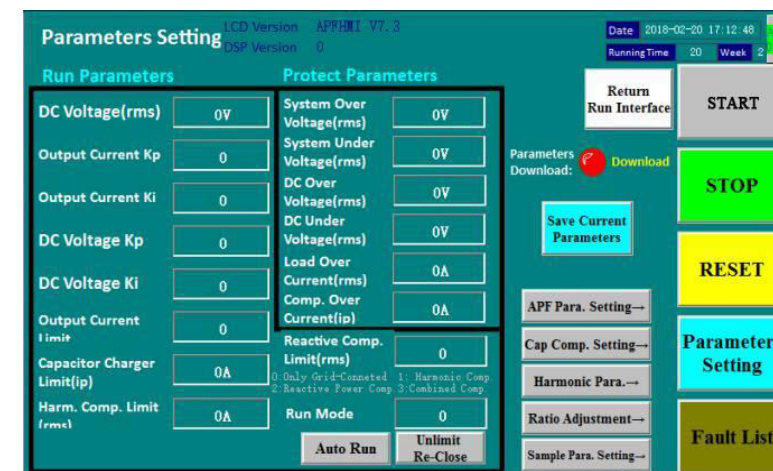
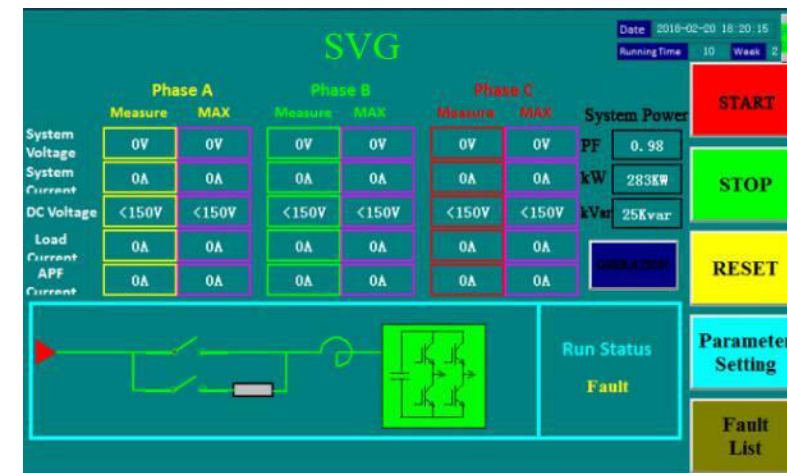
	CAPACITOR BASED APFC	STATIC VAR GENERATOR
ELECTRO-MECH FAILURES	Require frequent switching of the stages to achieve correction for changing power factor and are subjected to frequent failures.	Low losses and needs little maintenance. The service life is expected to greater than 10 years.
SCALABILITY & MODULARITY	No such facility	It can be augmented in future by inserting additional modules

CONTROL & MONITORING - SVG

Easy to use, with displays on every unit providing all system information including grid voltage, compensating current, grid current, load current, grid pf, load pf, alarm code and operating status.

- Cabinet based systems come complete with colour TFT touch screen so you can see exactly what is happening with your complete system. In addition to the information available on the standard unit display you can view individual module temperatures, THDv, THDi, voltage waveforms, harmonic spectrum.
- Optional alarm monitoring card allows SVG to be integrated into any plant control system
- RS485, CAN, RJ45 network port
- Modbus RTU, Modbus TCP/IP, PMBus protocols supported

HMI ACTS AS A FULL POWER QUALITY METER



PEACE OF MIND - SVG

Unlike traditional capacitor based systems, the SVG does not negatively interact with your electrical system. Today's harmonically rich environments are tough on capacitor based systems with increased risks of resonance and capacitor failures:

- Unaffected by harmonic distortion and free from harmonic resonance
- Three phase unbalance compensation
- Unaffected by grid voltage drop. Even under reduced grid voltage levels, full reactive current can be provided to meet working conditions. Operating voltage range of -40% to +20%
- No damaging transient voltage spikes caused by the switching of capacitors
- Overheating capacitors and harmonic reactors are a thing of the past.
- <3% THDi input harmonics won't pollute the users electrical distribution system



HIGHER RELIABILITY AND SAFETY OF ELECTRICAL SYSTEMS

PEACE OF MIND - SVG

- 100% solid state with latest generation IGBTs
- Latest inverter technology provides efficiency of greater than 97%
- Output provides a better quality wave form with a lower harmonic content than traditional systems.
- Electronics free from contaminated air flow
- Long life cooling fans are simple to replace
- Capacitor free. No degradation of failures due to capacitors
- Low risk – no swollen or leaking capacitors. It reduces risk of fire.
- No contactors to replace
- Design service life of more than 100,000hrs, without maintenance. That's more than 10 years operation in a plant that operates 24/7. Capacitor based systems can last as little as three years.
- High power density means less precious switchboard room is used.

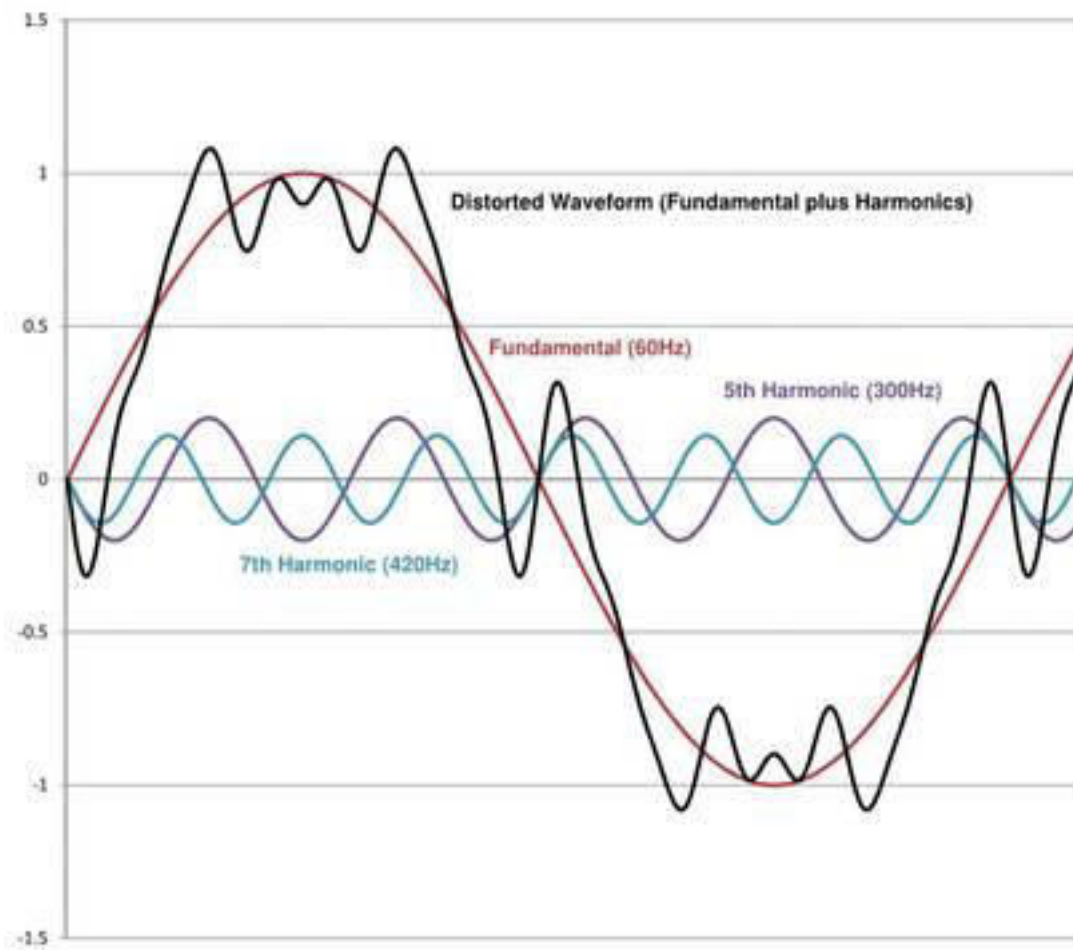


LONG LIFE WITH EXTREME DURABILITY

WHAT IS HARMONICS ?

A harmonic of a wave is a component frequency of the signal that is an integer multiple of the fundamental frequency.

i.e. if the fundamental frequency is 50Hz, the frequencies of the next harmonics are: 100 Hz (2nd harmonic), 150 Hz (3rd harmonic), 100 Hz (4th harmonic) etc.

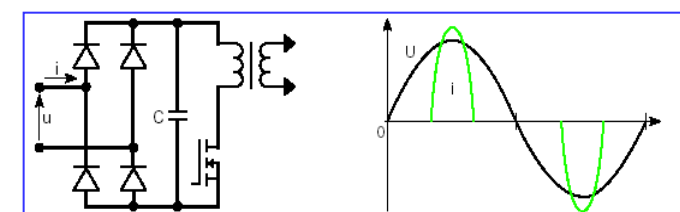
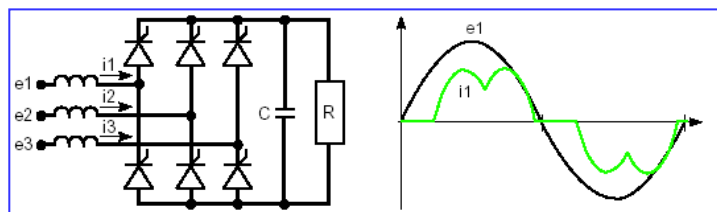
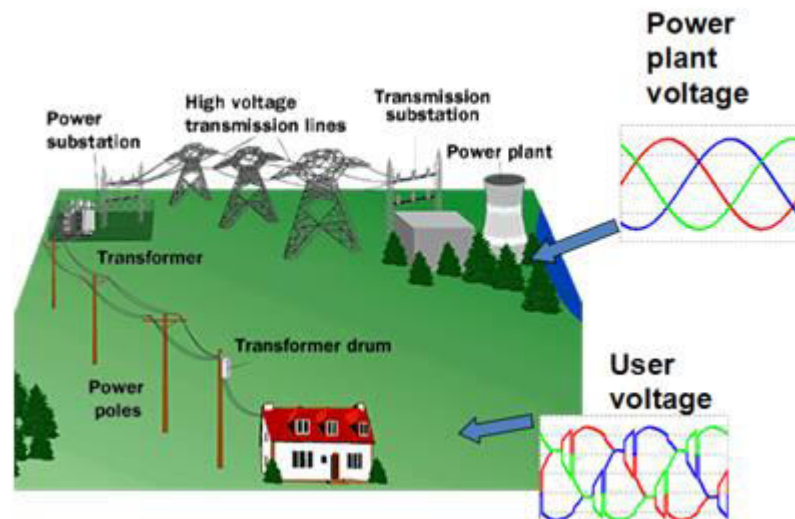


WHY THERE ARE HARMONICS ?

Because of nonlinear components that are inherent in today's loads, there are harmonics.

Main nonlinear load includes

- UPS
- Switching power supply
- Rectifier
- Frequency inverter
- Frequency adjustable air conditioner
- Inductive heating furnace
- Electronic computer
- Charger
- Others



EFFECTS OF HARMONICS

Effects on power grid and power equipments

Effect on capacitors	Add power loss, Get abnormally hot, Shorten life span
Effects to transformer	Increase copper loss, shorten life span, may cause burning
Effects to power cable	Less current conduction ability, cause resonance
Effects on power distribution circuits	Affect line stability and safe running, Distortion in current and voltage waveform
Effects to power equipments	Low voltage switching equipment mal function, cause power trip
Effects on motor	Shorten life span , increase power loss, damage motor



EFFECTS OF HARMONICS

Effects on surrounding equipments

Reduce relay protection system reliability, Interference to communication systems, image distortion, data errors etc

More power loss, increase power cost

- Harmonic generates extra harmonic power and increase company 's power. cost
- Harmonic's skin effect on cable cause very big cable temperature rise, power changes to heat cable and cause power waste, and cause insulation damage, cause discharge to earth.
- Transformer's iron loss and copper losses are increased, cause transformer's noise and heat.



PQ PROBLEMS DUE TO HARMONICS



The The neutral current is too large	Due to the third harmonic current and multiple of third harmonic current all conduct through the neutral line, so the neutral line current exceeds cable specification, resulting in cable overheat and safety potential danger.
Reactive power compensation capacitor failure	Because of harmonic is easy to have resonance with reactive power compensation capacitor, resulting in excessive current on capacitor, causing capacitance value decrease, liquid leakage etc. phenomenon, therefore, reactive power compensation capacitor could not work properly, seriously cause equipment damage because of too large resonant current.
The transformer's capacity waste	Reactive power and harmonic increase total power of the user, resulting in the capacity of the transformer is occupied
The trigger device abnormal protection	The peak of voltage and current harmonics is very high, which may exceed the protection value of equipment, which leads to the relay protection.

PQ PROBLEMS DUE TO HARMONICS

The screen light flashes, affect the normal work

Inverters and other uncontrolled rectification equipments will generate high harmonics, resulting in electric lights, computer screen flicker, affecting normal work.

The Precision instrument can't work normally

Some precision instruments are very sensitive to voltage and current fluctuations, and the requirement to power quality is very high, poor power quality will make these precision instruments can not work properly.

PQ PROBLEMS ALSO CAUSES LOW PF

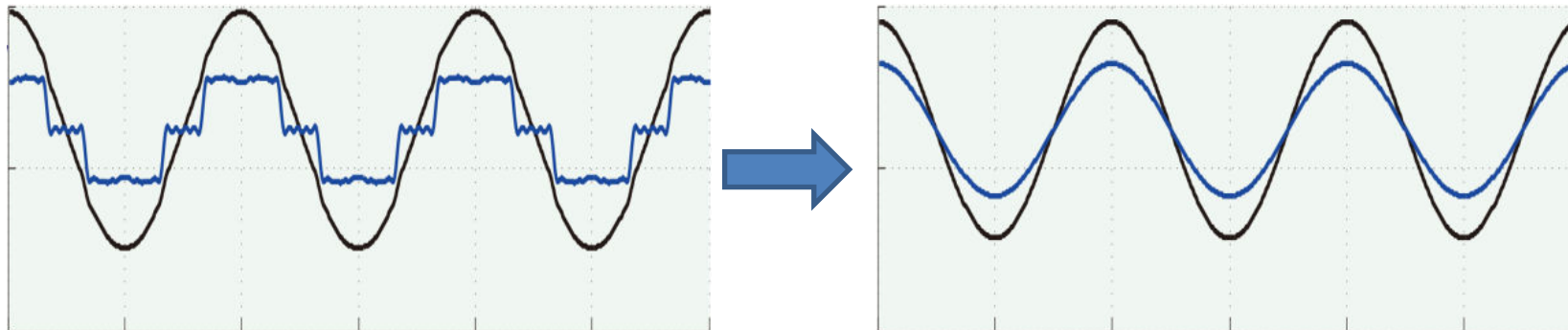
- **Low** power factor, fined by government.
- **Reduce** distribution system effective capacity, need to increase system capacity.
- **Increase** power cost, low efficiency, increase power loss and equipment get hot.
- **Generate** voltage drop caused by reactive current, equipment is derated.

When active power is same
100kW,
Power grid needs to supply
35% more
current for power factor 0.7
than 0.95

HOW AHF (ACTIVE HARMONIC FILTER) CAN HELP

After Harmonic compensation

- Improve equipments reliability, reduce economical loss caused by equipment false action.
- Reduce line heating, reduce insulation aging, improve safety and reliability of electricity using.
- Reduce resonance probability of compensation capacitor, improve the safety of the electricity using.
- Reduce electromagnetic interference produced by harmonic, ensure communication system normal operation.
- Meet national standard requirements



WHAT IS AHF & STATCOM

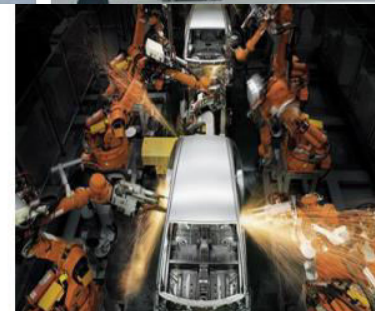
- Active harmonic filter (AHF) is a new **active** electronic harmonic filtering device to **reduce voltage harmonic and current harmonic** and improve power quality.
- Based on voltage source inverter, it's connected in parallel with non-linear loads which need to compensate.
- For compensating harmonic current which is with changing Amp and frequency and reactive power, it overcomes the shortcomings of traditional passive filter. It has the advantages of high compensation accuracy and fast dynamic response etc.



APPLICATION FIELDS

- Electro mechanical factories
- Subway
- Airport
- Highway
- Hospitals
- Sea platform
- Port
- Vehicle manufacturing
- Metallurgy
- Petrification
- Data center
- Photovoltaic
- Shopping mall
- General Factory

- And many more



THANK YOU VERY MUCH

