ALLSAI®

Innovating Power

Power Quality Products

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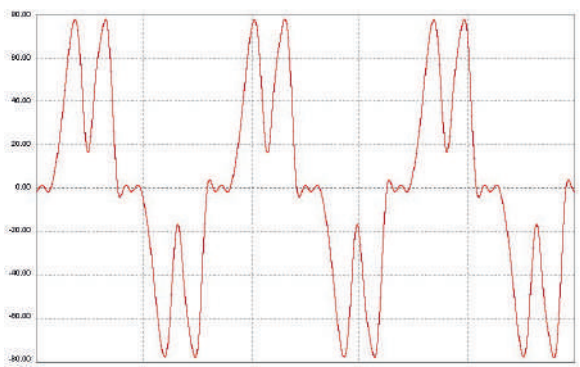
Power Quality Products

APF SVG SPC

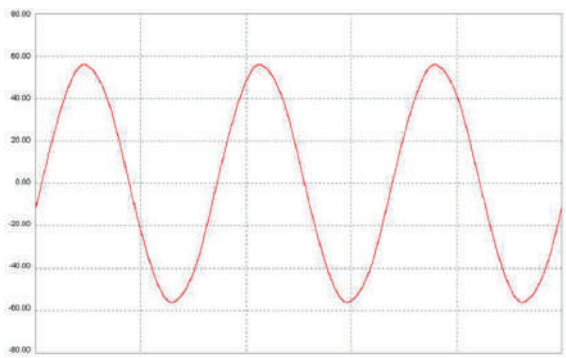
380-690V
50-600A

CE

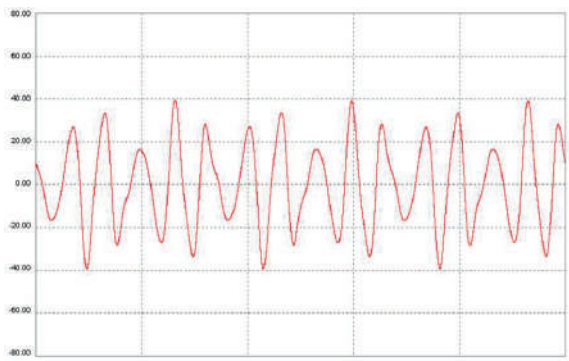
Harmonic



three-phase rectifier current

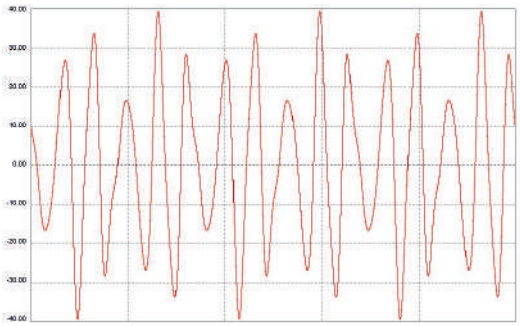


fundamental current

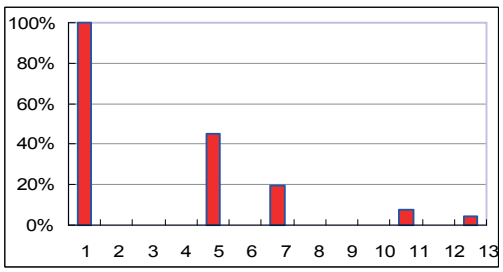


Harmonic current

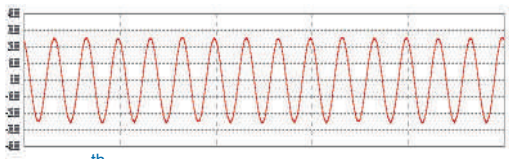
Harmonic



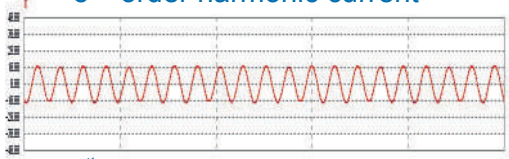
Harmonic current waveform



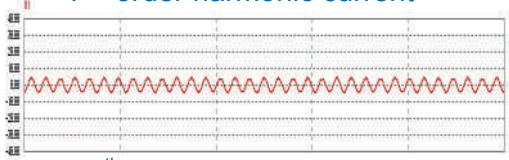
spectrum



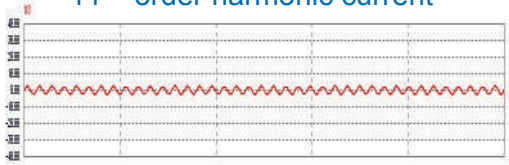
5th order harmonic current



7th order harmonic current



11th order harmonic current



13th order harmonic current

Harmonic Index

Total Harmonic Distortion (THD)

- Based on fundamental

$$THD_F\,\% = \frac{I_H}{I_1} x\,100\% = \frac{\sqrt{\sum_{n=2} I_n^2}}{I_1} x\,100\%$$

- Based on total RMS

$$THD_R\,\% = \frac{I_H}{I_{rms}} x\,100\% = \frac{\sqrt{\sum_{n=2} I_n^2}}{I_{rms}} x\,100\%$$

$$I_{rms} = \sqrt{\sum_{h=1,2,3,..} I_h^2} = \sqrt{I_1^2 + I_2^2 + I_3^2 + I_4^2 + I_5^2 + ...}$$

- Note : I1 is fundamental RMS; Irms is total RMS

  IH is total harmonic current RMS

  In is harmonic current RMS for each order (n is 2, 3, 4….)

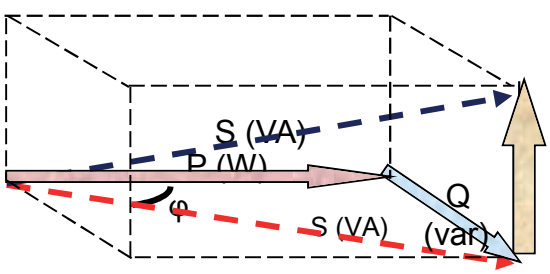
Harmonic Basic

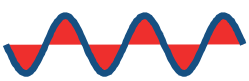
- current harmonic distortion is due to nonlinear load
- Voltage harmonic distortion is due to voltage drop on source impedance by harmonic current
- Lower source impedance will be beneficial for harmonic current to flow to source, meantime voltage distortion is lower
- Higher voltage impedance prevent harmonic current flowing to source, but voltage distortion is also high
- The relation between source impedance and total harmonic distortion (u, i) is non-linear

Harmonic Basic

linear load without harmonic:

• Power factor = Cosφ

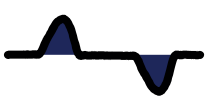




$S = \sqrt{P^2 + Q^2}$

> S = apparent power
> P = active power
> Q = reactive power
> D = distortion power

$S = \sqrt{P^2 + Q^2 + D^2}$



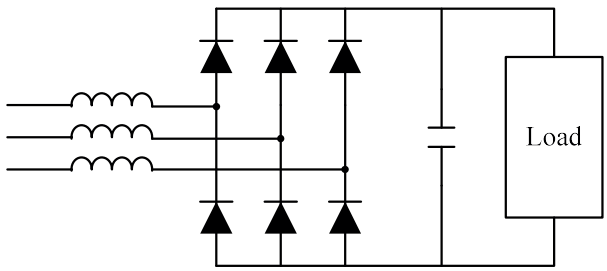
Nonlinear load:

• Power factor =
P/S (active power/apparent power)

Typical Three Phase Nonlinear Load

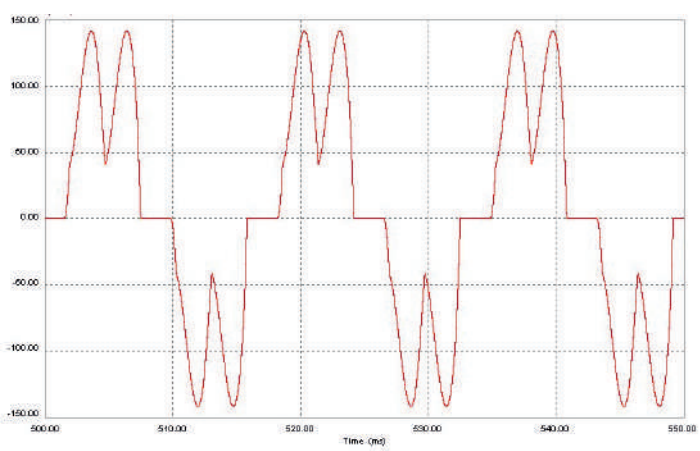
6 Pulse Rectifier

- UPS, VFD
- Current harmonics order: 6n±1



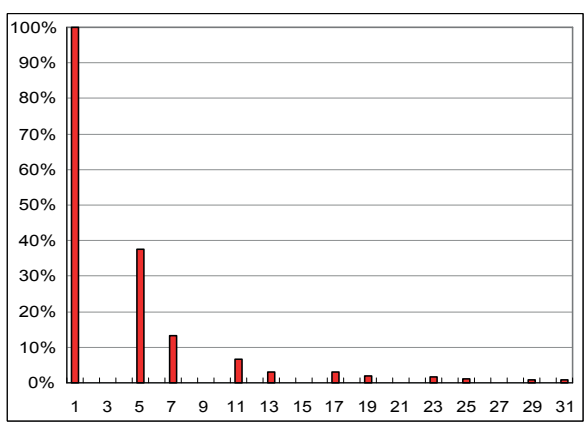
Typical Three Phase Nonlinear Load

6 Pulse Rectifier



Irms=84.5 A

THDF%=40.7%

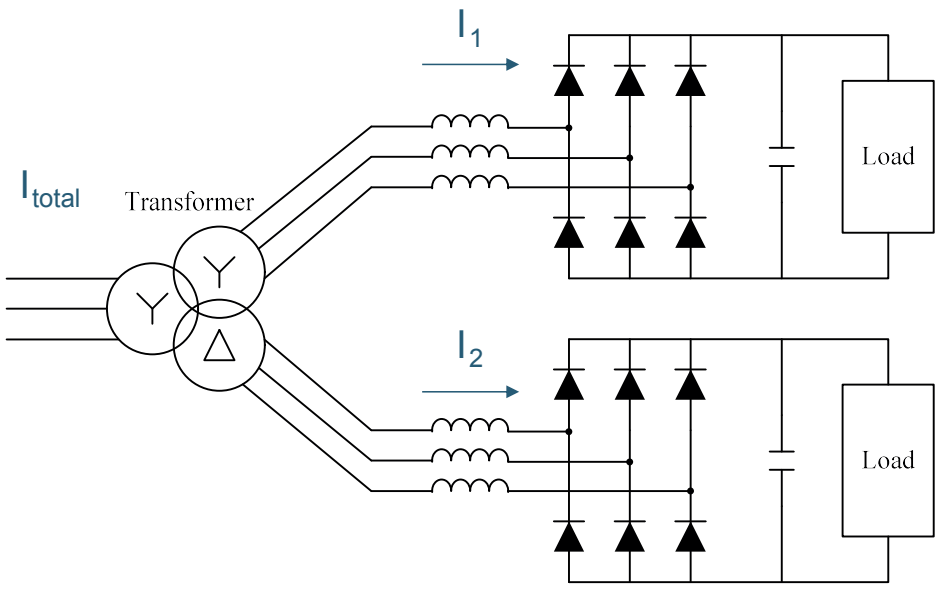


Spectrum

Typical Three Phase Nonlinear Load

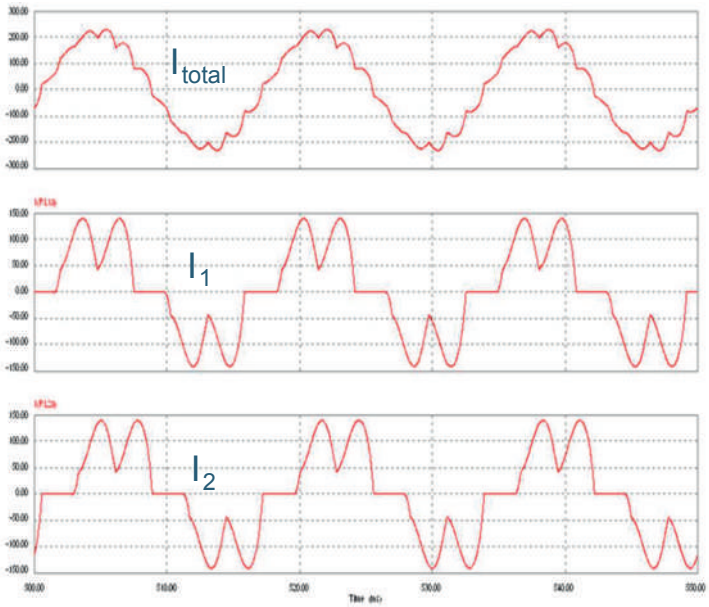
12 Pulse Rectifier

• Current harmonics order:12n±1



Typical Three Phase Nonlinear Load

12 Pulse Rectifier



I_{rms}=156.7 A

THD_F%=7.9%

I_{rms}=84.5 A

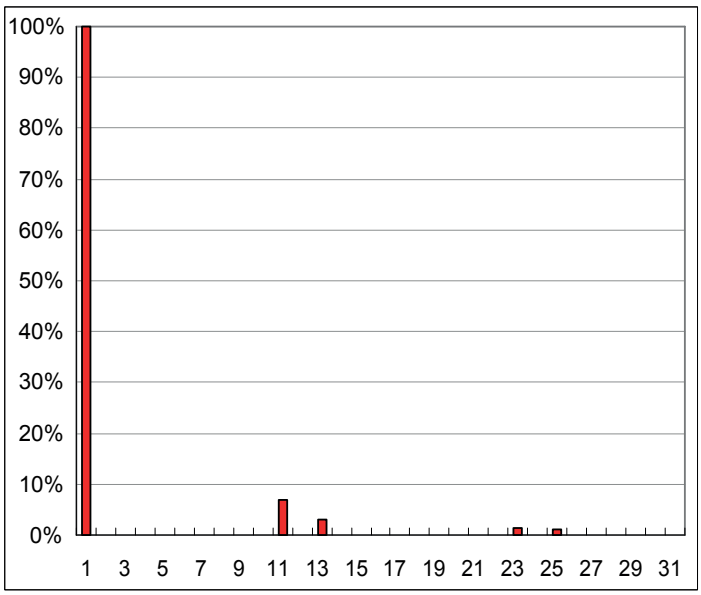
THD_F%=40.7%

I_{rms}=84.5 A

THD_F%=40.7%

Typical Three Phase Nonlinear Load

12 Pulse Rectifier



Spectrum

Harmonic Order

$$n = k \times p \pm 1$$

n: harmonic order

k: constant 1,2,3,…

p: pulse number

Example:

n=1*6±1 → **5**, **7**

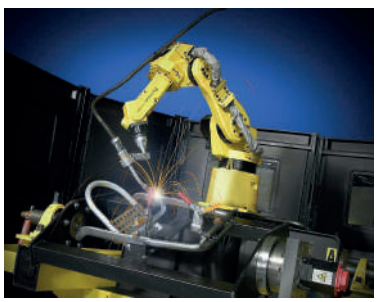
n=2*6±1 → **11**, **13**

:

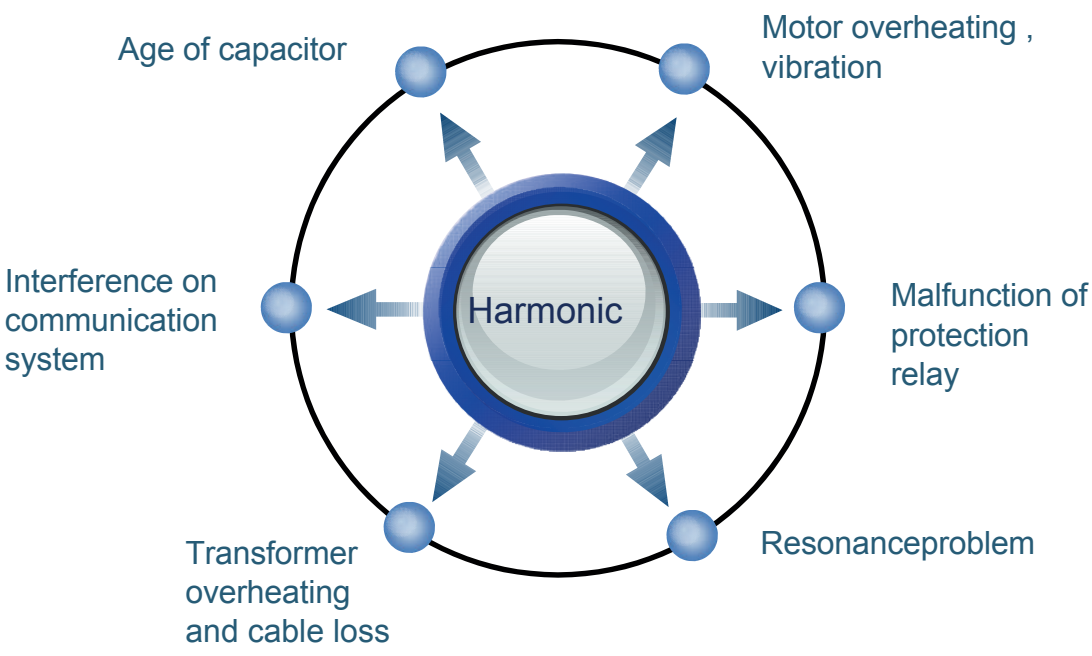
:

Harmonic Source-Nonlinear Load

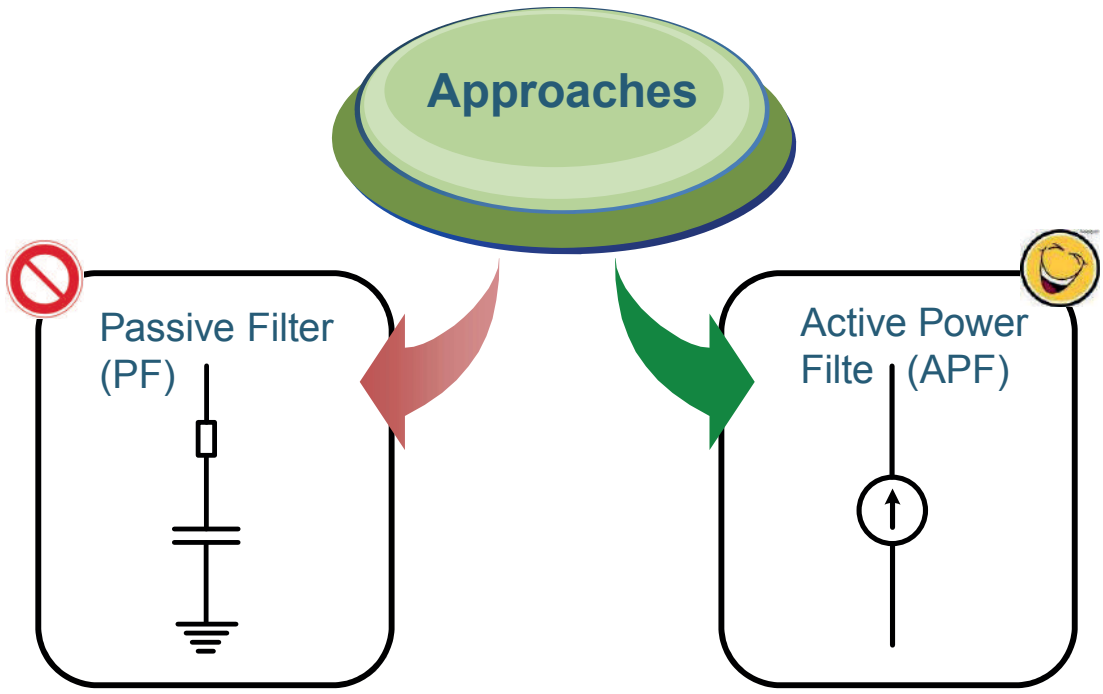
- Uninterruptable Power Supply (UPS)
- DC Power, Rectifier, DC Charger
- Variable Frequency Drive, DC Drive
- Lighting, Gas discharge lamp, Fluorescent lamp
- Welding equipment, Inductive heating, Arc furnace
- Computer and peripheral equipment
- Transformer, Reactor

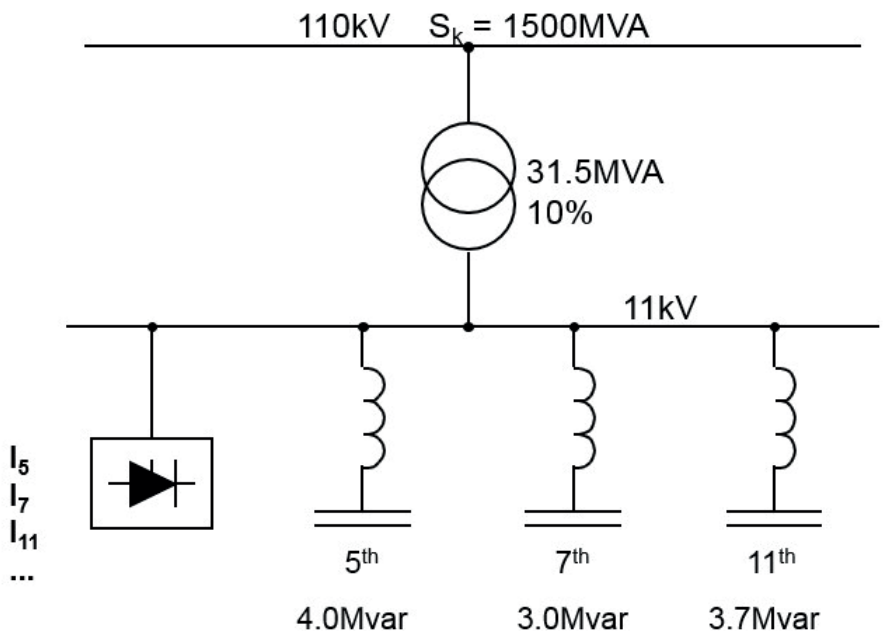

Harm of Harmonics



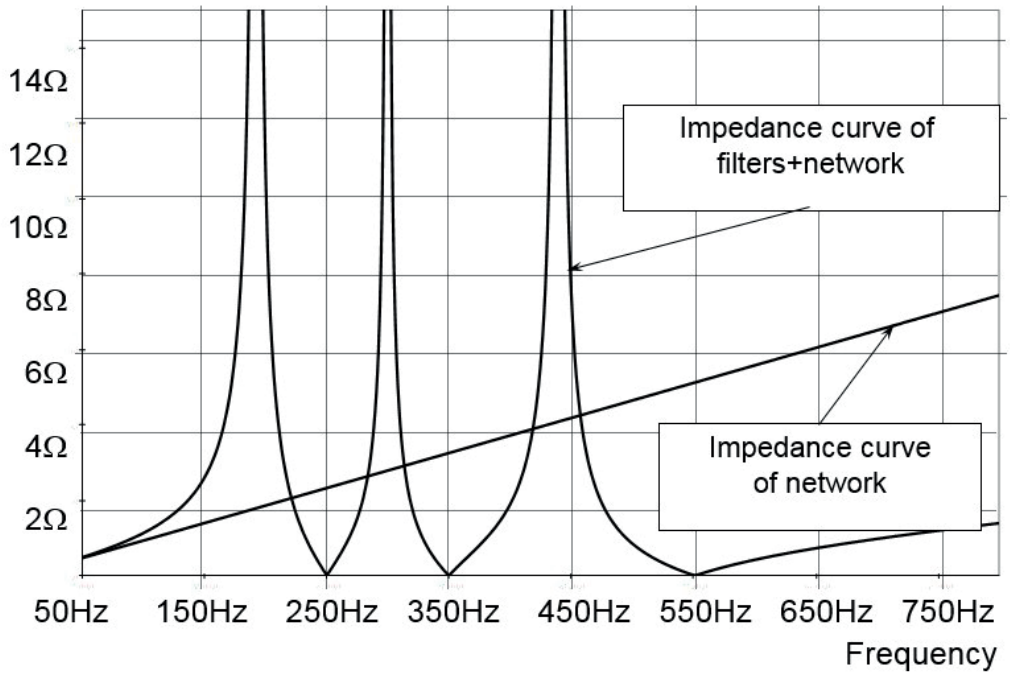
Solution of Harmonic



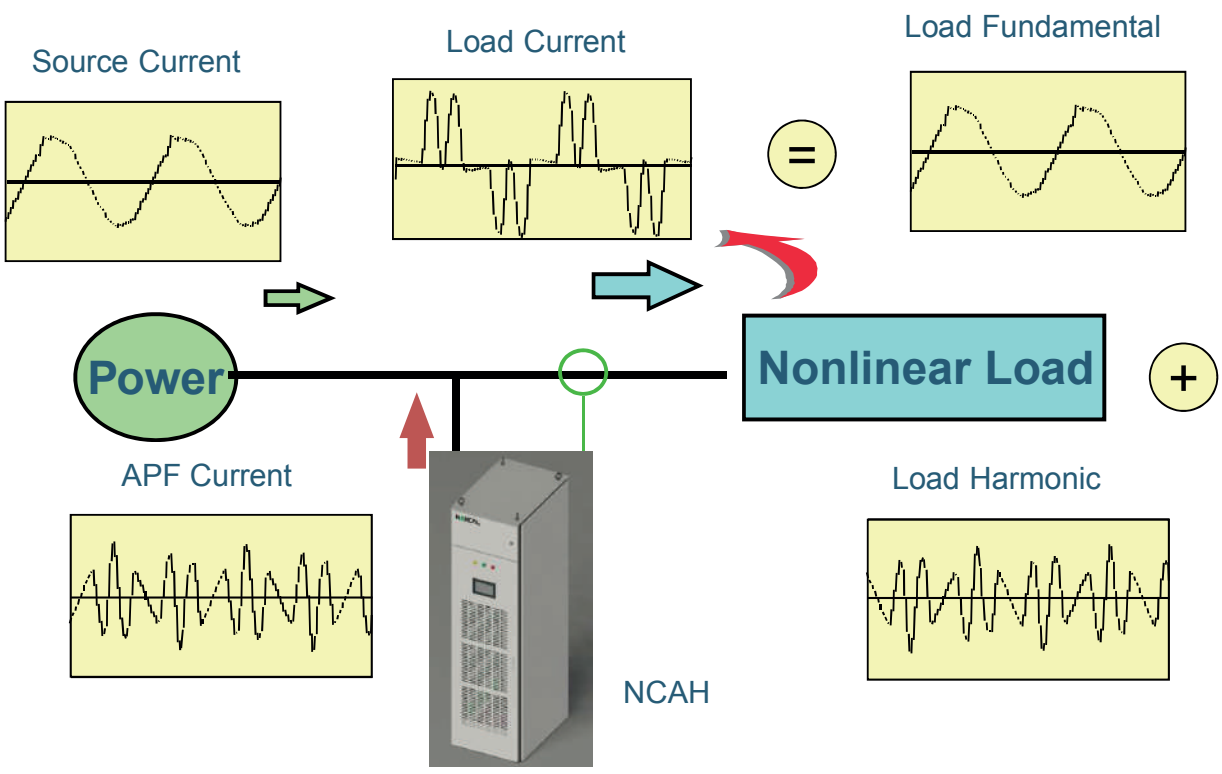
Passive filter



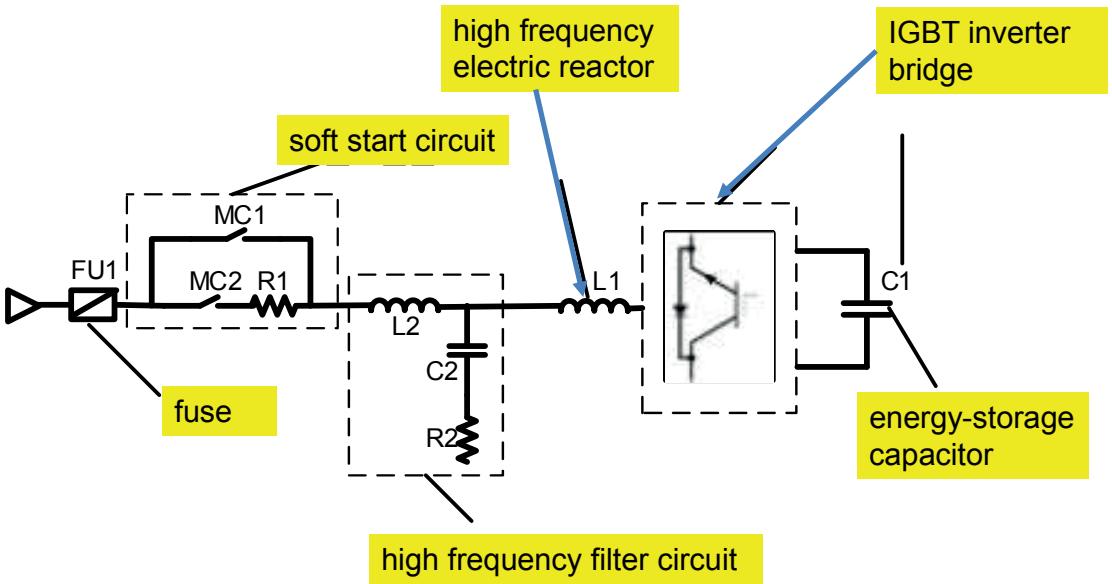
Passive filter



Active Power Filter Principle



Structure

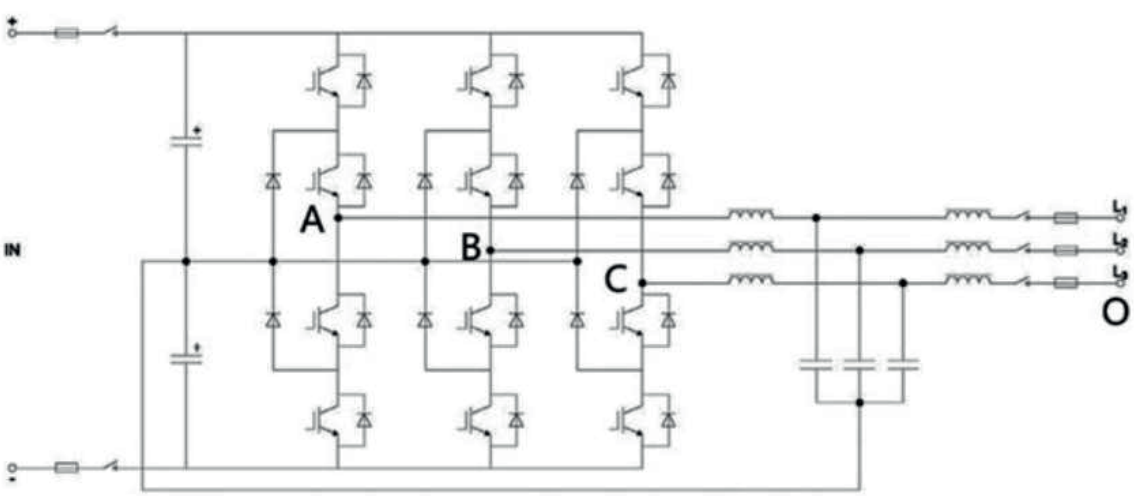


NPC PWM, 20kHz switching frequency, Compact design, High efficiency, High reliability

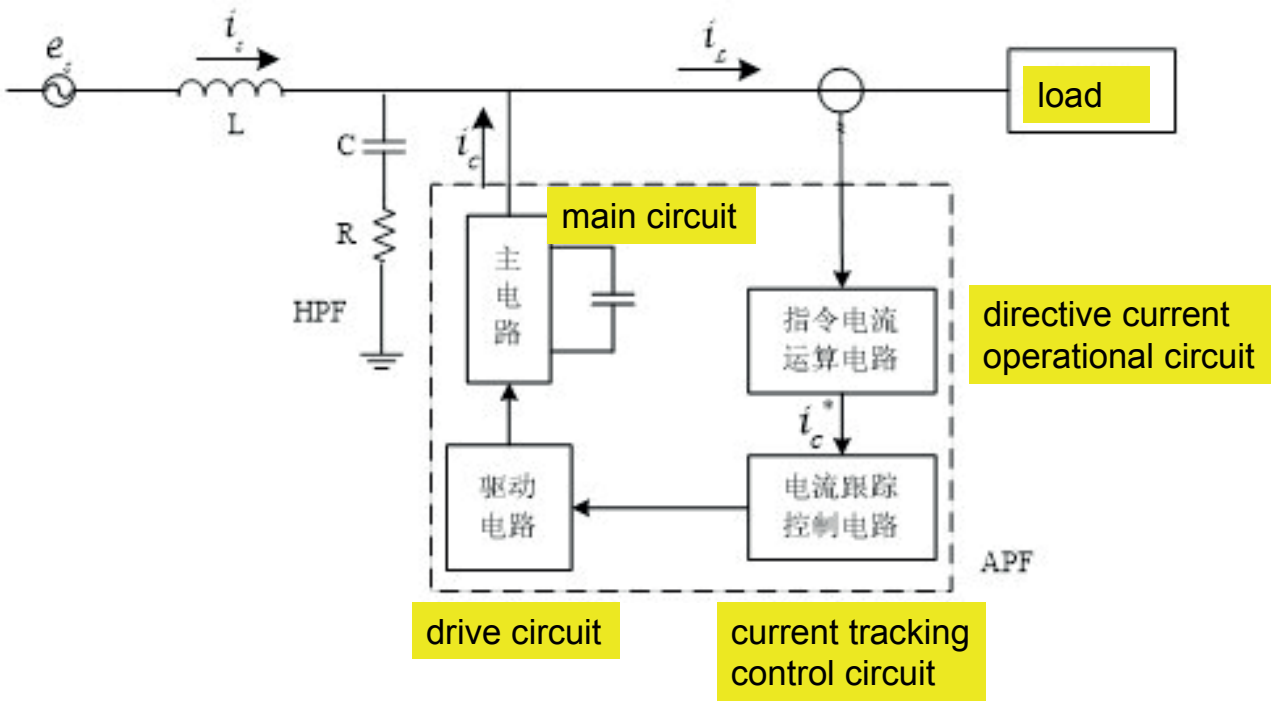
Topology

Three-level inverter

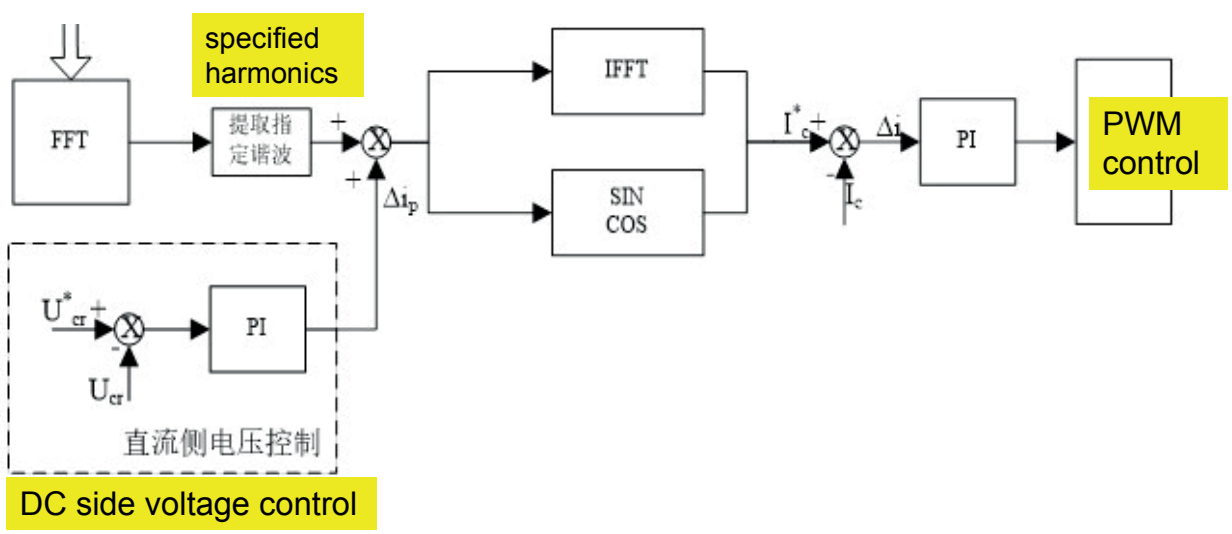
NPC mode three-level PWM inverter, high power density, high efficiency, better waveform and high reliability.



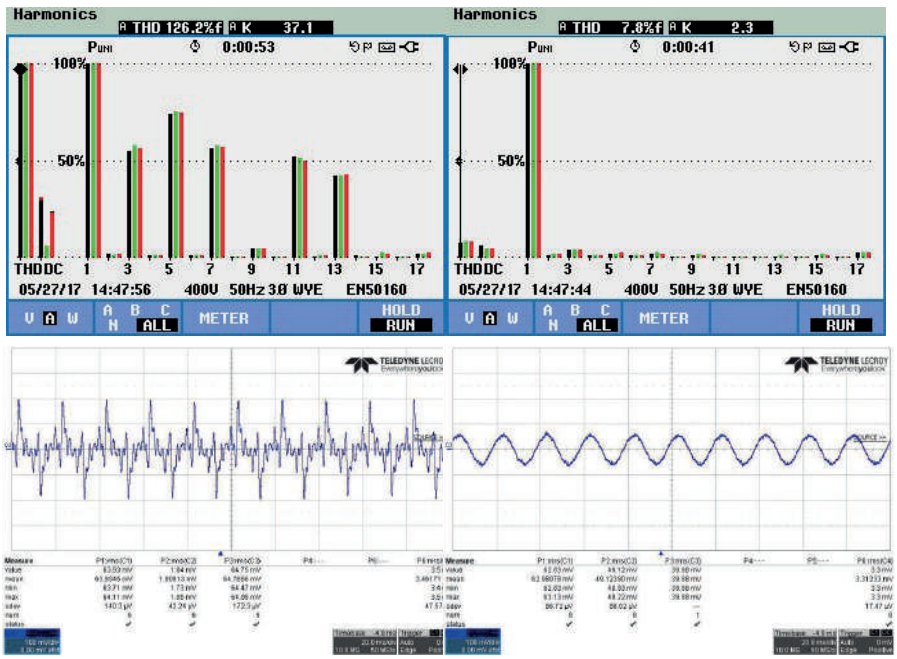
APF Control Principle



APF Control Principle

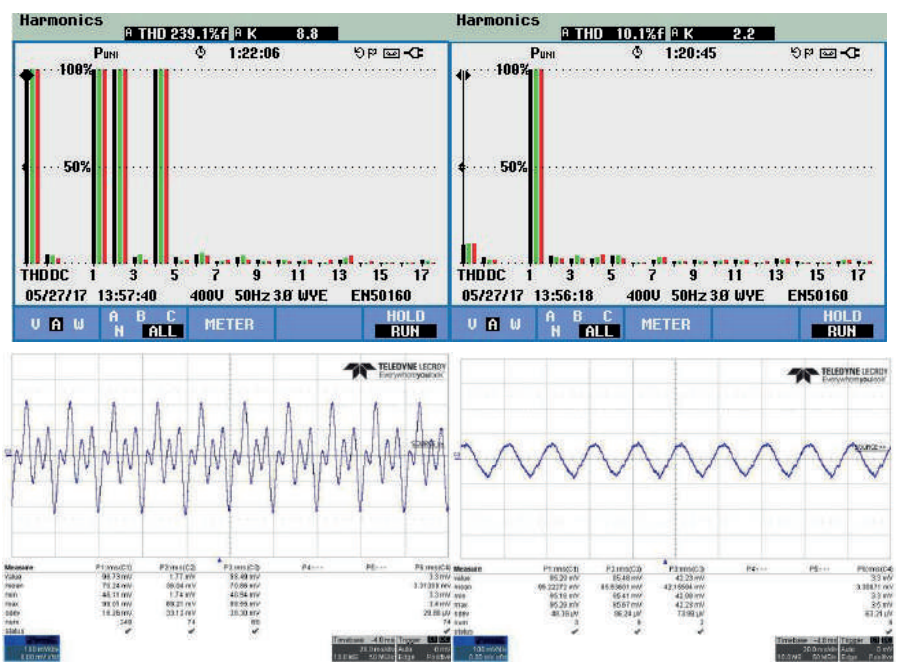


Harmonic Compensation Effects



Odd harmonics

Harmonic Compensation Effects



Even harmonics

Product Features

- **Modular design (Module 30A/50A/60A/100A/150A)**

  wall-mounted/cabinet

  convenient installation

  plug type optional, maintenance friendly

- **Remarkable performance**

  harmonic elimination rate＞97%

  2～61 order compensation (selectable or whole)

  reactive compensation range: -1~1（adjustable）

  three-phase unbalance compensation ＜3%

  3 wire / 4 wire compatible

- **Reliable and stable**

  automatic resonance avoiding, automatic limiter, overvoltage, overcurrent,

  Germany brand IGBT chip

- **Energy saving**

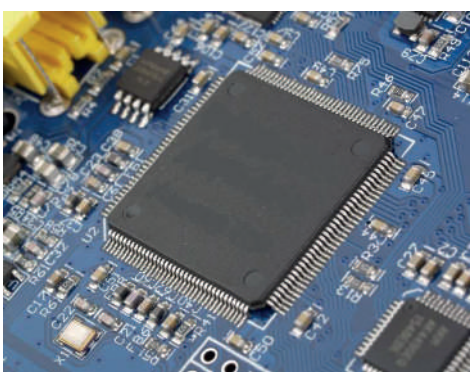
  speed adjustable cooling fans and Isolated air duct design, hibernation/ awakening

  efficiency≥97%

Product Features

Texas Instrument

DSP28377 chip



- **Control hardware**

  Dual core 32-bit CPU + 2CLA

  Main frequency 200MHz

  Each CPU equips three32-bittimers

  12 channel16-bit high-accuracy ADsampling

- **Calculation**

  2rd generation complex calculator VCU II

  Trigonometric functionscalculator TMU0

  Floating point arithmetic

- **APF Response time**

  Instantaneous response time<25us

  Total response time<5ms

Product Features

Global leader

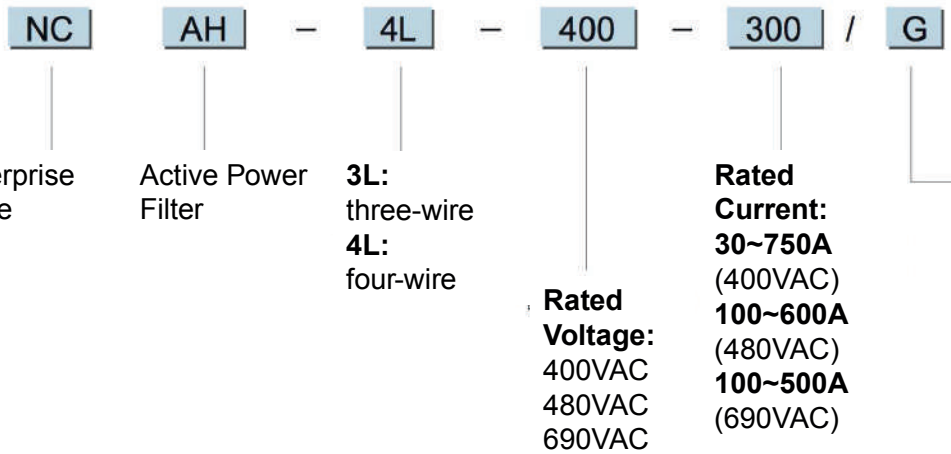
power semiconductor

- **3-level topology structure**
  lower voltag estress per each IGBT
  optimize output waveform
  high performance, low power consumption
- **High-performancedrivecircuit**
  self-designed,stable and reliable
  special design,high-efficiency
  safety design, comprehensive protection
- **Highquality**
  GermanybrandIGBT
  domestic leading brand inductor and capacitor
  long service life

Product Features

- **Modulardesign， flexibleconfiguration**
  - canbe expandedlater per requirement , up to 16 modules, low initial investment
  - easymaintenance,highreliability
- **Cabinetorwall-mountedinstallation**
  - cabinettype,or modules can be placed in customer'sswitchgear
  - wall-mountedinstallationtosavespaceandcost
  - APFcan be paralleled for capacity expansion up to 10 units

APF Product Model



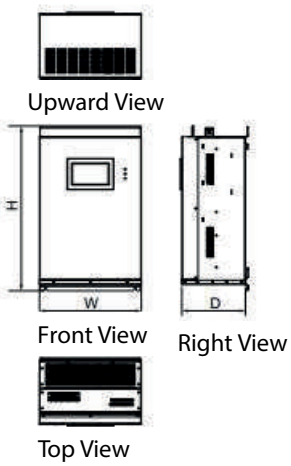
APF Specifications

rated current	30/50/60A	100A	150A	100-750A	100-600A	100-500A
rated voltage	380V（-40%～+20%）				480V（-40%～+20%）	690V（-40%～+20%）
controller	DSP based full-digital control					
compensation current of neutral line	triple phase current					
filter capacity	2～61 order（selectable or whole compensation）					
harmonic elimination rate	>97%					
Line frequency	50Hz/60Hz ± 5%					
line structure	three-phase three-wire /three-phase four-wire					
topology	three-level NPC					
three-phase unbalance compensation capacity	<3%					
reactive compensation	-1～1 (adjustable)					
response time	<5ms complete response ;<25us transient response					
automatic current limiting	yes					
switching frequency	20 kHz (adjustable)					
cooling method	air cooling, speed adjustable					
noise level	<60dBA					
efficiency	≥97%					
protection function	overvoltage, undervoltage, overcurrent, over-temperature etc.					
HMI	standard 7 inch colorized touch screen or customized					
communication interface	RS485/CAN/internet access					
installation	wall-mounted/cabinet			cabinet		
color	RAL7032(optional)					
storage temperature	-40~70 °C					
operation temperature	-10~50 °C					
humidity	<95% non-condensing					
altitude	<1500m (derating when exceed 1500m)					
enclosure	IP21 or customized					

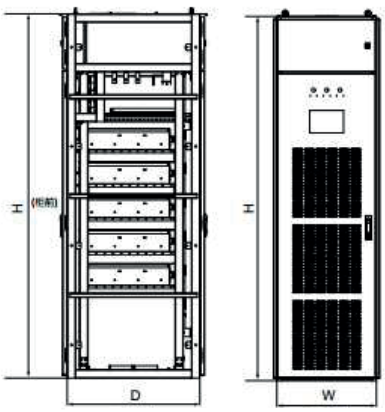
APF Size Outline

Module

Wall-mounted



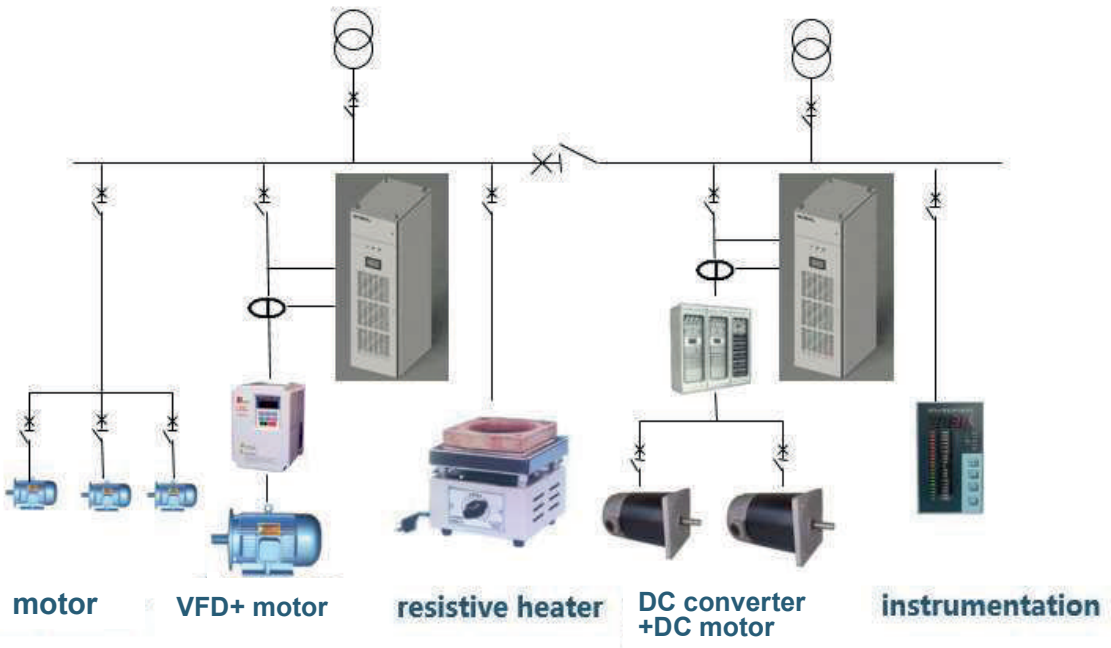
Cabinet



Module & Wall-mounted	Module size （W*D*H mm）	Wall-mounted size （W*D*H mm）	Weight （kg）
30A/50A/60A （400V）	450*545*205	450*265*545	35
100A （400V）	450*645*230	450*290*645	45
150A （400V）	550*645*290	550*350*645	60

Cabinet	Size （W*D*H mm）	Weight （kg）
100-750A (400V)	600*800*2200	200-600
100-600A (480V)	800*1000*2200	200-600
100-500A (690V)	800*1000*2200	200-600

Distributed Compensation



Centralized Compensation