SOJO

SOJO Power Quality Mitigation Devices

BEIJING SOJO ELECTRIC CO., LTD.

CONTENTS

Company Profile

Founded in December 2002, Beijing SOJO Electric Co., Ltd. is a joint-stock high-tech enterprise, whose registered capital is 276 million RMB. Currently there are more than 700 employees. The headquarter is located at Silicon Valley of China-Zhongguancun Shangdi Information Industry Zone, Beijing. SOJO is mainly engaged in the research, production, sales and export of power distribution equipment and automation equipment in the field of 35kV (or lower) power transmission and distribution networks.

In April, 2015, SOJO was officially listed in Shenzhen Stock Exchange (SZSE) (Stock Code: 300444; Stock name: SOJO Electric).

Through more than 12 years, SOJO constantly grows in strength; its products are applied in over 97% of provinces and municipalities of China, wining wide applause from users. In 2009 and 2010, 2-year continuous, SOJO has been named as "Top 12 Best Innovated SMEs in Z-Park" and 3-year continuous named as "Forbes China Best SMEs". SOJO is the first batch of domestic companies which independently research and produce compact switchgear, has nearly hundred products including switching station, ring main unit, sectionalizing cabinet, overhead switchgear, medium and low voltage switchboard, intelligent switchgear, power distribution remote monitoring system, fault detection equipment, cable accessories and etc. Currently, SOJO Electric has one international invention patent, 27 domestic invention patents and 64 utility model patents.

Leader of Power Distribution Industry

SOJO is aiming at providing first-class products and services; being responsible to the society and contributing to the people. In order to realize this aim, SOJO will make every effort and be the top 1 brand in domestic switchgear industry. SOJO will keep pacing on being the first-class smart grid applications supplier, and leading the development of national manufacturing industry.

The products such as switching station, ring main unit, cable distribution cabinet, secondary substation, pole mounted switch and etc. are intensively and stably used in the State Grid, China Southern Power Grid and their sub-companies of province levels or municipal levels, power plant, wind power industry, railway and aviation industry, petroleum and chemical industry, mining industry and other industries.

Cave sheetmetal fabrication system

Automation production line

Serve the Society

- Provide important traffic infrastructure with reliable power supply service
- Provide large energy companies and factories with reliable equipment and services
- Provide important port, coastal work platform with the low voltage power distribution equipment and solutions
- Provide municipal construction, commercial buildings, hospitals, banks and residential area with light and security guarantee.

The problems of power quality

Harmonic Control

1. Total harmonic distortion of voltage THDu

0.38kV < 5%； 6—10kV < 4%
35-66kV < 3%； 110kV < 2%

2. Total harmonic distortion of current THDi

Reactive Power Balance

1. Reactive Power Balance

Power factor PF is more than 0.95

2.Voltage fluctuation and flicker

Three-phase Balance

1. Three-phase load balance

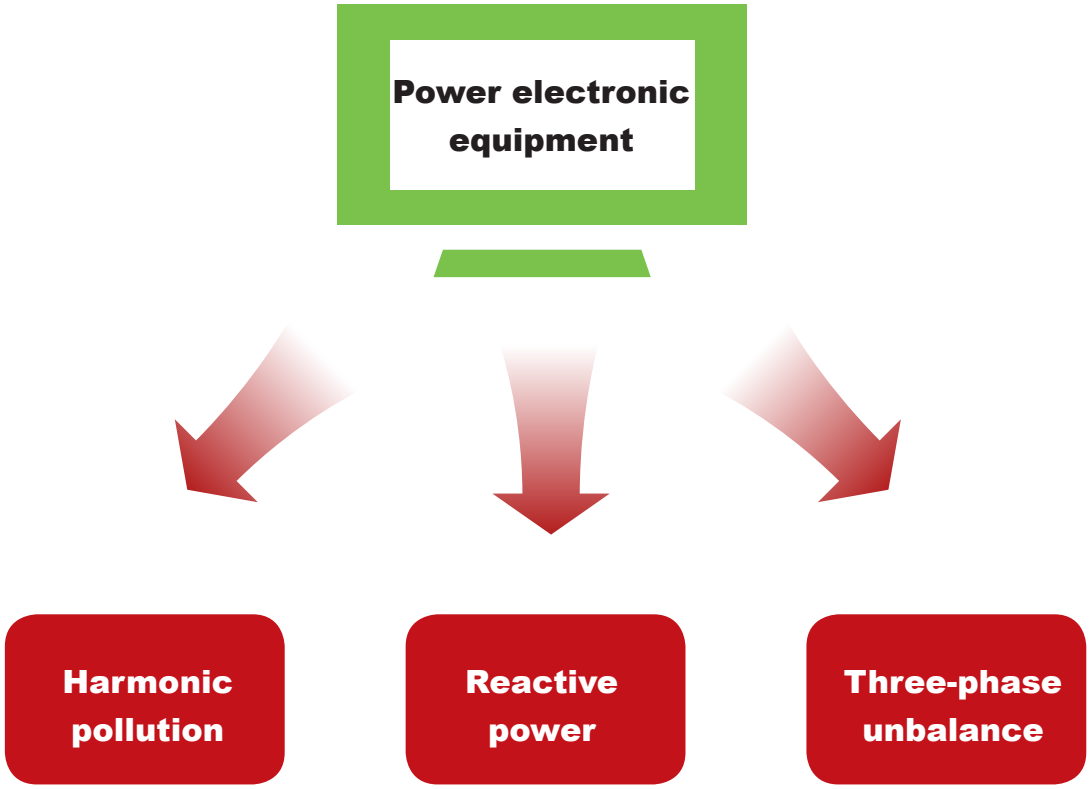
Degree of load current unbalance＜3%.

2. Deviation of power supply voltage

35kv and higher, the sum of positive and negative deviation absolute value＜10%20kv and below three-phase power supply， ±7%
220v single phase，-10%-+7%

Frequency adjustment

±0.2Hz



SOJO is working hard in distribution power quality mitigation and aiming at providing the users with the more professional and more excellent product and service. The main products are including professional power quality assessment service, power system harmonic treatment service, power system reactive power compensation service, smart grid access service and customized intelligent electrical devices etc.

SOJO has strong R&D ability, leading manufacturing technologies and effective management strategy. SOJO is always working for providing the users with the best solutions combined with design, R&D， manufacture， service of power quality mitigation.

The main harms of harmonic

- Increase the working load of power facilities, reduce power factor of the system, and reduce the effective capacity and efficiency of power generation, distribution and electric equipment, which can lead to equipment waste, line waste and power waste.
- It will introduce the rise of reactive power compensator resonance andamplification of harmonic current, which lead to compensator groups damage or cannot be put into operation because of overcurrent or overvoltage.
- Zero sequence (multiple times of 3) harmonic current can lead to N line overload in three-phase four wire system and lead to ring current in transformer winding in delta connection, which could cause accidents.
- The harmonics will change the performance characteristics of protection relay, which lead to malfunction of relay protection device.
- Harmonic wave changes change rate and peak value of voltage or current; and delays the arc extinguishing, which influence the breaking capacity of breakers.
- Interfere with the adjacent power electronic equipment, industrial control equipment and communication device, which influence the normal operation.
- Influence the motor efficiency and normal operation; generate vibration and noise, shorten the life of motor.
- Due to the eddy current and the skin effect, the power loss will happen at the motor, transformer and transmission line, which will waste power and accelerate insulation aging.
- Cause power grid harmonic.

The harm of reactive

- The remote transmission of power grid reactive power lead to network loss and voltage reduction.
- The system power factor cannot reach national standard，which will lead to power rate fine.
- Sudd enload change and grid flicker will reduce the quality of power supply.
- The increase of the power distribution system capacity lead to the waste investment of the equipment.

The harm of three-phase unbalance

- Cause the additional heat and shake of motor; and endanger the safe operation and the normal output.
- Cause malfunction of multi protection device which is on the basis of the amount of negative sequence start elements (especially when there is harmonic in the power grid at the same time).
- Make the semiconductor converter equipment generate additional harmonic current (uncharacteristic harmonics).
- Transformer' s three-phase unbalanced load not only shorten working duration due to overload in single phase, but also lead to overheat of walls and clips due to the unbalanced magnetic circuit and magnetic flux leakage.
- Zero to earth voltage is too high, which can influence the safe operation of weak current equipment of the control system

The benefits of managing harmonics

- Improve the power quality and production efficiency, reduce the mulfunction of the equipment.
- Reduce the transformer and line loss caused by harmonics, waste investment of saving power.
- Improve the changing rate and peak of voltage or current because of the harmonic and reduce the insulation loss of the line.
- Prevent harmonic oscillation because of the harmonics and prevent fire

The benefits of improving power factor

- The benefits of improving power quality
- Meet national standards and reduce fines
- Improve the effective capacity of transformer and reduce the cost
- Reduce the power loss of line and transformer, reduce the user's electricity charge
- Improve the terminal voltage and power quality

The benefits of compensating the three-phase imbalance

- Reduce the transformer damage caused by imbalance and reduce transformer loss
- Reduce the N line current, reduce the line loss, avoid the situation of the fire caused by N line overheat.
- Avoid local null line voltage increase and affect weak current control

Relative policies

Chinese government has introduced relative standards and documents in order to support and ensure the power supply quality.

Complied Standards

- Quality of electric energy supply Harmonics in public supply network
- Power quality-Admissible deviation of supply voltage
- Power quality-Frequency deviation for power system
- Power quality-Three-phase voltage unbalance
- Power quality-Voltage fluctuation and flicker
- Power quality-Interharmonics in public supply network
- General requirements for monitoring equipments of power quality
- Power quality-Voltage dips and short interruptions

Solutions of power quality mitigation

- For the seasonal “low voltage” problem with variable average load rate is less than 25%, on-load capacity regulating and variable voltage regulating can be used;

- Power supply radius, load size and balance distribution should be considered when design;

- When unbalance degree of output current is more than 15%, load rate is greater than 60%, and through the management measures is difficult to adjust, the three-phase unbalance automatic adjustment device can be used to adjust. Especially for “low voltage” problem caused by low voltage harmonic, voltage flicker, insufficient reactive compensation capacity, etc., Static VAR Generator (SVG) can be installed.

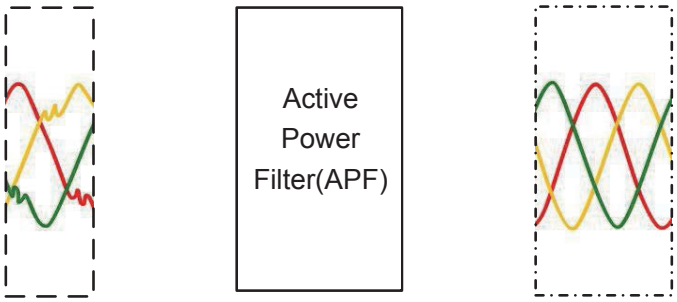
- When the voltage of one certain phase is too high due to the unbalanced three-phase; and another court with low terminal voltage cannot be adjusted by management measures, the Smart Three-phase Unbalance Regulator (STUR) can be equipped to adjust the unbalanced three-phase.

- For the “low voltage” problem caused by over large supply radius and overload, which cannot solved by increasing reactive power compensation devices, low voltage line adjustment device can be equipped.

SOJO SPQR 100 Active Power Filter (APF)

SOJO SPQR100 APF Product Introduction

● Active Power Filter: Active Power Filter（APF）is a kind of electronic device used for dynamic suppression harmonic and reactive power compensation.



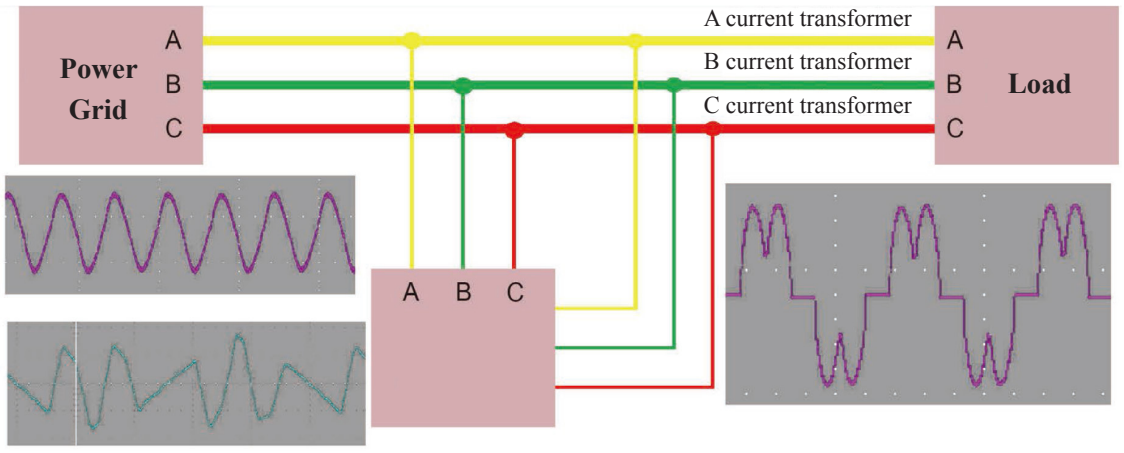
Model Explanation

SOJO SPQR100	F	050	C	4L	4	XXX
Product series	F:APF	Rated Current: 50A 125A 150A 200A 250A 300A	Structure: C:Cabinet Model MH:Horizontal Model MV:Vertical Model H:Hanging Model	Circuit: 4L:Three-phase four-wire 3L:Three-phase three-wire	Rated Voltage: 4:400V 6:600V	Enterprise code

Operating Principle

SOJO Active Power Filter（APF）is new type suppression device for power harmonic, which adapts modern power electronics and digital signal processing technology based on high-speed DSP device.

It consists of two main parts, which are the command current operation circuit and the current compensation circuit. The harmonic current and reactive current in the grid are detected by the external transformer in real time. The line current is detected by command current operation circuit. The analog current signals are converted into digital signals; then the signal is processed by a high-speed digital signal processor (DSP) to separate the harmonic from the base wave and the pulse width modulation (PWM) signal is sent to the compensating current to drive the pulse. The IGBT or IPM power module is driving and the compensation current is injected into the grid with the same value as the harmonic current of the grid and the opposite of the polarity. The harmonic current will be compensated or canceled, actively eliminate the electric harmonic.



Technical Features

- More Functions, More Modes
  - Harmonic compensation,reactive compensation,harmonic and reactive compensation,three phase unbalance compensation,etc;
  - Harmonic sub-compensation function; the proportion of reactive compensation can be set;
  - 7-inch HD touch screen;
  - Internet of Things technology; real-time monitoring site operation;

- Advanced control strategy and topology design
  - The improved detection techniques based on instantaneous reactive power theory can detect the harmonic current in real time and track harmonic load change automatically, which is highly controllable and responsible.
  - The unique sub-phase harmonic extraction algorithm is adopted. When three phase unbalanced, every phase can be controlled independently, therefore, in the case of sufficient capacity, it is optional to eliminate the unbalance function.
  - LCL topological structure filtering is adopted, in the case of output harmonic current, no high-frequency IGBT harmonic interference will be introduced. And it is suitable to any field grid system impedance, no resonance occurs.

- Overall protection function, improve user's application stability
  - SOJO patented technologies, effective value peak double-limiting flow algorithm, the output of device is limited to 100% automatically without the risk of overload;
  - Complete protection functions, which can ensure the system work reliablyand safely.
  - Self-diagnose function;
  - Fault alarm and recall function;

- High degree of Integration, Modularity and Serialization
  - Module design, light weight, high power density, easy to maintain;
  - The combination can meet different demand of capacity. The reliability and maintainability are improved, and at the same time, standardized production is realized;
  - Single and independent modular air flue design, which can effectively insulate the environmental dust and enhance the heat emission efficiency;

Technical Parameters

Name	SPQR100-F Active Power Filter			
Input				
System Voltage	V1：208~480V AC V2:480~690V AC			
System Voltage Range	±10%			
Frequency	50/60±5%			
Output and Installation Method				
Rated Current	MH	MV	H	C
	50，60，75	100,125，150	50，75，100，125，150	100,125,150,200,250,300,375，400，450
Type	Modular Type		Hanging Type	Cabinet Type
Method of Incoming Line	Back	Top	Top	Top/Down/Through the bus at top
Performance Index				
Filter Rate	≥85%			
Filter Range	2~51 times harmonic wave			
Total Response Time	≤10ms			
Transient Response Time	≤100 μ s			
Working Mode	Harmonic Compensation、Reactive Power Compensation、Harmonic and Reactive Power Compensation			
Dynamic Current	1.2 times of rated capacity output of filter			
Power Factor Correction	Yes, can be set up			
Protection				
Overload Protection	Yes, automatic current-limiting when the rated output is 100%			
Other Protection	Over Voltage Protection、Undervoltage Protection、Over-temperature Protection			
Operation Method				
Unit Operation	Yes			
Parallel Operation	Yes			
Display and Operation				
Display Interface	7-inch touch screen			
Display Status	Current、Voltage、Power、Harmonic Distortion Rate etc			
Operation	Multi-options of operations, Remote or Local			
Communication (RS485 Interface)	Modbus-RTU, with remote monitoring interface and background database			
Environment Conditions				
Protection Level	IP20			
Operation Condition Temperature	-10℃~45℃			
Storage/Transportation Temperature	-40℃~70℃			
Working/Storage Humidity	Relative humidity is 20~95%, without condensation/ relative humidity is 10~95%			
Altitude	Below 1000m, (for higher altitude,derating capacity should be used)			

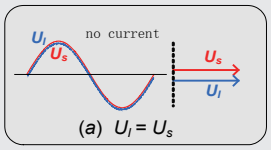
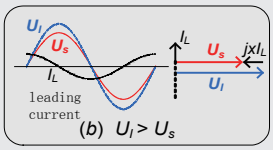
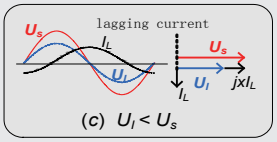
Structure Parameter

Name		MH		MV		H		C
Installation Method		Horizontal Type	Vertical Type	Vertical Type		Hanging Type		Cabinet Type
Capacity (A)		50 60 75	50 60 75	100 125 150	150	50 60 75	100 125 150	100、125、150、200、250、300、375、450
Configuration Dimension	Width	490	440	265	265	440	555	400/700/1000
	Depth	680	178	550	630	230	265	800
	Height	178	700	1205	1205	700	1450	1800
Oder Number		SPQR100-F050MH4L4		SPQR100-F100MV4L4		SPQR100-F100H4L4		SPQR100-F100C4L4

SOJO SPQR 200 Static VAR Generator (SVG)

SOJO SPQR200 SVG Product Introduction

● Static VAR Generator:SVG (Static VAR Generator) is one of the main devices of FACTS (flexible alternative current transmission systems), which is a kind of parallel type reactive compensation device. It can emit or absorb reactive power, and it can output the changeable and specific parameters to control the power system. In the power distribution grid, the small capacity SVG installed near some special load can improve the power quality between load and the connection of public power grid. And the main function is improving the overcoming factor, overcome the three-phase imbalance and eliminating voltage flashes and fluctuations, etc.

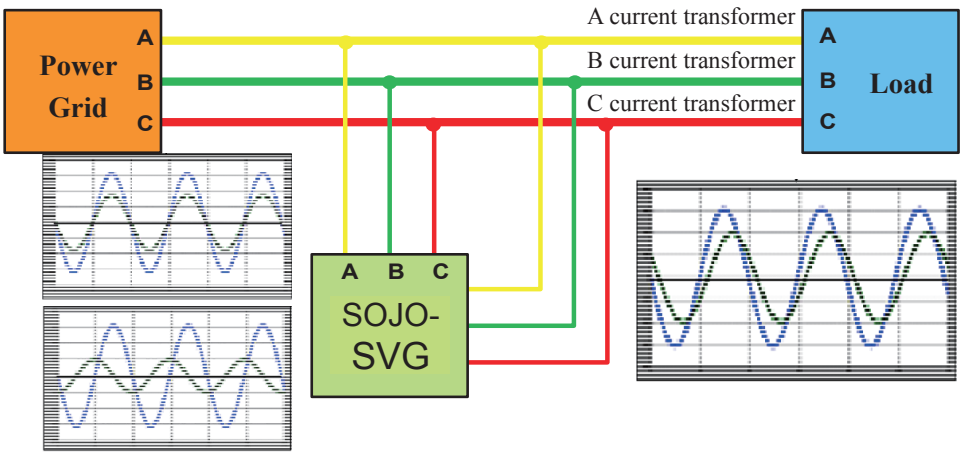
Name	MH	MV
No-load operation		UI=US;IL=0
Capacitive operation		UI>US;ILis capacitive current
Inductive operation		UI<US;ILis inductive current

Model Explanation

SOJO SPQR200	G	035	C	4L	4	XXX
Product series	G:SVG	Rated Capacity: 30Kvar 50Kvar 75Kvar 100Kvar 150Kvar 180Kvar 200Kvar 300Kvar 450Kvar	Structure: MC:Cabinet Model (Built-in Split Type Model) MH:Withdrawal Type Model MV:Vertical Model H:Hanging Model MS:Split Type Model C:Cabinet Type	Circuit: 4L:Three-phase four-wire 3L:Three-phase three-wire	Rated Voltage: 4:400V 6:600V	Enterprise code

Operating Principle

SOJO SVR is based on DSP technology, and the self-commutation bridge circuit is parallel to the grid through the reactor. The real time data acquisition technology and dynamic tracing technology are adapted to detect the voltage and current information of the power grid; through the build-in DSP calculation, the reactive element of load current is extracted. Then the PWM signal is sent to IGBT and according to the settings, the inverter is controlled to generate the demanded reactive current to achieve the goal of reactive compensation.



Technical Features

- Excellent performance of reactive compensation
  - Inductive reactive power compensation, and also capacitive reactive power compensation. The device can adjust between these two compensation methods.
  - Increase power factor to above 0.99
  - It has three-phase imbalance compensation function

- Stable and rapid performance of compensation
  - Real-time compensation, total response time is ≤20ms
  - Dynamic response time is less than 200us
  - The compensation capacity is equal to installation capacity, which is not effected by system voltage drop.
  - All-digital control; advanced control algorithm based on instantaneous reactive power theory; real-time and precise reactive power compensation

- Strong protection function which can ensure the reliable operation of the system
  - When the device is running, it is controlled as a current source, there is no resonance with the system
  - Automatic current-limiting, avoid over compensation or under compensation
  - Complete protection functions, including overcurrent, over voltage, under voltage and over temperature etc.
  - Friendly man machine interface, 7 inches touch screen, real-time parameters display, fault alarm and recall function
- Modular design improves the product quality
  - Power circuit and control circuit adopt modular design.
  - Highly reliable parallel operation can realize parallel connection and provide various capacity demands.

Technical Parameters

Name	SPQR200-G Static VAR Generator				
Input					
System Voltage	V1：208~480V AC V2:480~690V AC				
System Voltage Range	±10%				
Frequency （Hz）	50/60±5%				
Output and Installation Method					
Rated Capacity (kvar)	MH	MV	MS	H	C
	35，50	75，100,150	100,125,150,180,200	35，50，75，100，150	100,125,150,180，200,250,300,350，400
Type	Unitary Module		Split Module	Hanging Type	Cabinet Type
Method of Incoming Line	Back	Top	Top	Top	Top/Down/Through the bus at top
Performance Index					
Total Response Time	≤10ms				
Transient Response Time	≤200 μ s				
Working Mode	Reactive Power Compensation、Harmonic and Reactive Power Compensation				
Three-phase Imbalance Correction	Yes				
Power Factor Correction	Yes				
Protection					
Overload Protection	Yes, automatic current-limiting when the rated output is 100%				
Other Protection	Over Voltage Protection、Undervoltage Protection、Over-temperature Protection				
Operation Method					
Unit Operation	Yes				
Parallel Operation	Yes				
Display and Operation					
Display Interface	7-inch touch screen				
Display Status	Current、Voltage、Power、Power Factor etc				
Operation	Multi-options of operations, Remote or Local				
Communication (RS485 Interface)	Modbus-RTU				
	Standards				
Reference Harmonic Standard	IEEE519				
Design Standard	EN60146				
Safety Standard	EN50178				
EMC	EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-4-8, EN61000-4-11, EN61000-6-3				
Environment Conditions					
Protection Level	IP20				
Operation Condition Temperature	-10℃~45℃				
Storage/Transportation Temperature	-40℃~70℃				
Working/Storage Humidity	Relative humidity is 20~95%, without condensation/ relative humidity is 10~95%				
Altitude	Below 1000m, (for higher altitude, derating capacity should be used)				

Structure Parameter

Name		MH		MV			H		MC
Installation Method		Horizontal Type	Vertical Type	Vertical Type			Hanging Type		Cabinet Type
Capacity (A)		35，50	35，50	75	100	150	35，50	75，100	75、100、125、150、200、250、300、
Configuration Dimension	Width	490	440	265	265	295	440	555	600/800/1000
	Depth	680	178	550	630	690	230	265	800
	Height	178	700	1205	1205	1450	700	1450	1800
Oder Number		SPQR200-G035MH4L4		SPQR200-G075MV4L4			SPQR200-G035H4L4		SPQR200-G075MC4L4

Name		MS				C
Installation Method		Split Type Main Control Unit	Split Type reactor			Cabinet Type
Capacity (A)		125，150，180，200	LK-190A	LK-230A	LK-280A	LK-300A	125,150,180,200,250, 300,350,400
Configuration Dimension	Width	265	380	500	480	480	600/800/1000
	Depth	600	250	290	320	320	800
	Height	950	330	330	390	390	2200
Oder Number		SPQR200-G125MS4L4				SPQR200-G125LC4L4

SOJO SPQR 300 Series Power Distribution Smart Three-phase Unbalance Regulator (STUR)

SOJO SPQR300STUR Product Introduction

● Smart Three-phase Unbalance Regulator：Smart Three-phase Unbalance Regulator (STUR) is a new type electric device which is used to dynamic govern distribution network imbalance and compensate reactive power. When the three phase imbalance due to the load varying in different time period, STUR can adapt advanced control algorithm to split the positive sequence, negative sequence, zero sequence and reactive component of the unbalanced current. By triggering IGBT, the inverter generates the opposite counter vailing current to eliminate the imbalance and compensate reactive power.

Model Explanation

SOJO SPQR300	STUR	100060	C	4L	4	XXX
Product series	STUR Smart Three-phase Unbalance Regulator	Rated Capacity: 30Kvar 50Kvar 75Kvar 100Kvar 150Kvar	Structure: C:Complete Machine MH:Withdrawal Type Model MV:Vertical Model	Circuit: 4L:Three-phase four-wire 3L:Three-phase three-wire	Rated Voltage: 4:400V 6:690V	Enterprise code

Operating Principle

Three phase imbalance compensation principle: DSP controller can detect the load current in real time, and it can determine whether the system is in an unbalanced state through calculating and analyzing the load current. Advanced control algorithm is adapted to split the positive sequence component, negative sequence component and zero sequence component. And then the controller drives IGBT in real time, the STUR generates a current in reverse of the negative sequence component and zero sequence component, and finally the grid side current reaches a three-phase balanced state

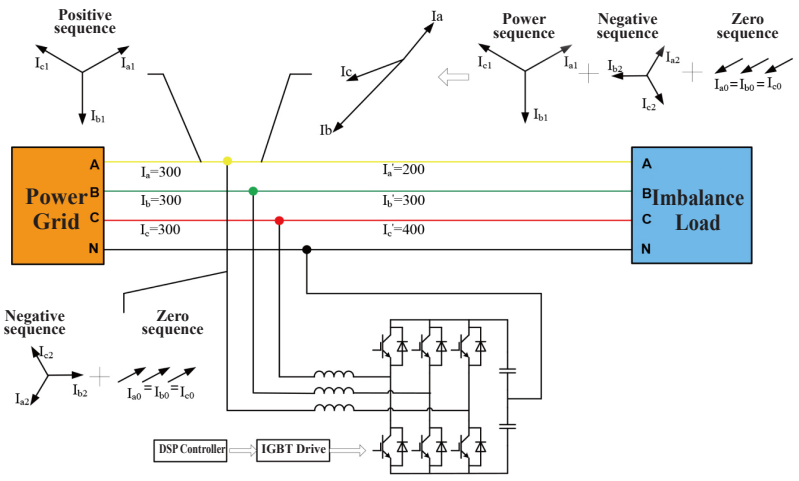
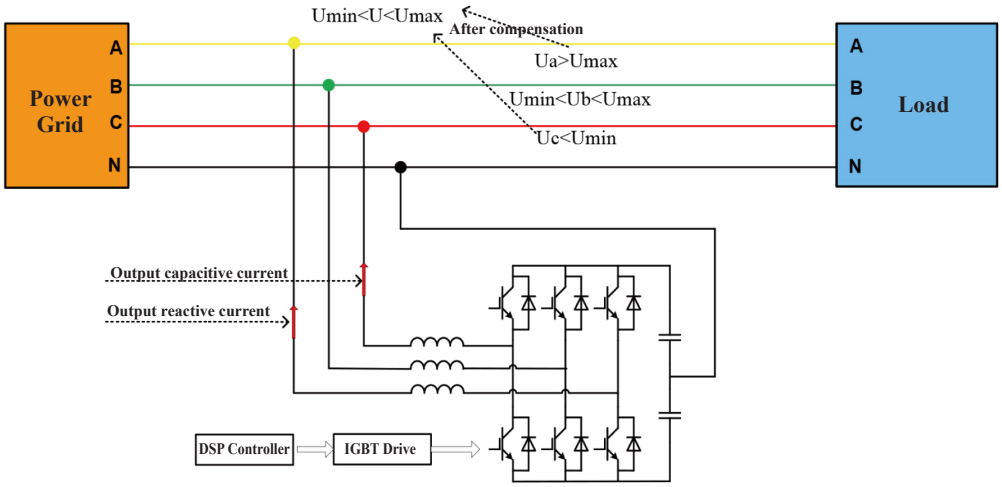


Diagram 1 Operating Diagram of three phase imbalance

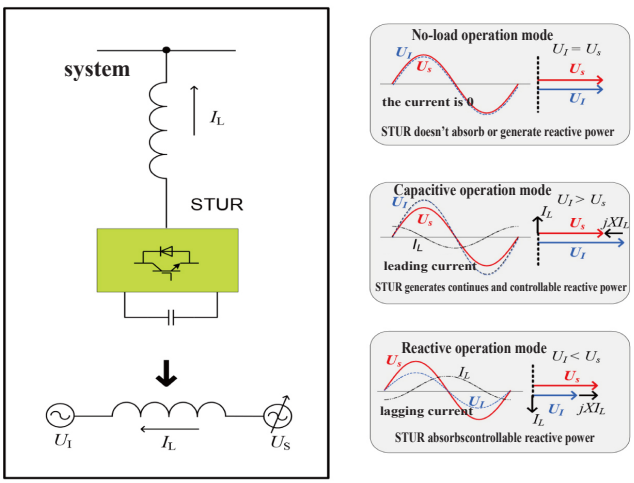
Operating Principle

● Principle of Grid Voltage Support: DSP controller detect the data of compensatory point in real time and determine whether the compensatory point voltage exceeds the set value; when over the max value of the voltage (Umax), the device output reactive current, and the voltage of compensatory point decrease; when below the minimum value of the voltage (Umin), the device output capacitive current, and the voltage of compensatory point increase; and finally, the voltage of every phase keep stable in normal range.



Principle Diagram of grid voltage support

● Reactive compensation principle: DSP controller detects load current in real time, and calculates the reactive current data of load current. The reactive current is the reference value of the controller; the controller drive IGBT to generate the demanded compensation current (capacitive or reactive), and finally, the goal of dynamic reactive compensation is achieved.



Principle Diagram of Reactive Compensation

Technical Features

● More Functions and More Modes

- This device is multi-functional. It has the functions of zero sequence compensation, negative sequence compensation, reactive power compensation and harmonics compensation
- Specific harmonics compensation function, zero sequence and negative sequence and reactive repair or repair function
- Friendly UI; 7 inches HD color touch screen. The screen can display the parameters of system and device in real time.
- WIFI, 3G/4G communication mode, various APPs can be installed, which can enable monitoring and operating in time

● Advanced Control Strategy and Topological Structure Design

- This device based on IRPT detecting technologies, the harmonic current can be monitored in time and the change of loading harmonic can be traced, which make this device highly controllable and reactive.
- The LCL topological structure of filter is adapted, when outputting harmonic current, the high frequency IGBT switching harmonic interferencewill not be introduced. And it is suitable in any field with grid system impedance and no resonance will happen.

● Complete Protection, High Stability

- SOJO Patent technology, effective peak values anddouble current limit algorithm, the device output can be limited by 100% automatically and without overload risk
- Complete protection, in order to ensure the system work reliably and safely.
- Fault self-check function
- Fault alarm and recall

● High Power Density, Easy to Install

- Modularization, small and light; easy to install and maintain
- Group parallel operation
- Independent air duct design, which can effectively isolate the environment dust and improve the product cooling efficiency

Technical Parameters

Name	SPQR300-G Smart Three-phase Unbalance Regulato				
Rated Voltage（V）	400/690±10%				
Working Frequency（Hz）	50/60				
Output Capacity	30	50	75	100	150
Compensation Type	Unbalance，Harmonics and Reactive Power				
Single harmonic filtration rate	≥95%				
Total Response Time	≤10ms				
Active Power Loss	＜3%（Rated）				
Compensation Ability of Neutral Line	Three times of phase current				
Noise Objective	65dB				
Overload Capacity（1min）	120%				
Protection Level	IP44（can customize）				
Heat-dissipating Method	Air-Cooled				
Communication	Modbus，RS485、WiFi、3G				
Parallel Operation	Multiple Parallel				
Protection	Overcurrent，Over-temperature, Over DC Voltage and communication etc.				
Display Method	7-inch touch screen				
Installation Method	Outdoor Pole Mounted Installation				
Environment Temperature	-25℃~40℃（for higher temperature, derating capacity should be used）				
Storage Environment	-40℃~60℃				
Relative Humidity	95% max，without condensation				
Altitude	Below 1000m, (for higher altitude, derating capacity should be used)				

Diagram 1 Technical Parameter

Transformer Capacity（kvar）	Secondary Side Voltage（kV）	Rated Secondary Current（A）	Unbalanced Current Need to Compensate（A）	Matching Capacity（kvar）
160	0.4	230	50	30
200	0.4	288	60	50
250	0.4	360	75	50
315	0.4	454	90	75
400	0.4	577	120	100
630	0.4	909	180	150

Diagram 2 Model Selection

Note： 1. The unbalanced current mentioned here is suggestive value, which is about 20% of transformer’ s rated current.

2.Accurate calculation

$$Q = \sqrt{Q_N^2 + Q_U^2}$$

Q Total Compensation Capacity, Q_N Reactive Capacity Need to Compensate, Q_U Unbalanced Capacity Need to Compensate

SOJO SPQR 400 Series Power Quality Compensator(PQC)

SOJO SPQR 400 Series PQC Introduction

● PQC (Power Quality Compensator) is one of the main devices of power system quality solution, which is a kind of parallel power electronic equipment. It is based on SVG, with APF function in order to realize APF+SVG functions for the price of one SVG.

Model Explanation

SOJO SPQR400	PQC	100060	C	4L	4	XXX
Product series	Power Quality Compensator	Rated Capacity: SVG:100Kvar APF:60A (Specific capacity needs to be customized)	Structure: C:Cabinet Model V:Vertical Model H:Hanging Model	Circuit: 4L:Three-phase four-wire 3L:Three-phase three-wire	Rated Voltage: 4:400V 6:600V	Enterprise code

Technical Features

● One-Stop Solution

- PQC combines the main technology features and some functions of APF and SVG, which can provide the “one-stop” solution for harmonics, reactive power and unbalance problems.

● Technology Innovation

- An innovative automatic proportioning idea has been introduced aiming at different load environment. The ratio of harmonic current and reactive power can be set up automatically, which can improve power quality.

● Customization

- According to customers’ demands and load environment, complete customization can be adopted. For some users, some interfaces of the software can be open for them, which is convenient for them to do the second develop.

Technical Parameters

Name	SPQR400-PQC Power Quality Compensator				
Input					
System Voltage（V）	V1: 208~480V AC　V2: 480~690V AC				
System Voltage Range	±10%				
Frequency （Hz）	50/60 ±5%				
Output and Installation Method					
Structure Code	MV		C		
SVG Capacity (kvar)	100	150	200	300	450
APF Capacity (kvar)	60	90	120	180	270
Type	Vertical Module		Cabinet Type		
Method of Incoming Line	Top		Top or Down		
Performance Index					
Total Response Time	≤10ms				
Transient Response Time	≤200us				
Working Mode	Capacitive and reactive compensation and 2~13 times harmonic compensation				
Three-phase Imbalance Correction	Yes				
Power Factor Correction	Yes				
Protection					
Overload Protection	Yes, automatic current-limiting when the rated				
Other Protection	Over Voltage Protection				
Display and Operation					
Display Interface	7-inch touch screen				
Display Status	Current、Voltage、Power、Power Factor、Harmonic Distortion Rateetc				
Operation	Multi-options of operations, Remote or Local				
Communication (RS485 Interface)	Modbus-RTU, with remote monitoring interface and background database				
Operation Method					
Unit Operation	Yes				
Parallel Operation	Yes				
	Standard				
Reference Harmonic Standard	IEEE519				
Design Standard	EN60146				
Safety Standard	EN50178				
EMC	EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-4-8, EN61000-4-11, EN61000-6-3				
Environment Conditions					
Protection Level	IP20				
Operation Condition Temperature	-10℃~35℃				
Storage/Transportation Temperature	-40℃~70℃				
Working/Storage Humidity	Relative humidity is 20~95%, without condensation/ relative humidity is 10~95%				
Altitude	Below 1000m, (for higher altitude, derating capacity should be used)				

Structure Parameter

Structure Code		MV		C	
Installation Method		Module		Compete Equipment	
Output Capacity (A)		100kvar+60A	150kvar+90A	100kvar+60A 200kvar+120A	150kvar+90A 300kvar+180A 450kvar+270A
Configuration Dimension	Width	265	295	400/700	600/800/1000
	Depth	550	685	600	800
	Height	1450	1362	2200	2200
Oder Number		SPQR400-PQC100 060MV4L4	SPQR400-PQC150 090MV4L4	SPQR400-PQC150090C4L4	SPQR400-PQC150090C4L4
Accessories		Touch screen	Touch screen		

SOJO SPQR 500 Series Power Quality Customized Services(PQCS)

SOJO SPQR500 PQCS Introduction

● Power Quality Customized Services: PQCS (Power Quality Customized Services) is a kind of customized service which is firstly developed by our company over the entire industry combined with years' experience and customers'demands. It is specialized, customized, and intelligent in order to provide partners and clients with suitable and customized solutions.

SOJO SPQR500 Series PQCS Main Services Sector

Service Sector: Internet+ PGS System

Cloud Service

Connect any power quality mitigationproduct to the Internet， and monitor the product remotely through the cloud.

Client Side

The customers can monitor the operation status of the power quality mitigation devices through computer, mobile phone and other Internet devices.

Data Storage

Through connecting to the Internet, the operation data of the devices can be stored in the cloud, which can be used in any time.

Remote Operation

When the power quality mitigation equipment connect to the Internet, some users can operate the device remotely, which is easy and convenient.

Technical Features

● One-Stop Solution

• Taking PQCS as a purpose and taking the internet as the tool, a cloud service platform is built based on power quality mitigation devices. Through Internet， high-end customized and customers-demanded devices can be developed; SOJO PQC is a representative example.

● Internet of Things

• With SPQR500 series PQCS configured with intelligent Internet of Things integrated system,customers can monitor the running status of the PQCS product in real timeon the PC or the mobile phone. The function of setting the self-starting time, self-stopping time, protecting fault resetting, immediate starting, immediate stopping and the local control releasing could be achieved.

Application Areas and Effect Picture

Industry

Iron and steel metallurgical enterprises
Petrochemical enterprises
Mining enterprises
New energy enterprises
Automobile manufacturing enterprises
.....

Municipal Works

Medical industry
Telecommunication industry
Business building
Research institution
Railway industry
.....

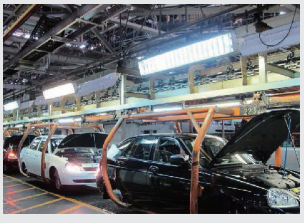
Comparison of before and after APF compensation on secondary side of the transformer in an automobile factory (The main load is the silicon-controlled rectifier)

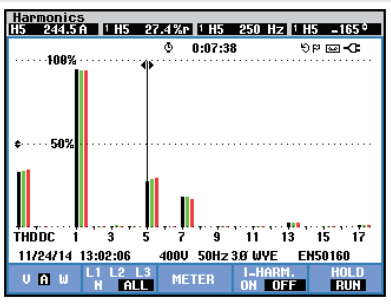
The problem occurred:

The heat damage of the passive reactive power compensation capacitor in the electrophoretic coating workshop is serious, and even more sometimes the reactive power compensation circuit and reactor burned. After testing, the 5th and 7th harmonic exceeded seriously, and passive reactive power compensation have the problem of harmonic amplification.

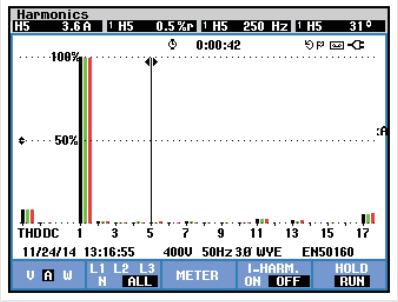
Treatment plan and results:

A 1300A active filter is equipped in the distribution room, and the passive reactive power compensation is replaced by the anti-harmonic compensation; 5th harmonic is reduced from the original 244A down to 3.6A, the 7th harmonic is reducedfrom the original 160A down to 2.4 A, the heat of passive reactive power compensation is normal, and no longer burned.

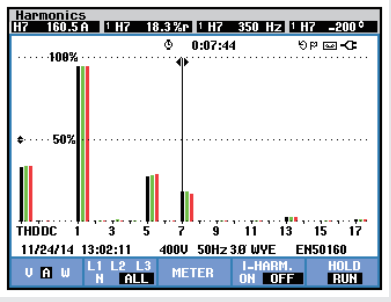




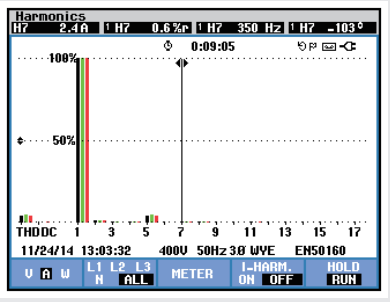
Before compensation, 5th harmonic



After compensation, 5th harmonic

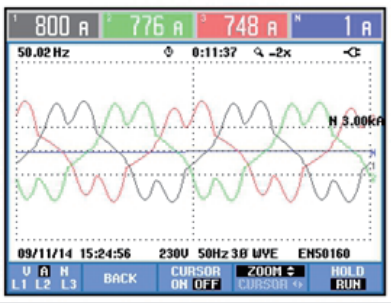


Before compensation, 7th harmonic

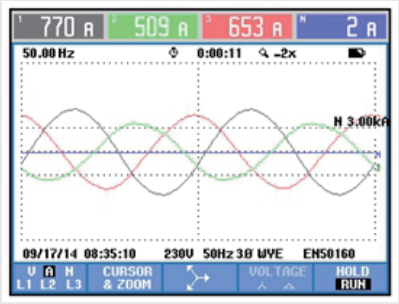


After compensation, 7th harmonic

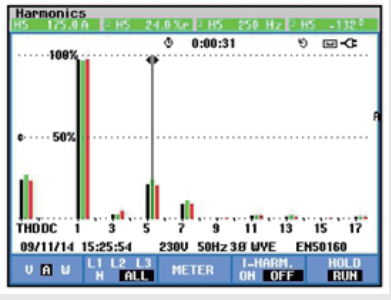
Comparison of before and after APF compensation on secondary side ofthe transformer in antextile processing plant (The main load is the frequency converter)



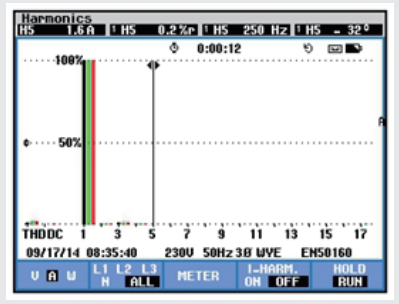
Current waveform before compensation



Current waveform after compensation



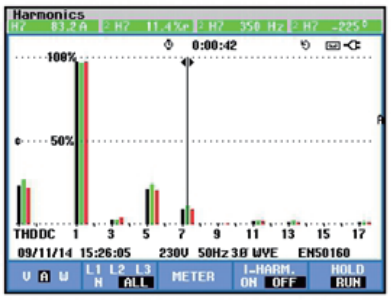
Before compensation, 5th harmonic



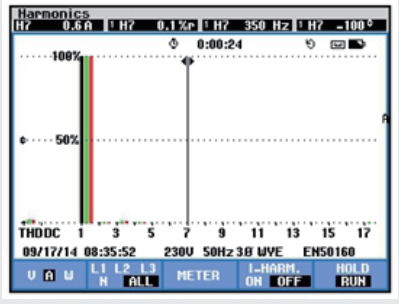
After compensation, 5th harmonic

The problem occurred:

There are four 110kW frequency converters and ninety-six 1-5kW frequency converters in total in this textile processing plant. After production expansion, the additional two 90kW frequency converters is added into the system, there encounters the problem of 110kW and 90kW frequency convertersburning. The result of on-site testing is that the 5th and 7th harmonic exceeded seriously.



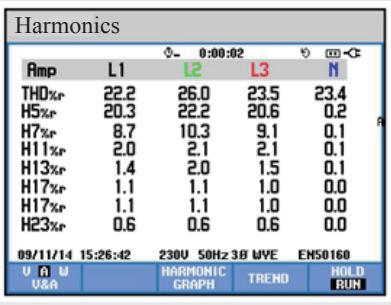
Before compensation, 7th harmonic



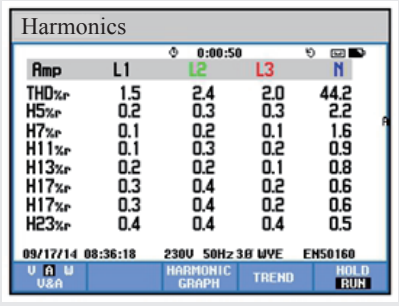
After compensation, 7th harmonic

Treatment plan and results:

A 300A active filter is equipped in the distribution room, and reactors were added in front of 110kW and 90kW frequency converters.

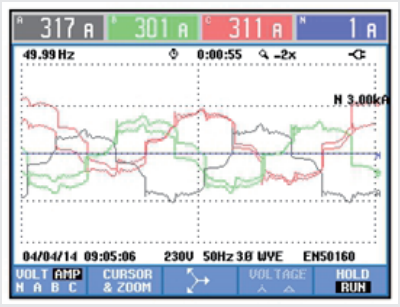


Contents before compensation

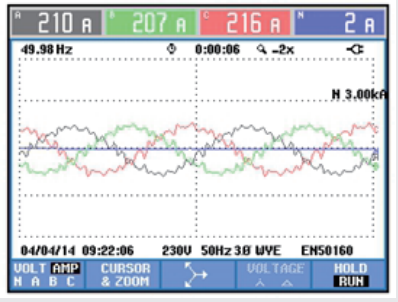


Contents after compensation

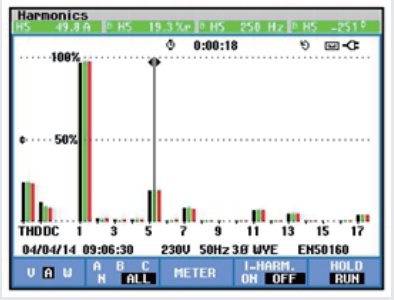
Comparison of before and after APF compensation on secondary side of the transformer in anpetrochemical industry processing plant (The main load is the impact medium frequency furnace)



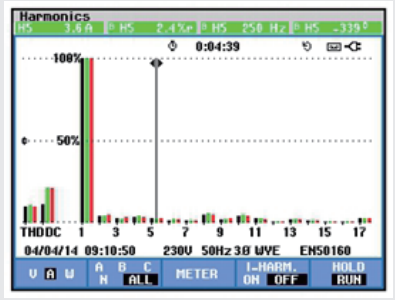
Current waveform before compensation



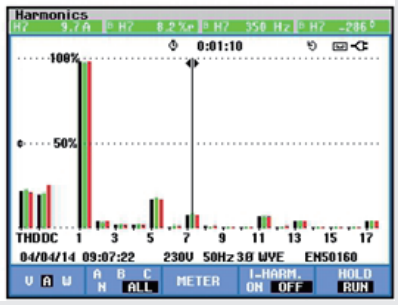
Current waveform after compensation



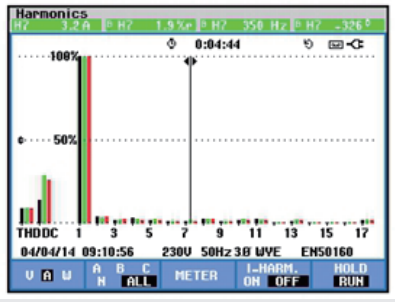
Before compensation, 5th harmonic



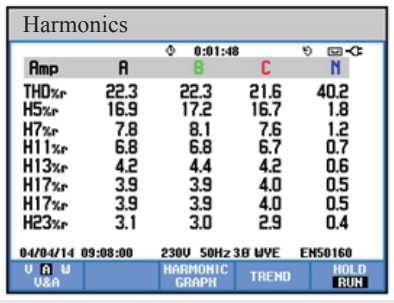
After compensation, 5th harmonic



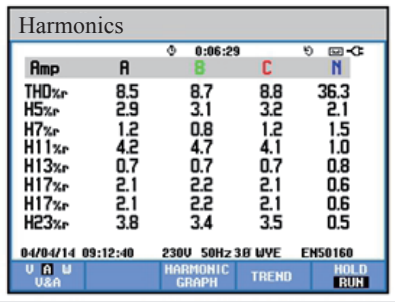
Before compensation, 7th harmonic



After compensation, 7th harmonic



Before compensation, 11th harmonic



After compensation, 11th harmonic

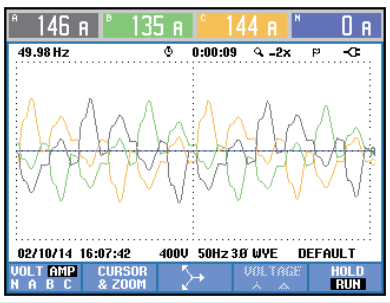
The problem occurred:

The load is mainly the medium frequency furnace heating equipment, the load impact variationis large, resulting other equipment running unstably. The test result is that the 5th,7th,11th,13rd harmonic contentexceeded and the load variationrate is much too big.

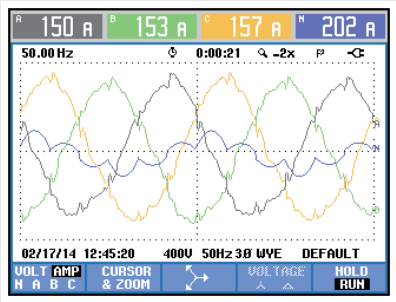
Treatment plan and results:

A 300A active filter is equipped in the distribution room, the current distortion rate is reduced from 22.3% to 8.5%, eliminating the effect of harmonics on other devices.

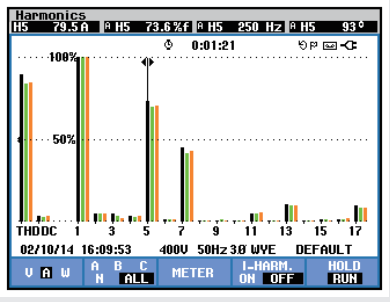
Comparison of before and after APF compensation on secondary side ofthe rectifierin aninverter plant (The main load is the rectifier)



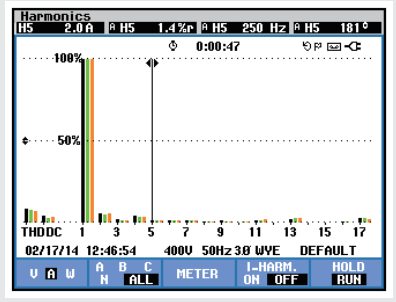
Current waveform before compensation



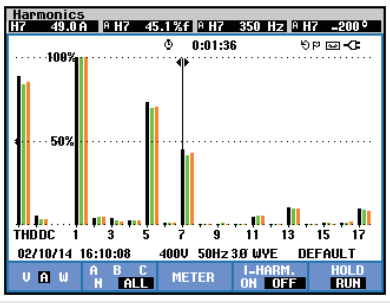
Current waveform after compensation



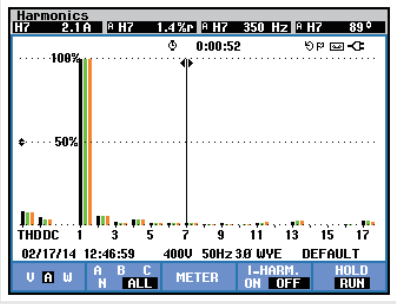
Before compensation, 5th harmonic



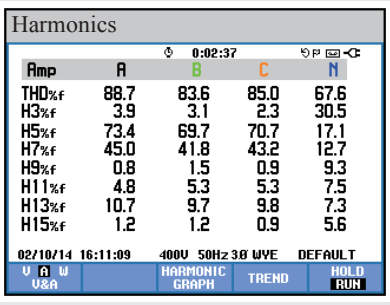
After compensation, 5th harmonic



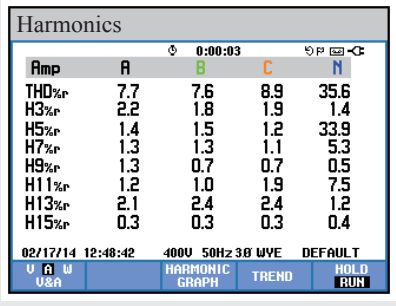
Before compensation, 7th harmonic



After compensation, 7th harmonic



Contents before compensation



Contents after compensation

The problem occurred:

This customer is an inverter manufacturer, producing photovoltaic grid-connected inverters and off-grid inverters, the main load is the regulator to provide DC source to the inverter. The rectifier power supply contains a large number of harmonics,which mainly contains 5th,7th, and 11th harmonic currents.

Treatment plan and results:

A200A active filter is equipped on the rectifier incoming line side, the current distortion rate decreased from 88.7% to 7.7%, effectively reduced harmonic pollution, ensured the stability of the rectifier and the grid operation.

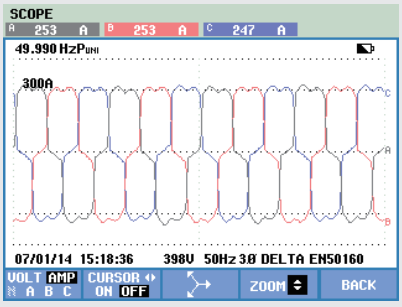
Comparison of before and after APF compensation on secondary side ofthe transformer in antele-communication enterprise (The main load is the UPS power supply)

The problem occurred:

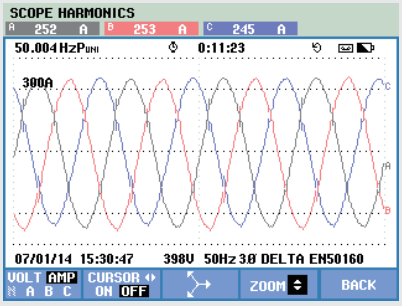
This customer is thetele-communication enterprise data room, the main load is non-linear load such as UPS power supply, switching power supply and frequency converters etc, which are mainly 5th,7th,11th harmonic, andthe harmonic content is large.

Treatment plan and results:

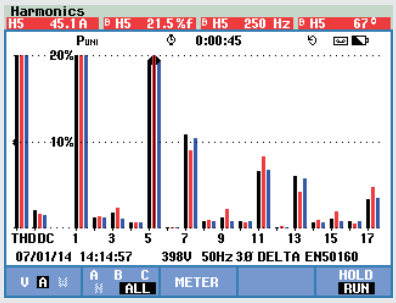
A 150A active filter is equipped, the harmonic content decreased from 26.4% to 4.1%, effectively reduced harmonic pollution, solved the problem of computer splash screen.



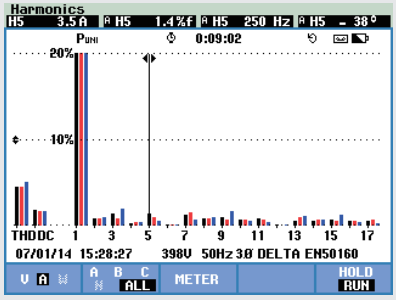
Current waveform before compensation



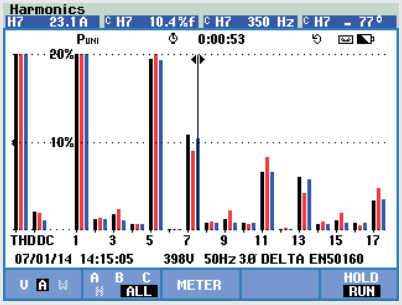
Current waveform after compensation



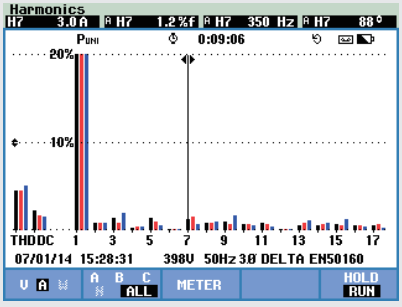
Before compensation, 5th harmonic



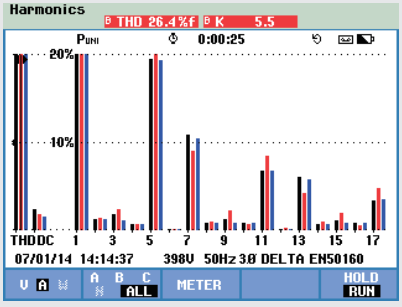
After compensation, 5th harmonic



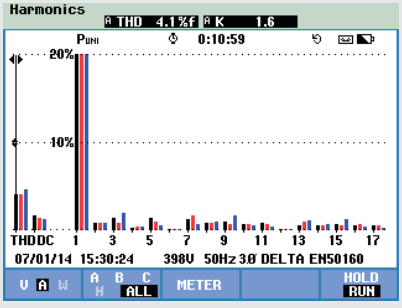
Before compensation, 7th harmonic



After compensation, 7th harmonic



Before compensation, 11th harmonic

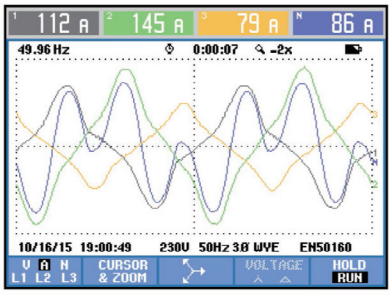


After compensation, 11th harmonic

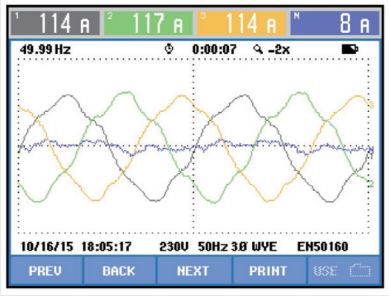
Typical applications of STUR

The problem occurred:

In a rural power grid, due to the presence of a large number of single-phase load, the common distribution network area three-phase current imbalance is serious, caused a serious impact to the resident living electricity and industrial electricity, reduced the transformer output and even affect the safety of the transformer running. Transformer parameters are: capacity 200kVA, the output voltage 380V, rated output current 288A.



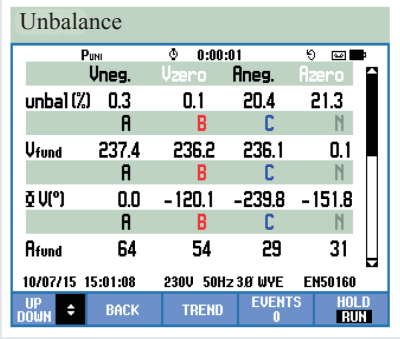
current value and waveform at a certain time before the compensation



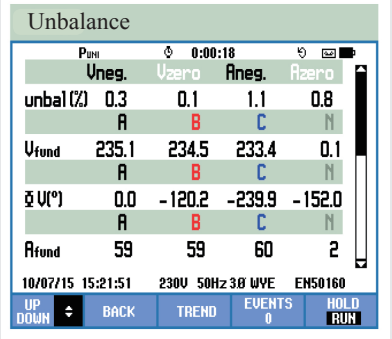
current value and waveform at a certain time after the compensation

Treatment plan and results:

The three-phase current imbalance is serious, and the current distortion rate is large, the phase-phase current difference reaches 65A, the zero line current reaches 90A, the third harmonic reaches 30A; After compensating the three-phase current imbalance and the controlling the harmonic, the three-phase currenton the transformer low-voltage output side is basically balanced, zero line current reduced down to 8A, third harmonic isjust 1A.



current at a certain time before compensation-zero sequence and negative sequence



current at a certain time after compensation-zero sequence and negative sequence

Before compensation				After compensation			
Total current of phase A	Total current of phase B	Total current of phase C	Total current of phase N	Total current of phase A	Total current of phase B	Total current of phase C	Total current of phase N
64	54	29	31	59	59	60	2

The table is the comparison of the three-phase current data on the low-voltage side before and after STUR running. The result is that a three phase reach balance on the low-voltage side of the transformer, the negative sequence current imbalance, neutral-line current imbalance and the N-line current are greatly reduced. It increased the stability of the operation of the low-voltage distribution system for the safety and reliability.

Workshop

Appendix: the APF Selection Rule

Harmonic Capacity Estimation

The harmonic current is generated by nonlinear load. The accurate calculation can be effected by many factors, although the generated harmonic of same device is different with different working period and working environment. Therefore, it is recommended to test on site usingthe professional power quality tester, and make the compensation according to the test results. For the projects that cannot be measured or in the initial stages, THDi can be estimated based on the table below and then calculated according to the formula.

Harmonic Percentile Estimators

Industry Category	HDI(%)Concentrated Compensation Estimated THDI(%)	Load Type	Characteristic Harmonic	Note
Medical Industry	15-20	CT, X-ray machine, Nuclear Magnetic Resonance UPS etc.	3、5、7、11	
Building Area	10-15	Inverter air conditioner, charger, computer, fluorescent lamp, elevator etc.	3、5、7、11	
Banking & Finance	15-20	UPS and Switching Power Supply etc.	3、5、7、11	
Communication Building	20-25	UPS and Switching Power Supply etc.	3、5、7、11	
Mine Hoisting	30-35	Frequency Converter	5、7、11	
Automobile Manufacture	30-40	Frequency converter, switching power supply, welding machine etc.	2、3、4、5、7、11、13	
Cement Plant	30-35	Frequency Converter etc	5、7、11	
Metallurgy Drive	30-45	Frequency Converter, medium-frequency power supply, switching power supply and rectifier supply etc.	5、7、11、13	
Textile	30-35	Frequency Converter	5、7、11、13	
Electrolytic Plating	35-45	Switching power supply and rectifiersupply etc.	5、7、11、13	
Theater	20-25	Audio video equipment, LED etc.	3、5、7、11、13	
Railway	30-35	Frequency converter and rectifier equipment	5、7、11、13	
Petrochemical Industry	20-30	UPS and frequency converter etc.	5、7、11、13	
Gem, single crystal, glass synthesis industry	40-60	Rectifier power supply, voltage regulating power supply, switching power supply, medium frequency power supply	5、7、11、13	

Equation of harmonic content:

$$I_h = \frac{S \times K}{\sqrt{3} \times U \times \sqrt{1 + THDi^2}} \times THDi \qquad \text{(Formula 1)}$$

Including:

Ih is estimated harmonic content value

K is load rate, usually is 0.6-0.8;

S is transformer capacity

U is system voltage

THDi system estimated harmonic content value

THDi usually is not big, the following formula can be used in the daily design

$$I_h = \frac{S \times K}{\sqrt{3} \times U} \times THDi \qquad \text{(Formula 2)}$$

For example: the capacity of one transformer is 1200 KVA, the voltage of secondary side is 400V, and load is frequency converter; according to the table, THDi should be 30%, and the load rate should ne 0.6, then, according to Formula 1:

$$I_h = \frac{S \times K}{\sqrt{3} \times U \times \sqrt{1+THDi^2}} \times THDi = \frac{1200 \times 0.6}{\sqrt{3} \times 0.4 \times \sqrt{1+0.3^2}} \times 0.3 = 299A$$

According to Formula 2：

$$I_h = \frac{S \times K}{\sqrt{3} \times U} \times THDi = \frac{1200 \times 0.6}{\sqrt{3} \times 0.4} \times 0.3 = 312A$$

The conclusion calculated according to Formula 2 is bigger than using Formula 1.

Reactive power capacity estimation

Reactive capacity is relatively steady (the harmonic content usually is less than 15%), when design, the reactive capacity usually is 25-35% of transformer capacity. Except some special working conditions, the power factor is calculated between 0.6 to 0.8.

The detailed formula is:

Qc=P×(tanarccosθ1-tanarccosθ2)×K2=P×K1×K2

Including:

S is designed capacity of transformer;

K1 is (tanarccosθ1-tanarccosθ2)

K2 is reservation coefficient, usually is 1.05-1.2

cosθ1 is power factor before compensation;

cosθ2 is power factor after compensation;

P is the active power of transformer

The value of K1 can be concluded according to the table below:

K1	Power factor after proposed compensation									
Power factor before compensation	0.9	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99
0.51	1.2023	1.231	1.261	1.291	1.324	1.3579	1.3949	1.436	1.4836	1.544
0.52	1.1583	1.187	1.217	1.247	1.28	1.3139	1.351	1.392	1.4396	1.5
0.53	1.1157	1.1444	1.174	1.205	1.237	1.2713	1.3083	1.3494	1.3969	1.458
0.54	1.0743	1.103	1.133	1.163	1.196	1.23	1.267	1.308	1.3556	1.416
0.55	1.0342	1.0629	1.092	1.123	1.156	1.1898	1.2268	1.2679	1.3154	1.376
0.56	0.9951	1.0238	1.053	1.084	1.116	1.1508	1.1878	1.2288	1.2764	1.337
0.57	0.9572	0.9859	1.015	1.046	1.079	1.1128	1.1498	1.1909	1.2384	1.299
0.58	0.9202	0.9489	0.979	1.009	1.042	1.0758	1.1128	1.1593	1.2015	1.262
0.59	0.8842	0.913	0.942	0.973	1.006	1.0398	1.0768	1.1179	1.11954	1.226
0.60	0.849	0.878	0.907	0.940	0.97	1.006	1.041	1.085	1.13	1.189
0.61	0.815	0.844	0.873	0.906	0.936	0.972	1.007	1.051	1.096	1.159
0.62	0.782	0.810	0.84	0.872	0.903	0.938	0.974	1.017	1.063	1.125
0.63	0.749	0.776	0.807	0.838	0.87	0.904	0.941	0.983	1.03	1.091
0.64	0.717	0.745	0.775	0.807	0.838	0.873	0.909	0.952	0.998	1.060
0.65	0.685	0.712	0.743	0.774	0.806	0.840	0.877	0.919	0.966	1.027
0.66	0.654	0.683	0.712	0.745	0.775	0.811	0.846	0.890	0.935	0.998
0.67	0.624	0.652	0.682	0.714	0.745	0.780	0.816	0.859	0.905	0.967
0.68	0.594	0.622	0.652	0.684	0.715	0.750	0.786	0.829	0.875	0.937
0.69	0.565	0.592	0.623	0.654	0.686	0.720	0.757	0.799	0.846	0.907
0.70	0.536	0.565	0.594	0.627	0.657	0.693	0.728	0.772	0.817	0.880
0.71	0.508	0.536	0.566	0.598	0.629	0.664	0.7	0.743	0.789	0.851
0.72	0.48	0.507	0.538	0.569	0.601	0.625	0.672	0.714	0.761	0.822
0.73	0.452	0.480	0.51	0.542	0.573	0.600	0.644	0.687	0.733	0.795
0.74	0.425	0.452	0.483	0.514	0.546	0.580	0.617	0.659	0.706	0.767
0.75	0.398	0.426	0.456	0.488	0.519	0.554	0.59	0.633	0.679	0.741
0.76	0.371	0.398	0.429	0.460	0.492	0.526	0.563	0.605	0.352	0.713
0.77	0.345	0.373	0.403	0.435	0.466	0.501	0.537	0.580	0.326	0.680
0.78	0.318	0.347	0.376	0.409	0.439	0.475	0.51	0.554	0.599	0.662
0.79	0.292	0.319	0.35	0.381	0.413	0.447	0.484	0.526	0.573	0.634
0.80	0.266	0.2944	0.324	0.355	0.387	0.4213	0.458	0.4994	0.547	0.608
0.81	0.24	0.2684	0.298	0.329	0.361	0.3953	0.432	0.4734	0.521	0.581
0.82	0.214	0.2424	0.272	0.303	0.335	0.3693	0.406	0.4474	0.495	0.556
0.83	0.188	0.2164	0.246	0.277	0.309	0.3433	0.38	0.4214	0.469	0.53
0.84	0.162	0.1903	0.22	0.251	0.283	0.3173	0.354	0.3953	0.443	0.503
0.85	0.136	0.1641	0.194	0.225	0.257	0.2911	0.328	0.3691	0.417	0.477
0.86	0.109	0.1378	0.167	0.198	0.23	0.2647	0.301	0.3427	0.39	0.451
0.87	0.083	0.1111	0.141	0.172	0.204	0.238	0.275	0.3161	0.364	0.424
0.88	0.056	0.0841	0.114	0.145	0.177	0.2111	0.248	0.2891	0.337	0.397
0.89	0.028	0.0567	0.086	0.117	0.149	0.1836	0.22	0.2617	0.309	0.37

http://www.sojoline.com
E-mail:sojo@sojoline.com
Tel:8610-62979948
Fax:8610-62988464
Add: Office 1111 of D Building, Jiahua Plaza, No.9 of Shangdi 3rd Street, Haidian District, Beijing of China.(100085)