Sineteng
SVG
(Static Var Generator)
PFC (Power Factor Correction) Solution

PF 0.99

Three phase 100% balance

< 13th harmonic compensation

Sineteng

1. Power, power factor in the power grid
2. What is power factor?
3. What cause the low power factor?
4. Power triangle
5. What need to improve power factor?
6. One of the conuntries PF policy for reference
7. The benefit of power factor correction
8. Industries' power factor before correction
9. What is the method to compensate power factor?
10. Comparison of PF compensation methods
11. Reactive power compensate principle
12. Topology of S-SVG
13. High THDU, High THDI harm the capacitor
14. Sineteng SSVG

1. Power, power factor in the power grid

Power is divided into active power, reactive power and visual power. In the AC power grid, due to the existence of impedance and reactance (inductance and capacitance) at the same time, so the power supply to the electrical power is not completely doing the homework.

Because some of these electrical power (the electrical energy stored by inductors and capacitors) can still be returned to the power grid, so the electrical power absorbed by the actual electrical appliance (resistance properties) is called active power. The electrical energy stored by inductors and capacitors can still be returned to the power grid, which is exchanged between the power supply and the reactance, exchanged without consumption, and is called reactive power.

2. What is power factor?

In AC power grids, if the load is pure resistance, voltage and current is the same phase, then the product of voltage and current is active power, but in the circuit with inductance or capacitance, voltage and current have phase difference, so the product of voltage and current is not the actual absorption of electrical power of the load circuit, but the value on the surface, called the power, Represented by the letter S. Usually seen in the unit of power with KVA, expressed in the letter kVA.

cosφ＝P/S (%)The ratio of active power to apparent power is the power factor, which is expressed in measured, and it has no unit. COSΦ=P/S (%).

3. What cause the low power factor?

and the voltage and current are in the same phase, the power P absorbed by the resistive electrical equipment from the grid is equal to the product of the voltage U and current I, namely: P=u*I

Resistive electrical equipment includes incandescent lamps, electric converters and so on.

The motor and transformer need to establish a magnetic field when operating, this part of the energy can not be converted into active power, so called power- free Q. At this point the current hysteresis voltage is an angle phi(φ).

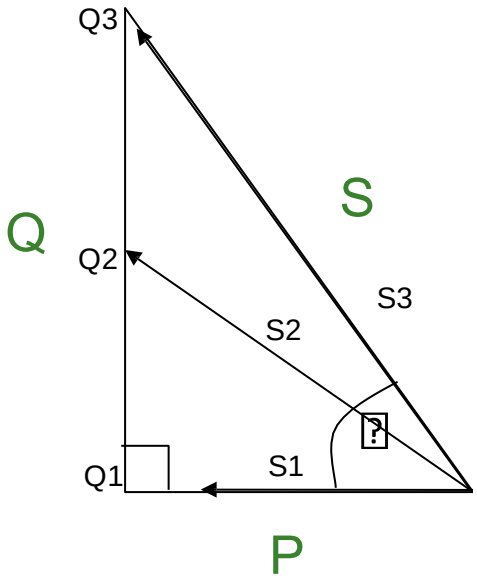
When selecting a power distribution device, it should be based on the geometric and reactive power S, that is, the geometry and: S=√p2 + Q2

4. Power triangle – The energy saving calculation method

Power factor: The proportion of active power output in equipment capacity.

$$0 \leq cos\varphi \leq 1.0$$

Power Triangle



$$S^2 = Q^2 + P^2$$

$$P = S\ cos\varphi$$

$$Q = S\ sin\varphi$$

Saving power : P.→S Or $cos\varphi \rightarrow 1.0$; Q.→0

5. Why need to improve power factor?

In a certain amount of active power, when the user's measured is relatively small, depending on the power is relatively large, in order to meet the needs of electricity, **power supply lines and transformers need to be large**, so that the **increase in power supply investment, reduce equipment utilization rate**, but also **increase the line network loss**. And continue to **waste the power(reactive power). If supply reactive power to the system then will not need the grid to supply the reactive power.**

The power factor of the load is too low, the capacity of the supply equipment can not be fully utilized, in a certain voltage to the load to transport a certain amount of active power, through the transmission line of the current increase, **the wire resistance of the energy loss and wire impedance will cause voltage drop.** Therefore, power factor is an important index in power system.

6. One of the countries PF policy for reference

7. The benefit of power factor correction

1) Avoid the fines from the utility due to the low power factor
2) Reduce electric energy loss
3) Increase the transmission capacity of the power grid and improve the utilization rate of equipment
4) Reduce line loss and transformer active loss by heating
5) Increase the capacity of power system
6) Improve the quality of the voltage, avoid arise voltage drop due to reactive power

8. Industries' power factor before correction

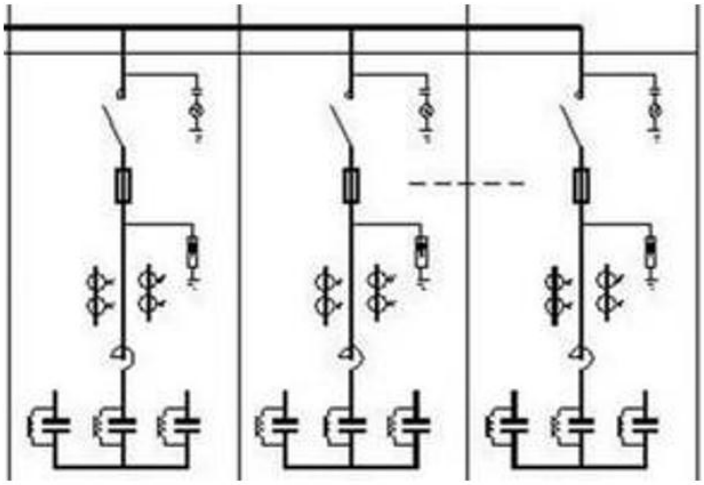
Chemical industry	65-80
Coal mining industry	60-80
Electroplating industry	65-70
Foundry industry	70-80
Forging industry	70-80
Medical industry	75-80
Machine manufacturing	60-65
Commercial building	80-90
Petroleum drilling	40-60
Papermaking industry	55-65
Steel mill	55-80
Plastic industry	75-80
Textile industry	60-75

9. What is the method to compensate power factor?

10. Comparison of PF compensation methods

Cap Bank Working Principle

The reactive power compensation principle of CAP BANK is to utilize the own properties of capacitive capacitor and reactor to govern the power factor of the grid.



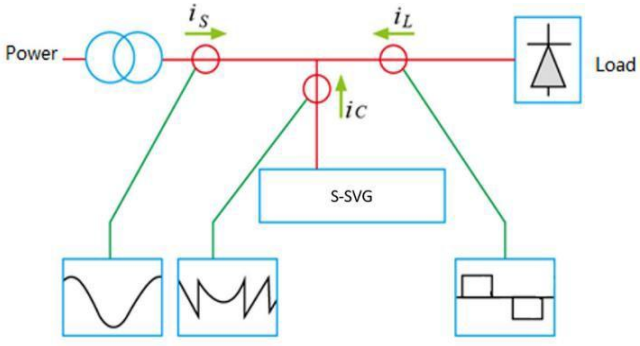
Group1 Cap group2 Cap group3 Cap……

SVC use capacitors to grouping switch .Its output current is step by step, **which leads the overcompensation or under compensation.**

The power factor is **between 0.8 and 0.9. Only compensate inductive reactive power. Still lost a lot of power, and would possible be fined by utility company.**

S-SVG Working Principle

SSVG according to the system reactive power, through IGBT power converter generate capacitan ce or inductance fundamental current,



SVG compensate reactive power by constantly generating the same size and opposite waves of reactive power.

Would not lead the overcompensation or under compensation.

THDI =< 5% when harmonic orders below 13th; **DPF 0.99 from -1 to 1(capacitive reactive power and inductive reactive power compensation);** Three phase balance;

Cap bank		S-SVG	
			
Total response time	Normally near **20-200ms**	Total response time	<10ms

Can't catch up with some changing fast load such as welding machine and so on which equipment changing speed within dozens of ms.

Can catch up with almost all of the electric loads.

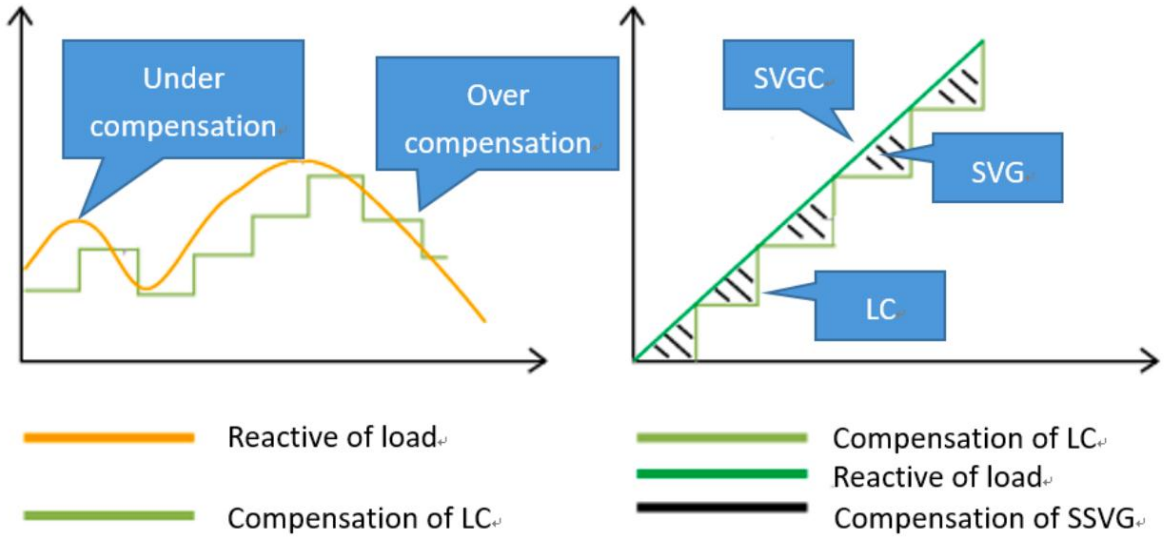
1) LC is big size and not easy to expand capacity.
2) When one component broken, whole cabinet broken.
3) LC can’t working normally in high THDI or THDU power environment.

1) Sineteng cabinet SSVG can be installed up to 600kvar SSVG with 6 sets 100kvar SSVG modules , almost the largest capacity of one cabinet in this industry.
2) And easy to expand or reduce the capacity according to project requirement by add or reduce modules. When one module broken, other modules can continue to work.
3) Module can also install in customers’ switchgear.

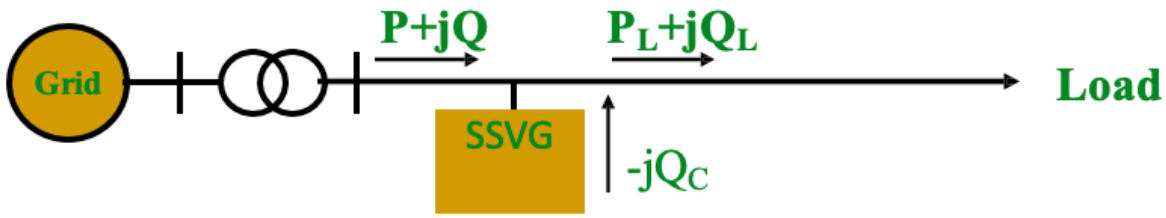
Shown as below, our wall mounted products can hanged on the wall and fixed it. Each capacity of our module have the wall mounted products. In the cities and distribution room which space are expensive or no place to install cabinets, wall mounted would occupy a more little space.And also saving manual transportation cost. Capacitor bank is hard and too big to hang on the wall.

1) **Cap bank** use capacitors to grouping switch .Its output current is step by step, **which leads the overcompensation or under compensation.**
2) The power factor is **between 0.8 and 0.9. Only compensate inductive reactive power. Still lost a lot of power, and would possible be fined by utility company.**
3) LC is big size and not easy to expand capacity.
4) When one component broken, whole cabinet broken.
5) LC can't working normally in high THDI or THDU power environment.
6) Slow reaction time, normally near **20- 200ms,** can't catch up with some changing fast load such as welding machine and so on which equipment changing speed within dozens of ms.

1) **SSVG** compensate reactive power by constantly generating the same size and opposite waves of reactive power. **Would not lead** the overcompensation or under compensation.
2) **THDI =< 5%** when harmonic orders below 13^{th}; **DPF 0.99 from -1 to 1(capacitive reactive power and inductive reactive power compensation);** Three phase balance.
3) Sineteng cabinet SSVG can be installed up to 600kvar SSVG with 6 sets 100kvar SSVG modules , almost the largest capacity of one cabinet in this industry. And easy to expand or reduce the capacity according to project requirement by add or reduce modules. Module can also install in customers' switchgear.
4) When one module broken, other modules can continue to work.
5) Not only can working in High THD environment, but also can compensate harmonic $<13^{th}$ order to mitigate the harmonic. Response time < 20ms, Can catch up with almost all of the electric loads.



11. Reactive power compensate principle



Schematic diagram of reactive power compensation

$$Power\ Balance: \boldsymbol{P + jQ = P_L + jQ_L - jQ_C = P_L + j(Q_L - Q_C)}$$

$$\boldsymbol{P = P_L}$$

$$\boldsymbol{Q = Q_L - Q_C}$$

$$\boldsymbol{cos\varphi = costg^{-1}(\frac{Q}{P})}$$

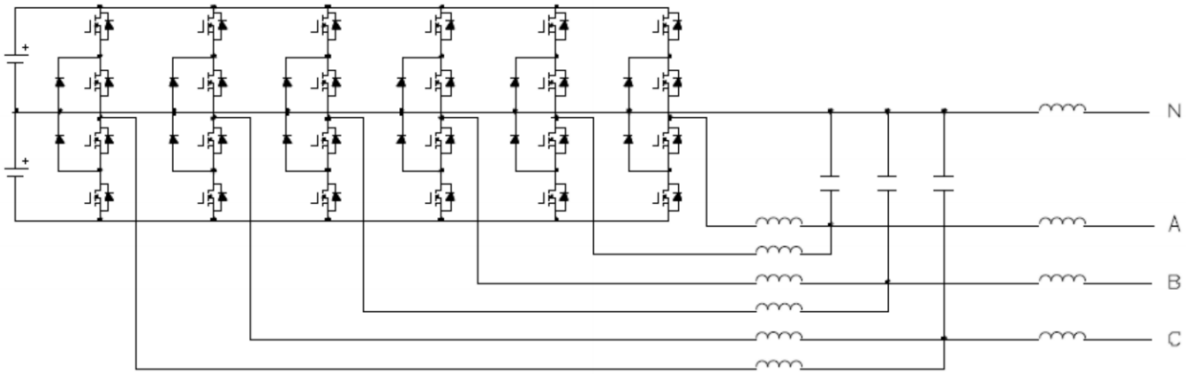
$$When\ \boldsymbol{Q_L = Q_C}:$$

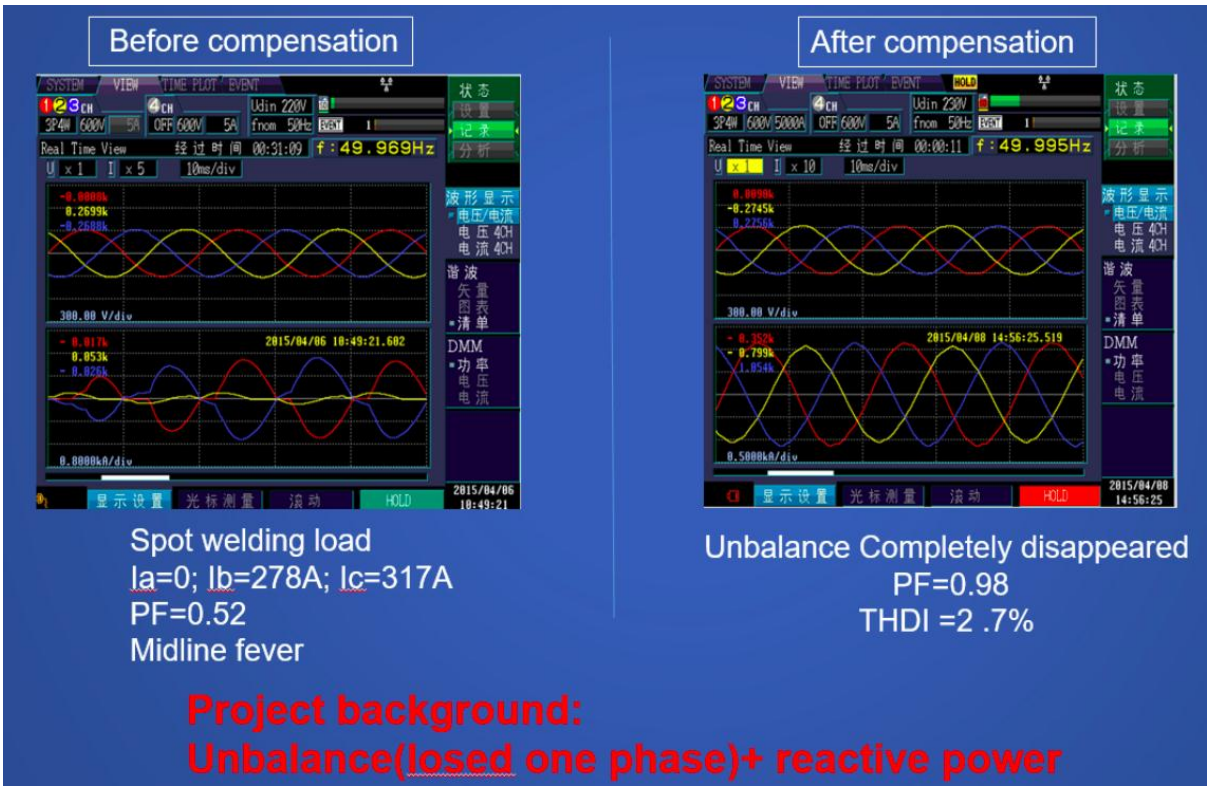
$$\boldsymbol{P = P_L}$$

$$\boldsymbol{Q = 0}$$

$$\boldsymbol{cos\varphi = 1.0}$$

12. Topology of S-SVG

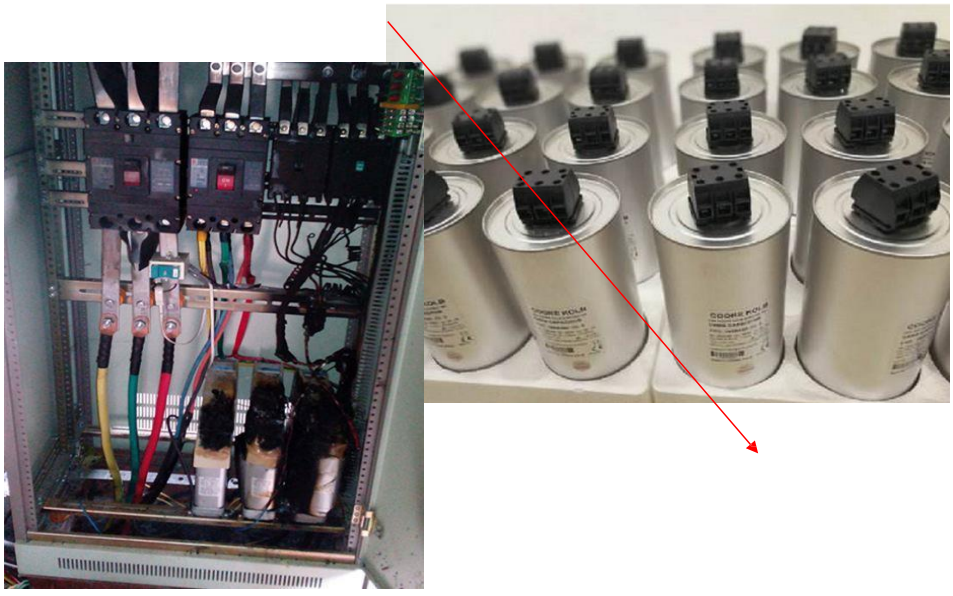




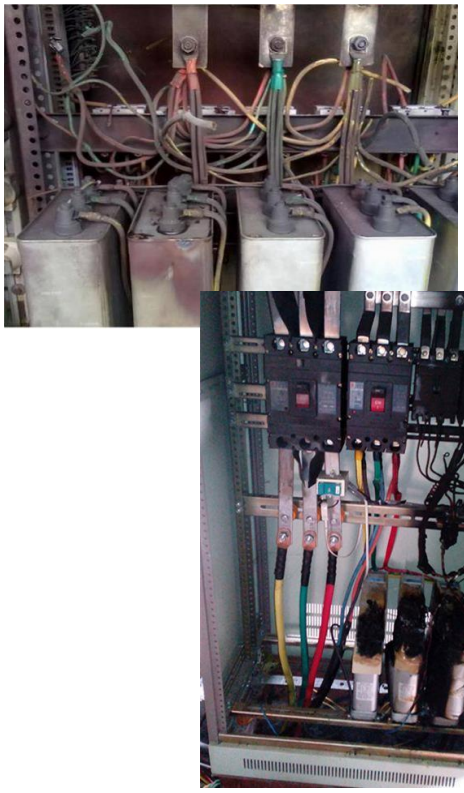
Most of electric equipment are nonlinear loads, such the inverter, converter, LED, UPS, furnace, silicon controlled rectifier devices which **cause reactive power, Harmonic at the same time. Harmonic will damage other equipment and the electric power system.**

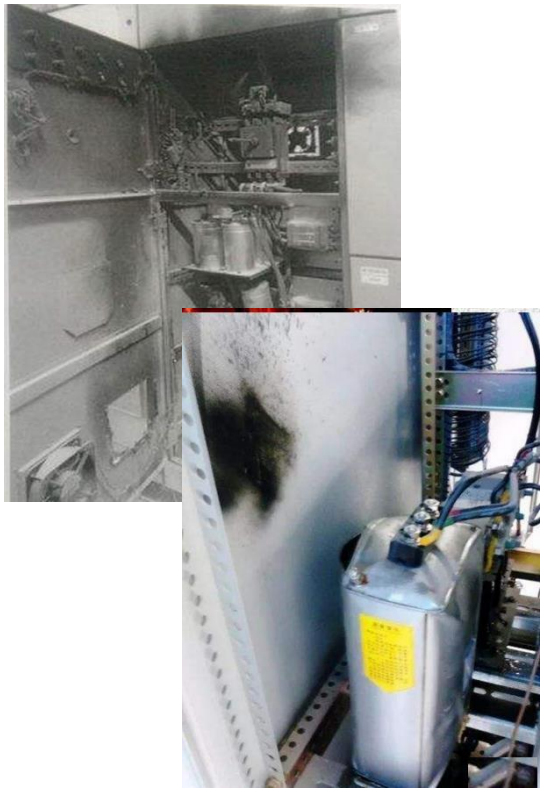
13. High THDU, High THDI harm the capacitor

Overvoltage and overcurrent, high THDU and THDI etc. Would easy cause capacitors Malfunction , breakdown, **burn or explode.**



Capbank burned or leakage….





Capbank burned or leakage and harmonic cause fires…

14. Sineteng SSVG

SSVG: PF 0.99

-1 to 1(capacitive reactive power and inductive reactive power compensation)

Three phase 100% balance

< 13th Harmonic compensation

Modules:30kvar,50kvar,75kvar,100kvar

Cabinet: Modules arbitrary combination up to 600kvar.

Sineteng SSVG - Specifications

Modules: 20/35/50/75/100/150kVar

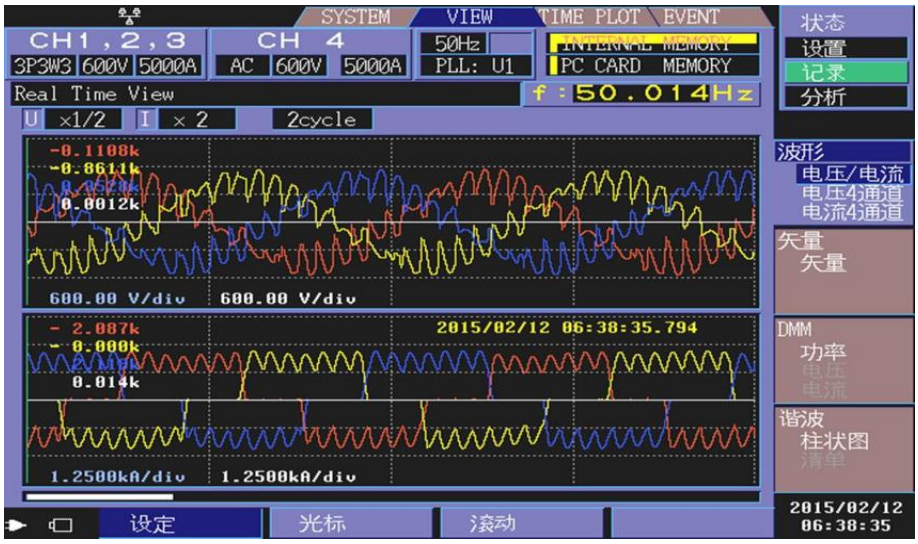
Item		Description
Electrical	Rated voltage	220/380/400/440/480/600/690Vac
	Wiring	3P3W/3P4W
	Frequency	50/60Hz
	Capacity	20~100kVar (150kvar can be customized)
	Efficiency	Up to 97.5%
	Response time	<7.8ms
Functions	Compensation harmonic	Most 60% capacity: 2 to 13th orders, THDi 5%.
	Compensation for reactive power	-1~+1 adjustable
	Compensation for three-phase imbalance	100% imbalance full compensation

(mm)	Rack mounted				Wall mounted			
	20kVar 35kVar	50k Var	75k Var	100k Var	20kVar 35kVar	50k Var	75k Var	100k Var
A	359	399	484	554	521.5	545	611	621
B	341	381	466	536	500	520	575	585
C	315	355	440	510	300	360	300	300
D	200	200	232	250	120.5	85.5	137.5	142.5
E	89	89	89	89	379	419	500	570
F	55.5	55.5	71.5	80.5	350	390	475	545
G	556.5	611.5	646	656	315	355	440	510
H	500	555	575	585	200	200	232	250
K	35	35	35	35				
Weight (kg)	23	28	38	47	23	28	38	47

Sineteng

working in Reactive + harmonic + dust pollution + high TDHU + high temperature power environment

Before Compensation



Intermediate frequency furnace load THDi = 31%; THDv = 21%; PF = 0.55

Serious dust Ventilation is not good

After Compensation

Harmonic basically disappeared THDi = 4.3%; THDv = 4.5%; PF = 0.98

Project background:
<u>Reactive + harmonic + dust pollution + high TDHU + high temperature</u>

Sineteng

Sineteng products application and installation sites

We are committed to providing users with healthy, stable and clean electricity consumption environment.









PF 0.99
Three phase 100% balance

Sineteng

Rail traffic

Car plant

Port

Metallurgy

Petroleum and chemical

CNOOC Zhanjiang drilling platform

Suzhu fifth people's hospital

Beijing electric power corporation

HUAWEI Unicom data center

Nanjing Jiangning sewage treatment plant

Jinlong bus factory

Shaoxing textile mill

and so on....

Sineteng

Compensate the reactive power is necessary, but alleviate the harmonic is also imminent.

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