Power Factor Correction

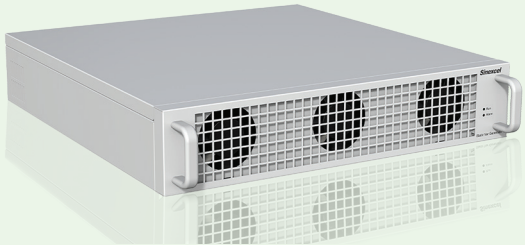
Power Factor Correction

Simple power factor correction solutions incorporate banks of capacitors that work as silent reactive power 'generators'. These systems were designed many decades ago when electrical environments were a lot simpler than they are today. They are common, very economical and suitable for linear load environments.

However, in today's modern electrical environments, linear loads are not easy to find. Due to the proliferation of LED/ energy efficient lighting, switch-mode power supplies, VSD's, UPS's, servers/computers and typical appliances, today's electrical systems experience complex, dynamic non-linear loads. Loads are being switched so fast that the traditional capacitor bank PFC systems struggle to maintain an effective compensation set-point. Therefore, they are perpetually 'chasing' the load, either under or over-compensating but rarely providing effective compensation.

- SiC-MOSFET Technology
- Dynamic Step-less Compensation
- No Capacitor Banks
- Wall Mounting Solutions
- Load Balancing

Sinexcel®



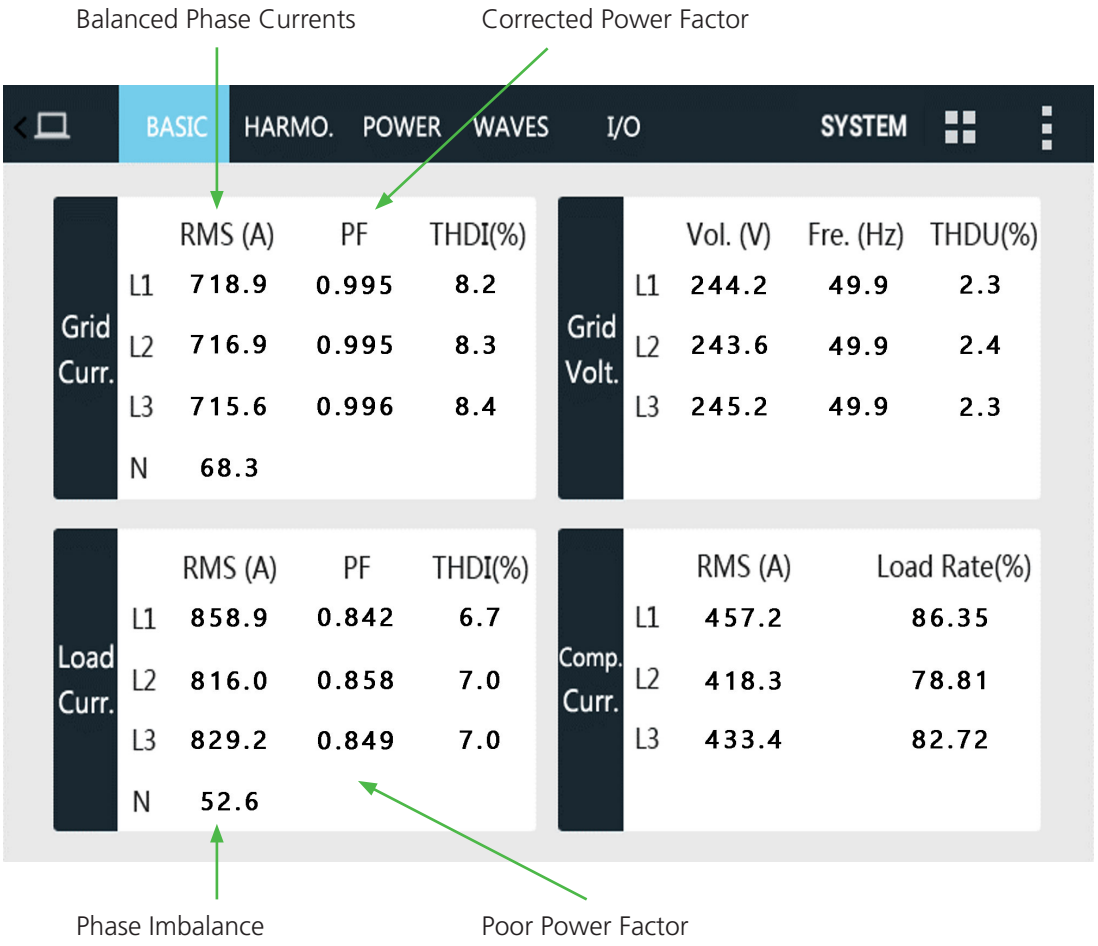
The Sinexcel SVG (Static Var Generator)

The Sinexcel SVG represents the latest generation technology in the power factor correction field. It operates by detecting the load current on a real-time basis through an external CT (current transformer) and determining the reactive content of the load current. The data is analysed and the SVG's controller drives the internal SiC-MOSFETs by using PWM signals to make the inverter produce the exact reverse reactive current of the corresponding load reactive content which is injected into the grid.

The SVG range offers instantaneous, dynamic step-less compensation, ideal for the challenging demands of modern electrical environments. Sinexcel SVG solutions do not need an AC capacitor bank and offer many advantages due to their compact & modular configuration (including wall-mount options).

The SVG in Action

This screen shot is from a Sinexcel SVG unit operating at one of our customer locations.



- The Load Current information in the bottom left of the screen displays the actual load, RMS (Amps) of the site, the PF (Power Factor) and the THDI (Total Harmonic Distortion Current).
- There are 2 important factors to note here. Firstly, this site has a significant phase current imbalance. The RMS between the 3 phases ranges from 858.9A to 816A. That is a 42.9A phase current imbalance. Secondly, the PF ranges from 0.842-0.858 across the three phases which is considered poor and correction is required.
- The Grid Current information at the top left of the screen displays the corrected RMS and PF after compensation by the Sinexcel SVG. Note that the phase current imbalance has been corrected and the RMS has been reduced to 442A (approx. 17% reduction). The PF has been corrected to 0.995. This sort of performance cannot be achieved with traditional PFC systems.
- By correcting the power factor and the phase imbalance, the Sinexcel SVG presented an almost perfect load to the grid, resulting in a maximum return available when a kVA peak demand tariff is used, which significantly reduced their energy costs.

Unprecedented Performance

- Up to 200kVAr capability from a single wall-mounted module – can be parallel connected for unlimited capacity.
- Up to 200kVAr capability from a single rack-mounted module.
- Up to 900kVAr capability from a single cabinet solution.

The SVG Range

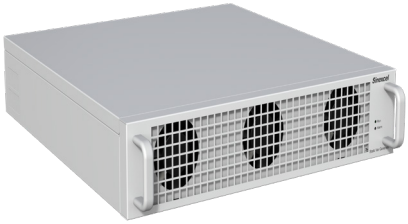
Wall-Mount Solutions

30kVAr
500W x 183D x 550H (mm)
Weight: 23kg

50kVAr
500W x 190D x 585H (mm)
Weight: 28**kg**

100kVAr (P5 Series)
500W x 100D x 520H (mm)
Weight: 25kg

200kVAr (P5 Series)
500W x 220D x 646H (mm)
Weight: 50kg



Rack-Mount Solutions

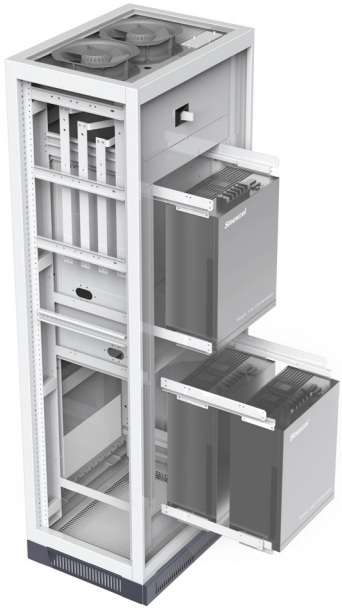
30kVAr
500W x 530D x 180H (mm)
Weight: 23kg

50kVAr
500W x 600D x 190H (mm)
Weight: 28kg

100kVAr (P5 Series)
500W x 520D x 100H (mm)
Weight: 25kg

200kVAr (P5 Series)
500W x 646D x 220H (mm)
Weight: 50kg

The SVG Range



Flexi-Cabinet Series

Capacity: Up to 900kVAr (9x100kVAr)
800W x 800D x 2200H (mm)

Features

- Large Capacity
- Top or Bottom Cable Entry
- IP21 or IP31

Top Vent Cabinet Series

Capacity: Up to 400kVAr (4x 100kVAr)
800W x 600D x 2200H (mm)

Capacity: Up to 500kVAr (5x 100kVAr)
1000W x 600D x 2200H (mm)

Capacity: Up to 600kVAr (6x 100kVAr)
1200W x 600D x 2200H (mm)

Features

- Only 600mm deep
- Flush against the wall
- Top ventilated
- Top or Bottom Cable Entry
- IP21 or IP31

IP54 Cabinet Series

Capacity: Up to 300kVAr (3x 100kVAr)
800W x 600D x 2000H (mm)

Features

- Flush against the wall
- Top Vent
- 2 x 300mm Doors
- 400mm Plinth

Capacity: Up to 600kVAr (6x 100kVAr)
700W x 900D x 1800H (mm)

Capacity: Up to 800kVAr (8x 100kVAr)
1000W x 1000D x 2200H (mm)

Features

- Flush against the wall (300kVAr)
- Bottom Cable Entry
- IP54

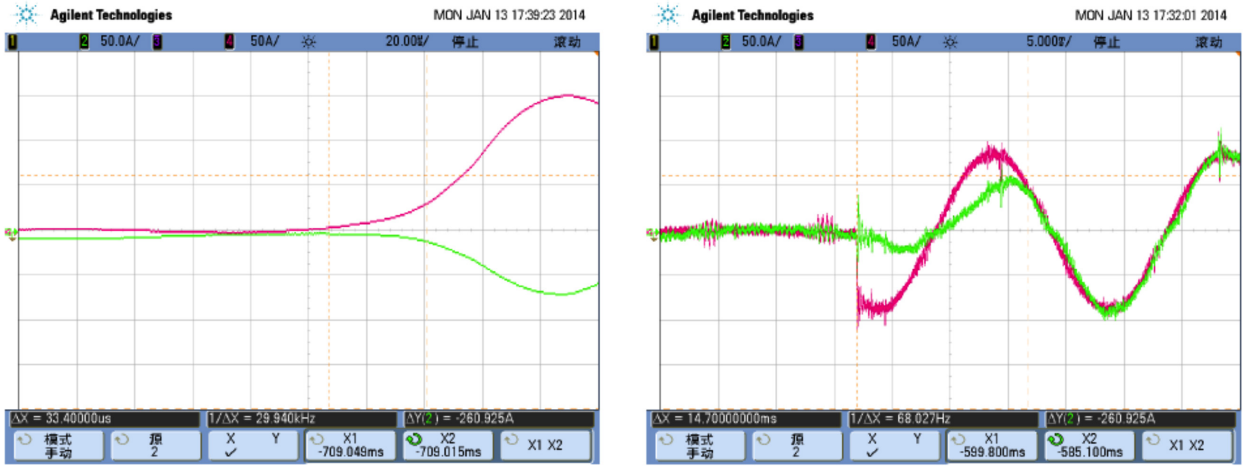
Features

Exceptional power factor correction performance

- Can maintain a Power Factor of 0.99 lagging or unity if required.

Dynamic step-less compensation

- Profiles the load and operates with a response speed of <5ms.
- Dynamic reaction time is less than 50µs. It is a virtual real-time instantaneous response.
- Only injects the kVAr that is required in that moment.
- No possibility of over-compensation or under-compensation.



The SVG recalculates the required load accurately and quickly. The IGBT technology switches with high speed, quickly matching the load requirement.

SVG Modules can be parallel connected

- Wall or rack mounted modules can be parallel connected to increase capacity in a 'Master / Master / Master' arrangement. In the event that one unit shuts down, the other units remain operational.

Corrects lagging (inductive loads) AND leading (capacitive loads)

- Power factor range (-1 to +1)

Corrects Load Imbalance

- Can balance the phase currents to further lower the peak kVA presented to the grid.

Operates in all 3 Phases

- Measures and provides dynamic kVAr compensation throughout all three phases.

Not affected by resonance & harmonics

- No AC switched capacitors to be affected by resonance & harmonics in the system.

Can work with & enhance existing capacitor bank systems

- If you already have an existing capacitor bank PFC system, you can add an SVG to improve the performance achieved.

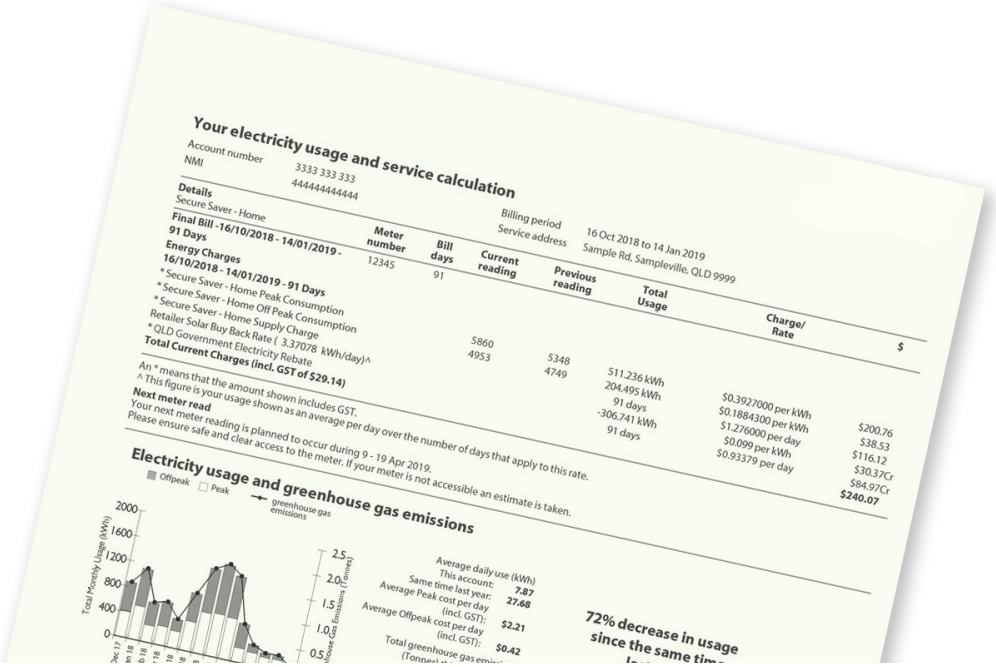
Can operate at low voltages

- Handy in regional/remote areas or challenging environments.

Benefits

Save money on electricity costs

- If your billing has changed to a kVA demand tariff and you have poor power factor, you are definitely paying for electricity that you are not using. In such cases, the SVG will reduce your electricity bills. Typically, most installations achieve savings of 10%-30%.



Your electricity usage and service calculation

Account number 3333 333 333
NMI 4444444444444

Billing period 16 Oct 2018 to 14 Jan 2019
Service address Sample Rd, Sampleville, QLD 9999

Details	Meter number	Bill days	Current reading	Previous reading	Total Usage	Charge/ Rate	$
Secure Saver - Home							
Final Bill -16/10/2018 - 14/01/2019 - 91 Days	12345	91					
Energy Charges 16/10/2018 - 14/01/2019 - 91 Days							
* Secure Saver - Home Peak Consumption			5860	5348	511.236 kWh	$0.3927000 per kWh	$200.76
* Secure Saver - Home Off Peak Consumption			4953	4749	204.495 kWh	$0.1884300 per kWh	$38.53
* Secure Saver - Home Supply Charge					91 days	$1.276000 per day	$116.12
Retailer Solar Buy Back Rate (3.37078 kWh/day)^					-306.741 kWh	$0.099 per kWh	$30.37Cr
* QLD Government Electricity Rebate					91 days	$0.93379 per day	$84.97Cr
Total Current Charges (incl. GST of $29.14)							**$240.07**

An * means that the amount shown includes GST.
^ This figure is your usage shown as an average per day over the number of days that apply to this rate.

Next meter read
Your next meter reading is planned to occur during 9 - 19 Apr 2019.
Please ensure safe and clear access to the meter. If your meter is not accessible an estimate is taken.

Electricity usage and greenhouse gas emissions

Offpeak Peak greenhouse gas emissions

Total Monthly Usage (kWh) 2000 1600 1200 800 400 0
Dec 17 Jan 18 Feb 18 Mar 18 Apr 18 May 18 Jun 18 Jul 18 Aug 18 Sep 18 Oct 18 Nov 18 Dec 18
Household Greenhouse Gas Emissions (Tonnes) 2.5 2.0 1.5 1.0 0.5

Average daily use (kWh)
This account: 7.87
Same time last year: 27.68
Average Peak cost per day (incl. GST): $2.21
Average Offpeak cost per day (incl. GST): $0.42
Total greenhouse gas emissions (Tonnes)

72% decrease in usage since the same time

Virtually no on-going maintenance costs

- No maintenance costs required, no on-going servicing or spare parts required.

Eliminating the weakest link – the capacitors

- The most vulnerable and weakest link in a traditional PFC system are the switched capacitors. Capacitors can leak, rupture or ignite & have life expectancy of 3-7 years, depending on environmental conditions, resulting in high maintenance costs. The SVG eliminates the need for AC capacitors, resulting in greater longevity and minimal maintenance costs.

ROI (Return on Investment)

- It makes great financial sense to invest in SVG technology. Typically, our customers achieve a ROI of 18 months – 3 years. After this period, they benefit from on-going cheaper electricity costs permanently.

The SVG does not require a maintenance contract

- Because there are no capacitors to maintain, the on-going costs are negligible.

Reduced burden on infrastructure

- The SVG reduces heat on the electrical system, resulting in greater longevity and lower maintenance costs.

Greater longevity

- With traditional capacitor-based systems, when smaller steps are needed for fine adjustment, the space required for either 6.25kVAr or 50kVAr steps is the same. Small steps for fine adjustment also result in the system getting frequently switched, over-used & worn out. The SVG does not suffer from this problem.

Sinexcel SVG vs Switched Capacitor Bank Systems

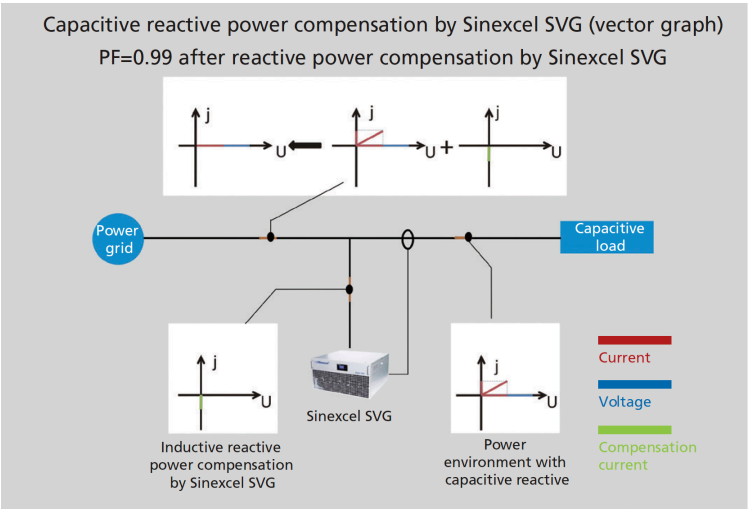
When to use the Sinexcel SVG:

- Ideal for fast switching load environments (switched capacitor bank system can't keep up).
- Environments with space restrictions. Wall mounting solutions save valuable floor space -single modules are available up to 200kVAr and can be parallel connected. Single cabinet solutions up to 900kVAr are available.
- Electrical systems with leading power factor loads (eg. data centres).
- Unbalanced load environments. SVG's correct load imbalances.
- Low voltage environments (eg. country or remote areas, mining locations).
- Harmonically rich environments, possibly with resonance issues (eg. VSD's, LED lighting, data centres).

When to use a Switched Capacitor Bank System:

- Electrical environments with stable linear loads. (eg. Direct-on-line electric motors).

Performance	Sinexcel SVG (Static VAr Generator)	Switched Capacitor Bank System
Mode of Operation	The SVG detects the load current on a real-time basis through an external CT and determines the reactive content of the load current. The data is analysed and the SVG's controller drives the internal SiC-MOSFETs by using PWM signals to make the inverter produce the exact reverse reactive current of the corresponding load reactive current.	The system detects the load current on a real-time basis through an external CT and determines the reactive content of the load current. The data is analysed and the system's controller switches in the required amount of reactive current in steps, depending on the amount of reactive current available to it in that moment from the capacitor bank.
Compensation method	The SVG performs as a controlled current source, thus obtaining a power factor of 0.99 lagging or unity.	Traditional PFC systems use capacitors in groups. Their output current is in fixed steps (50kVAr, 25kVAr, 12.5kVAr, 6.25kVAr).
Response Time	Profiles the load and operates with a response speed of <5ms. Dynamic reaction time is less than 50us. It is a virtual real-time instantaneous response. Only injects the kVAr that is required in that moment, thus avoiding over-compensation and under-compensation.	Take 20ms-40s to respond to a change in load. Their delay combined with the stepped response performance means that they are perpetually over or under compensating.



Performance	Sinexcel SVG (Static VAr Generator)	Switched Capacitor Bank System
On-going costs	The SVG does not require a maintenance contract. It simply requires that the unit is kept clean. Aside from the initial purchase cost, on-going costs are negligible.	Capacitor bank style PFC systems are typically sold with a maintenance contract which is an on-going monthly charge to pay for regular maintenance and the cost of replacement parts like the capacitors, contactors, fuses, etc.
3 Phase Operation	The Sinexcel SVG measures and provides dynamic kVAr compensation individually in all three phases.	A switched capacitor bank style PFC system measures only one phase and provides stepped kVAr compensation to suit that phase, irrespective of what the other two phases need.
Load Imbalances	The Sinexcel SVG can, if required, balance the phase currents to further lower the peak kVA presented to the grid (or energy authority).	Capacitor banks with Delta connected capacitors cannot balance the load currents in a 3 phase system.
Wall-Mount Solutions	The Sinexcel SVG is available in the following wall-mount options: 30kVAr, 50kVAr, 100kVAr & 200kVAr. They can be parallel connected in a 'Master / Master / Master' type arrangement. This 'plug and play' system provides the safest continuous operation. If one unit is shut down for whatever reason the remaining modules remain in operation until the alarm is attended to or the situation resolved.	Limited Range
Resonance	The capacitance of the SVG does not require the installation of a de-tuning reactor. Performing as a current source and an active compensation device the SVG has been designed to not be affected by resonance.	Traditional PFC systems are affected by resonance, which is detrimental to the capacitors. To lower the risk, de-tuning reactors are introduced into the circuit to lower the resonant frequency below that of the lowest harmonic in the circuit.
Harmonics	The Sinexcel SVG can operate in harmonically rich environments of up to 15% THDV without detriment to itself or its performance.	Even with the use of de-tuned reactors, harmonics play a major role in shortening the lifespan of capacitors and contributing to their destruction.
Load Type	The SVG can correct both a lagging and a leading power factor, as well as work with a traditional capacitor type PFC system to eliminate over and under compensation.	Capacitor bank style PFC systems can only compensate for inductive loads.
Operation at low voltages	Designed with an active compensation circuit. Therefore the voltage of the grid has little influence on the compensation capacity. The output of reactive current matches the working conditions even when the voltage of the power grid is low.	Capacitor output is subject to the voltage of the grid, so if the grid voltage is low the output of the capacitors will be low, resulting in a decline in available compensating capacity, under-compensation and possible fault conditions.
Sizing	The compensation capacity of the SVG is the same as the installed capacity. Therefore for a given compensation effect, the capacity of the SVG may be 20%-30% less than that of a standard capacitor type PFC system.	To better suit the changing dynamics of the load, a traditional capacitor type PFC system needs to be oversized and to have a greater number of smaller steps to better suit the application. This increases the cost.
ROI (Return on Investment)	The SVG does not require a maintenance contract. It simply requires that the unit is kept clean. Aside from the initial purchase cost, on-going costs are negligible.	When estimating the ROI for capacitor bank style PFC systems, apart from the initial cost of the system, other factors over the medium to long term must be considered, including the on-going cost of the maintenance contract and replacement parts like the capacitors, contactors, fuses, etc.

Case Study - Campari

Campari

Located near Derrimut, Melbourne is a bottling & distribution facility of the timeless classic brand Campari. The electrical engineering team on site suspected that they had poor power factor, a fact that was confirmed once they conducted their power quality measurements. They calculated that a 350kVAr solution would be required and reached out to Fuseco for advice. The installation of a Sinexcel SVG system transformed their electrical environment.

The Challenge

The Campari bottling and distribution facility is a dynamic environment with all the usual challenges associated with growth. The electrical systems have grown with the demand however the engineering team reached a point where they knew that opportunities existed to optimise the system and achieve some significant cost savings. Once they measured their power factor performance, it was clear that the addition of a 350kVAr system would reap dividends. After consulting with the Campari management, the Fuseco team proposed a Sinexcel SVG cabinet solution to be located near the main switchboards.

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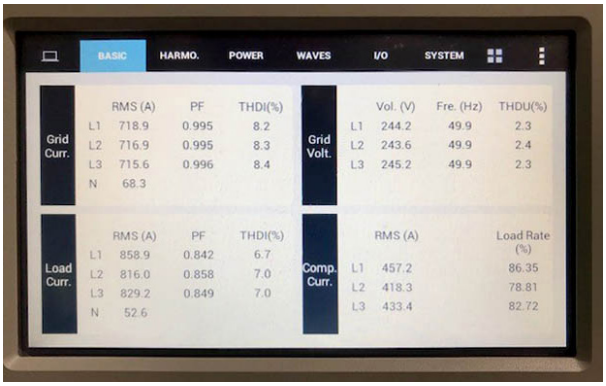

The Outcome

The addition of the Sinexcel SVG had a very positive affect on the electrical system. If we check the screenshot of the unit's LCD display, we can see that the power factor has improved from around 0.84 to 0.99. The current is now balanced across all three phases and has been reduced by around 100A. The operation of some solar inverters has a minimal affect on the THDI, however the electrical system is now benefiting from the improved power factor. Campari reported post-installation that they were extremely happy with the cost savings achieved and were happily reporting that their power bills were significantly reduced.