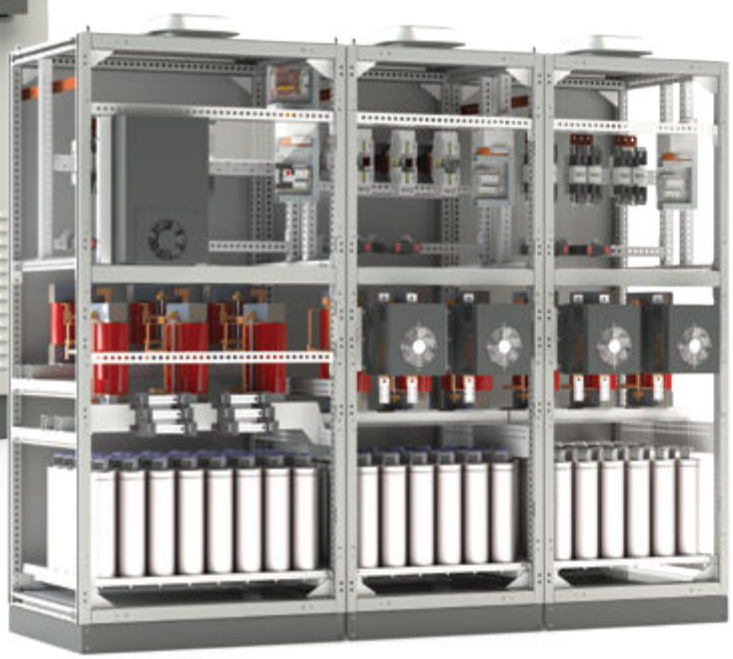
# Power Quality Solutions

## Real Time Dynamic VAR Compensation Systems

ELSPEC
When Power Meets Quality

# Elspec's Power Quality Solutions

## Fast, Reliable and Built for Results

Elspec's power quality solutions compensate for full load reactive power demands in less than one network cycle. Our real-time compensation systems stabilize voltage, enhance PF, mitigate Harmonics and reduce voltage flickering & fluctuations in real-time. Thanks to their free transient switching technology through precise zero-crossing thyristor control, Elspec's solutions enable quick problem identification, power factor correction and faster decision making. The result is smoother operation, better equipment protection and standard regulations compliance. Built for durability, Elspec's solutions are designed for reliable performance over years of operation.

## Customer Benefits

### Ensures Uninterrupted Production

Elspec's solutions fast response corrects disturbances before they disrupt operations, stabilizing power in less than one network cycle to prevent costly downtime and ensure smooth operations. Phase-by-phase correction accurately compensates each phase independently, ensuring optimal performance even under unbalanced load conditions.

### Improves Operational Reliability and Control

Integration with the G4 analyzer and PQSCADA Sapphire management software provides real-time monitoring, fast troubleshooting and actionable insights for smarter decisions and better control.

### Maximizes Energy Savings

With losses of only about 7%, Elspec's solutions minimize waste, lower operating costs and improve overall system efficiency. By reducing THDV and system losses and leveraging voltage-controlled reduction, our technology helps cut unnecessary energy consumption and deliver measurable savings over time.

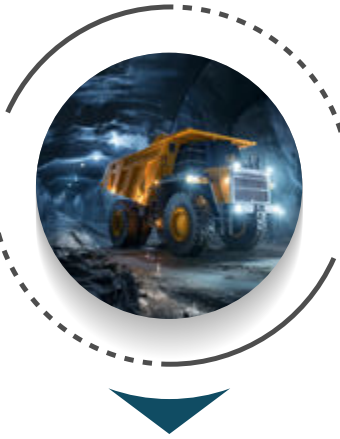
### Tailored for Every Challenge

Elspec's solutions are engineered to adapt-whether it's a compact design for limited space, special installation requirements, or custom development for complex power quality challenges. Every system is tailored to deliver maximum performance in your unique environment.

# Applications

**Spot Welding & Metal**

**Food & Beverage**



**Mining**

**Plastic & Packaging**

**Car Industry**


**Hospitals**

**Pharmaceutical**

**Ports & Crane**

**Motors & Pumps**

**Renewable Energy**

## Why Elspec

Elspec is a leader in power quality solutions, backed by over four decades of global experience. What sets Elspec apart is not only the ability to solve a wide range of power quality challenges, but also the expertise to investigate complex issues and deliver the right solution for each case. With real-time compensation, advanced monitoring and full visibility into system performance, Elspec empowers customers to optimize efficiency, ensure compliance and take complete control of their electrical networks.

# Our Technology

In power quality, speed and precision matter.

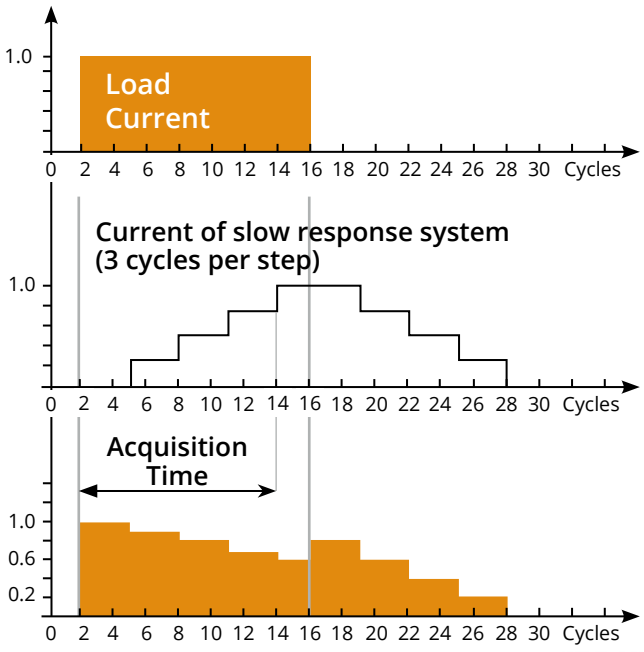
Our power quality solutions provide real-time compensation, fully compensating load's reactive power demand in less than a single cycle. It compensates reactive power, stabilizes voltage and reduces harmonics and flicker, even under rapidly changing, unbalanced, or high-distortion load conditions. This performance is made possible by thyristor-based, transient-free zero-crossing switching, which prevents the damaging switching transients that other systems may inherently generate.

Systems that use electromechanical contactors create transients at every switching action. These transients, propagate through the electrical network and can cause costly failures and malfunctions in sensitive equipment. Elspec's systems, by contrast, operate with precise zero-crossing thyristor control, ensuring transient-free switching, longer equipment life and safer operation.

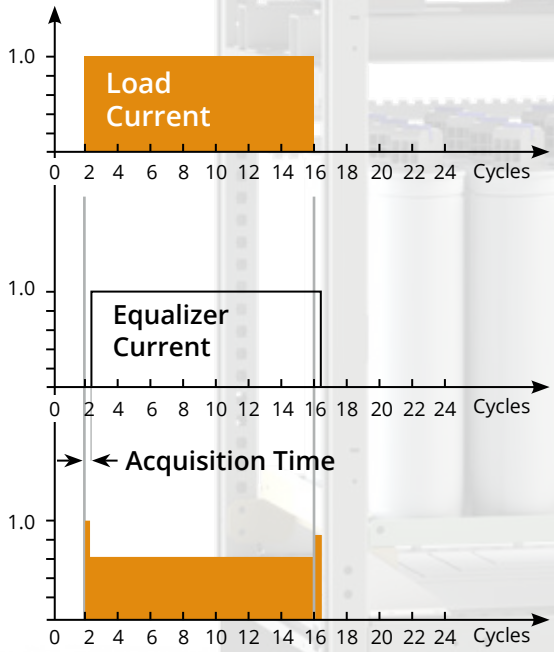
## Compensation in less than 1 cycle

Competing systems may initiate their response in real time, but they take several cycles to complete compensation. This partial and delayed correction reduces effectiveness, increases the risk of overcompensation and can cause instability such as voltage flicker. Elspec's solutions, by contrast, completes full compensation within less than one network cycle.

### Response Time Comperison




**Total Current with Slow Response System**




**Total Current with Equalizer**

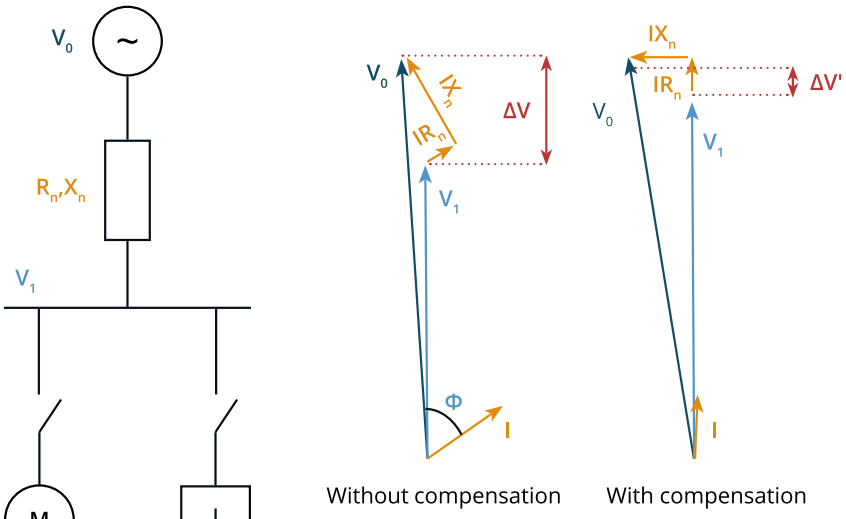
The graph shows how Elspec's power quality solution reduces voltage drop in real time. The diagram illustrates how Elspec's real-time reactive power compensation system reduces voltage drop (ΔV) across a distribution line by dynamically compensating for reactive power.

On the left side ("without compensation"), the motor (M) operates without power factor correction. The current (I) lags behind the voltage (VΔ) by an angle φ due to the inductive nature of the load. As current flows through the network

impedance ($R_n/X_n$), it creates voltage drops ($I \cdot R_n$ and $I \cdot X_n$), resulting in a total voltage drop ΔV between the source voltage ($V_0$) and the load voltage ($V_1$). This causes lower voltage at the load and increased losses in the line.

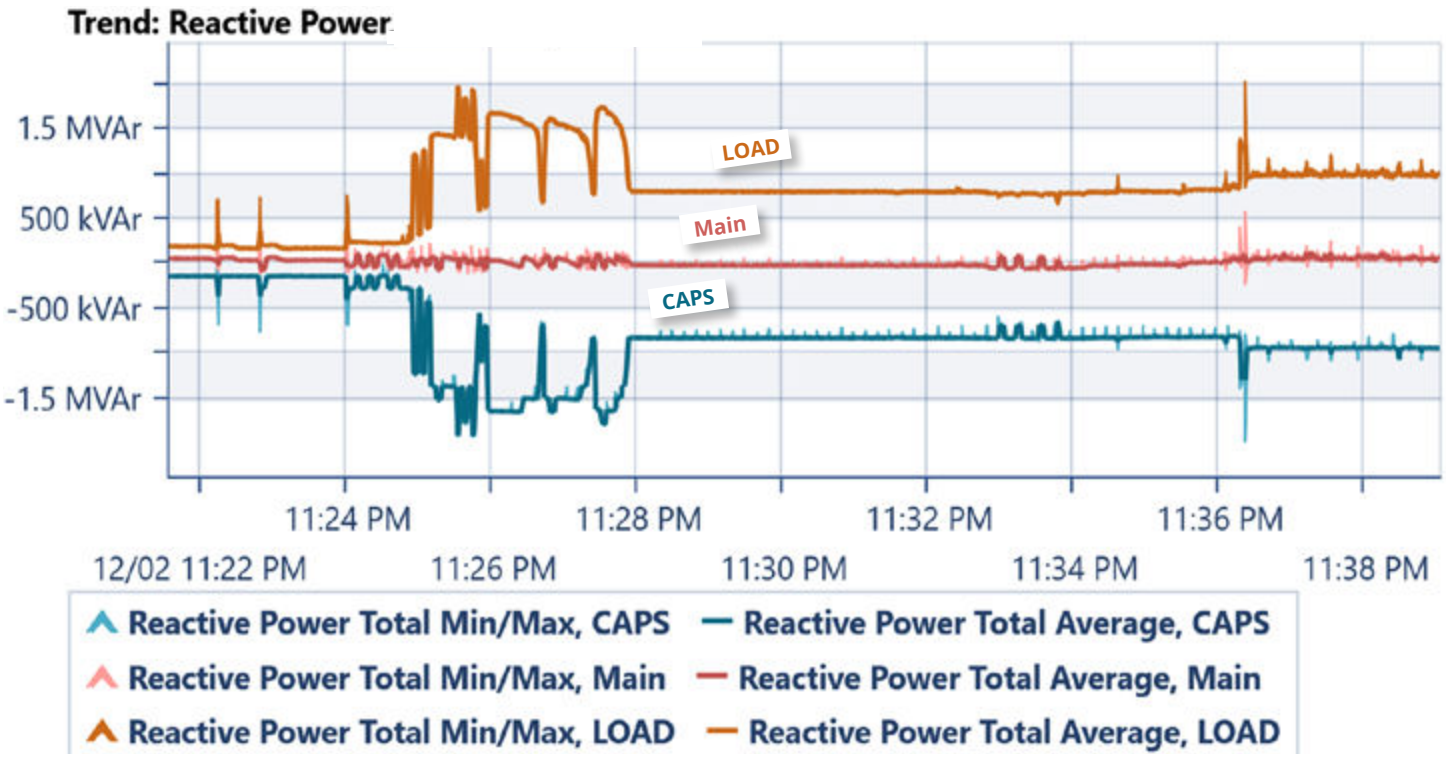
On the right side ("with compensation"), Elspec's solution provides real-time reactive current compensation. By injecting capacitive reactive current instantly and continuously, the total line current becomes almost purely active, significantly reducing the reactive component ($I \cdot X_n$) and hence the voltage drop, now represented as ΔV'. The result is a higher and more stable load voltage ($V_1$) and improved overall efficiency.

In essence, the movement from ΔV to ΔV' visually represents how real-time compensation minimizes voltage deviation - ensuring steady voltage and optimal system performance.




The difference between competing systems and Elspec's real-time full compensation is clearly seen in practice. In the customer example below, the chart shows reactive power from the Load, the Caps (Elspec PQ Solution) and the Main (electrical network).

While competing systems would still be stepping toward correction, Elspec's solutions instantly and completely compensate, leaving the Main nearly flat. This multi-source visibility provides undeniable proof of performance-showing exactly how much reactive power is drawn, how much is corrected and the net result at system level, all in one view.



# System Advantages

| | |
|---|---|
| **Correction per phase** | **Stabilizes load, reduces reactive power and fully compensate reactive power demand for each phase separately** |
| **Heavy duty design** | **Extending system lifetime** |
| **Hybrid capabilities** | **Eliminates harmonics and enables smooth, stepless compensation** |
| **Multiple rated voltage operation** | **For both low and medium voltage networks** |
| **Energy saving** | **Reduces system losses to minimize waste and lower operating costs** |
| **Tailored design** | **For limited space and special installation requirements** |
| **Custom development** | **For complex power quality requirements** |

# Key Component Highlights

Elspec offers a wide range of power quality solutions that can be easily adapted to different needs and environments. With multiple configuration options, we can adjust system size, functionality and performance to suit various applications. We also design fully customized solutions for more complex or specialized needs. Our team works closely with each customer to evaluate their electrical environment and deliver the right solution for you.

At Elspec, we believe power quality solutions should be both high-performing and built for longevity. Every system we design is equipped with premium-grade components selected for durability, reliability and long-term operation in demanding environments.

## Heavy-Duty Capacitors

Elspec uses heavy-duty capacitors with enhanced film thickness and thermal ratings, designed to withstand high inrush currents and operate reliably under harsh conditions for longer service life and reduced maintenance. These capacitors are also optimized to absorb and mitigate harmonic currents, supporting cleaner power quality in distorted networks. Capacitor groups are switched on and off using state-of-the-art electronic switching at precise zero-current crossing points. This ensures smooth transitions and eliminates harmful transients often seen in electromechanical PFC systems-greatly extending system life.


## In-House Iron Core Inductors

Elspec's systems feature premium iron-core copper Inductors, tight tolerance ratings and insulation voltage up to 8,000V. Our Inductors are proudly designed and manufactured in-house at our advanced production facility. By controlling every step of the process, we ensure the highest quality standards (UL approved), precise tolerances and long-term reliability. Our inductors-available in Series 4.2%, 5.67%, 7%, 14% and customized as well. Built with low-loss laminated cores, copper windings and Class H insulation (180°C), each inductor is manufactured under tight tolerances for long-term durability and performance.

## Advanced Thyristor Switching Modules

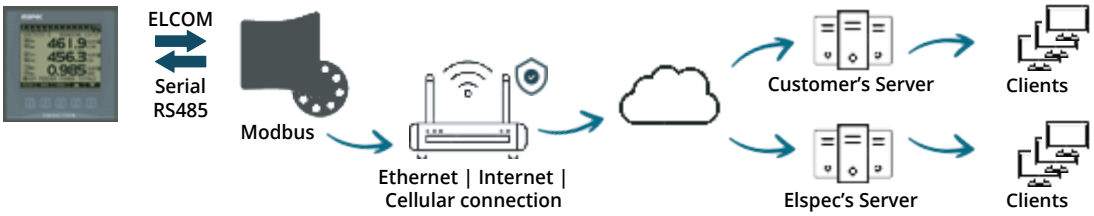
Zero-crossing technology ensures smooth, transient-free capacitor switching. UL approved. Supports real-time response for real-time compensation without stress on system components. 2 main module series: Single Group: High power up to 350A, 690V and Three Groups: up to 200A, 480V.

## Forced Ventilation

Elspec systems use a temperature-controlled forced air cooling system to keep internal components within their optimal operating range. For extreme environmental conditions, integrated air conditioning units can be added to ensure reliable performance even under the harshest temperatures or high ingress protection ratings.

## Advanced Monitoring and Control

The controller performs cycle-by-cycle FFT (Fast Fourier Transform) and communicates with PQSCADA Sapphire through the G4 Power Quality Analyzer, which serves as the gateway for remote communication over TCP. The G4 also measures the system's behavior internally and the customer's system, enabling advanced analysis across all phases and providing detailed power data, system status and event logs. This capability allows early detection of new issues or failures, ensuring timely alerts and proactive maintenance.




## Designed for Harsh Environments

Every solution can be designed for tough conditions and high-performance environments under request. Suitable for both indoor and outdoor installations, with an operating temperature range of -20°C to +55°C. Built for durability with corrosion-resistant construction, special protective coatings, dust protection and high humidity tolerance.

## Custom Mechanical Design

Elspec systems are fully built in-house at our production facility, allowing complete flexibility for custom mechanical designs based on customer requirements. From tailored layouts to specialized coatings and finishes, we deliver solutions that meet unique installation and environmental demands.

## International Standards

Elspec systems comply with leading international standards. Whether your project demands compliance at the grid level, EMC standards, or complete system and panel certification, we will tailor the solution to ensure full compliance and long-term reliability.

### IEEE 519 (Harmonics Control – Grid Level)

Sets recommended limits for harmonic voltage and current distortion at the point of common coupling (PCC). Ensures power quality systems do not negatively impact grid voltage waveform quality.

### EN 50160 (Grid Level)

Defines voltage characteristics at the point of common coupling - frequency, magnitude, flicker, harmonics, unbalance. Ensures PFC systems do not violate grid voltage quality.

### IEC 61000 series (EMC & Power Quality Level)

Governs electromagnetic compatibility and PQ behavior (harmonics, flicker, immunity, measurement methods). Ensures PFC systems operate without introducing disturbances.

### IEC 61921 (System / Equipment Level)

Specifies requirements for low-voltage power capacitor banks, including design, construction, protection and safe operation.

### UL 508A (Panel/Assembly Level, North America) - Certified

Standard for industrial control panels, covering the assembled PFC bank with capacitors, switching and protection devices to ensure safety and certification.


Making energy
systems more
sustainable,
flexible &
resilient.

# The Right Solutions For Your Needs

At Elspec, we believe power quality solutions should be both high-performing and built for longevity. Every system we design is equipped with premium-grade components selected for durability, reliability and long-term operation in demanding environments.

| | | |
|---|---|---|
| Reactive power<br>Flicker<br>Voltage dips<br>Harmonics in rapid changing loads | **Reactive Power Compensation<br>Voltage Stabilization<br>Tuned Harmonic Filtration** |  <br>**Equalizer LV<br>Equalizer Compact** |
| Over 20% Unbalanced demand | **Compensation for<br>Unbalanced Load Conditions** |  <br>**Equalizer Unbalanced** |
| Motor Start Current Surges | **Motor Start Compensation** |  <br>**Equalizer ST** |
| Harmonics<br>Harmonics+PF | **Filtering Harmonics** |  <br>**PQ-Hybrid Equalizer** |
| Reactive Power<br>Harmonics in Stable loads | **Reactive Power Compensation<br>Voltage Stabilization<br>Tuned Harmonic Filtration** |  <br>**Activar** |
| Reactive power<br>Flicker<br>Voltage dips<br>Harmonics in rapid changing loads | **Reactive Power Compensation<br>Voltage Stabilization<br>Tuned Harmonic Filtration** |  <br>**Equalizer MV** |
| Resonances | **Damping Resonances** |  <br>**Equalizer LV<br>Equalizer MV with<br>Detuned Reactors** |

# Built For Perfomance Designed For Longevity


# Technical Information

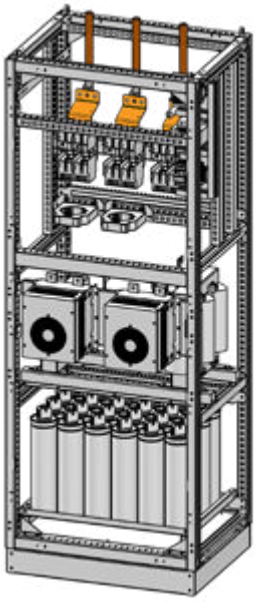
## Specification for LV solutions

| | | | | |
|---|---|---|---|---|
| **LV Equalizer System** | Rated power | Up to 4MVAr in LV, for higher rates refer to MV solution | | |
| | Rated voltage | 200V to 690V | | |
| | Rated frequency | 50/60Hz ±10% | | |
| | Network configuration | Three phases WYE/DELTA<br>Single phase | | |
| | Losses | 7% inductors < 0.8% \| 14% inductors < 1.2% | | |
| | Communication | ELCOM/ModBus (IEEE 754 Floating Point)<br>Remote control with G4 Analyzer as a gateway via TCP | | |
| **Acquisition Time** | Full compensation within one network cycle | Up to 20ms for 50Hz network<br>Up to 16ms for 60Hz network | | |
| **Compensation Method** | Transient free operation | Zero-crossing, ensures smooth, transient-free capacitor group connection | | |
| **Control Mode** | Main CT installation location | Load only (open loop)<br>Load + Capacitors (close loop) | | |
| **Controller** | Calculation method | True RMS measurements (up to 63rd harmonics) Based on FFT algorithm which is carried out cycle by cycle (128 samples per cycle) | | |
| | Number of groups | Up to 12 groups per controller | | |
| | Binary switching sequence | 1:1:1<br>1:2:2<br>1:2:4<br>1:2:2:4<br>1:2:4:8 | | |
| | Operation modes | Manual<br>Automatic | | |
| | Functions | **G** | Generator | Allows two power factor targets dependent on the power source |
| | | **T** | Transformer | MV compensation using LV capacitors and step-down transformer |
| | | **U** | Unbalanced | Independent compensation per phase |
| | | **M** | Medium Voltage | Used for MV compensation system |
| | | **V** | Voltage Control | The controller connects or disconnects steps according to programmed voltage levels |
| | | **S** | Single Phase | For single phase network (L-L/L-N) |
| | | **W** | Wind Generator | Special version for wind generator applications |
| | | **D** | Motor starter | Solution for the challenges related to large motor start up (EQ-ST) |
| | | **P** | Pulse | Synchronized compensation, using external signal |
| | Simultaneous measurement of the following sections | **Mains** (total of load and capacitor system)<br>**Load**<br>**Capacitors** (system)<br>**Combination of Mains, Load and Capacitors.**<br>For example, if reactive energy parameter is selected, the user can see the kVAr consumption by the **Load**, the connected kVAr by the **Capacitor** System and the result on the **Mains.** | | |
| | Measured parameters | Most common requited parameters including harmonic spectrum and waveform graphs | | |
| | Energy | Active Energy (kWh)<br>Reactive Energy (kVARh)<br>Stores energy data every 15 minutes for previous | | |

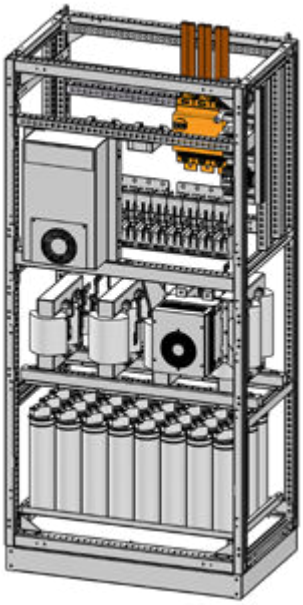
| | | | |
|---|---|---|---|
| **Switching Module** | Rated voltage | Up to 480V | Up to 690V |
| | Groups | 3 groups | Single group |
| | Rated current | 200Amp | 350Amp |
| | Electrical breakthrough | 3kVDC SCR/Chassis | 6kVDC SCR/Chassis |
| **Capacitors** | Heavy duty capacitors | 450V: 7.5um film thickness<br>550V: 10um film thickness<br>690V: 12um film thickness<br>800V: 14um film thickness | |
| | Maximum ratings | Overcurrent: $2I_N$<br>Inrush current: $500I_N$ | |
| **Inductors** | Copper inductors | Rated inductance and tolerance: -1.5% / +2.5%<br>Insulation voltage: 8,000V<br>Windings: Temperature class H / 200 ºC | |
| **PC Software** | PQScada Sapphire Software | Data can be reached from any location using standard secured, firewall friendly protocols | |
| **Environment** | 0°C to 40°C (32°F to 104°F) | | |
| | < 1000m without derating (for higher altitudes contact us) | | |
| | Forced Ventilation | | |
| | <95% (non-condensing) | | |
| **Enclosure** | IP20 (other on request) | | |
| | Hot dip zinc coated steel sheet | | |
| | Powder epoxy light texture, thickness: 90-120µm | | |
| | RAL 7035 (others on request) | | |
| | Hinged doors with key lock | | |
| **Standards** | EN 50160, IEEE 519, IEC 61000 series, IEC 61921, UL 508A | | |

# System Examples

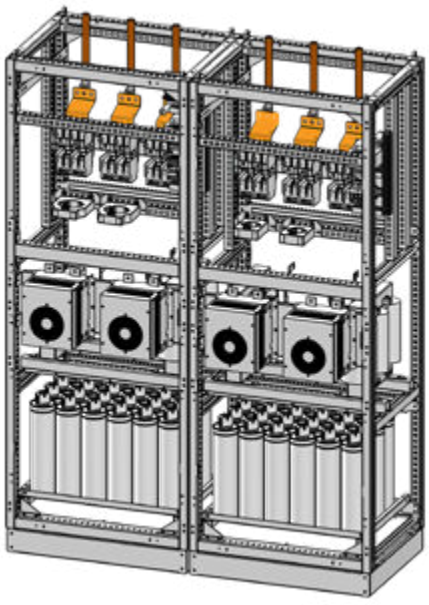
## Cable Connections



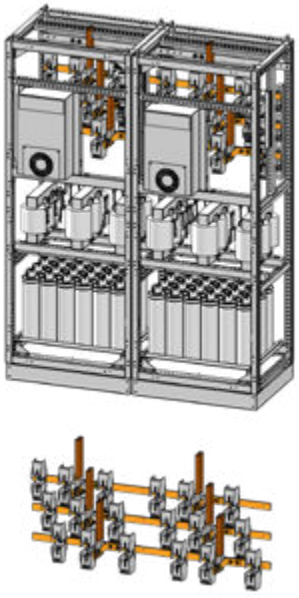
Single cabinet



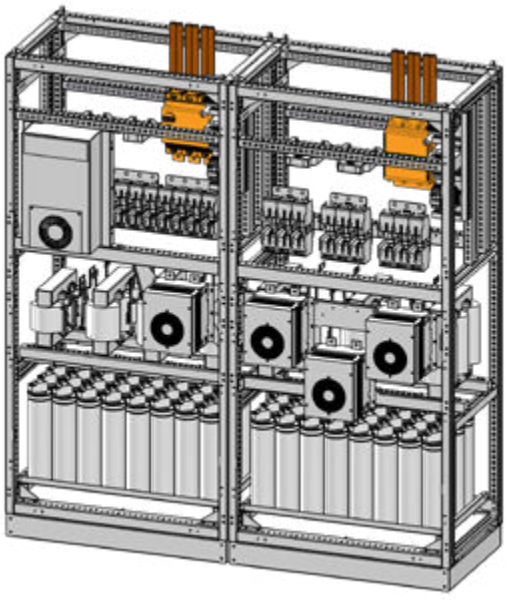
Single integral CB/disconnector



Multiple Connection Points



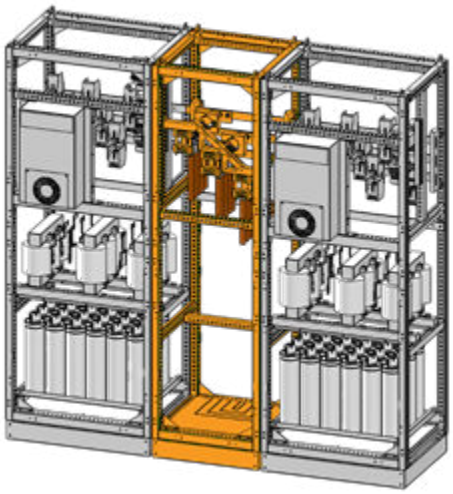
Multiple Connection Points with bridge busbar



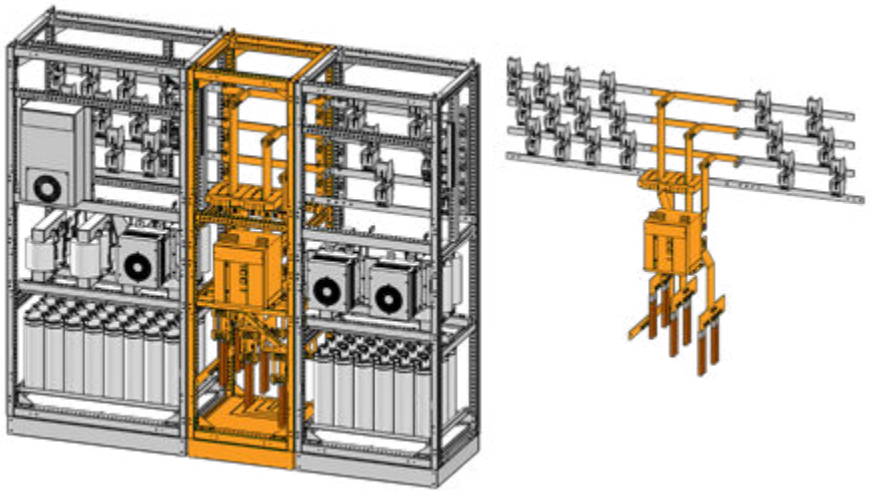
Multiple Connection Points with integral CBs/disconnectors

# System Examples

## Cable Connections

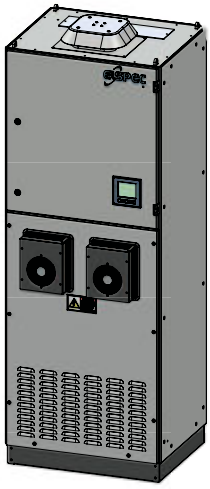


Connection cabinet



Connection cabinet
with CB/disconnectors

## Protection Degree



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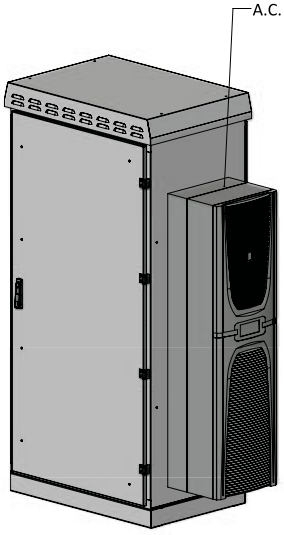


IP54

# Worldwide Innovator in Power Quality

Since 1988 Elspec has developed, manufactured and marketed proven power quality solutions far exceeding our clients' needs and expectations. Our innovations not only simplify the understanding of the quality of power itself, but are also highly compatible, making it suitable for any business and/or application. Elspec's international team of professionals with extensive experience in electrical engineering, are ready to provide a tailor-made strategy that will enable a sustainable and efficient use of your electrical energy.




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