



POWER QUALITY SOLUTIONS FOR INDUSTRY



Dynamic Voltage Restorer
AVC DVR 50kVA to 4200kVA

Industrial UPS
DVC SEPEC 200kVA to 2100kVA
DVC 500 to 3000kVA



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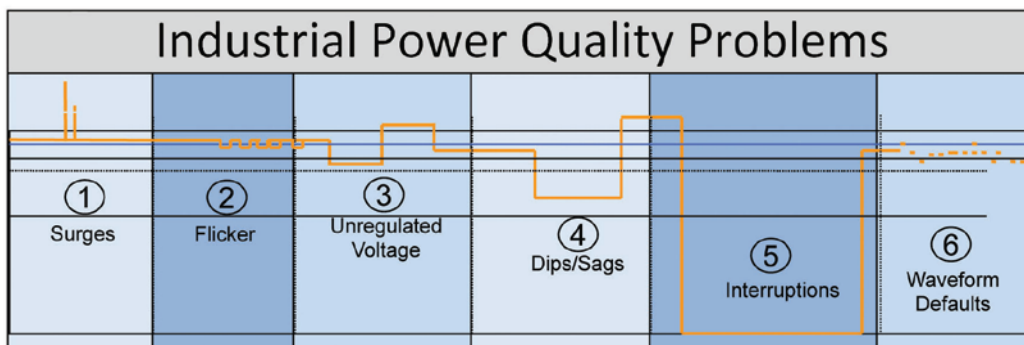
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1. Industrial Power Quality Solutions

1.1. The Problem

Although utilities keep on trying to improve the reliability of the grid, sensitivity of industrial equipment to Power Quality (PQ) disturbances increases as automation and electronics become more ubiquitous in industry. Unfortunately, utilities cannot guarantee 100% availability in the power supply.

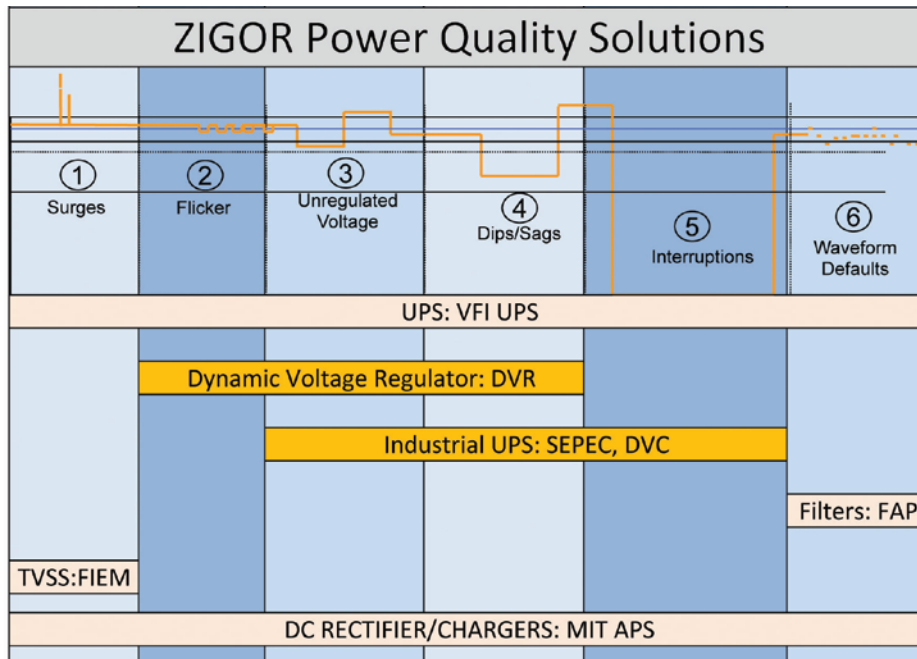
Typically industrial equipment is designed to comply with sensitivity standards like, SEMI F47 or others similar immunity references, however many times to achieve higher levels of availability or better Power Quality (PQ) for industrial process, complementary equipment has to be used.



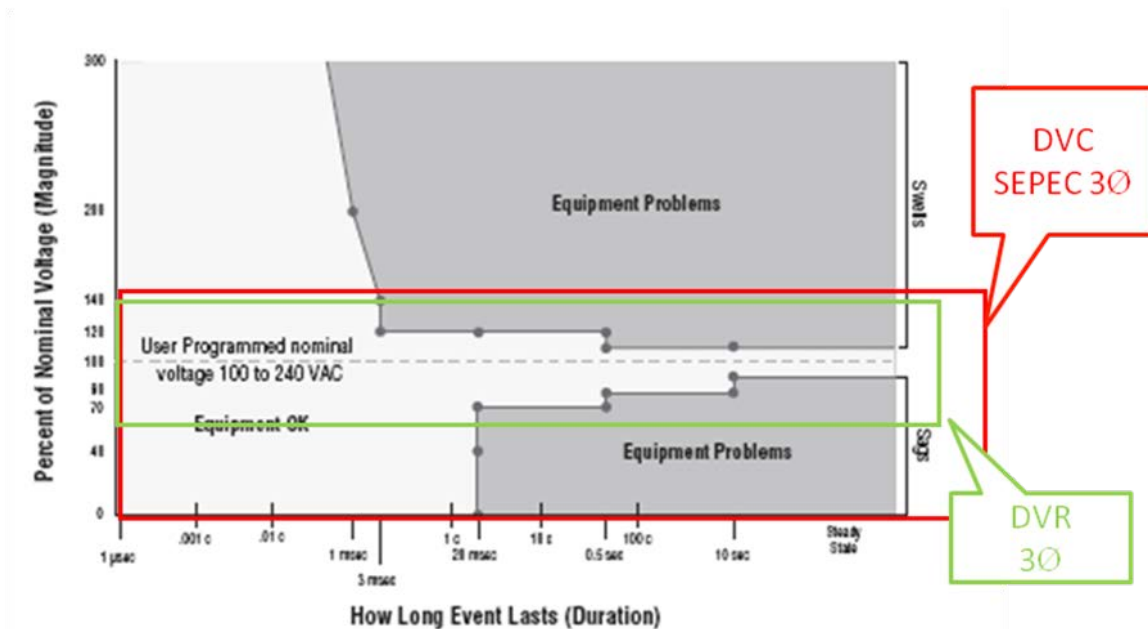
Identifying the power quality problem affecting the normal operation of industrial process, it is a must to prescribe previously the power quality solutions. The figure above shows the most common grid problems affecting the adequate operation of industrial equipment, namely: transient over voltages or surges, flicker, voltage regulation, voltage dips or sag, interruptions or waveform disturbances (power factor, harmonics, others).

1.2. Zigor Power Quality Solutions

As summarised in the following table, Zigor offers two ranges of products specifically designed to solve industrial power quality problems, namely: The **Dynamic Voltage Restorer** range (AVC DVR) for sag and regulation problems and The **High Efficiency Industrial UPS** range (DVC SEPEC and DVC) for sag, regulation and short interruption. The DVC or DVC SEPEC Systems, a battery based Industrial UPS for several minutes back up time, is available for Lead Acid and Lithium batteries. Complementary a super capacitor storage based model is also available, which is adequate for a few seconds sag and/or interruptions.



The following figure summarises the coverage offered by the AVC DVR and DVC SEPEC/DVC, increasing the immunization level over the IEEE 446 curve.



Complementary to the above described equipment, AVC DVR & DVC SEPEC designed to protect industrial processes against power quality problems, Zigor offers a comprehensive portfolio of UPS for IT market, a complete range of rectifiers and battery chargers for Telecom, Industry and Utilities as well as a number of especial products for Railway and industry: filters, AVR, TVSS, etc. More information about these products could be found at www.zigor.com.

1.3. Design Recommendations and Configurations

Designing the optimum power quality investment requires expertise and know-how to ensure a nonstop power system at your most demanding and sensitive processes.



Additionally to the surges and power factor correction problems that normally are well solved at the stage of industrial process design, interruptions and voltage dips are probably the disturbances causing the highest economic losses in industry.

Zigor also offers a System Design Service to provide Customised Solutions both for existing processes and new plants. In order to design and succeed in the installation of Zigor power quality systems, a professional network of engineers and field application engineering team are offered worldwide.

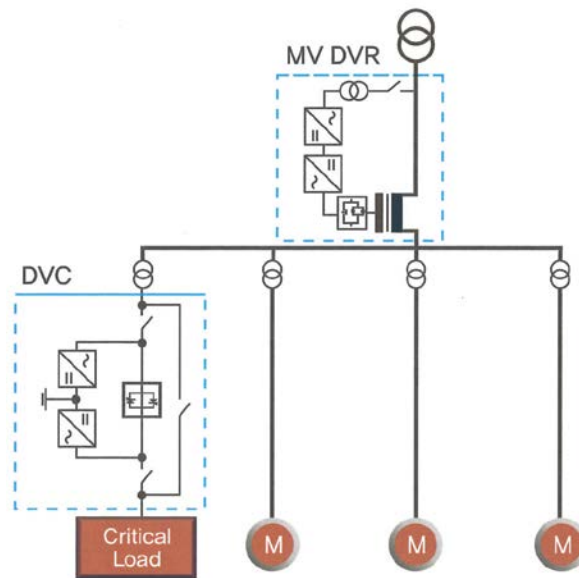
The following table summarizes the most frequently recommended equipment for the different load specs.

Load Distribution and Protection		
LOAD TYPE	REQUIREMENT	RECOMMENDED EQUIPMENT
Non Critical	Power Factor, Harmonics	PFC, Filter
Non Critical Sensitive	Overvoltage sensitive	TVSS
Low Power Critical	Regulation, Sag, Interruption	On-line UPS
High Power Critical I	Regulation, Sag	DVR: Dynamic Voltage Restorer
High Power Critical II	Regulation, Sag, Interruption	SEPEC, DVC : High Efficiency Industrial UPS

Another relevant design configuration criterion that fundamentally affect to the cost and effectiveness of the solutions, is to use centralised (normally medium voltage) equipment in combination with smaller distributed low voltage solutions, as shown in the following figure.



The figure presents a typical configuration where the complete plant is protected from sag using a centralized MV AVC DVR and the most critical loads are complementary protected from interruption with a DVC to cover interruptions.



For those processes having space limitations to install the equipment near the process, many times the centralised (MV) solution is the best option. For medium voltage centralised solutions Zigor offers turn key projects.

The below picture shows a real system installed in a Oil Refinery and protecting a 5MVA process with a MV (6,6 KVolts) AVC DVR.





1.3. Typical Application Sectors

Traditional online UPS are often used in industry to immunise PLC and control processes; however they are not always adequate to high power demanding industrial applications. For those load requirements Zigor AVC DVR and DVC SEPEC, as dynamic voltage restorer and high power high efficiency industrial UPS are suitable. Typical industries and sectors where the AVC DVR and the DVC SEPEC would be the right PQ solutions are:

- Semiconductor Industry
- Automotive Industry
- Pottery Industries
- Automatic Logistics Warehouses
- Paper mills
- Mining
- Continuous production processes
- Automation with Robotics
- Other industrial equipment sensitive to sags and/or interruptions.

2. AVC DVR: Dynamic Voltage Restorer

Protect industrial processes from sag, overvoltage and regulation problems

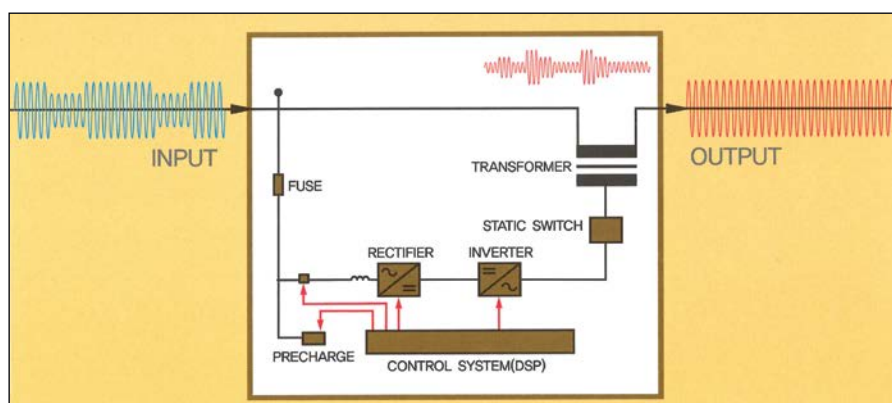
2.1. Product Description and Advantages

The AVC DVR is an innovating system designed to mitigate sags or dips and overvoltage as well as to solve regulations problems.

The AVC DVR guarantees the quality of the grid, meeting the demands of industrial production processes, keeping stable and constant the output voltage regardless of input voltage variations. The AVC DVR is a flexible voltage compensator, injecting and absorbing energy, capable of correcting sags of 40% of input voltage, to offer a highly stable voltage ($\pm 0,5\%$) with immediate response ($<3\text{msec}$). It consists of a booster transformer, a reversible rectifier unit, plus an inverter. The aim of the AVC DVR is to offset disturbances, voltage imbalances, and to regulate them in case of possible fluctuations and overvoltage.

The system also supervises controls and logs sag and grid events. The output voltage stabilisation is assured both for balanced (three phases) and unbalanced input voltage variations.

The AVC DVR offers an important advantage which is the lack of energy storage components leading to a very low maintenance cost and maximum power supply availability. The following figure illustrates graphically its compensation method:





Because the energy flow could be reversed throughout the (booster) transformer in series with the grid, the AVC DVR system achieves high efficiency as well as some other advantages, like:

- Free from any energy storage components.
- Longer time frame for repetitive dips events (10 to 15 seconds)
- Allows continuous operation to offer very high voltage regulation accuracy.
- Allows bi-directional energy flow.
- Improved time response to allow permanent voltage distortion filtering.

The dynamic response of the AVC DVR is summarized in the following table:

Dynamic response	
SAG DEPTH INPUT VOLTAGE	OUTPUT VOLTAGE
30 % of the Rated Voltage	Rated Voltage $\pm 0,5\%$
40% of the Rated Voltage (15 seconds)	Rated Voltage $\pm 0,5\%$
50% of the Rated Voltage (15 seconds)	90% of Rated Voltage $\pm 0,5\%$
$\geq 50\%$ of the Rated Voltage	Bypass: Input = Output

2.2. Product Features and Technical Specifications

As mentioned before, the AVC DVR has been designed to immunize processes and equipment requiring complying with SEMI F47 and is available in power range from 50 kVA to 4.2 MVA.

The Zigor Dynamic Voltage Restorer offers the following disturbances compensation capabilities:

- Voltage dips and swells
- Voltage variations
- Voltage distortion
- Voltage flicker
- Voltage unbalance
- Some level of transient over voltages

Complementary the AVC DVR system has the following main features:

- No battery or alternative energy storage required, minimizing maintenance cost and increasing reliability.
- Continuous voltage regulation within the $\pm 0.5\%$.
- Compensation of deep long lasting dips (-50% up to 15 sec).
- Avoids relays and brushes.
- Time response less than 3 milliseconds.
- Capable to operate with industrial regenerative loads (e.g. four-quadrant converter).
- Improves the voltage distortion.
- Non-stop of process operation in case of failure.
- Easy to parallel additional equipment.
- Independent phase compensation.
- Balanced and unbalanced sag/dip compensation.
- Automatic Bypass.
- Efficiency 97.5% for LV and 98.5% for MV.
- Overload capacity: 150% during 1 second.
- Dips logging and system monitoring.



Due to the independent phase compensation capability as well as the bidirectional energy flow control operation, this equipment can balance and equalize three phase unbalanced systems, both during transients and continuously.

Its capability to respond to 2 - 3 msec sub-cycle transients together with complementary TVSS equipped as standard offers a high level of overvoltage protection both for very fast and fast transients (e.g. capacitor's bank switching).

The specs shown bellow correspond to the general specs for all the models. Low voltages models are designed for indoor use and medium voltage models could be build in steel or concrete containers for outdoor usage.

Technical Specifications DVR	
Input	
Nominal Voltage (V)	208/220/240/400/460/480 and other customised voltage for MV
Frequency	50Hz/60Hz
Output	
Power Range	50kVA to 4200kVA (6000kVA for 30% sag)
Continuous regulation	+/- 0.5% (within the +/- 10% range)
General Specs	
Sag correction	40%
Sag correction time	< 3 msec
Maximum Efficiency	> 97,5%
Overload capacity	110% - 30 sec 150% - 1 sec
Operation temperature	0°Cc - 40°C
Storage temperature	0°Cc - 80°C
Cooling	Fan assisted
Noise	< 75 dBA @ 2 m.
IP	IP21 for indoor cabinets and IP54 for outdoor containers (option for MV)
Protection	IP 21 acc to IEC 529, 944 IEC
Relative humidity	< 95% (no condensation)
Maximum operating altitude	< 1000 m. with derating at higher altitudes
Bypass type	SCR
Bypass transfer time	< 0,5 msec
Remote	Web Server via TCP/IP
Local	LCD display
Maintenance	
MTTR	low due to modular architecture
Standards	
	CE
	Semi F47 (by test)



Different topologies for maintenance and redundancy are possible depending on customer's requirements. The size for the different models is presented in the next table.

(kVA)	Low Voltage		Medium Voltage **
	Single Cabinet*	Multi-Cabinet***	
50	800x660x1600		
100	800x660x1600		
150	800x660x2100		
200	1212x660x2100		
300	1212x660x2100		
500	2424x660x2100		
600	2424x660x2100	(5x800)x600x2350	20 feet container
900	1609x2008x2350	(5x800)x600x2350	20 feet container
1200	1609x2008x2350	(6x800)x600x2350	40 feet container
1500	1609x2008x2350	(7x800)x600x2350	40 feet container
1600	2450x3155x2350	(7x800)x600x2350	40 feet container
2000	3150x3155x2350	(7x800)x600x2350	40 feet container
2400	3150x3155x2350	(8x800)x600x2350	40 feet container
2700	3150x3155x2350	(8x800)x600x2350	40 feet container
3100	3150x3155x2350	(8x800)x600x2350	40 feet container
3500	4400x3155x2350	(10x800)x600x2350	40 feet container
3800	4400x3155x2350	(10x800)x600x2350	40 feet container
4200	4400x4155x2350	(10x800)x600x2350	40 feet container

* *Booster transformer included, Maintenance bypass not included*

** *MV Transformers switch gears not included*

*** *Transformers and maintenance bypass not included*

Standard equipment does not include maintenance bypass nor protection elements that are normally defined by the customer on a project by project basis.

Low voltage models 208 to 480Vac are offered in an all-in-one cabinet with the booster transformer included. For MV systems, two options are available: full equipped container with and without the MV transformer and switchgears.

3. DVC SEPEC and DVC: High Efficiency Industrial UPS

Protect industrial process from sag and short interruptions problems

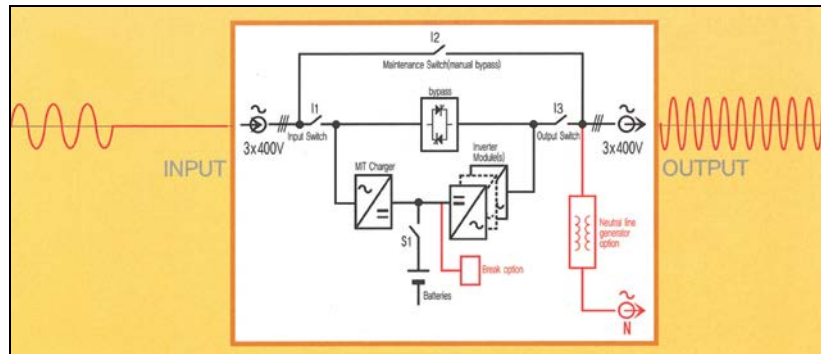
3.1. Product Description and Advantages

The DVC SEPEC and DVC Systems have been designed to solve the problems of short interruptions and sags for industrial process.

Both products, DVC SEPEC and DVC equipped with battery and Uncaps respectively to cover short interruptions and others important power quality problems like (voltage sags/swells or surges) but also to avoid common problems of double-conversion UPS.

Operating efficiencies higher than 99%, integrated air-conditioning system for batteries and robustness are some of their features. They do not introduce harmonics into the installation (upstream) as well as they do not expose services to inverter distortions.

DVC SEPEC Series eliminates fast ageing of batteries due to low current ripples of charger. It is capable of operating with regenerative loads (optional).



3.2. Product Features and Technical Specifications

Summarising fundamental specs:

- High efficiency emergency supply system (>99%).
- Compatibility with existing protection system.
- Short term ROI as compared to IT UPS.
- Minimal maintenance cost (energy, maintenance, etc.)
- Maximum system availability.
- Optimal integration with Diesel Generators.
- Regulation of overvoltage.
- Optional surge protection.
- Operating temperature up to 50°C.

The specs shown bellow correspond to the general specs for all the models:

Technical Specifications SEPEC AND DVC	
Input	
Nominal Voltage (V)	208/220/240/400/460/480 and other customised voltage for MV
Frequency	50Hz/60Hz
Output	
SEPEC Power Range	200kVA to 2100kVA (Battery)
DVC Power Range	500kVA to 3000kVA (Ucaps)
Continuous regulation	Adjustable. Typical +/- 10%
Emergency Mode	Interruption and Sag compensation: Off-line compensation
General Specs	
Interruption and Sag correction	100%
Correction time	< 3 msec
Maximum Efficiency	> 99,5% (SEPEC), > 99% (DVC)
Overload capacity	110% - 30 sec 150% - 1 sec
Operation temperature	0°Cc - 40°C
Storage temperature	0°Cc - 80°C
Cooling	Fan assisted
Noise	< 75 dBA @ 2 m.
IP	IP21 for indoor cabinets and IP54 for outdoor containers (option for MV)
Protection	IP 21 acc to IEC 529, 944 IEC
Relative humidity	< 95% (no condensation)
Maximum operating altitude	< 1000 m. with derating at higher altitudes
Bypass type	SCR
Bypass transfer time	< 0,5 msec
Communications	
Remote	Web Server via TCP/IP
Local	LCD display
Maintenance	
MTTR	Low due to modular architecture
Standards	
	CE
	Semi F47 (by test)

* Other powers are possible under demand

4. PQ Survey for Optimum Pay Back and Energy Saving

Nowadays it is possible to reach almost 100% availability of power supply for many applications. However there is still a gap when facing to use standard UPS to some of these power quality problems in high power industrial and other critical processes, for several reasons (investment, space, long-term energy losses cost, regenerative loads), since most of them have been developed for IT industry. When immunising against disturbances, purchasing cost, return on investment versus saving, maintenance cost, efficiency, size, reliability or availability are the key decision criteria to industrial decision makers. The following table present and ROI analysis comparison for protecting an industrial load of 600kW using Zigor industrial UPS (DVC SEPEC), or AVC DVR as compared to a double conversion IT UPS.

ROI and COST versus SAVINGS			
	SEPEC	STD Doble Conv. UPS	DVR
Process Power (kW)	600	600	600
Nominal Equipment Power (kVA)	600	880	600
Power Equipment losses (%)	0,50%	10%	2%
Cost per kWh	0,08 €	0,08 €	0,08 €
Process Operation Hours a Year	3600	3600	3600
Initial Investment	45.000,00 €	45.000,00 €	50.000,00 €
Maintenance Cost	1.000,00 €	1.500,00 €	500,00 €
Other maintenance costs	0,00 €	0,00 €	0,00 €
Operation Energy Cost of Equipment	864,00 €	17.280,00 €	3.456,00 €
Total Costof Operation of Equipment	1.864,00 €	18.780,00 €	3.956,00 €
Savings from inmunization	25.000,00 €	25.000,00 €	25.000,00 €
(Saving - Cost) per Year	22.136,00 €	4.720,00 €	20.544,00 €
ROI (years)	2.0	9.5	2.4

The sample illustrates how the effect of the high efficiency of Zigor products has a relevant impact on the return of investment (ROI). Different customers and processes present different potential savings when using Zigor Protection Solutions and the advantage of them are more important for high power and for processes that operates long periods of time during the year.



5. Reference Projects

After more than six years of successful installation in many different industrial sectors with over 80 MVA of systems already installed all over the World, DVC SEPEC, AVC DVR and DVC are probably the most reliable, sturdy and state-of-art Power Quality systems available in the market.

Contact with our field application engineering team to lean more about the advantages of our solutions and to do a survey for your process.

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