



Laurent Maillefer, 19th to 21 May 2014

# **14th Annual PQSynergy™ International Conference and Exhibition 2014**

## **Power Protection - PCS100 AVC & UPS-I**

# Power Protection

## Agenda

1. Introduction of power protection
2. Overview PCS100 platform
3. Solutions for Power Protection
  - PCS100 AVC → Active Voltage Conditioner
  - PCS100 UPS-I → Industrial UPS system

# Power Quality Problem

## Power events don't come with a warning



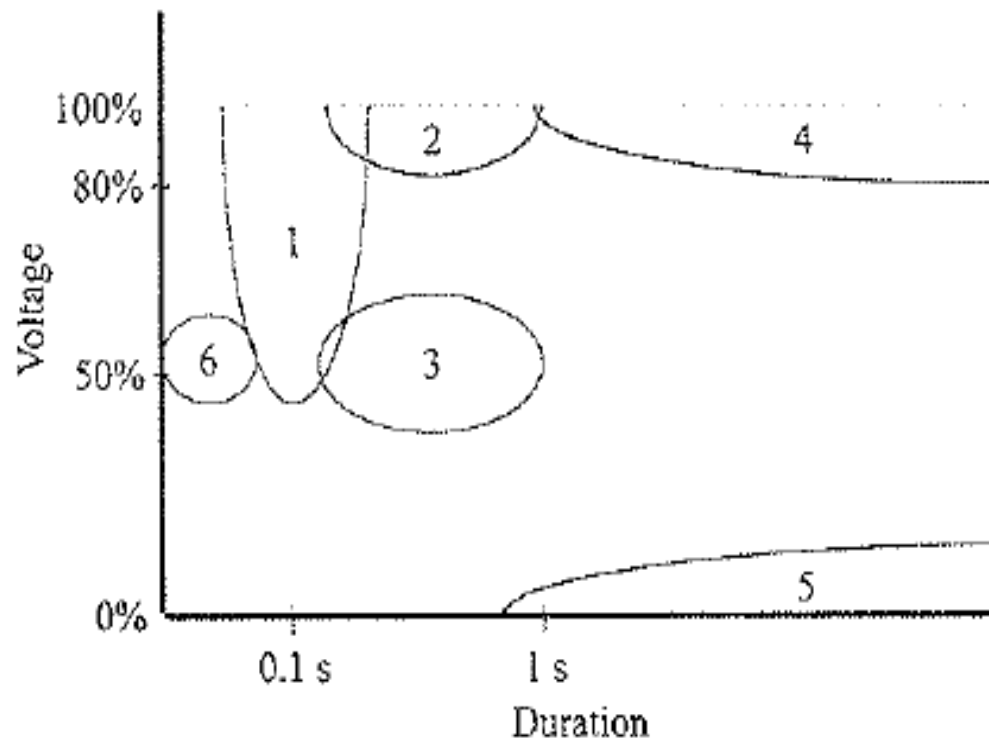
- The most common PQ problem facing industry is sag events.
- Brief power disruptions account for up to 70 percent of all unscheduled downtime in modern manufacturing. Studies show that these events are caused by voltage sags lasting less than two seconds.
- Facilities do not get advance warnings of impending sags

# Sag Characteristics and profile

- Normally caused by unpredictable system faults
  - Weather events – lightning, trees on lines
  - Urban construction – digging up lines
  - Network failure – transformers, insulators, switchgear, lines
  - Events are inevitable even in meticulously maintained networks
- Sag profile and event meaning
  - Power source are available, but not in the right quality
  - The duration of a sag is short ( $<1\text{s}$ ) and determined by protection settings
  - A sag is most commonly unbalanced and spreads like waves in the water
  - The sag is felt at various levels throughout the distribution system
  - Power networks gets more interconnected (ring feeder structure) to secure supply  
→ Faults spreads more widely in the network

# Sags of different origin

- 1) Transmission connected faults
- 2) Remote distribution system faults
- 3) Local distribution system faults
- 4) Non-faults eg: large motor starting
- 5) Short interruptions
- 6) Fuses



# Power Protection against voltage disturbance

## Voltage sags & surges cause production to stop





# Power Protection against voltage disturbance

## Protect YOUR production lines and processes




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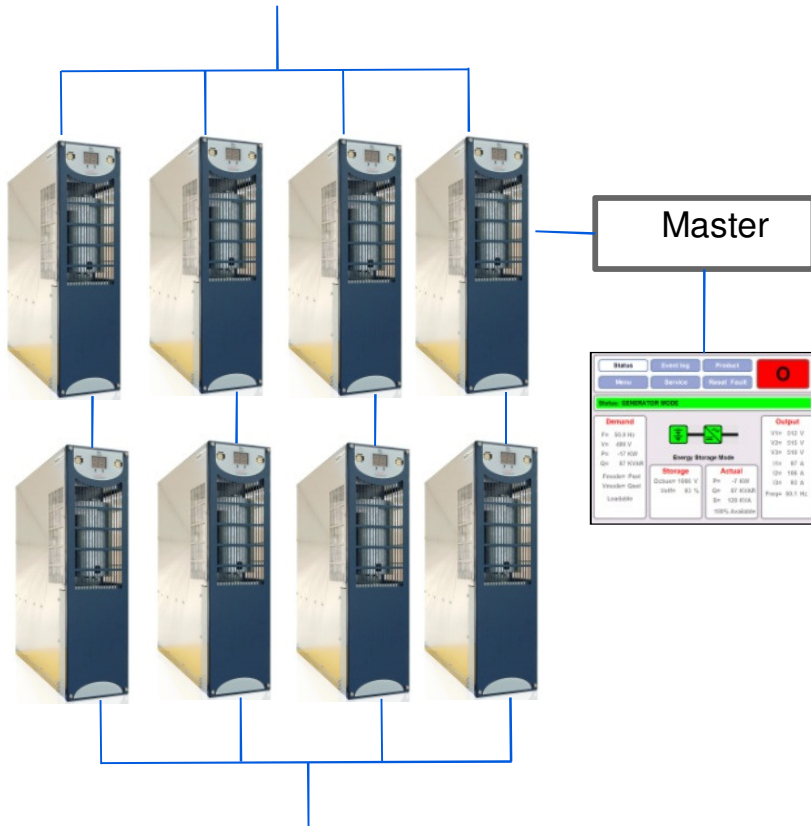
# Product Portfolio

## PCS100 Converter – one technology many products

	Product Groups			
	Power Protection	Frequency Conversion	STATCOM	Battery Energy Storage
<b>PCS100 Product Line</b>	<b>AVC &amp; UPS-I</b>	<b>SFC</b>	<b>STATCOM</b>	<b>ESS</b>
<b>Major Market Segments</b>	<ul style="list-style-type: none"> <li>▪ Flat panel, LCD and ship/memory</li> <li>▪ Datacenter</li> <li>▪ 24/7 industry</li> </ul>	<ul style="list-style-type: none"> <li>▪ Speciality boats</li> <li>▪ Dockside OPS</li> <li>▪ Industry</li> </ul>	<ul style="list-style-type: none"> <li>▪ Wind OEMs &amp; parks</li> <li>▪ Solar EPCs</li> <li>▪ Distribution grid</li> <li>▪ Industry</li> </ul>	<ul style="list-style-type: none"> <li>▪ Renewable energy back-up (wind/solar)</li> <li>▪ Utilities</li> <li>▪ Industry</li> </ul>
<b>Picture</b>				
<b>Load Power Range</b>	125kVA – 20 MVA	125kVA – 5MVA	100kVA – 10MVA	100kVA – 50 MVA
<b>Input voltage of power electronics</b>	208-480V (any LV or MV with standard transformer)	208-480 VAC (any LV or MV with standard transformer)	208-480 VAC (any LV or MV with standard transformer)	208-480 VAC (any LV or MV with standard transformer)
<b>Market Positioning</b>	+ AVC > 400 MVA installed base	+ SFC > 100 MVA installed base	+ 1 <sup>st</sup> order Dec. 2009 with Suzlon Wind Energy	Strategic Alliances with key battery suppliers.

# PCS100 Platform

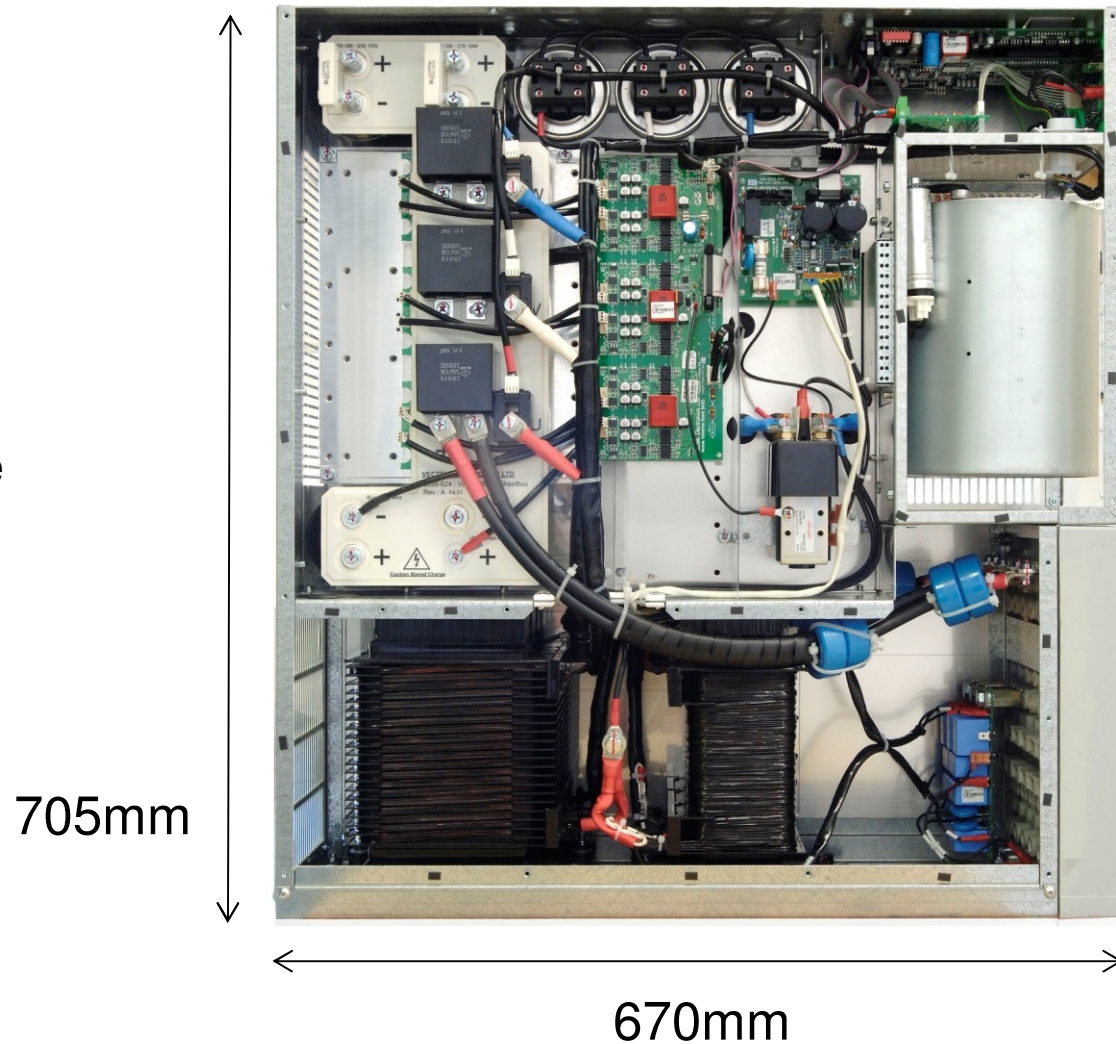
## The Concept



- The PCS100 converter platform is a modular structure
- Flexible sizing of converters by adding power modules
- Service is simple
- Highly reliable with redundancy

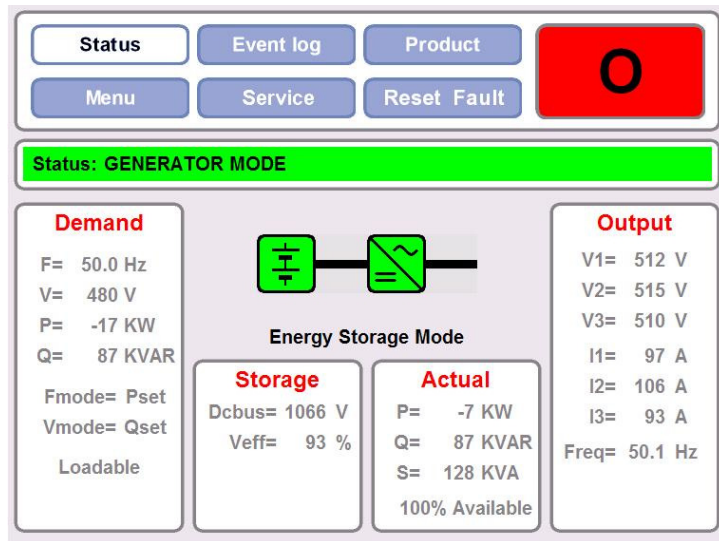
# PCS100 Power Converter Module Detail (Side panel removed)

- Ease of service, fan removable from the front
- Module weight 78.5kg
- Conformal coated PCBs used throughout the module
- Laminated low inductance DC bus



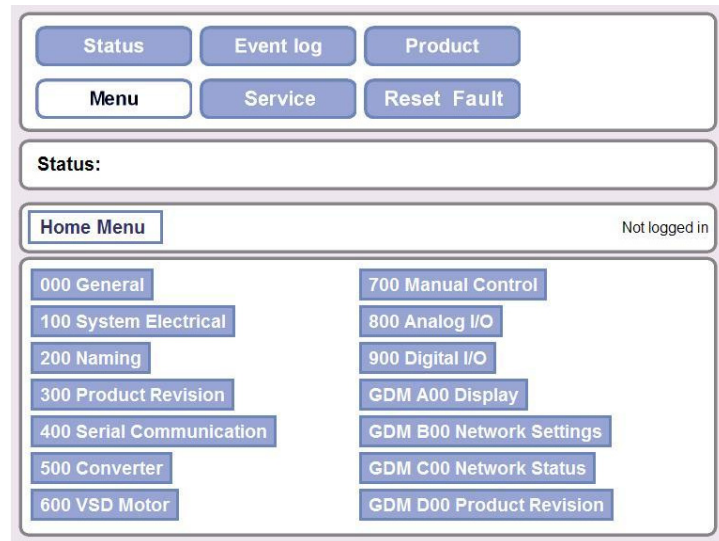
# PCS100 Platform

## User Interface



### Graphic Display Module

- Touch panel PC
- Easy access to information
- Visual representation of the system
- Event log, date and time stamped
- Fault log, date and time stamped
- User Identification and location data
- Ethernet Communications





# PCS100 Power Converter Systems



- Converter pairs (rectifier and inverter) housed in 800mm x 800mm cabinets
- Multiple cabinets used to construct system based on the power requirement
- Options for racks to integrate converters into container enclosures
- IP23 and IP42 cabinet options

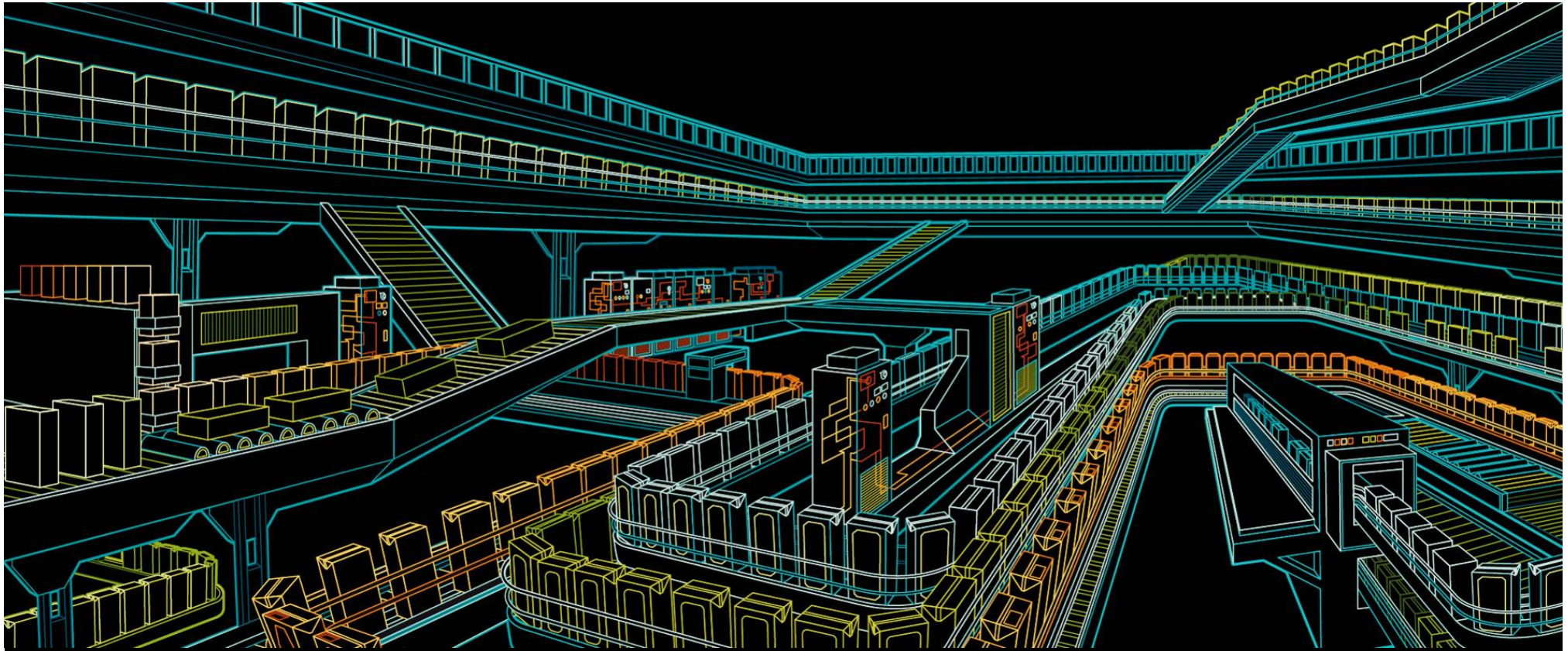




# Power Protection

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# Power Protection - PCS100 AVC

## Sags, surges and poor voltage protection

# PCS100 AVC – Active Voltage Conditioner

## Purpose

- Reduce the cost of sag events
  - Close the electrical compatibility gap between the supply and plant
  - Applicable to industrial loads using significant power
  - Targeted to voltage sag events – the major cause of lost production
- Improve plant operation and reduce waste and damage
  - Regulates the voltage removing long term under-voltage over-voltage and unbalance.
  - Removes voltage fluctuations which can cause process variation.
- Economic and secure
  - Low cost of ownership. High efficiency, small footprint, low capital cost.
  - Impossible to drop the load due to an internal malfunction
  - Very high availability
  - Simple servicing and low on-site product knowledge required.

# PCS100 AVC – Active Voltage Conditioner

## Overview



- Protects sensitive loads from the most common disturbances in utility supplies by correcting the damaged voltage wave form.
- Sags, surges, unbalance, flicker and poor regulation are corrected within a few milliseconds.
- Rated 160kVA - 30MVA.
- High power and performance inverter based system.
- Operating efficiency 98-99% (model dependent)



# PCS100 AVC – Active Voltage Conditioner

## Key advantages



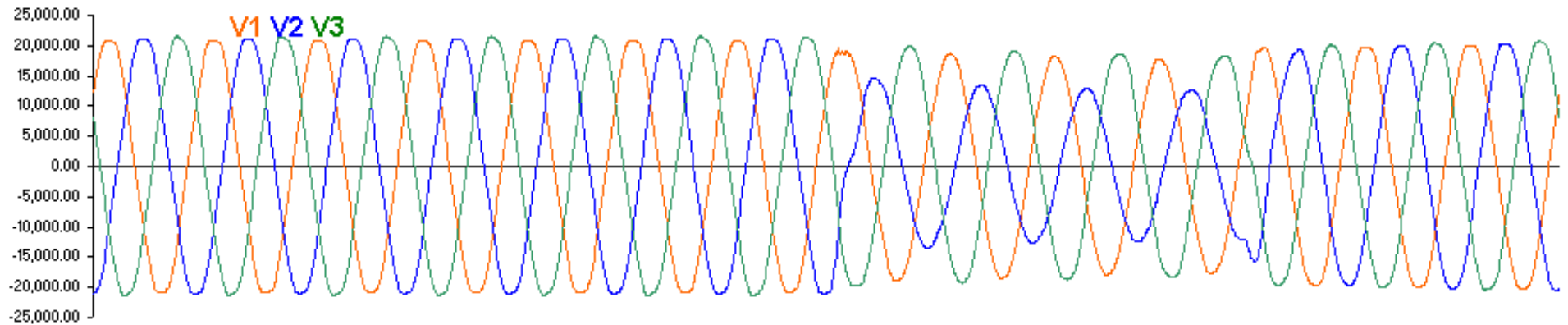
- 98-99% Efficiency
- Simple user controls
- Cannot drop the load
- Short circuit protected
- Extensive diagnostics
- Fault log
- Voltage event data logging
- Ethernet connectivity
- Modular construction and small footprint
- Very little maintenance
- No batteries



# Transmission sag correction

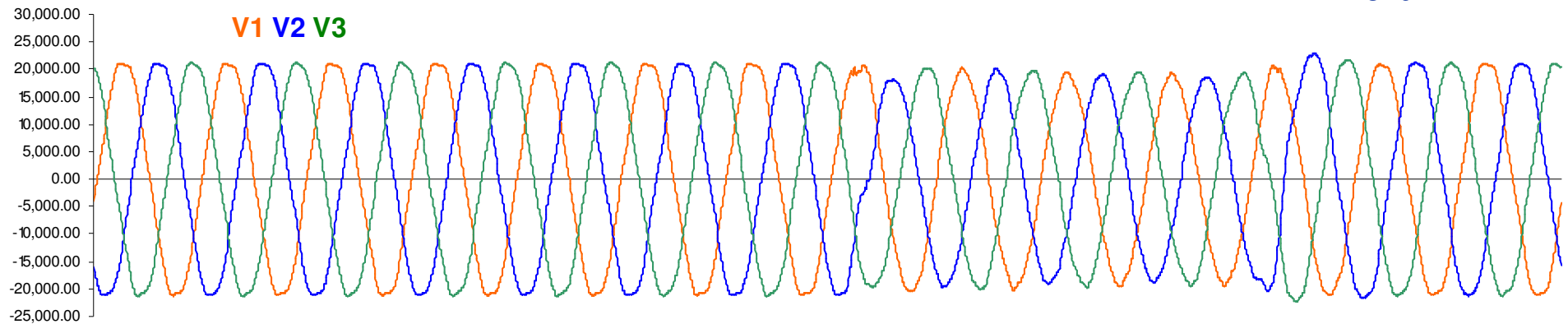
V1=82  
V2=58  
V3=87

Input



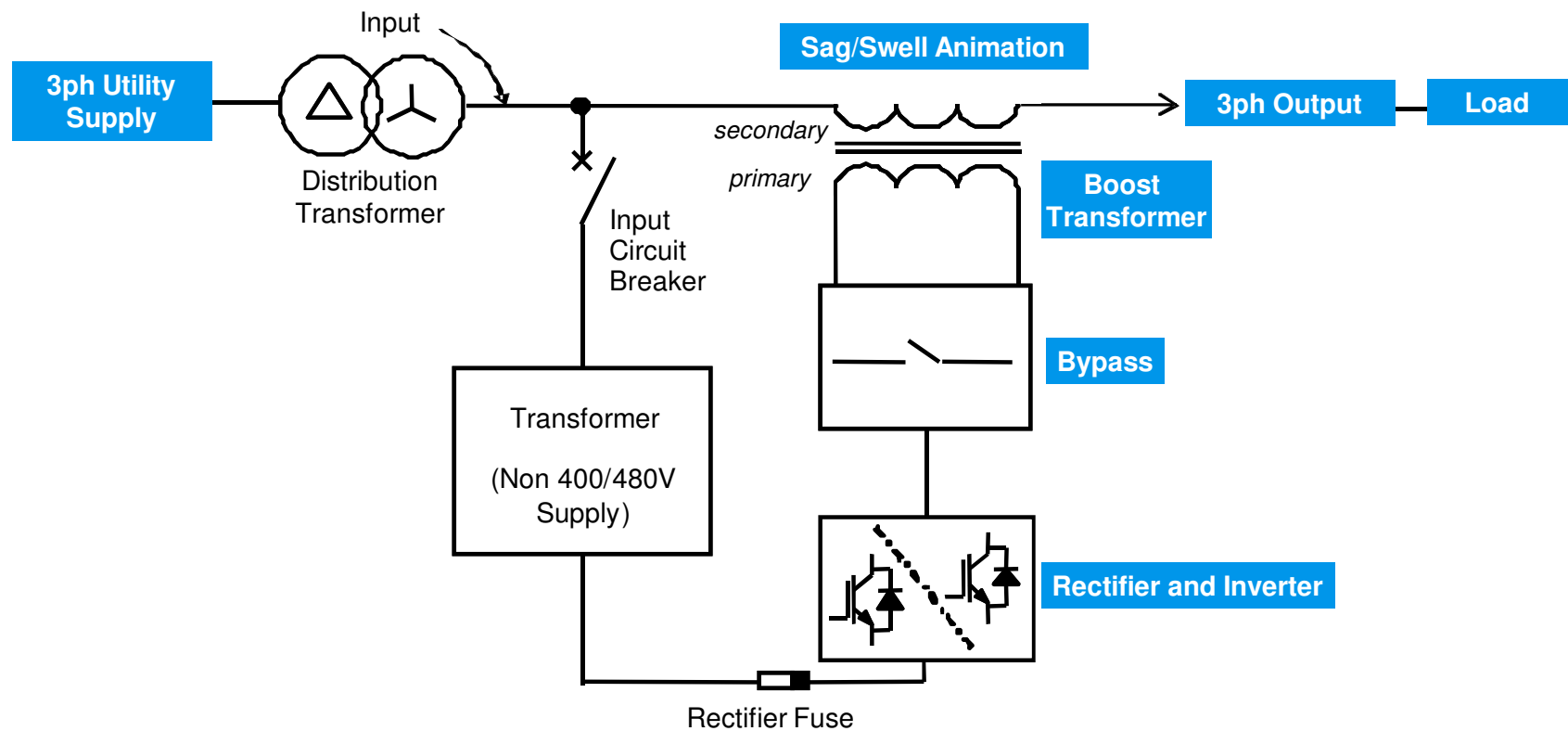
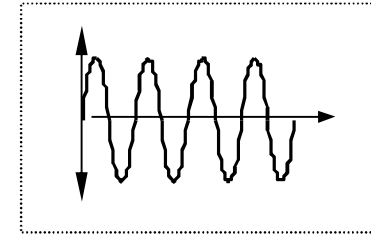
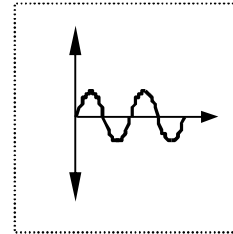
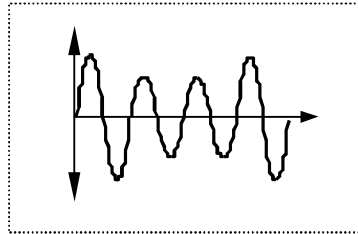
V1=97  
V2=98  
V3=97

Output of AVC



# PCS100 AVC – Active Voltage Conditioner

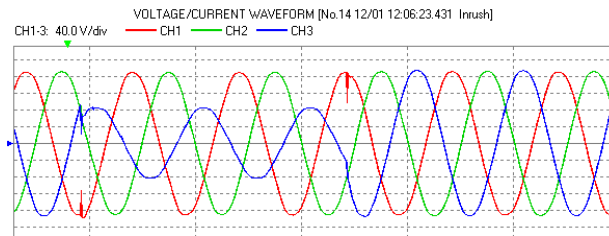
## Single Line Diagram



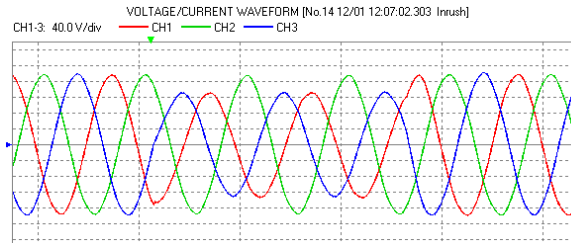
# PCS100 AVC - Active Voltage Conditioner

## 50 % retained voltage single phase sag

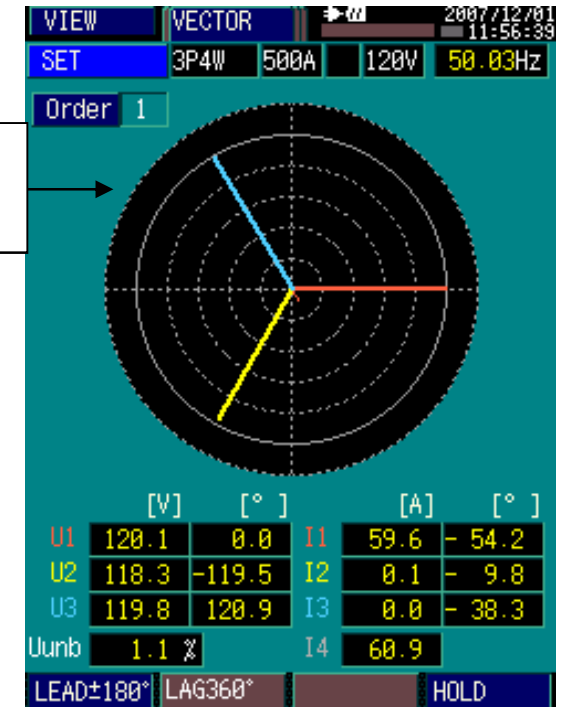
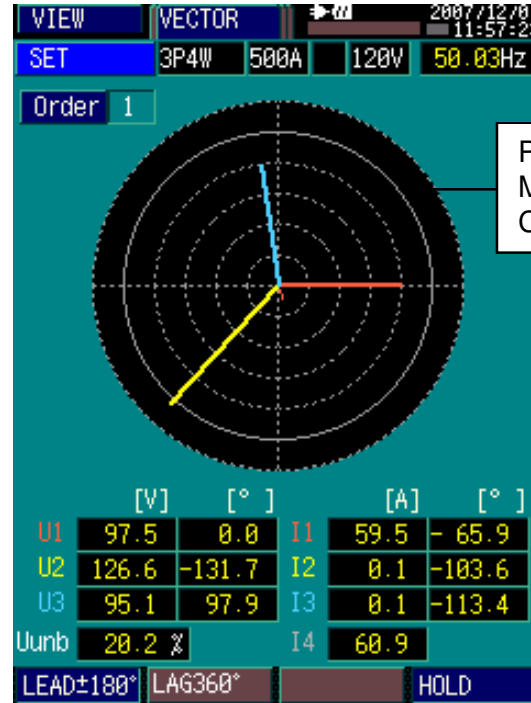
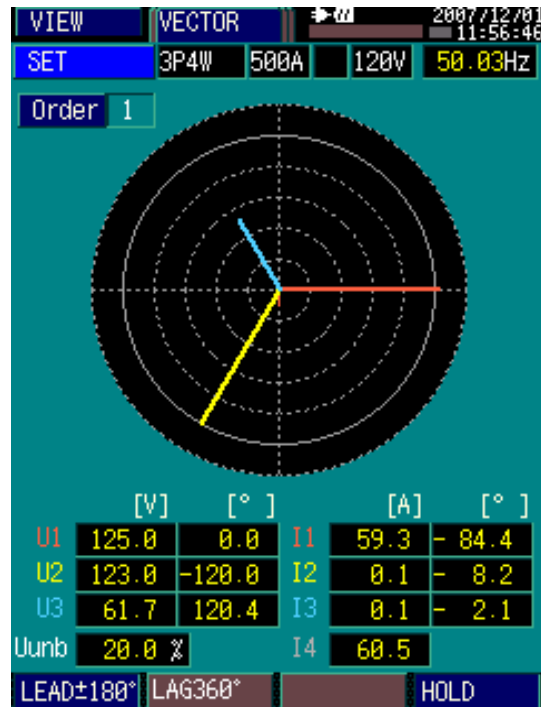
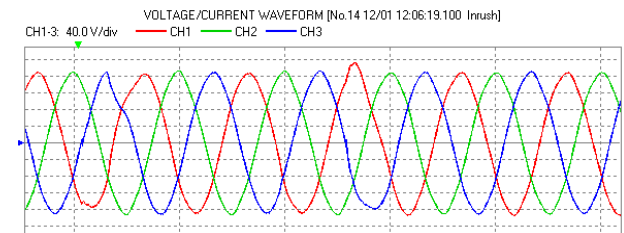
Transmission line sag



AVC Input



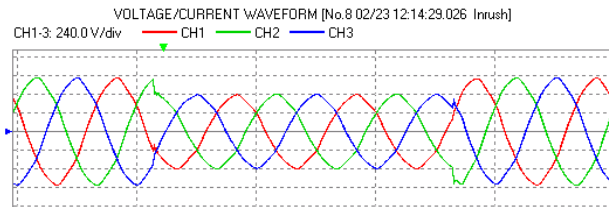
AVC Output



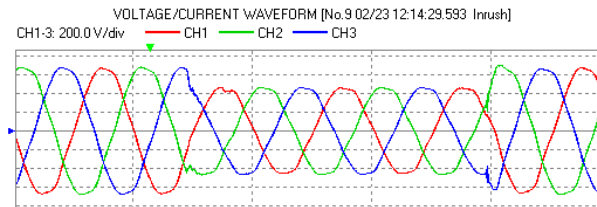
# PCS100 AVC - Active Voltage Conditioner

## 70 % retained voltage three phase sag

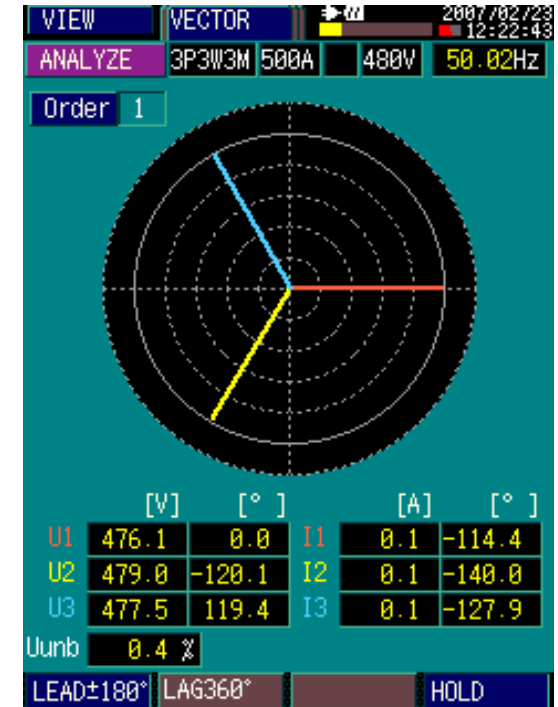
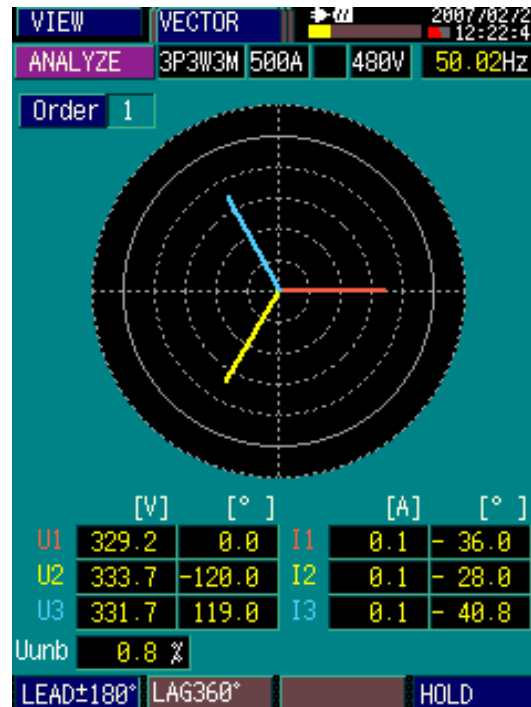
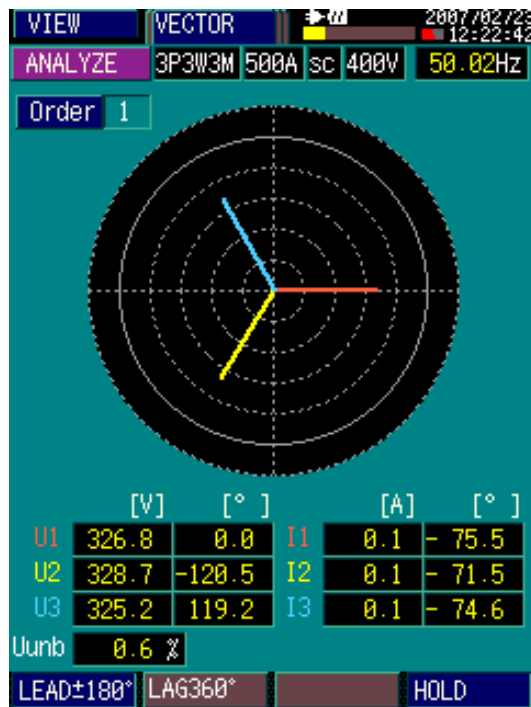
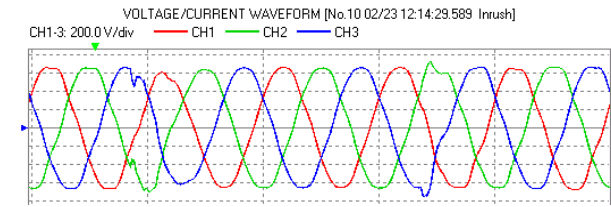
Transmission Line Sag



AVC Input



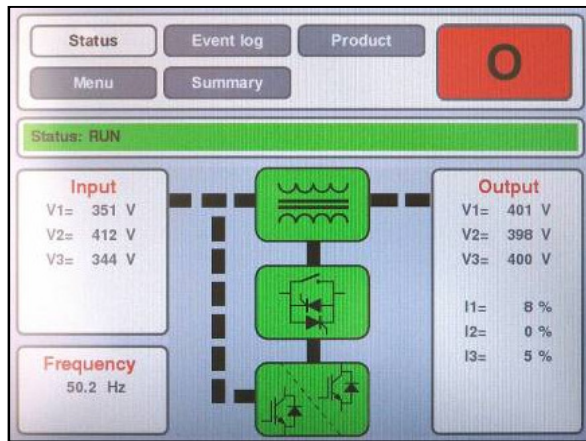
AVC Output



back

# PCS100 AVC – Active Voltage Conditioner

## Graphical user interface



PCS100 AVC Online

**The graphic display offers:**

- Easy access to information
- Visual representation of the system
- Event log, date and time stamped
- Fault log, date and time stamped
- Factory tags and location data
- Web browsing
- Serial communications

The PCS100 AVC Event log GUI displays a table of events with the following columns: Date, Time, Type, Origin, and Description. The table shows several sag and surge events with their respective durations and severity levels.

Date	Time	Type	Origin	Description
2007-08-24	14:42:58.66	Sag end		
Running	110 ms, 48%, 48%, 48%, 79%, 80%, 78%			
2007-08-24	14:42:58.56	Sag start		
Running				
2007-08-24	14:42:54.76	Sag end		
Running	110 ms, 68%, 68%, 68%, 99%, 100%, 100%			
2007-08-24	14:42:54.66	Sag start		
Running				
2007-08-24	14:42:48.08	Surge end		
Running	100 ms, 114%, 115%, 114%, 101%, 101%, 101%			

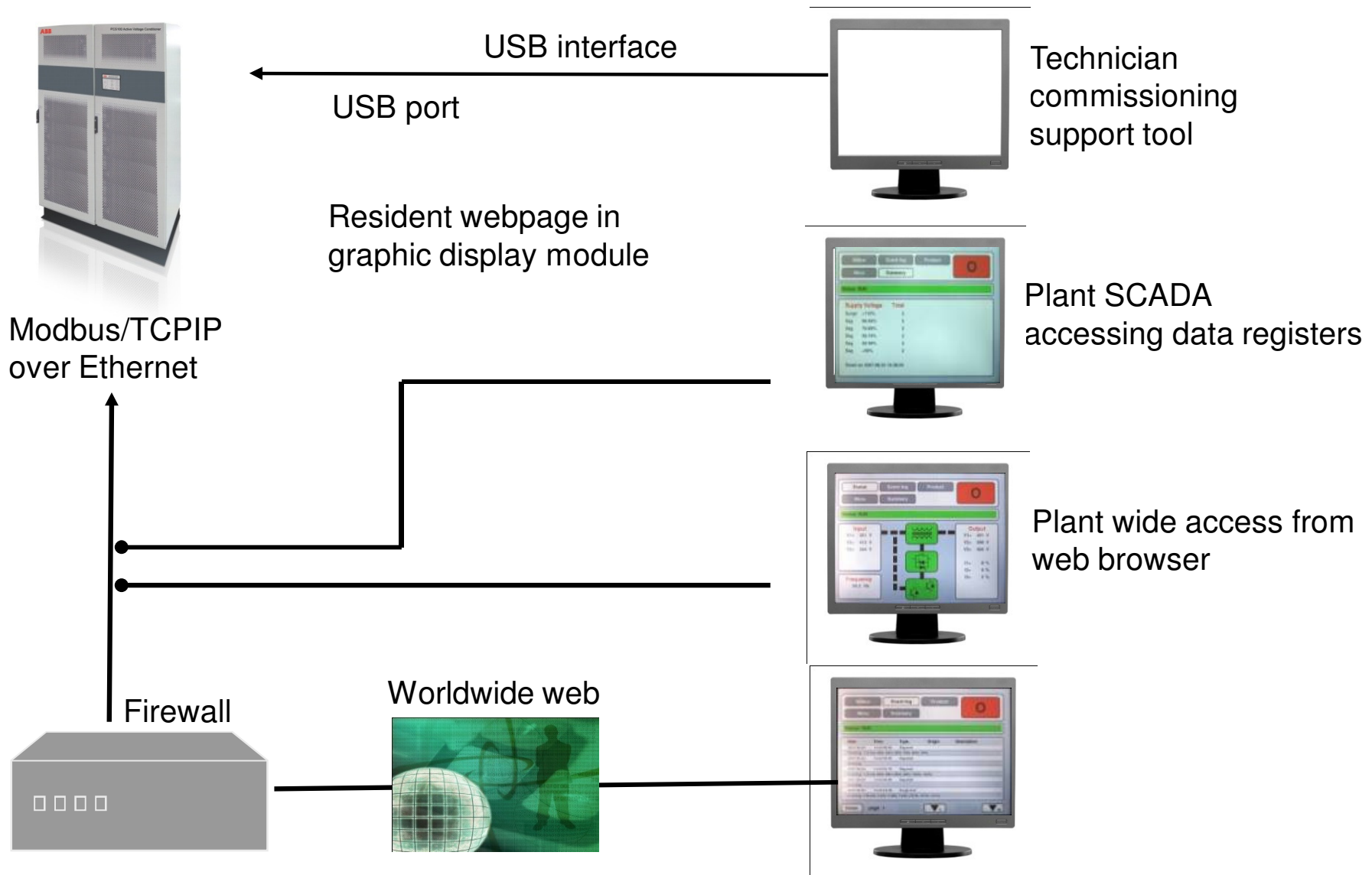
Navigation: Home, page 1, and a dropdown menu showing 1 and 10.

Event log



# PCS100 AVC – Active Voltage Conditioner

## Full web and plant system



# PCS100 AVC – Active Voltage Conditioner

## Reference clients (Electronics)



More than 400 MW of voltage conditioners supplied to semiconductor FABs in Asia and North America over the last three years



BP Solar



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# Power Protection - PCS100 UPS-I

## Sags & short term outage protection

# PCS100 UPS-I, Industrial UPS

## Prevent costly shutdowns



- Network voltage sags and surges along with short outages are common and often cause electronics to self protect by switching off
- When this occurs in a critical control operation it can cause a complete shutdown of a facility





# PCS100 UPS-I, Industrial UPS

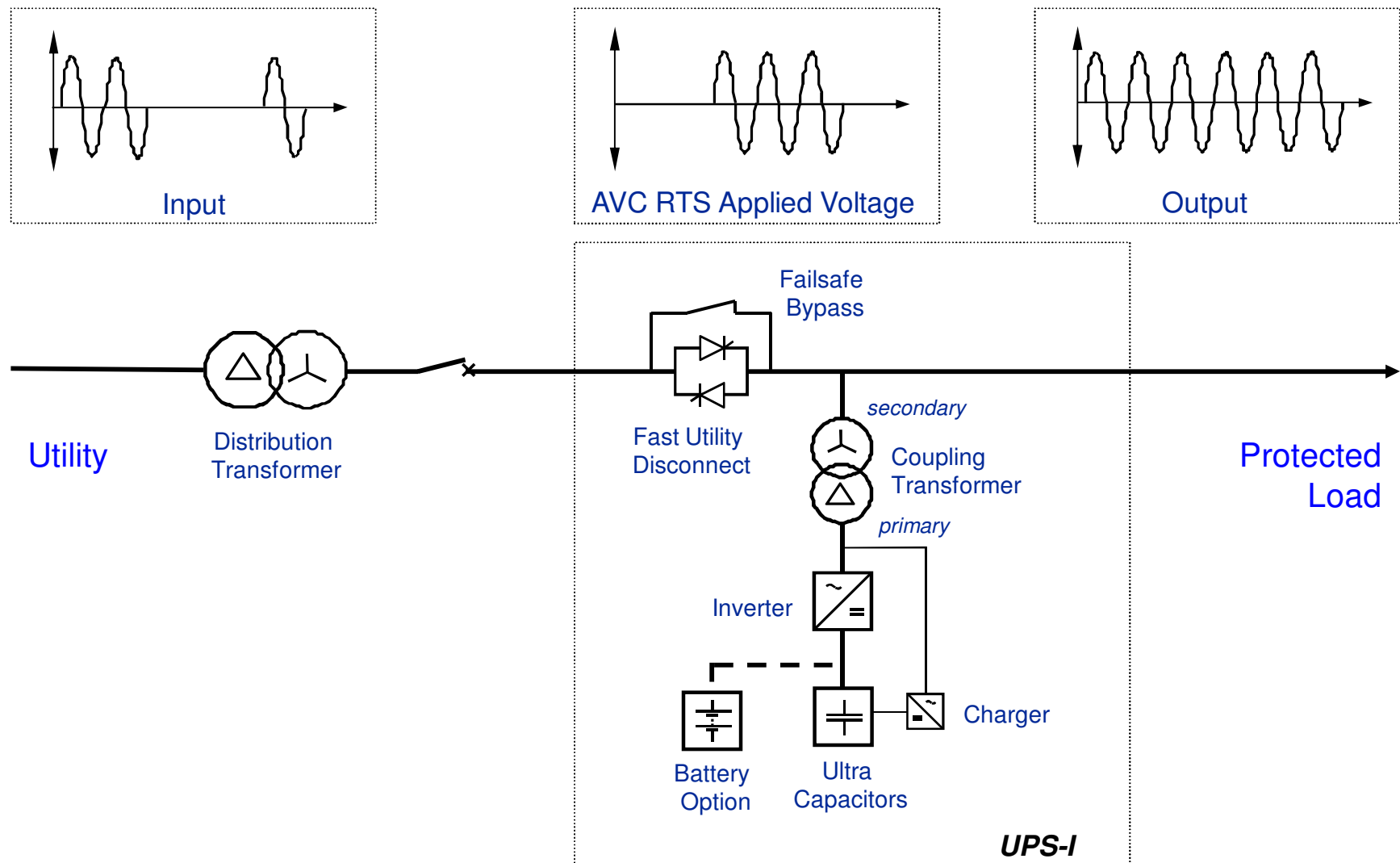
## Overview



- The PCS100 UPS-I is the ideal solution where very deep sags or short term power outages are a problem
- The PCS100 UPS-I uses energy storage coupled through an inverter to allow the downstream load to ride through very deep sags and short term outages
- The PCS100 UPS-I is an offline system. It is inactive unless the voltage falls by 10% - 13%. This enables it to be very efficient, up to 99%.

# PCS100 UPS-I, Industrial UPS

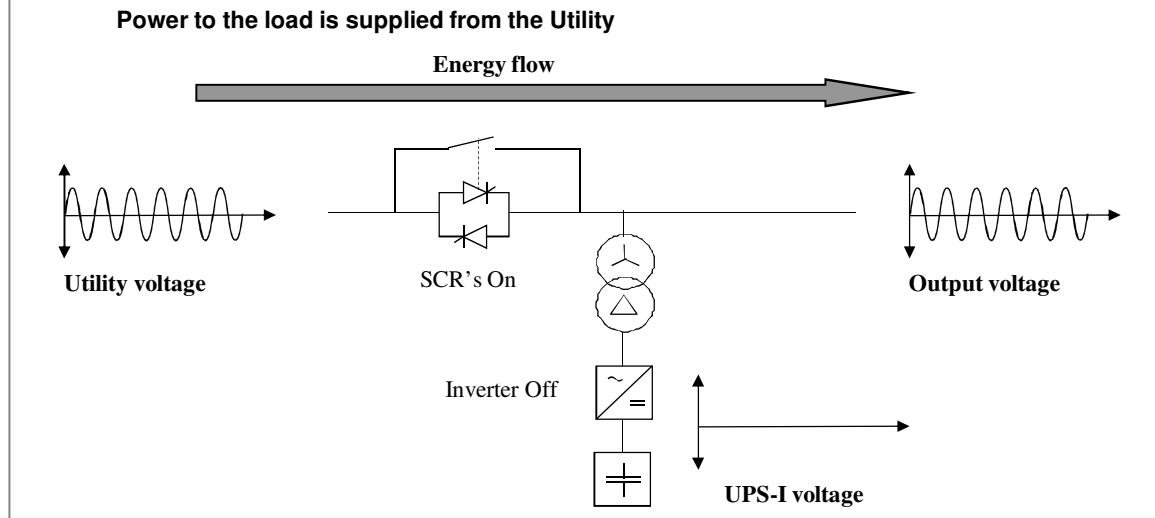
## Single line diagram



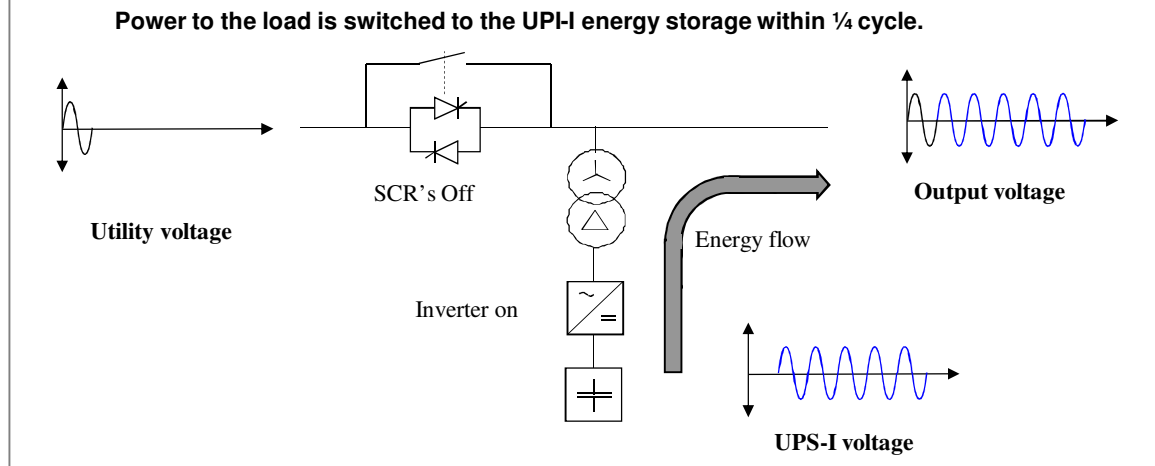
# PCS100 UPS-I, Industrial UPS

## Operation cycle

### 1. Utility voltage within limits



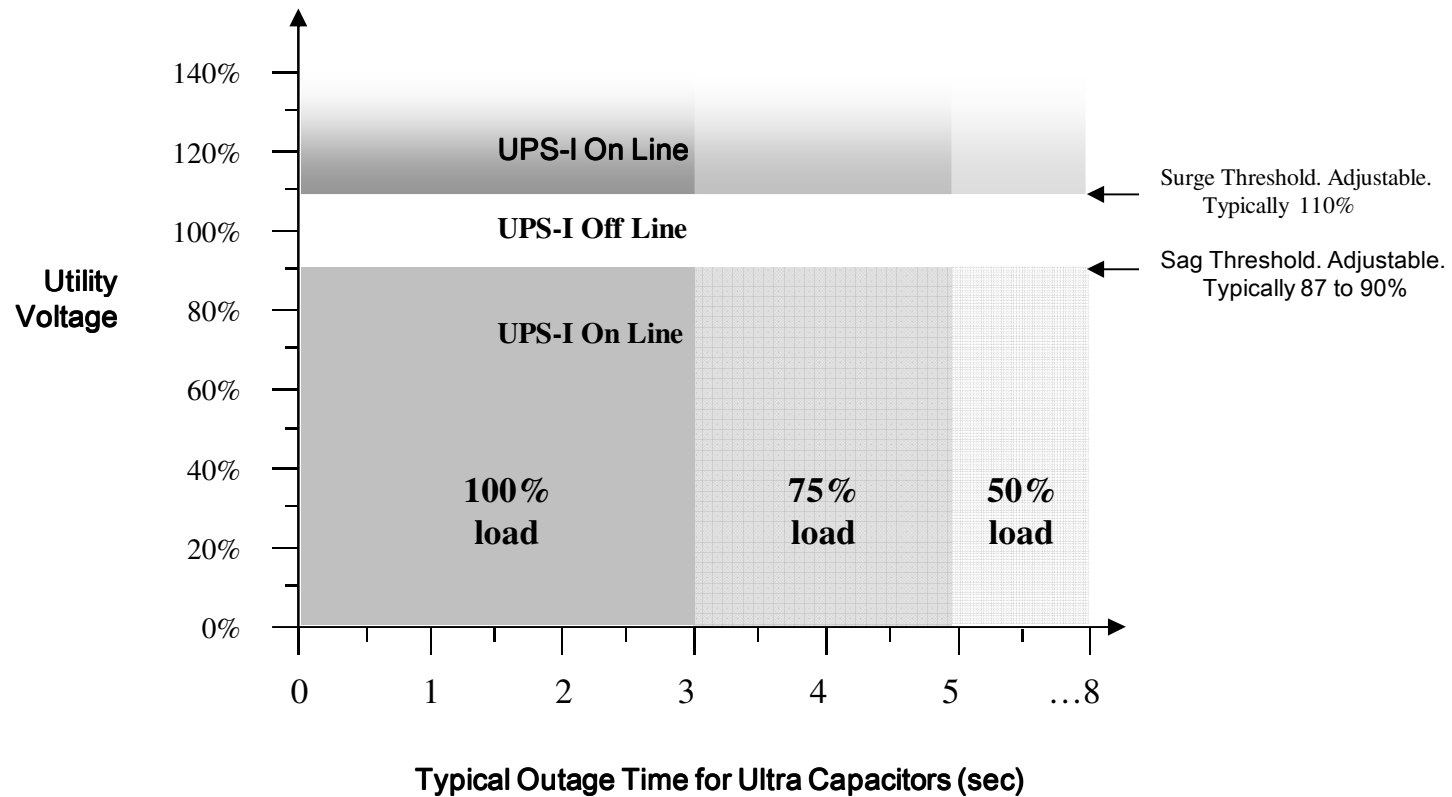
### 2. Utility Outage Occurs



### 3. Utility returns

# PCS100 UPS-I, Industrial UPS

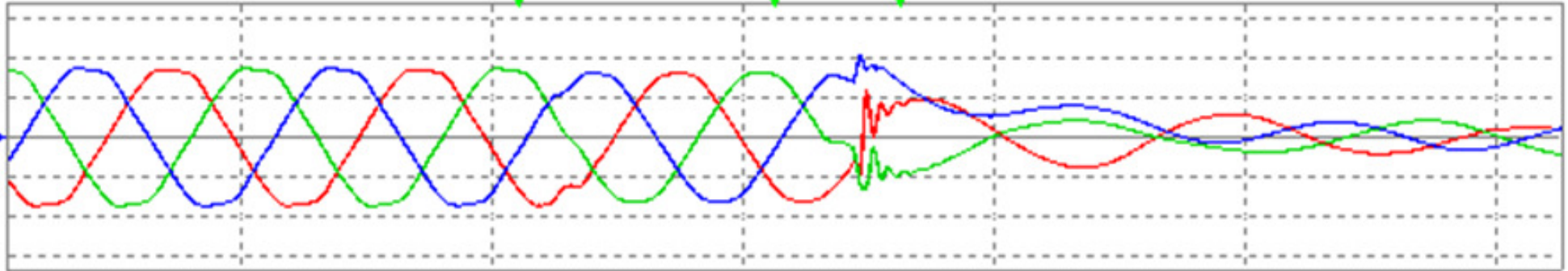
## Operating range



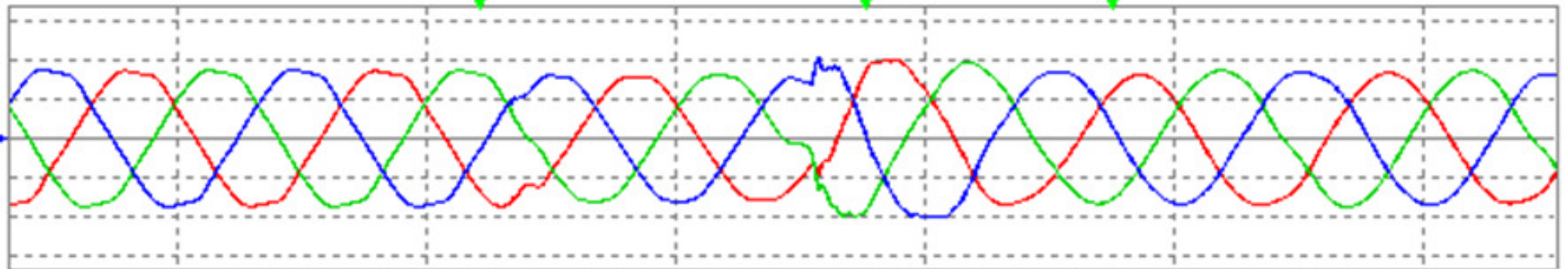
# PCS100 UPS-I, Industrial UPS

## Response to supply loss

PCS100 UPS-I Input



PCS100 UPS-I Output



- On detecting a disturbance the inverter takes over the load by actively commutating (turning off) the Utility Disconnect SCR switch
- Transfer takes place in less than 1/4 cycle



# PCS100 UPS-I, Industrial UPS

## Energy Storage – Ultra Capacitors



### Ultra Capacitors

- Protection for up to 3 seconds
- Ultra capacitors by LS Mtron, Korea
- Design Life: 15 years
- Cycle life: >500,000
- 2 x 24 pieces of 32V blocks (double string)
- +/- 375Vdc, 500kW, 1080A DC per cabinet
- Safe and compact matching cabinet
- A no battery solution

### User Benefits

- Reduced maintenance
- Smaller footprint

# PCS100 UPS-I, Industrial UPS

## Energy Storage - Batteries



### Spiral Lead Acid Battery

- Protection for up to 30 seconds
- Design Life: 10 years
- Cycle life: >1200
- 56 of 12V cells
- +/- 375Vdc, 250kW, 540A<sub>dc</sub> per cabinet
- Super high discharge rate
- Easy service
- Easy to obtain spares
- Sealed - low maintenance
- Very low cell resistance by spiral geometry
- Small foot print

# PCS100 UPS-I, Industrial UPS

## Utility disconnect SCR stack

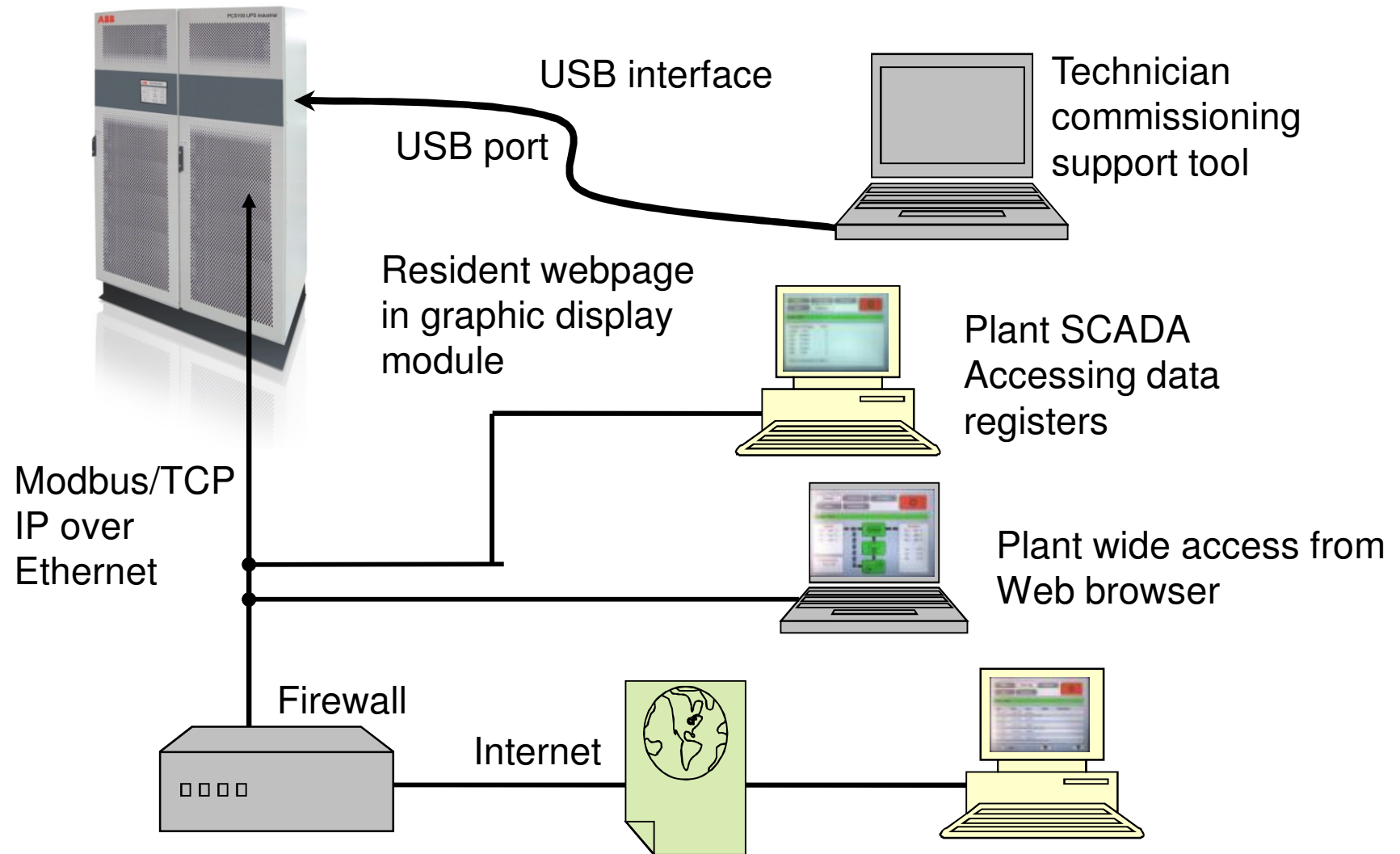


4000A Disconnect Switch

- For a device to provide outage protection it must be able to disconnect the utility supply to prevent back feed into the utility
- The Utility Disconnect consists of a naturally commutated SCR based electronic switch (augmented with ABB's revolutionary inverter commutation capability)
- The Utility Disconnect is designed for industrial installations with regard to overload ratings and operation in harsh electrical environments

# PCS100 UPS-I, Industrial UPS

## Full web and plant system



# PCS100 UPS-I, Industrial UPS

## Payback

Due to its superior efficiency, any extra money required to pay for the PCS100 UPS-I over a conventional UPS can be recovered in the order of months

### Example

▪ PCS100 UPS-I size	1200kVA
▪ PCS100 UPS-I efficiency	99%
▪ Conventional UPS efficiency	93%
▪ Average load	1000kVA
▪ Price / kWhr	10 USc
<b>Savings / month</b>	<b>US\$ 4320.00</b>

This does not take into account the reduced load on any air-conditioning



# PCS100 UPS-I & AVC Documents

[inside.abb.com / power electronics / power quality](http://inside.abb.com/power-electronics/power-quality)



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[Offerings A-Z](#) [Sales support A-Z](#) **[Products](#)** [Industries and utilities](#) [Service Guide](#) [Business Units](#)

[Product Guide](#) > [Power Electronics](#) > [Power Quality](#)

## Power Quality

With the increasing complexity of the electrical grid transmission system operator TSO, distribution system operator DSO and end users realized how sensitive the grid is regarding fluctuations and disturbances. Due to the availability of rapid, efficient and compact power electronic devices ABB has developed new products, which help to improve the quality of the Power Grid. With these new products a better power flow is achieved and the reliability of electrical transmission grid is guaranteed. Finally this directly affects the profitability of network operators and industrial end user.

ABB has developed successfully for the end user as well as for the TSO or DSO power quality equipment to improve the reliability of the electrical grid.



### Our offering

#### → Uninterruptable Power Supplies

Protects from short power outages

#### → Voltage Conditioners

Protects sensitive loads from disturbances

#### → VAr Compensation

Power Frequency Converters for reactive power compensation

Power and productivity  
for a better world™

