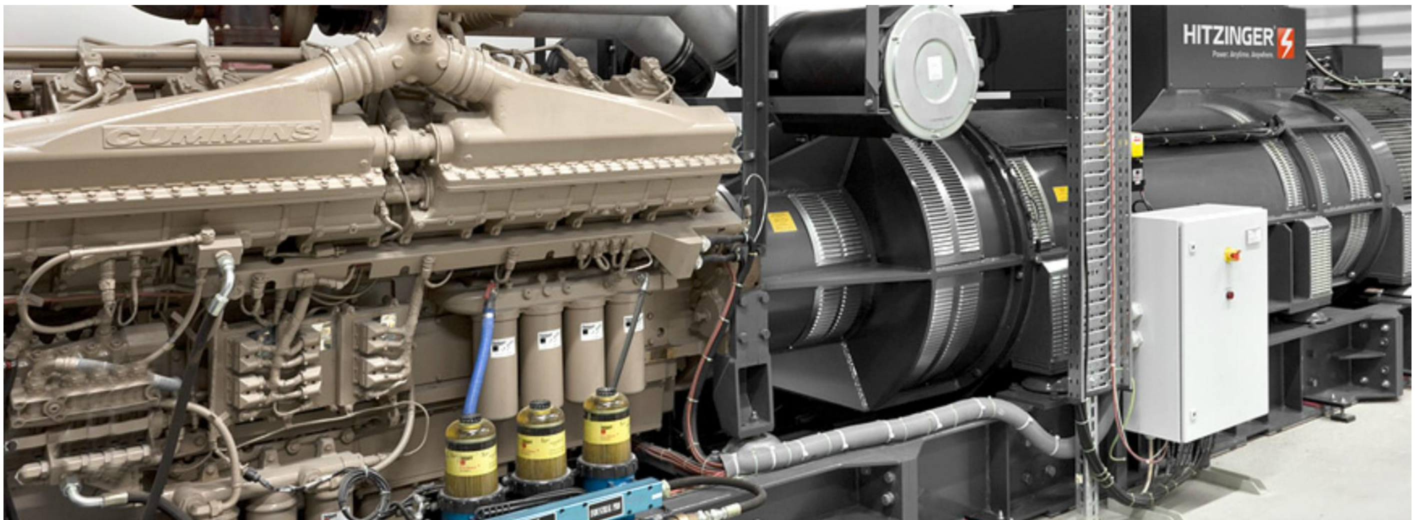
HITZINGER®
A Member of Dr. Aichhorn Group

Typical Power Quality Issues Affecting Business Continuity



White Paper Summary

As our society becomes ever more reliant on its digital backbone, the importance of reliable, high-quality electrical power continues to grow with commercial power enabling today's modern world to function at its busy pace. Our digital society means business activities have become ever more increasingly sensitive to disturbances in the power supply. Today, the quality of power feeding our consumer, is as important as protecting against total outage. This paper address's the various power quality issues and further examines how we can protect against them, to ensure business continuity.

Whitepaper HitzWP002
Date June 16th 2016

Author Ben Jones, CEO and President at Hitzinger USA, LLC.

Introduction

Power quality determines the equipment's ability to function properly; with a poor quality supply leading to equipment malfunction, premature failure or the complete inability to operate. In the United States, the SAIFI (System Average Interruption Frequency Index) can be used to determine the reliability of the utility against power loss. The index shows the average outages that a customer might experience divided by the number of customers the utility serves (In its most simply form) as;

$$\text{SAIFI} = \frac{\text{Total Interruptions to Customer}}{\text{Total number of Customers}}$$

The index is used to measure zero voltage provided to the customer for more than 5-minutes, many people therefore might argue about its validity given that most power interruptions at zero volts for longer than 20miliseconds may cause failure of equipment.

With that said, the average customer could expect one to five prolonged outages per year caused by utility failure, but this doesn't take into account issues arising from the quality of the power itself. Power quality issues including rolling brownouts, voltages sags and spikes, electrical noise and harmonic distortion should be given due consideration as these on-going mains distribution issues will affect the supply regardless of power loss. An independent survey conducted by the Electric Power Research Institute, found that disturbances lasting for less than 2-seconds account for 84% of failures and disturbances less than 10 seconds are 98.7%, this means that only a small percentage are sustained outages. Protecting against power loss and power quality are equally important and customers should familiarize themselves with the possible issues affecting their supply and how to protect against them.

Recent studies in the US have found power interruptions have an annual estimated economic loss of between US$104 billion and US$164 billion, with the industrial and digital businesses contributing to $45 billion annually. With another $15 billion to $24 billion attributed to momentary interruptions caused by voltage fluctuations, power surges and spikes.

A report by the Galvin Electricity Initiative found that on average, financial trading centers are the most susceptible to longer term loss of power with estimated losses of $6million per hour. The loss of power to computer centers, irrespective of momentary and sustained losses, equals a massive $750,000 per event.

It's important that users of sensitive power equipment know that power quality issues can cause equipment and machinery to become damaged or fail altogether, when subjected to these power anomalies. With possible outages affecting business continuity, it's not surprising that UPS systems are used as both a filter from mains disturbances and designed to provide power during total outages.

When we consider that power quality is equally as important as power availability, we should also look to address what typical power quality problems are present and what causes them to exist in the utility network.

Typical Power Quality Problems

This section looks to briefly describe the typical power disturbances affecting your consumer. It's important to note that the steady state voltage range for sensitive power equipment is typically +/- 10% from the nominal, this range refers to the equipment's ability to operate within preferred limits for an indefinite period. This tolerance is typical and subject to normal loadings and losses in the distribution system. In addition, most sensitive power equipment would have a +/1% frequency deviation from the standard 60Hz, with less critical equipment capable of tolerating +/-5% frequency deviation.

Voltage Surge/ Spikes – A 'spike' is a quick electrical transient lasting for a short duration. Voltage spikes are increases >120% above nominal and can cause the IT equipment to fail if lasting over 300ms. When voltage is above nominal lasting longer than a few seconds, this is referred to as a voltage surge, rather than a spike. Typical an increase in voltage is caused when larger loads are turned off causing the computer systems and other similar high tech equipment to experience errors, memory loss or complete shut-down.

High Voltage Spikes – High voltage spikes usually occur due to nearby lightning strikes, this can cause a sudden voltage peak up to 6,000volts. High voltage spikes can have severe impact on the consumer equipment, including errors, memory loss and shut-down. Instances of burned circuit boards and complete product failure have occurred.

Voltage Sags - There are two different types of voltage sag; generally, these transients are a result of heavy loads being introduced to the system, as well as fault conditions on the AC distribution system. For voltages sags up to 80% of nominal, the sag has a typical duration of up to 10-seconds, however, sags up to 70% of nominal typically lasts up to 500ms and are also referred to as 'brownouts'. A dropout is a term that refers to both severe voltage sags and complete interruptions of the applied voltage, which is followed by immediate re-application of the nominal voltage.

A dropout may typically last up to 20 milliseconds and results from the occurrence and subsequent clearing of faults in the AC distribution system.

Both sags and dropouts will not cause damage to IT equipment, but will cause an interruption in the normal operation of your consumer loads.

Frequency Variation – A frequency variation of +/-1% is typically the allowable tolerance for data processing equipment. The mains voltage of 60Hz in the United States may vary due to erratic operation of emergency generators or unstable frequency power sources, in any case, frequency variations can cause sensitive equipment to have undesirable results from data loss to equipment failure. It should be noted that some sensitive equipment and most non-sensitive equipment can tolerate +/-5% in frequency variation. One of the roles of a UPS, is to make sure that the mains frequency is within tolerance, a static UPS provides an artificial waveform on the output of the inverter to ensure this, where as a Rotary Diesel UPS will simply monitor the mains and take over the load in-case of frequency variation.

Low-Frequency Decaying Ringwave - The introduction of power factor correction capacitors can cause a decaying ringwave transient that may range between 200Hz to 5 KHz, depending upon the resonant frequency of the AC distribution system. The magnitude of the transient is expressed as a percentage of the peak 60Hz nominal voltage (not the RMS value). The transient is assumed to be completely decayed by the end of the half-cycle in which it occurs and is thought to occur near the peak of the nominal voltage waveform.

High-Frequency Impulse and Ringwaves are transients which typically occur as a result of lightning strikes. Wave shapes applicable to this transient and general test conditions are described in ANSI/IEEE C62.41-1991.

Total Power Loss/ Blackouts - A power failure or blackout is a zero-voltage condition that lasts for more than two cycles. It may be caused by tripping a circuit breaker, power distribution failure or utility power failure. A blackout in a datacenter, without a UPS protecting the consumer, can cause data loss or corruption and equipment damage.

Case Study – Hitzinger's Rotary Power Conditioner

The Hitzinger Rotary Power Conditioner, named HPCON, is designed to provide a continuous high-quality consumer supply and prevent downtimes in critical processes due to power quality issues. The Power Conditioner System guarantees extremely low tolerances in both voltage waveform and value in the event of mains disturbances.

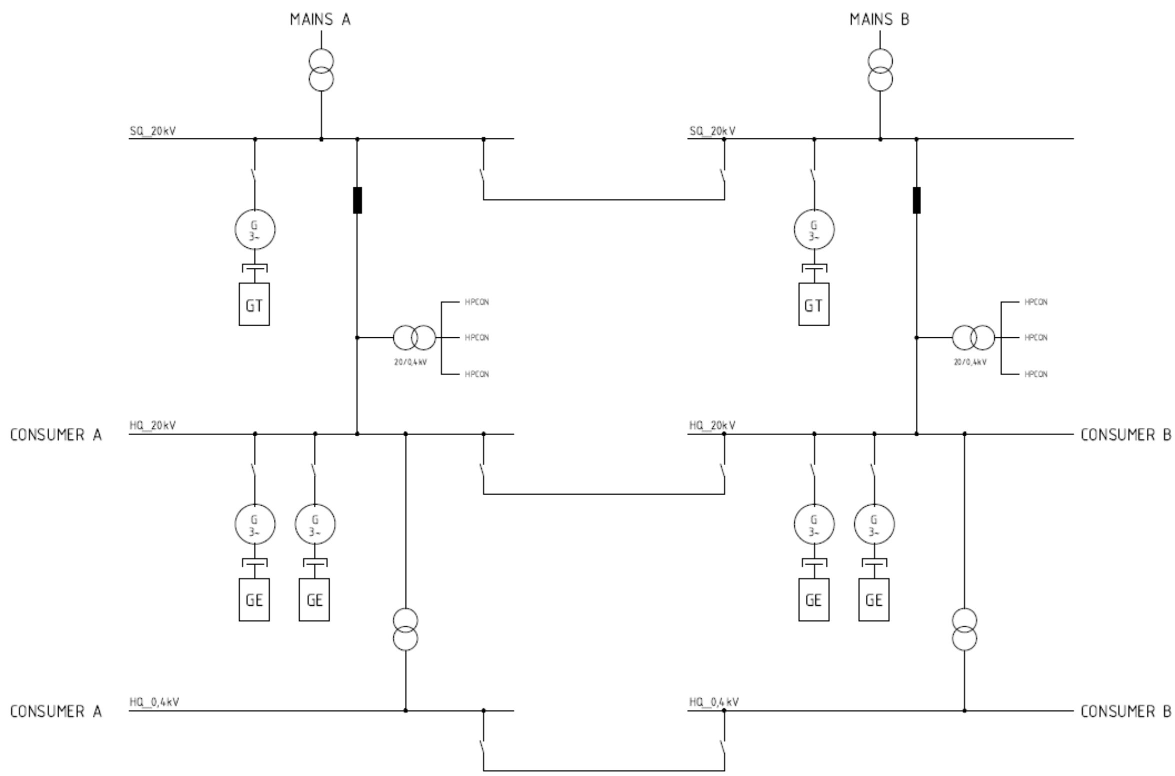
Hitzinger provided 6no HPCON Rotary Power Conditioners to a facility in Italy for the purpose of protecting a gas cogeneration plant from the poor 130kV utility supply. The 6no 1750kVA/1400kW power conditioners providing 480V output into a step-up transformer, are downstream from the Gas Engines/ Turbines and provide stabilization in-case of load steps and load shedding, in-which the response could be between 5-10seconds. During these load changes, the HPCON provides the necessary active and reactive power to the consumer until the Gas Engine/ Turbine is available to resume the load within tolerance.

The system was designed together with the client to ensure that the standard quality (SQ) loads and High Quality (HQ) loads were independently protected against the 130kV supply, which constantly suffers from momentary power loss. The solution was to use a Gas Turbine on the SQ bus bar and Gas Engines on the HQ bus bar, as shown on the single line diagram below;

HITZINGER USA, LLC.
11764 Marco Beach Drive, Suite 4-6 | Jacksonville | Florida 32224
Tel. (904) 330-0267| Cell. (904) 518-9635 | benjones@hitzinger.us | www.hitzinger.us

Affiliation Companies:
HITZINGER GMBH (Head office) | Helmholtzstraße 56 | 4021 Linz | ÖSTERREICH | Postfach 5000
HITZINGER (UK) Ltd. | 50 Churchill Square | Kings Hill | West Malling | Kent | ME19 4YU
HITZINGER Singapore Pte Ltd | 3 Loyang Way 4 | 506956 Singapore

Figure 1 – Single Diagram for Italian Gas Cogeneration plant



This design ensured that the clients load was completely protected against the 130kV supply as requested. The special design of the choke also provides a high degree of decoupling between the mains input and output in case of a mains power failure, in addition, the Rotary Power Conditioner can supply a short term bridge of power to stabilize the voltage in-case of momentary power loss.

HITZINGER USA, LLC.
11764 Marco Beach Drive, Suite 4-6 | Jacksonville | Florida 32224
Tel. (904) 330-0267| Cell. (904) 518-9635 | benjones@hitzinger.us | www.hitzinger.us

Affiliation Companies:
HITZINGER GMBH (Head office) | Helmholtzstraße 56 | 4021 Linz | ÖSTERREICH | Postfach 5000
HITZINGER (UK) Ltd. | 50 Churchill Square | Kings Hill | West Malling | Kent | ME19 4YU
HITZINGER Singapore Pte Ltd | 3 Loyang Way 4 | 506956 Singapore

Conclusion

As our economy becomes increasing reliant on sophisticated IT networks, it is more apparent than ever that the need for high quality power has grown accordingly. Each of these power quality problems has a different cause. Some problems are a result of the shared infrastructure. For example, a fault on the network may cause a dip that will affect local customers; the higher the level of the fault, the greater the number affected.

Alternatively, a problem on one customer's site may cause a transient that affects all other customers on the same subsystem. Problems such as harmonics, arise within the customer's own installation and may propagate onto the network and affect other customers.

All of the transients defined in this whitepaper can be easily dealt with by a combination of good design practice and a reliable UPS. In particular, both a Diesel Rotary UPS and Rotary Power conditioner, will protect your consumer and reduce real estate and carbon footprints compared to other UPS solutions.

With reduced cooling demands and flexible ambient variances, Rotary solutions are the preferred choice for protecting consumer loads. While Rotary solutions generally have higher initial investment costs, depending on the system load and topology, the longer lifespan of the equipment will result in a long-term cost reduction in TCO.

About the Author

Ben Jones is the CEO and President of Hitzinger USA. He graduated from London Southbank with a Bachelor of Science with Honors and a holds a Master's Degree from Greenwich University. He has worked with Hitzinger since 2005 where his tenure began in the UK, and has extensive experience with design and installation of turnkey power solutions.

Other Whitepapers are available upon request, please email benjones@hitzinger.us and receive a full list of whitepapers currently available.

Hitzinger USA LLC.

11764 Marco Beach Drive, Suite 4-6
Jacksonville, Florida 32224

Tel: (904) 518-9635