

Power Quality Testing

Megger
Power on





INTRODUCTION TO POWER QUALITY

Both natural and manmade drivers are spurring not only technological growth but are changing the nature of the electric grid. Concerns over global warming are only being compounded by the continuing billion dollar weather events. This is acting as a catalyst for the green reform and being realized in the growth of distributed generation (DG).

Globally, the growth of renewable energy sources is rising. We see more photovoltaic (PV) generation as well as more wind power generation. As these changes are implemented to improve reliability, they create new power quality issues.

As the grid modernizes, we see the emergence of new power quality problems. We see renewable sources as well as high efficiency electronics and new lighting technologies creating power quality phenomena such as rapid voltage change (RVC), unbalance, high frequency harmonics, frequency shifting between phases, and source reversals. These issues can lead to transformers and motors heating up, equipment tripping out, lights of all types flickering, high neutral current and much more.

As the smart grid grows, we see more communications over power lines (mains signaling) to help maintain reliability during peak times. This requires high-end, smart and simple-to-use power quality analyzers such as the Megger MPQ Analyzers.

They have the power to measure all power quality problems from high-speed transients to RVC, high frequency harmonics as well as mains signaling and much more.

Megger power quality analyzers are smart enough to recognize the CT connected as well as the CT range and let you know they are connected properly.

The on-board data analysis on the large color display makes analysis simple and easy for anyone to use.

Let the MPQ Analyzer be your expert.

MPQ2000

The MPQ2000 Megger Portable Power Quality Analyzer, with its latest software and enhanced capabilities, addresses the international IEC61000, IEEE1159, IEEE519 and EN50160 series of power quality and delivery standards used around the world. Powered off of either the phase A voltage input or an auxiliary input that operates off of 115 V 60 Hz or 230 V 50 Hz makes the unit highly versatile, allowing it to be used in any location. Additionally, the MPQ2000 measures ac and dc simultaneously up to 1000V.



- IEC61000-4-30 Class A compliance
- Powered off of phase A voltage ac/dc
- 1000 Vac and 1000 Vdc range
- Real time scope and DVM
- Connection verification
- On-board data analysis

The MPQ2000 is an easy-to-use advanced portable 3-phase power analyzer housed in a ruggedized weatherproof enclosure. It comes with a field-replaceable, rechargeable battery with backup/ride-through time up to 5 hours, making the MPQ2000 the ideal tool for outdoor use.

User Selectable Power Source:

Power off of Phase A, (AC or DC) power off of auxiliary power (115/230 AC 50/60Hz) or run off battery for up to 5 hours!

Indoor and Outdoor operation:

IP54 NEMA4 weatherproof enclosure is designed for outdoor operation. The unit is robust enough to remain recording outdoors.

Measures AC and DC Voltage:

up to 1000V (Measure Simultaneously)

4 Voltage Channels (3 Phase and Neutral) and **5 Current Channels** (3 Phase, Neutral and Ground Current) [All voltage channels are isolated]

Auto-identifying, 4 Range flexible current clamps, powered by the unit. No extra batteries needed.

Configuration Verification: Verifies the connection is correct prior to recording. (Supports 13 power configuration methods)

On Board Scope Mode: Includes Waveform Scope, Vector Scope and Harmonic Bar Chart Analysis with Harmonic Direction.

Records PQ parameters on BOTH Voltage and Current Channels: (Waveform captures for all events on all channels simultaneously): Sags / Dips, Swells, Sub-cycle Waveform Distortions, High Speed Transients (up to 1 μ sec), THD, Rapid Voltage Change (RVC), Mains Signaling Events and Voltage Phase Shifts.

APPLICATIONS

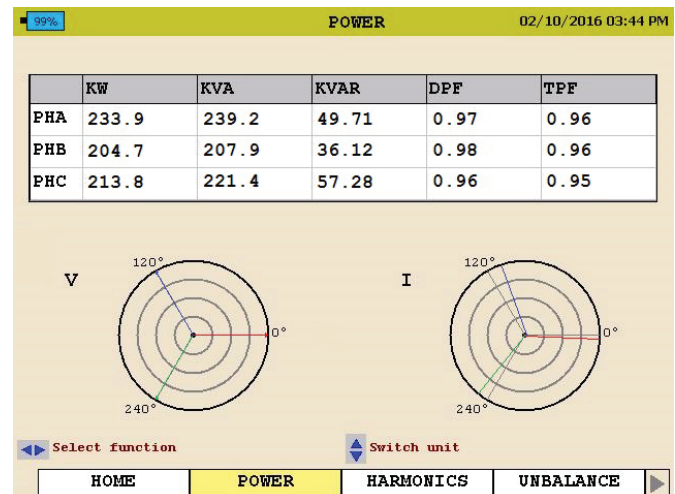
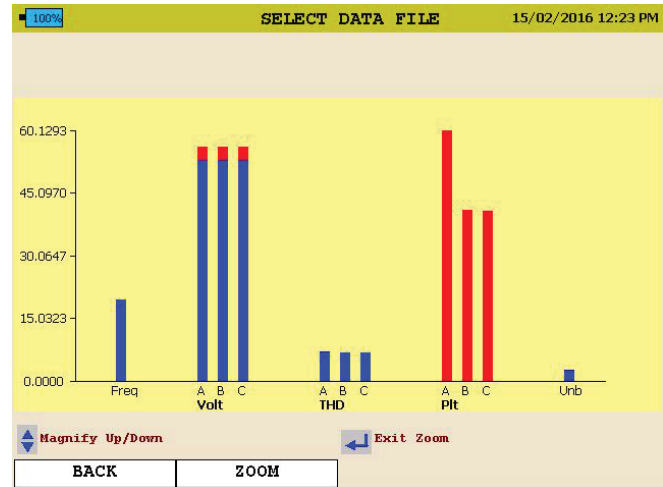
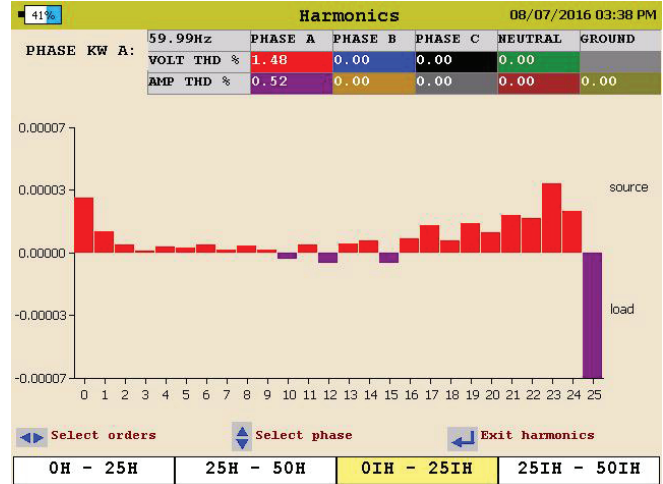
Using experience gained from supplying a multitude of analyzers to a large number of utilities, industries and service providers, Megger has designed the most versatile unit available today. Some of the applications include the following:

- Compliance testing to any PQ standard
- Power factor studies
- Load studies and load balancing
- Billing verification
- Substation monitoring
- Capacitor bank sizing
- Transformer analysis and de-rating
- Motor troubleshooting and inrush testing
- Switchgear and component failure
- Tripping breakers
- Equipment tripping offline
- Dimming/surging lighting
- Lamp flicker analysis
- Neutral overheating

Trends the following

parameters: RMS, KW, KVARs, KVA, Displacement Power Factor (DPF), True Power Factor (TPF), Unbalance, Frequency, THD, TDD, Harmonics, Inter-Harmonics, Flicker (PST), Flicker (PLT), Flicker Instantaneous.

Automatic Timed Waveform Capture User programmable to captures period waveform snap shots on ALL channels simultaneously. Waveforms are analyzed through the 128th harmonic order.



MPQ2000 FEATURE GUIDE

Power off Phase A voltage (90 - 600 V AC/DC)

Power from 115 - 240 V (50 Hz/60 Hz)

NEMA4 weather-resistant enclosure

-4°F to +122°F (-20°C to +50°C) temperature range

Differential inputs

4 voltage channels

5 Current channels

Fully Class A compliant (IEC61000-4-30 and IEEE1159)

0 to 1000 V ac/dc measurement range

RMS voltage and current

DC voltage and DC current (requires DC CT)

Power parameters (KW, KVAR, KVA, DPF, TPF)

Phase angles

Energy parameters (KWH, KVARH, KVAH)

Voltage dips (sags) and swells

Current dips (sags) and swells

Transient down to 1 msec

IEC unbalance (IEC61000-4-27)

ANSI unbalance

Total harmonic distortion (THD)

Total demand distortion (TDD)

Harmonics

Inter-harmonics

Harmonic direction

Main signaling recording

IEC flicker (IEC-61000-4-15)

Rapid voltage change

Phase angle deviation

Frequency

Auto CT identification

Record deviation

On-board data analysis

On-board scope

Real-time harmonics/inter-harmonics bar charts

USB communications port

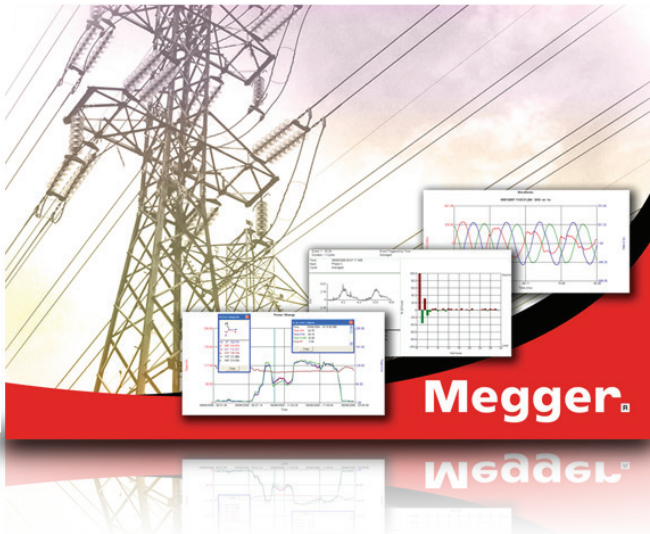
Ethernet port

USB and SD card support

METROSOFT

Metrosoft is a powerful PC-based software that supports local and remote communications to the MPQ2000. It will automatically create unit configurations based on the power quality problem being investigated. This assures that the phenomenon that can cause the power quality difficulty is recorded.

The free software requires no license and offers advanced charting, advanced waveform and advanced harmonic analysis.



Record and Analyze

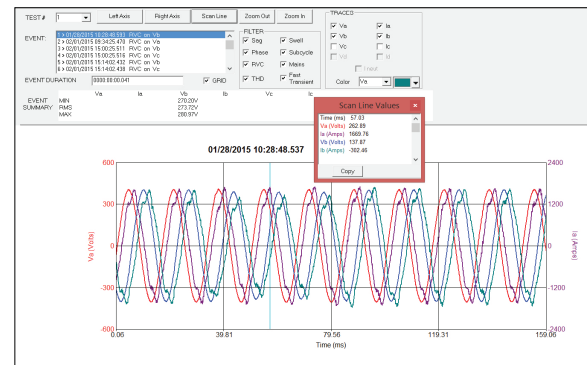
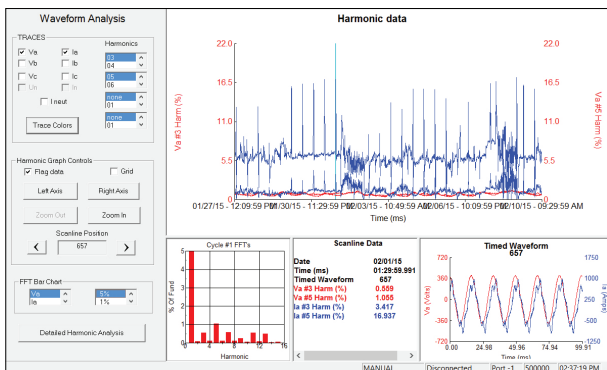
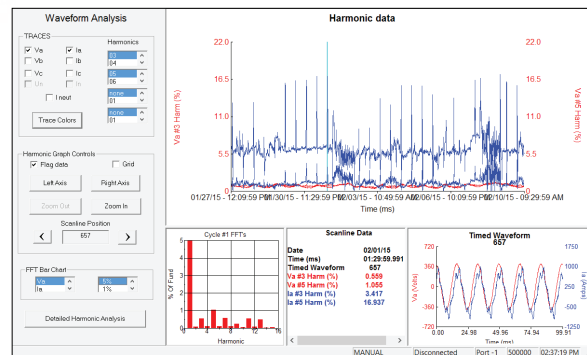
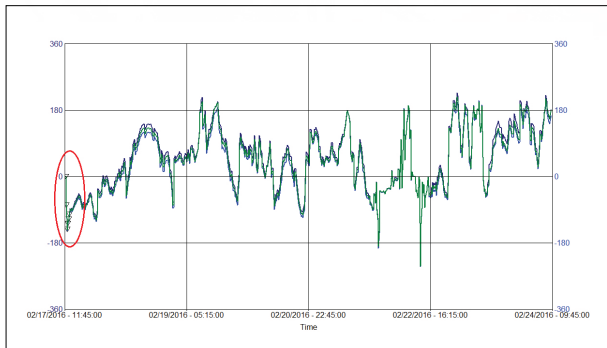
The Metrosoft software allows the user to analyze the recorded data on a PC.

The software will also automatically analyze the recorded data based on standard and custom templates created by the operator that meet local standards.

Charts and Reports


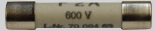










The operator can create charts and reports as well as perform detailed harmonic analysis of the data through the 128th harmonic order.

These can be used for data analysis on the PC or be loaded on to the MPQ analyzer. The analysis can then be done on the MPQ unit itself.



PQ ACCESSORIES

ACCESSORIES		
MCCV6000-18	Self-identifying, four range flexible CT. Powered by the analyzer. 18cm ID. (60A, 600A, 3000A and 6000A)	
MCCV6000-27	Self-identifying, four range flexible CT. Powered by the analyzer. 27cm ID. (60A, 600A, 3000A and 6000A)	
MCC6000-37	Self-identifying, four range flexible CT. Powered by the analyzer. 37cm ID. (60A, 600A, 3000A and 6000A)	
CP-5CE-ID	Self-identifying, split core 5A CT. 20mm (.78") ID.	
CP-20CE-ID	Self-identifying, split core 20A CT. 20mm (.78") ID.	
CP-100CE-ID	Self-identifying, split core 100A CT. 20mm (.78") ID.	
CP-1000WCE-ID	Self-identifying, split core 1000A CT. 50.8mm (2.0") ID.	
CP-600DC-ID	Self-identifying, split core 600A DC CT. 50.8mm (2.0") ID. (AC and DC)	
MPQ-2000 Voltage Lead Set	Set of 4 differential voltage lead cables for the MPQ-2000 PQ analyzer.	
Jumpers	Set of 3 jumper cables for the MPQ-2000 leads. Used to jump return lines together for non-differential applications.	
Color Bands	Set of multiple color bands. Used for color coding the MPQ-2000 voltage leads.	

Fuse Adapters	This fused adapter plugs into the standard MPQ leads. (2A Fused included)	
Fuses	Standard 2A fuse for the MPQ fused adapters.	
Carry Bag	Soft sided carry bag for the MPQ analyzers. This bag fits the MPQ-2000 plus all cables and a set of 3 current clamps.	
PQ Simulator	Three phase power quality simulator. Powered off a single phase AC adapter. (115-240 / 50 / 60Hz) Create dips (sags), swells, transients, harmonics and flicker. Also create phase shifts as well as leading and lagging power factor. Ideal for PQ and demand training.	
USB Cable	USB communications cable for use with MPQ-2000.	
Ethernet Cable	Ethernet communications cable for use with MPQ-2000.	
USB Stick	For use with MPQ-2000. Transfer setup configurations and data files.	
SD Card	For use with MPQ-2000. Transfer setup configurations and data files.	
Auxiliary power cables for the MPQ-2000.		
MPQ-2000 115V US Auxiliary Power Cable		
MPQ-2000 230V EU Auxiliary Power Cable		
MPQ-2000 230V UK Auxiliary Power Cable		
Plunger Clips		

MPQ2000 ACCESSORY KITS

MPQ2000 BASIC KIT

Includes MPQ2000 analyzer, voltage leads, 32GB SD card, USB cable, ethernet cable, universal power cords, soft-sided carry bag plus fuse adapters.

Does not include current clamps.



MPQ2000 SILVER KITS

Includes MPQ2000 analyzer, voltage leads, 32GB SD card, USB cable, ethernet cable, universal power cords, soft-sided carry bag, plus fused adapters and 3 MCCV6000-18 (four range flex 18 cm ID) CTs

Silver Plus kit: The same as the Silver kit above except with 4 MCCV6000-18 CTs.



MPQ2000 Silver Kit - C/N MPQ2000-S-KIT



MPQ2000 Silver Plus Kit - C/N MPQ2000-S-KIT-PLUS

MPQ2000 GOLD KITS

Gold kit: MPQ2000 analyzer, voltage leads, 32GB SD card, USB cable, ethernet cable, universal power cords, soft-sided carry bag, plus fused adapters, and 3 MCCV6000-27 (four range flex 27 cm ID) CTs

Gold Plus kit: The same as the Gold kit above except with 4 MCCV6000-27 CTs.



MPQ2000 Gold Kit - C/N MPQ2000-G-KIT



MPQ2000 Gold Plus Kit - C/N MPQ2000-G-KIT-PLUS

MPQ2000 PLATINUM KITS

Includes MPQ2000 analyzer, voltage leads, 32GB SD card, USB cable, ethernet cable, universal power cords, soft-sided carry bag, plus fused lead, and 3 MCCV6000-37 (four range flex 37 cm ID) CTs

Platinum Plus kit: The same as the Platinum kit above except with 4 MCCV6000-37 CTs.



MPQ2000 Platinum Kit - C/N MPQ2000-P-KIT



MPQ2000 Platinum Plus Kit - C/N MPQ2000-P-KIT-PLUS

GLOSSARY OF TERMS

EFT (Extremely Fast Transient)

Transients that have rise and fall times in the nanosecond region.

Flicker

An impression of unsteadiness of the visual sensation, induced by a light stimulus with a luminance fluctuation over time.

Harmonics

A sinusoidal component of a periodic wave or quantity having a frequency that is an integral multiple of the fundamental frequency.

Imbalance

The ratio of the negative sequence component of a voltage or current to the positive sequence component of that voltage or current, typically expressed as a percentage.

Inter-Harmonics

A harmonic component of a periodic quantity that is not an integer multiple of the fundamental frequency that the supply system is operating.

IP54

A measurement of environmental protection that states the ingress of dust is not entirely prevented but will not enter in sufficient quantity to interfere with the satisfactory operation of the equipment and dripping water (vertically falling drops) shall have no harmful effect.

Phase Angle

The delay between the zero crossing of the fundamental voltage signal and the fundamental current signal represented in degrees.

Power Factor

The ratio of the total power input, in watts, to the total volt-ampere input to the converter.

RMS Current

The root-mean-square value of the current, derived from the summation of the square root of the arithmetic mean (average) of the squares of the original current samples.

RMS Voltage

The root-mean-square value of the voltage, derived from the summation of the square root of the arithmetic mean (average) of the squares of the original voltage samples.

RVC

(Rapid Voltage Change) A variation of the RMS or peak value of a voltage between two consecutive levels that is sustained for a given duration.

Sag/Dip

An instantaneous or momentary decrease in the steady state RMS value.

Sample

The actual discrete instantaneous measurement the MPQ2000 performs 256 times per cycle.

Sub-cycle

A power quality event in which the duration is less than a cycle.

Swell

An instantaneous or momentary increase in the steady state RMS value.

TDD (Total Demand Distortion)

A measurement of the current THD taking into account the average current load on the circuit during the recording interval.

THD (Total Harmonic Distortion)

The ratio of the root-mean-square of the harmonic content to the root-mean-square value of the fundamental quantity, expressed as a percent of the fundamental.

Transient

A sudden non-power frequency change in the steady state condition of voltage or current.

Waveform Capture

A selection in the MPQ2000 setup file that allows the unit to record waveforms based on timed intervals. NOTE: the unit will always capture waveforms when an out-of limits-event occurs.

WHAT AND WHY?

WHY CLASS A?

Different instruments can aggregate their data differently. This means that if you have two different instruments you can get different readings on each. Which is correct? A Class A instrument will aggregate the data per the IEC61000-4-30 standard. (Now adopted by IEEE1159.) This means any two instruments that are Class A will get the same measurements. The majority of revenue meters used today are Class A, as are most monitors in substations. Therefore, they calculate their RMS voltage per the IEC61000-4-30 standard. A Class A instrument is needed in order to get the same measurements as other Class A meters.

WHY AUTO CT ID?

It is not uncommon to find operators connecting the wrong value CT to the analyzer. This means the CT range selected in the analyzer's configuration file does not match the range of the actual CT connected to the analyzer. A recording would be started with the wrong value CT connected. The analyzer could be left in the field for a week or more. They would retrieve the unit only to find that the data was no good. They would then have to correct the analyzer's configuration and repeat the test. The auto CT identification will now let them know there is a mismatch and ask them if they would like to adjust / change the CT or would like the analyzer to automatically alter the configuration to match the CT range that is connected. This eliminates the possibility of mismatched current clamps.

WHY CONFIGURATION VERIFICATION?

One of the most common problems we see is operators connecting the analyzer incorrectly. They would start a recording and leave the analyzer for a week or longer. When the analyzer was retrieved, the operator would find the data was no good. Therefore, they would have to repeat the test, wasting a great deal of time. Configuration verification solves this problem. The analyzer will examine the phase angle of all the channels and verify they are correct for the configuration selected. The analyzer will let the operator know if channels are connected incorrectly or if a current clamp is backwards, ensuring proper connection before the recording is started.

WHY PHASE ANGLE SHIFT DETECTION?

In today's modern grid, we can generate power from a variety of renewable sources. These can include wind energy as well as biomass. Some of these sources can produce a great deal of reactive power. For example, wind turbines use induction generators. These draw reactive power from the grid to create their magnetic field. When the wind is blowing, and they are producing power, we see good power factors at approximately 0.98. However, when the wind is not blowing they are not creating power, but are drawing reactive power. This can lead to very poor power factors, down to approximately 0.40. This can lead to low voltages in the transmission lines.

In some cases, these renewable systems need to be islanded from the grid. When they come back on the grid, the phase needs to sync up. This can be seen as a momentary change in phasing. The MPQ analyzer can record an event when it sees a phase shift which can allow the operator to see when islanded systems are coming back on line.

WHY IEC AND ANSI UNBALANCE?

Today, the recommended method to measure unbalance is to use the IEC unbalance method which follows the IEC61000-4-27 standard (now adopted by IEEE1159). This method allows you to see negative sequence or zero sequence unbalance. Sequence components provide a better way to analyze the data and determine what issues it may be causing. The majority of source-side faults are asymmetrical which means they will not only cause changes in phase magnitude but also in phase sequence. The ability to view the changes in phase sequence allow for quicker analysis.

ANSI unbalance is another method of measuring unbalance. This method averages the phases together, then compares each individual phase to the average. Many utilities may have legacy ANSI unbalance data.

WHY THD AND TDD?

When analyzing voltage harmonics, the Total Harmonic Distortion (THD) measurement is a good method to use. THD is the sum of all the harmonics referenced to the fundamental value. The voltage fundamental value is typically always present. However, the same cannot be said of current. When loads turn off, current drops and can drop to near zero. When this occurs, misleading THD values can be seen on the current channels. For example, if there is 1A of harmonics and 100A of fundamental, then the THD will be 1%. However, if there is 1A of harmonic noise and the current drops to 0.5A, the THD can be 200%, which can be misleading. IEEE519 recommends using Total Demand Distortion (TDD) when measuring current. TDD will reference the total current harmonics to the maximum

average current recorded during the test interval, which indicates the reference value will always be valid. Some utilities have their own reference value they use throughout the grid. The Megger PQ PC software allows them to enter this value to use as a reference when viewing TDD.

WHY EVENT AND TIMED WAVEFORMS?

Most power quality analyzers today will record a waveform when an out-of-limit event occurs, such as a dip / sag or a swell. However they may not capture periodic timed waveforms. If you have a recording that has no out-of-limit events then you do not record any waveforms. Waveforms tell us a great deal about the system. These are needed to truly understand a system. The MPQ analyzer will capture both event-triggered waveforms and periodic timed waveforms. This ensures you always have the information needed to determine the health of your system.

WHAT IS RVC?

In today's modern grid power can be obtained from many renewable sources. These can include both solar power and wind power. These particular forms of power do not supply constant power, meaning their output can fluctuate. This leads to Rapid Voltage Changes (RVCs) on the power lines. RVCs are typically small changes less than a dip/sag or swell and can happen quickly. RVCs can lead to problems such as lights flickering and equipment tripping off line. RVCs can cause flickering in any type of lighting system, not just incandescent bulbs. Many analyzers record the flicker parameter which uses a weighted curve that is based on the incandescent lamp. Additionally, RVCs can affect any type of lamp.

WHAT IS MAINS SIGNALING?

As the smart grid grows, we will see more and more communications between equipment. Some of that communication can be through the use of ripple signals sent over the power lines. Utilities can use these signals to turn equipment on and off. This allows them to turn off large loads during peak times and turn them back on at a later time. When these signals are sent, they can cause some issues. There have been reports of customer appliances resonating when the signal is sent. There have been reports of street lights turning on during the day and off at night. The MPQ analyzer will not only detect when a mains signaling event has occurred, but will capture the waveform as well. This means you can view in your trended data when a signal was sent and view the actual signal.

WHY ANALYZE WAVEFORMS THROUGH 128TH ORDER?

AC is converted to DC using rectifiers that create harmonics. In addition we now see DC being converted to AC using inverters. Modern inverters are using higher switching frequencies which create higher order harmonics. This is especially true in solar and wind applications where higher order harmonics can be seen. Today, these high frequency harmonic orders between the 39th and 49th harmonic order can be seen. However, as switching frequencies increase, these orders increase also. The MPQ analyzer gives us the ability to measure and analyze these high frequency harmonics.

WHAT IS INTER HARMONICS?

Harmonic frequencies are multiples of the fundamental frequency. Inter harmonics are harmonic frequencies that are between the harmonic orders. Typically, these values would be very low. However, if the inter-harmonic frequency happens to be at resonance value of a piece of equipment, it can be amplified significantly. This can create catastrophic failures in equipment. When equipment such as capacitor banks are out on a system, a harmonic and inter-harmonic study should be performed to ensure there are no potential resonance issues.

WHY CAPTURE TRANSIENTS DOWN TO 1 MICROSECOND?

High speed transients have limited energy because it is a function of time and a high speed transient can be as small as a microsecond. These transients are typically dampened out by just a few meters of cable. This is why high speed transients will typically not be an issue on distribution lines. However, these can be an issue in areas where there are limited cable runs. Traditionally, these areas would include offshore oil platforms as well as mines.

But, now we see residential and small commercial buildings getting solar panels. In a wind turbine when the wind changes, the output of the turbine does not change instantly. However, in a solar panel when the solar radiation changes, the output of that panel changes immediately. This can lead to repeating high speed transients. Repeated high speed transients can damage sensitive electronics. There have already been reports of homeowners having to replace their microwave ovens every 15 months. The MPQ analyzer can capture high speed transients down to 1 microsecond.



MPQ2000

MEGGER
CALIBRATION CERTIFICATE
CAL. NO. 1001
DATE 07/17/12
BY

PQ AN

Test Battery No.: 00 000 01
Elapsed time: 0:00:00:00 00 Battery No.: 01 001
Active setup: 600 2 Phase 400 V 50 Hz
Configuration: 4 Wire 4-wire 2-wire
Power calculations: On

	VOLTAGE	CURRENT
PHASE A	220.00	8.20
PHASE B	220.00	12.00
PHASE C	220.00	10.00
NEUTRAL	OFF	OFF
GROUND	OFF	OFF

Seq: 0 Swell: 0 Sag: 0
Transient: 0 Peak Angle: 0 50%
THD: 0 Scales: 0



MPQ2000_BR_EN_V02

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