DRANETZ™
THE STANDARD FOR ENERGY & POWER MEASUREMENT

TECH TIP

Dranetz HDPQ® and Encore Series® 61000 Data Acquisition Techniques

Introduction

Dranetz power quality instruments measure in accordance with the related standards from the Institute of Electrical and Electronic Engineers (IEEE) and the International Electrotechnical Commission (IEC). They use industry-proven triggering algorithms for event detection and recording. User programmable, record by exception methods are used to compress data recordings based upon the requirements of the user's application. Such techniques are extremely reliable and effective in capturing power quality phenomena in a highly efficient manner, while reducing memory requirements, communications bandwidth, and associated costs. Such capabilities are especially important in multipoint fixed monitoring systems that continuously record data for many years. In such cases, data management is a huge concern due to the large amount of information being continuously recorded and communicated to a central server database.

The Dranetz HDPQ and Encore Series 61000 product families use very similar sampling and data acquisition techniques, and comply with the same international standards. This Tech Tip breaks down the data acquisition techniques used in these products into their basic building blocks, including digitization, power quality event detection, harmonics, power measurements, and journal entries. Note that references to the 'instrument' below apply to both the Dranetz HDPQ and Encore Series 61000 product families except where noted. Also, this guide is intended to supplement and not replace the instruments operators' manual.

Digitization

RMS Cycle by Cycle Measurements

The instruments sample each cycle of each voltage and current channel 512 times. Sampling is gapless, which means that each voltage and current cycle is continuously sampled without gaps between cycles. Sampling is referenced to channel A voltage by default. The sampling rate is automatically adjusted to the power line frequency to ensure that the instrument always acquires 512 evenly spaced samples on every cycle, on every channel. Any variation in the power line frequency slightly adjusts the sampling rate accordingly. At 512 samples per cycle, the sampling rate is about 30.72KHz at 60Hz and 25.6KHz at 50Hz.

The analog samples are digitized by a 16-bit Analog to Digital (A/D) converter and are used as the foundation for all voltage, current, power, harmonics, and other computations.

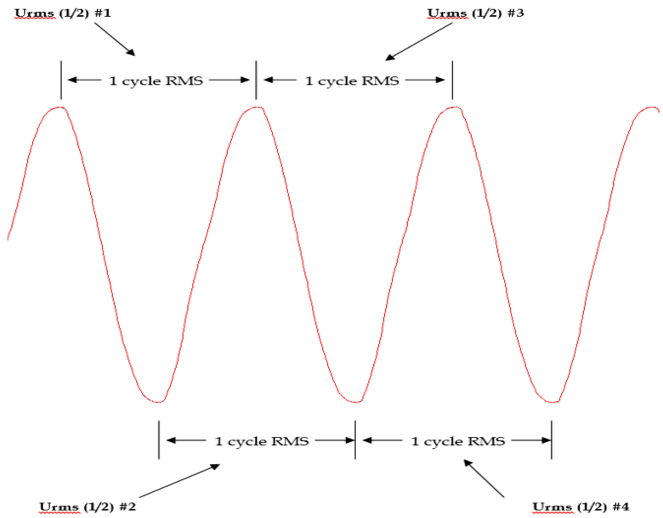
The data acquisition techniques are appropriate for low and medium frequency transients as defined by IEEE 1159. At 512 samples per cycle, the time between samples is about 32µs at 60Hz and 39µs at 50Hz, which is adequate to record transient activity on most power systems. High Frequency transient triggers are available in the Dranetz HDPQ Xplorer and Xplorer 400 instruments (only) which can detect transients to 1µs.

Power Quality Triggers

PQ disturbances can affect the power line waveform and connected loads in different ways, so different PQ event types may require different triggering methods. The most common method of triggering, RMS variations, will not capture every type of disturbance, even if the sampling rate is greatly increased. As a result, Dranetz has developed and patented advanced methods to capture virtually any type of PQ event. This section describes the various triggering methods available in the instruments and their applications.

RMS Variations

In accordance with IEEE and IEC standards, RMS measurements are made over one AC cycle, but are incremented in ½ cycle steps - See the diagram below. The standards refer to this as $U_{rms(1/2)}$. It is important to note that the measurement window for PQ triggers is still always 1 AC cycle, but the ½ cycle increments allow for more detailed event detection. Any one cycle that exceeds the instrument's limits will trigger an RMS type event, regardless if it's detected on a ½ cycle boundary.



When a trigger occurs, data is stored to memory in accordance with the RMS Summary and Waveform (# of cycles recorded) settings entered during instrument setup. Note that the instruments also detect and record *current* RMS events in the same manner as voltage. Please see the instrument's users guide for further details.

The *Urms*$(_{1/2})$ data is also used as the basis for all voltage and current min, max, and average measurements which also have a 1 cycle resolution with ½ cycle steps.

TRANSIENT DETECTION

As per IEEE 1159, transients are divided into 3 categories;

- Low frequency (<5Khz)
- Medium frequency (5 – 500Khz)
- High frequency (500Khz – 5Mhz)

All of the instruments can capture low and medium frequency transients. High Frequency transient capture is only available in the Dranetz HDPQ Xplorer and Xplorer 400 instruments, which can detect transients to 1µs.

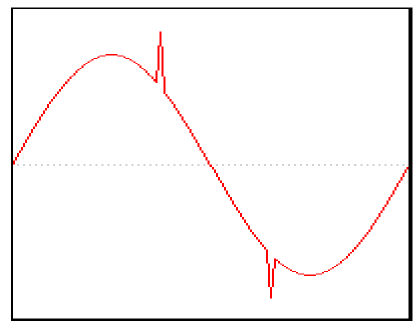
It is important to note that the instruments go well beyond the requirements of the IEEE 1159 and IEC 61000-4-30 standards, as these standards do not specify transient capture techniques and are limited to dips (sags), swells, and other measurements.

The text below describes the various transient detection methods that are available in the instruments. All instruments have two main transient capture trigger methods: Instantaneous Peak and Waveshape. The Dranetz HDPQ Xplorer and Xplorer 400 instruments add a third method for the capture of High Speed (frequency) transients:

Instantaneous Peak

This trigger looks for any one of the 512 samples to exceed the Instantaneous Peak limit. If at least one sample exceeds the limit, data is recorded to memory based upon the user's pre/post waveform settings. Applications for this trigger are for positive transients, such as peak over voltage (or current), lightning strikes, etc.

Instantaneous Peak



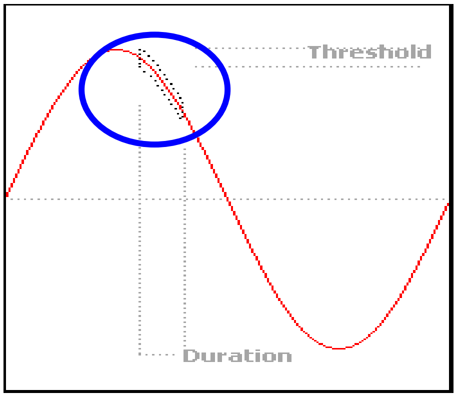
Waveshape Change

Waveshape change triggers look for changes in each and every voltage and current waveform on a cycle by cycle basis. These are important triggers, and are unique to Dranetz instruments because many types of transients, such as negative transients, do not affect the waveshape enough to change the RMS or harmonic content significantly.

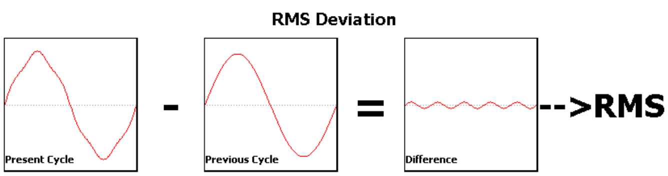
There are two waveform trigger methods available in the instruments: cycle to cycle waveshape difference and RMS distortion (or difference) waveshape. Both methods look for changes in the waveshape of the present AC cycle vs. the previous AC cycle, and if the difference exceeds the user's limits, an event is recorded. Both methods are quite effective, and the choice of which to use is based upon personal preference:

- Cycle to cycle Waveshape: This method breaks down the present AC waveform into user defined windows of time (shown below in the circle) that represents a percentage of the overall waveform. Each window is compared to the same window in the previous waveform, and if the difference exceeds the user's limits, an event is recorded. In the picture below, the duration (width of the window) is 10% (1.67ms @60Hz), which means that the waveform is broken down into 10 consecutive windows, with each representing 10% of the overall waveform. If the duration were 50%, the waveform would be broken down into 2 windows, with each representing 50% (8.3ms) of the overall waveform.

Waveshape Difference



- RMS distortion (or difference) waveshape: This method does a (sample) point by point subtraction of the previous AC cycle from the present AC cycle. If the waveforms are the same, the difference is zero; otherwise the difference will be the change in waveshape from the previous waveform. If the difference exceeds the customer’s limits, an event is recorded.



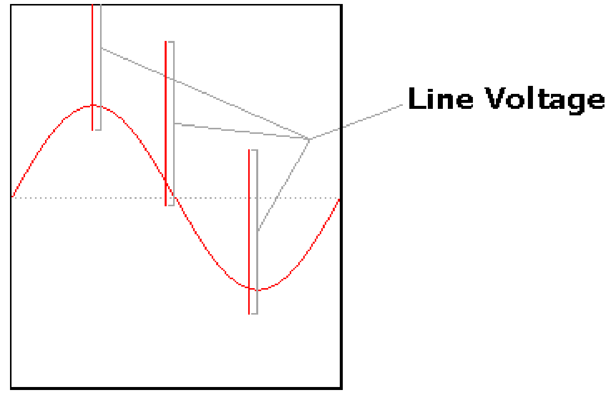
High Frequency

High Frequency transient triggers are only available in the Dranetz HDPQ Xplorer and Xplorer 400 instruments (Portable & SP), which can detect transients to 1µs. These instruments have additional circuity that samples at 1MHZ and operates in parallel with the standard 512 samples per cycle data acquisition that is used for the other triggers.

High speed transients can come from lightning strikes, wiring issues, and others sources, and due to their high frequency nature, are usually measured close to the source of the event.

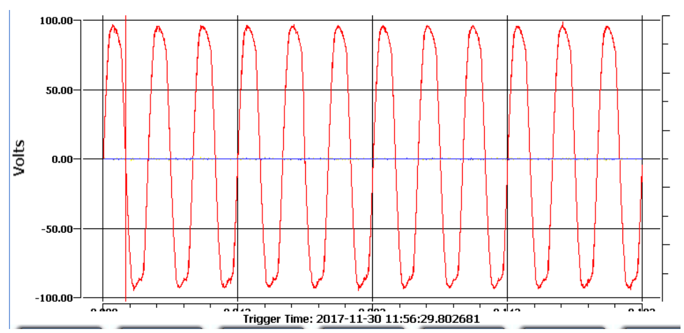
The settings for high frequency transients are similar to Peak transients, but the resolution is much finer due to the higher sampling rate.

High Frequency Energy



Magnitude of Supply 200ms Window

IEC 61000-4-30, IEC 61000-4-7, and IEEE 519:2014 require data be acquired over a 200ms window for use in certain measurements, such as magnitude of supply, harmonics, and interharmonics. The 200ms window equates to 12 cycles at 60Hz and 10 cycles at 50hz. A 12 cycle 60Hz example is shown below.



Most standards require the 200ms windows to be gapless for Class A, or full compliance, meaning that there are no gaps between 200ms windows, and any data processing by the instrument must be completed in time to process the next 200ms window. The instruments fully comply with this requirement.

Harmonic computations include all 10/12 cycles in the 200ms window and use the Discrete Fourier Transform (DFT) method. The results are used for all harmonic parameters and triggers. Therefore, 200ms is the smallest unit of time for harmonic and other parameters, and is the basis for all associated min, max, and average measurements.

Power Measurements – One second

Measurements for power parameters, such as Watts, VA, VAR, PF, etc. are computed over a one second interval. Each cycle measured over this one second interval is included in the measurement. The interval is adjusted to the nearest complete cycle to compensate for any frequency differences from the ideal 50/60Hz that are integer multiples of one second. The one second time unit is the basis for all associated min, max, and average measurements.

Journals

Journals are measurements and computations recorded to memory based upon a timer and operate independent of triggering mechanisms. Journal data is recorded at user-programmable time intervals and is used to produce historical trends of every parameter enabled. The instruments support four independent journal categories, each with a separate time base. These categories are described below, along with a description of the type of data included:

Power Values

Power values include V, I, W, VA, VAR, PF, etc. The user has the choice of the timer interval and whether to record waveforms (waveform snapshot) with the computed parameters recorded to memory. If the waveform snapshot is enabled, a 200ms window is recorded as described above. Therefore, the user will see 10 cycles at 50Hz and 12 cycles at 60Hz.

Min, max, and average values are based upon the data acquisition method used for the specific parameter. Therefore, V and I are measured on a cyclic basis (½ cycle increments) while power parameters such as W, VA, VAR, PF are based upon the one second power update rate.

Demand and Energy

This allows for an independent timer for demand and energy. It also supports a demand sub-interval timer. Min, max, and average is based upon the one second power measurement update rate.

Harmonics

This allows for an independent timer for harmonics. Min, max, and average are based upon the 200ms window required by IEC 61000-4-7 and IEEE 519:2014 for harmonic measurements.

Flicker

This allows for an independent timer for the Flicker parameters, Pst and Plt. The default is based upon the IEC and IEEE requirements of 10 minutes for Pst and 2 hours for Plt. Min, max, and average are based upon these times.

To Contact Dranetz

- Call 1-800-372-6832 (US and Canada) or 1-732-287-3680 for Technical or Sales support
- To submit a support request online, please visit: http://www.dranetz.com/contact-us-2/technical-support-request/