Introduction to PQDIF File Format and Application to PQ Analysis Tools

Thomas Szollossy
Senior Technical Support Engineer
Power Quality (Thailand) Company, Ltd.

Power Quality Thailand LTD.

Thomas holds a Bachelor of Engineering Degree from Carleton University in Ottawa, Canada, and has been based in Thailand for the last 15 years.

He has worked mainly in the electronics industry in R&D and support roles, and although he is new to the power quality industry, he brings a wealth of knowledge in the electronics, IT, and software fields.

Introduction to PQDIF

and
Practical Applications

Thomas Szollossy, B.Eng (EE)
Senior Technical Support Engineer
Power Quality Thailand Company Limited
52/44 Moo1, Ramkamhaeng Soi 90
Saphan Soong, Bangkok 10240

What is PQDIF?

- **P**ower **Q**uality **D**ata **I**nterchange **F**ormat = **PQDIF**

- PQDIF is a binary file format specified in IEEE® Std 1159.3-2003

- Used to exchange voltage, current, power, and energy measurements from monitoring instruments to computers

- Also used to exchange the these measurements computer-to-computer

- PQDIF is adopted by the overwhelming majority of energy quality analysis and reporting systems, such as PQView, DranView 7, and others

What is PQDIF?

- PQDIF is a binary format that features optional lossless compression using zlib

- zlib is written in C

- zlib is also a crucial component of many software platforms including Linux, Mac OS X, and iOS.

- Also been used in gaming consoles such as the PlayStation 4, PlayStation 3, Wii U, Wii, Xbox One and Xbox 360.

Justification for PQDIF

- Every manufacturer has their own proprietary data exchange formats
  - Dranetz' **ESS InfoNode®** talks to their 61k DataNodes
  - ABB's **PCM600®** software talks to their IED's
  - Schneider Electric's **StruxureWare®** software talks to their ION meters
  - Elspec's **PQCADA Sapphire®** software talks to their G4000 series Black Boxes
 - Etc.

Justification for PQDIF

- We are limited to using each brand of instrument's computer software

- Would be nice to import data into different software packages

- Can do this by adopting support for importing and exporting data that conforms to a standard such as PQDIF
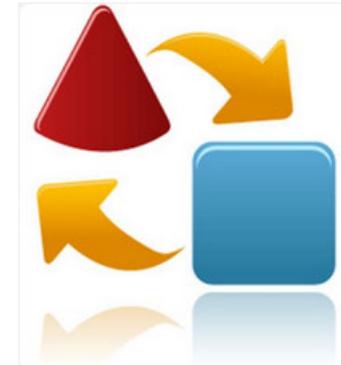
Justification for PQDIF

- IT communications systems, databases, web applications are standardized

- Electrical Data Sources are focused on electrical control and measurements, and hence have lagged in adopting IT standards

- Main obstacle is to get data into standard IT systems

- PQDIF offers a standard to bridge this gap
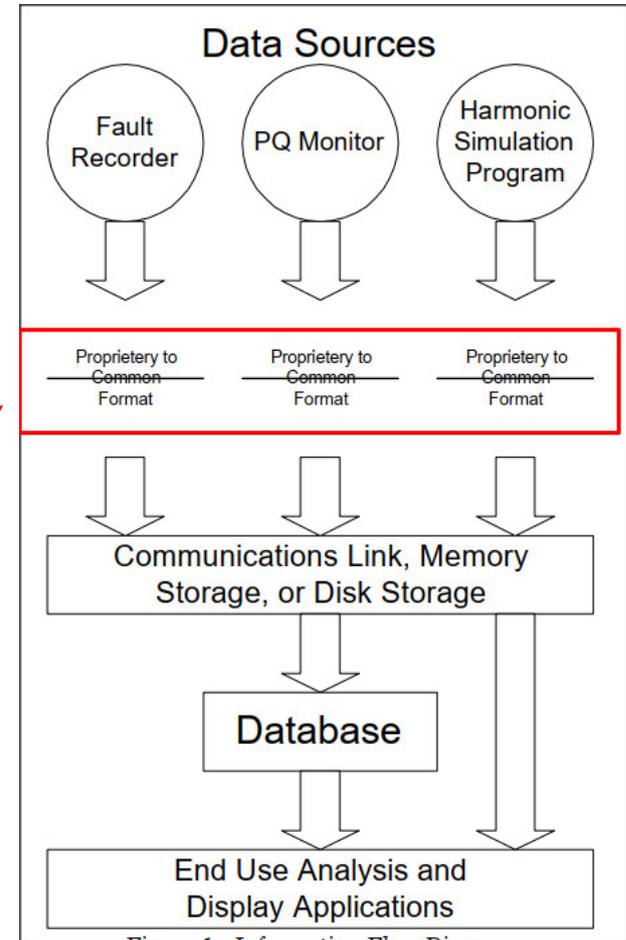
Functional Requirements for PQDIF

- Require a format that has the ability to represent data from a variety of sources (measured, simulated, or manually created)
- Must support data in the time, frequency, and probability domains.
- An example of a file format with many of these attributes has been developed and is being used in a research environment.
- This format has been put into the public domain by the author to facilitate debate and development of an eventual standard: PQDIF!

COMTRADE and Limitations

- An earlier data interchange format was IEEE COMTRADE
- Provides for an ASCII or binary file format for the interchange of transient data produced by fault recording devices
- Quite useful for general time domain data interchange
- Popular with the power quality community
- Principal limitation is its inability to deal with frequency domain and probability domain information
- Also somewhat limited in its extensibility and the ability to include additional site, instrument, and vendor specific information associated with a measurement or simulation

History of PQDIF

- Developed by IEEE Power & Energy Society
- The IEEE P1159.3 Task Force was formed in 1996 by the IEEE P1159 Working Group
- The first version of the standard was completed in 2002 and affirmed by vote in 2003
- A reaffirmation was completed in March 2009

IEEE 1159.3 PQDIF Task Force

- Task force maintains the IEEE Recommended Practice for the Transfer of Power Quality Data (PQDIF)
- Also maintains a PQDIF Software Developers Kit (SDK), source code, example files, overview documentation, and test programs in a documents library available online.

Chair	Secretary
Daniel Sabin Electrotek Concepts 100 Cummings Center, Suite 229C Beverly, Massachusetts, 01915 USA	Joseph Grappé Duke Energy Progress 1418 Mechanical Boulevard Garner, North Carolina 27529 USA
E-Mail: d.sabin@ieee.org	E-Mail: joseph.grappe@duke-energy.com

PQDIF and Electrotek

- Electrotek Concepts, Inc. is the Author of PQView®

- Over the last several years, the Electric Power Research Institute (EPRI) and one of its contractors, Electrotek Concepts, Inc. have been developing a vendor independent interchange format for power quality related information

- In 1996, EPRI and Electrotek placed PQDIF in the public domain

- EPRI and Electrotek have also offered the format, sample source code, and documentation to the IEEE 1159.3 task force here: http://grouper.ieee.org/groups/1159/3/docs.html

PQDIF On-Line Documents

http://grouper.ieee.org/groups/1159/3/docs.html

IEEE P1159.3 On-Line Documents

The following documents relate to the work of the IEEE P1159.3 Task Force.

Drafts of IEEE P1159.3

The drafts of IEEE P1159.3, Recommended Practice for the Transfer of Power Quality Data, can be accessed from this web site only if you have a user name and password. Contact the task force chair or secretary to obtain the latest password.

- IEEE 1159.3 PQDIF Draft 18, 2018-07-05 (First Ballot of Revision Document
- IEEE 1159.3 PQDIF Draft 17, 2018-05-31 (Version submitted to IEEE-SA for Mandatory Editorial Coorindation)
- IEEE 1159.3 PQDIF Draft 16, 2017-07-22
- IEEE 1159.3 PQDIF Draft 15, 2017-01-08
- IEEE 1159.3 PQDIF Draft 14, 2016-07-19
- IEEE 1159.3 PQDIF Draft 13, 2015-01-11
- IEEE 1159.3 PQDIF Draft 11, 2014-01-13
- IEEE 1159.3 PQDIF Draft 9 (Recirculated Ballot Document)
- IEEE 1159.3 PQDIF Draft 8 (First Ballot Document)

PQDIF On-Line Documents

http://grouper.ieee.org/groups/1159/3/docs.html

Source Code in C, VB, VB.NET, and C#

These files are the core of the specification. They contain all of the tags listed in the normative annexes in the standard. These files are updated periodically as vendors find bugs and add new tags. The updates are always backward compatible.

- PQDIF Physical Format Definitions - C Header File from IEEE Std 1159.3-2003
- PQDIF Logical Format Definitions - C Header File from IEEE Std 1159.3-2003
- PQDIF Identifier Definitions - C Header File from IEEE Std 1159.3-2003
- PQDIF 1.6 Source Code from October 2015 Draft

Example Files

- Example PQDIF File 01
- Example PQDIF File 02
- Example PQDIF File 03
- Example PQDIF File - Transient Waveform | ASCII Dump
- Example PQDIF File - RMS Variation
- Example PQDIF File - RMS Voltage and Current Trend
- Example PQDIF File - Evolving Fault with Waveform Samples and RMS Samples
- Example PQDIF File - Flicker Analysis using Short-Term and Long-Term Flicker Perception (Pst and Plt)
- Example PQDIF File - Harmonic Analysis with Voltage THD, Current THD, Harmonic RMS, Current IT Product, Voltage Harmonics, and Current Harmonics

PQDIF On-Line Documents

http://grouper.ieee.org/groups/1159/3/docs.html

PQDIF COM Library

PQDCOM4.DLL is an ActiveX/COM Library for reading and writing PQDIF files used by many third-parties. The ActiveX library itself is free to use and distribute. Contact the task force chair or secretary to obtain the password for the source code.

- PQDCOM4.DLL 4.2.0.4 (Posted 2017-01-18)
- Source Code to PQDCOM4.DLL 4.2.0.4 (Posted 2017-01-18, Requires Password)

PQDIF .NET Library

PQDIFNET.DLL is a .NET Assembly for reading and writing PQDIF Files. This library is free to use and distribute. Contact the task force chair or secretary to obtain the latest password.

- Source Code to PQDIFNET.DLL (Updated 2013-05-01, Requires Password)

Software Development Kit (SDK)

This kit is put into the public domain by Electrotek Concepts, Inc. It will be updated from time to time. No warranty is expressed or implied. Use at your own risk.

- PQDIF SDK
- PQDIF SDK Cover letter

Tools for the Software Developer

IEEE PQDIF Libraries

- Source Code for C++ Libraries for Reading and Writing PQDIF Files
- Updated in August 2014 to expand maximum number of samples in a single series instance to 16 million from current limit of 1 million.

PQDCOM4.DLL

- Source Code for Microsoft Windows ActiveX/COM Library for reading and writing PQDIF files
- Intended for Use with VB6, Microsoft Office VBA, MATLAB
- Written in C++.

PQDIF.NET

- Source Code for Microsoft Windows .NET Component Library for reading and writing PQDIF files that has similar interfaces to PQDCOM4.DLL
- Intended for Use with .NET Applications Built using C# or VB.NET

PQDIF File Naming Convention

To make the conversion process simple, a standard naming conversion for the PQDIF files has been established.

The Filename for different type of event are listed below.

No	PQDIF Files Type	Description
1	Waveform	Stores waveform for the three phase Voltage and Current for the disturbance (Phase A, Phase B, Phase C).
2	SagSwell	Stores Information about Sag/Swell for the three phase Voltage and Current (Phase A, Phase B, Phase C) i.e: 1. Time 2. Voltage during disturbance 3. Duration
3	Transient	Stores Information about transient for the three phase Voltage and Current (Phase A, Phase B, Phase C) i.e: 4. Time 5. Voltage during disturbance 6. Duration

PQDIF File Naming Convention

4	VUnbal	Stores unbalance voltage (IEEE unbalance Calculation)
5	Flicker	Stores Information about Flicker for the Three Phase Voltage (Phase A, Phase B, Phase C) i.e: 1. Time 2. Values
6	PowerFactor	Stores power factor values for the three phases
7	THDHarmonics	Stores Information about THD for the Three Phase Voltage (Phase A, Phase B, Phase C)i.e: 1. Time 2. Values
8	Harmonics	Stores Harmonic Spectrum for the Three Phase Voltage (Phase A, Phase B, Phase C) for N=0 to 40 for one day.

PQDIF File Naming Convention

Example :

EASTERN_GBNG_VCB10_Waveform_20-02-2005_21-02-2005_00000

LOCATION	:	EASTERN_GBNG_VCB
DATATYPE	:	Waveform
STARTTIME	:	20-02-2005
ENDTIME	:	21-02-2005
ID	:	00000

PQDIF File Naming Convention

In general, the PQDIF filename can be summarized as:

LOCATION_DATATYPE_STARTTIME_ENDTIME_ID.pqd

Where:

LOCATION	-Location name
DATATYPE	-would be one of the above in the table (Column PQDIF Files Type).
START TIME	-Start data time (format dd-mm-yyy)
END TIME	-End data time (format dd-mm-yyy)
ID	-Index

Data "Containers" (PQDIF ID's)

- PQDIF standard defines "Containers" for storing specific types of data

- Containers define the type of data (ASCII, integer, floating point etc.)

- Such containers are called "PQDIF ID's"

- Data can be recorded waveforms, measured PQ parameters, or site/instrument specific data (For example, site name, instrument make & model, etc.

- Each data type must be stored in the correct data container. Not doing so violates the PQDIF standard, risking making the PQDIF file unreadable in other software applications

Submit new PQDIF ID

- New data types needed as Power Quality standards evolve

- New instrument models may support measuring or calculating new data types not currently supported by PQDIF containers

- Developers may request IEEE P1159.3 Task Force to add new ID's to PQDIF standard at www.pqdif.info
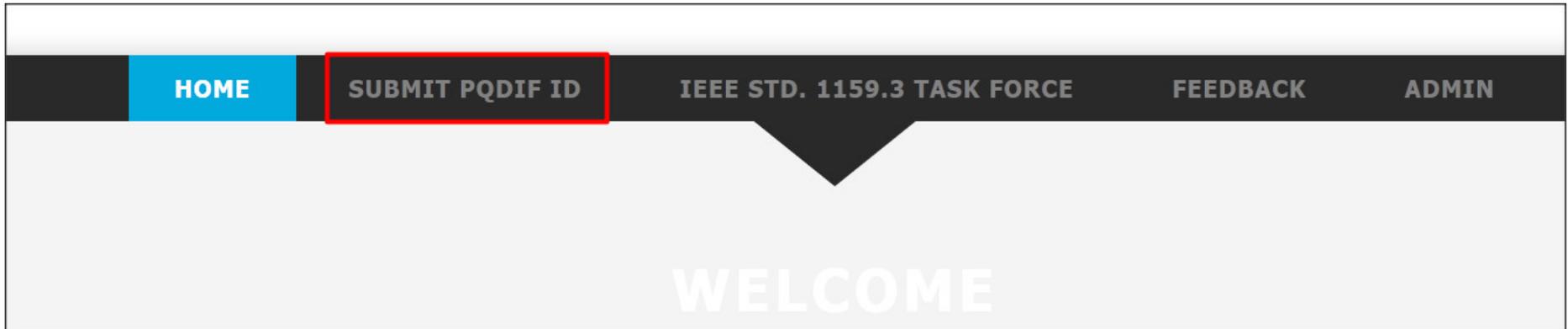
Contents of a PQDIF File

PQ Event Data:

- Voltage and current waveforms

- Voltage and current RMS plots

- Phasor information

Other data:

- Data trends (Journals) of parameters

- Connection type, nominal values, etc.

- Monitor settings

- Information about monitoring site (name, location, etc.)

Other Standard Data Interchange Formats

- COMTRADE

- IEC 61850

- CSV (Comma separated variable)
  - Files must be in text (ASCII) format, in columns and rows, separated by comma "," character
  - Files not compressed, can get huge in size very quickly
  - There is no standard specifying the column headers and contents, so CSV files need to be edited to conform to the format expected by the importing software

PQDIF Support in DranView 7

IMPORTING:

Loading a PQDIF file into DV7:

File → Open, select File type "PQDIF"
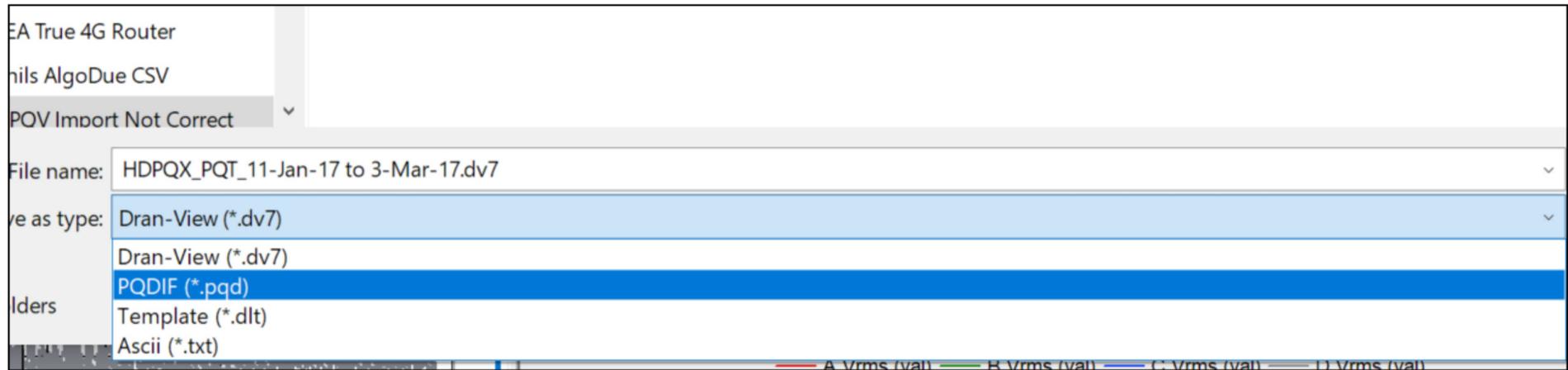
PQDIF Support in DranView 7

EXPORTING:

Saving a file as PQDIF:

File → Save as, select File type "PQDIF"
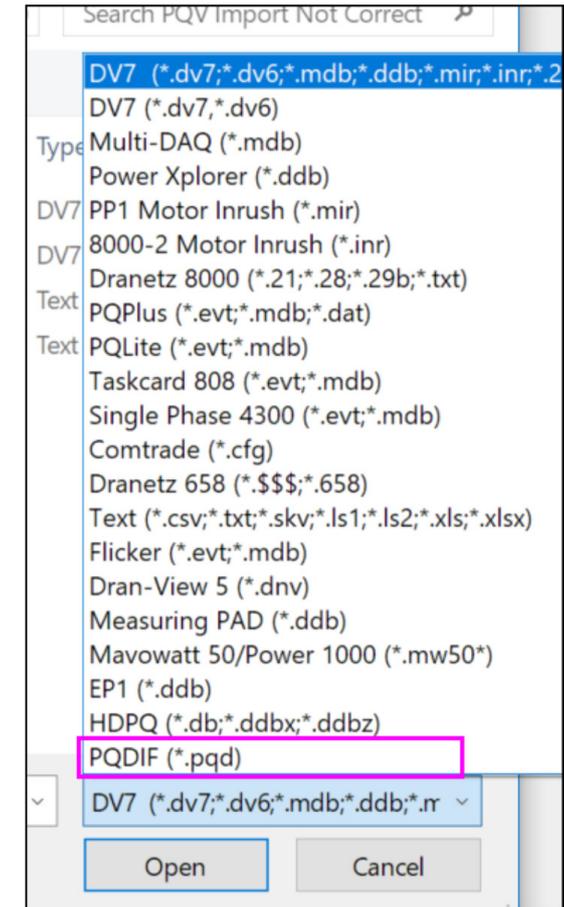
PQDIF Support in PQView Data Manager

IMPORTING:

- Import single PQDIF files or entire folders with multiple files
- Auto import by defining a data source
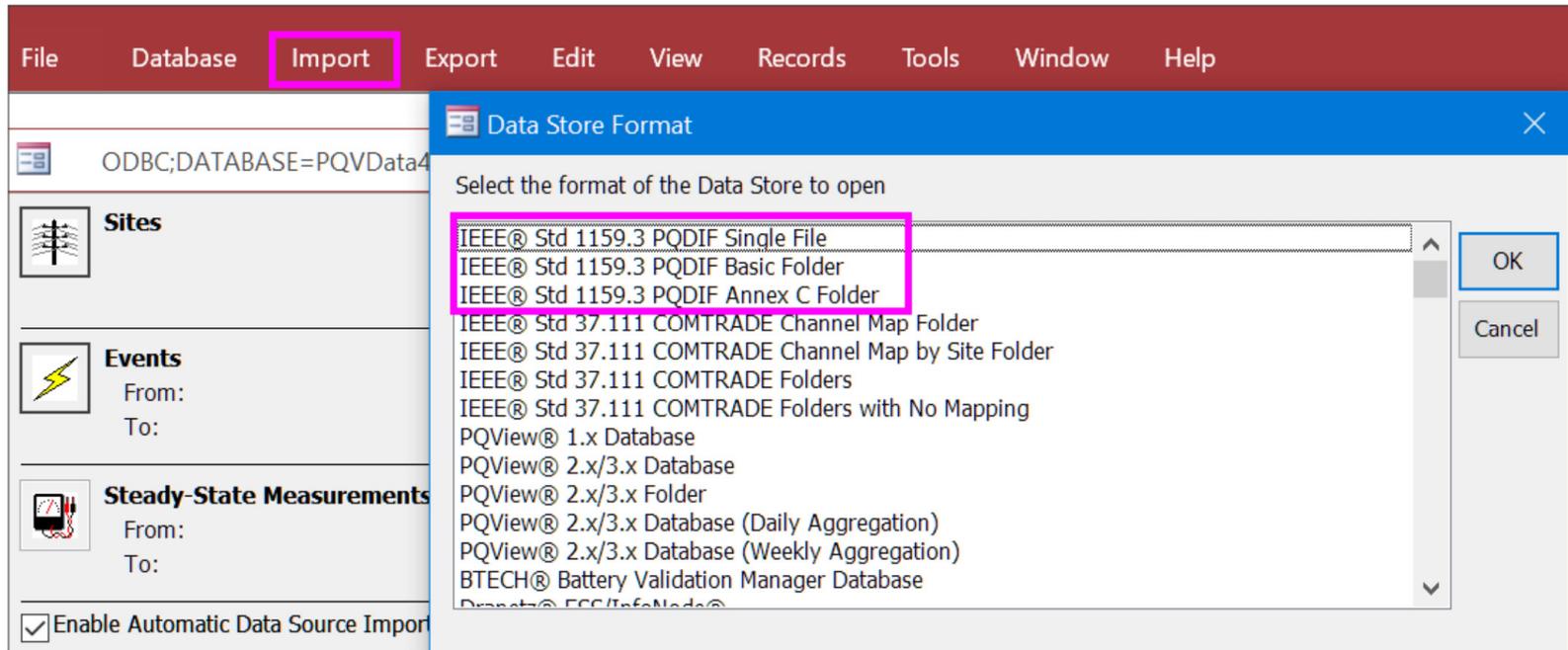
PQDIF Support in PQView Data Manager

EXPORTING:

- Select what data elements to include in the export PQDIF

PQDIF Support in PQView Data Analyzer

EXPORTING:

- Select events to export to PQDIF

PQDIF Support in PQView Web

IMPORTING:

- PQView Web Data Manager Service can poll a folder and automatically import any PQDIF files put there by another application or copied manually

PQDiffractor ® Free Viewer

- PQDIF and COMTRADE viewer
- Developed by Electrotek Concepts (Authors of PQView)
- View, browse, diagnose, convert PQDIF and COMTRADE files
- Register on PQView website and free download from http://www.pqview.com/pqdiffractor/
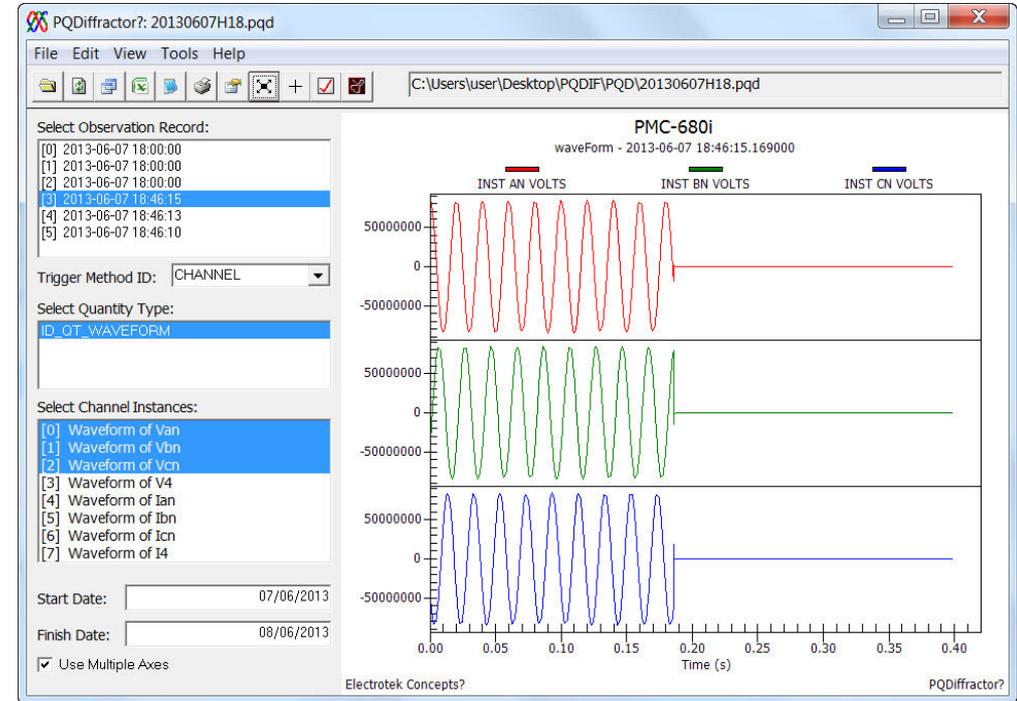
Summary

- PQDIF is a standard that defines a data file format used to store measurement data

- Data may come from power quality monitors, IED's (Intelligent Electronic Devices), and computers such as simulator software

- PQDIF Offers a level of compatibility by allowing interchange of data between different manufacturer's devices / software

- PQDIF compresses data in binary format → smaller files sizes than ASCII, such as CSV

- PQDIF is evolving to meet changes in industry standards and new instrument capabilities

The End

Thomas Szollossy
thomass@powerquality.co.th