CONTINUOUS WAVEFORM RECORDING

G5DFR
Multi-functional recorder

G4500
Portable power quality analyzer

PureBB
Hand-held power quality analyzer

G4400
permanently installed power quality analyzer

Contents

Abstract

Elspec long ago recognized the loop-hole that exists in the Power Measurement market - the impracticality of Logging parameters triggered by events. All of the existing technologies are limited due to the fact that they are only able to measure and display pre-programmed events

Elspecs' invention of the PQZIP compression algorithm takes power measurements to a new level, which puts us in a superior class of our own. It is the only technology available on the market today that allows for the recording and storing of waveform signals at sampling rate of 1,024 samples per cycle for extended period of time – an onboard recording capacity of 1+ years. By compressing data at a ratio of 1000:1, it allows for an annual worth of raw data to be stored onboard using small, compact flash memory. This opens the doors for many other unique capabilities such as:

- Enabling communicating the data through commercial communication networks
- Investigation of event propagation within the grid
- Long term event investigation
- Investigation of unpredictable events
- Wide area investigation
- Extending PMU (Synchro-phasor) application
- Advance network design and operation

Capabilities that would have been otherwise unfeasible with conventional technologies.

When coupled with Elspec PQSCADA Sapphire, a multi-vendors support power management software, over 5,000 power parameters at any given resolution are calculated for displaying and reporting purposes from the acquired waveform signals. Although PQSCADA Sapphire is a complete and standalone system, software interfaces are available to expand the scope of PQSCADA Sapphire's database to other systems, either by acquiring and combining data from other monitoring systems, or by allowing other systems to access PQSCADA Sapphire data.

This document shortly present the various application of the PQZIP technology and products developed by Elspec based on this technology.

Extending PMU (Synchro-phasor) application

Phasor Measurement Unit is a sensing device strategically placed in order to capture power system phasors using a common time source for synchronization.

Any pure sinusoidal signal can be presented as phasor with amplitude and phase angle, both representations are illustrated in figure 1 below:

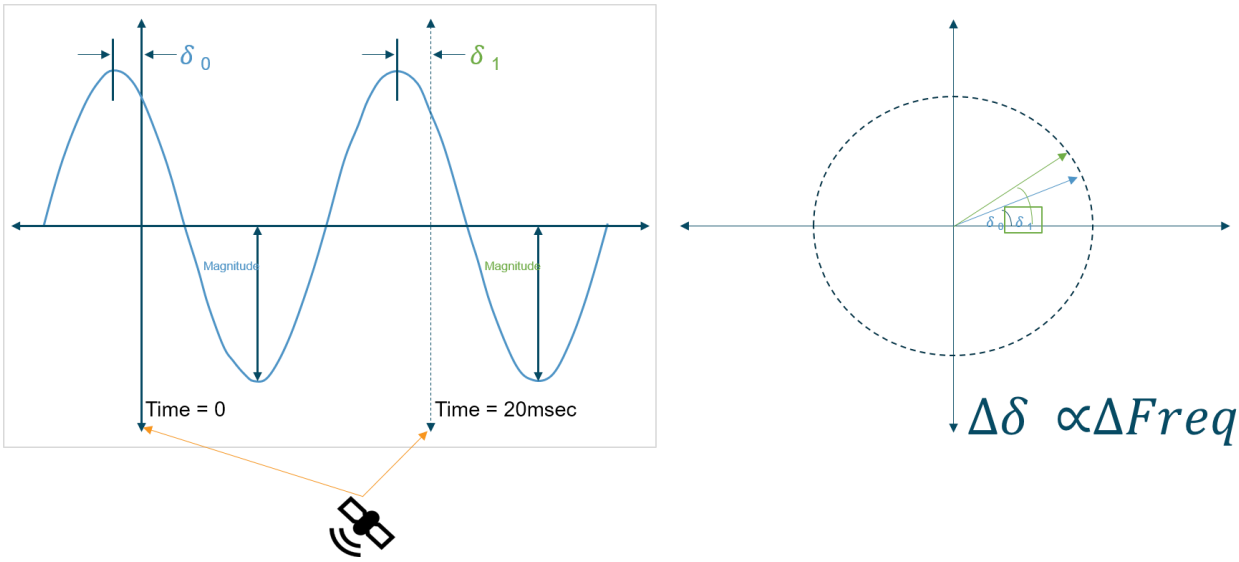


Figure 1: Vector presentation of waveform

According to Fourier series: any periodical signal can be express as sum of simple sine/cosine waves known as harmonics. Hence, extending the PMU technique to none fundamental frequencies will provide us the complete waveform signal.

The PQZIP compression algorithm extends the synchro-phasor data to none fundamental frequencies. The algorithm evaluate the real and image component of every harmonics up-to the 511th and store changes higher than TVE of 0.1%. This technique compress the data at 1000:1 compression ratio therefore, enable the recording of a continuous waveform signals at high sampling rate. A typical storage requirement for a complete waveform signals of 4 voltages and 4 currents is 1GB/month. Therefore, any event/phenomenon such as: Switching transient, Lightning transient, DC and high harmonics and Sub-harmonics is recorded and can be added to the model validation and calibration.

The products

The inventive architecture of Elspec Multi-Functional Recorders is a major technological leap. With various types of power quality analyzers, providing the ability to record the waveform at sampling rate of 1,024 sample/cycle on-board for 1+ years in a continuous way. Its intensified capabilities are distinctively adaptable to comply with the user's needs and requirements for nearly any business and/or application. Simultaneously carry out:

- Transient recording
- Disturbance Recording
- Phasor Measurement Unit (synchro phasor)
- Power quality analysis
- Sequence of events recording
- Impedance based fault location
- Energy billing measurement
- Power swing recorder
- IEC 61850 merging unit.

G4400 – Permanently installed power quality analyzer

The most advanced power quality analyzer in the market today, is equipped with the revolutionary PQZIP patent algorithm for continuous waveform recording. It enables you to predict, prevent and troubleshoot an incidence easily, without the need to set any trigger or threshold in order to capture a specific event.

General specifications

PRODUCT SERIES	G4410	G4420	G4430
Voltage sampling rate, maximum samples/cycle	256	512	1,024
Voltage harmonics (individual, even, odd, total) up to -	127th	256th	511th
Current sampling rate, maximum samples/cycle	256	256	256
Type of Analog to Digital Converter	16/20[1] bit	16/20[1] bit	16/20[1] bit
Internal Memory	128MB	4GB	16GB
Transient Detection, Microseconds (50Hz/60Hz)	78.1/65.1µs	39/32.5µs	19.5/16.3µs
Ethernet Ports	1	2	2
Power Over Ethernet (PoE- Out)	-	1	1
Voltage Ride Through on Power Loss (up to)	10sec	25sec	25sec
Communication protocols	Modbus TCP/IP, DNP 3, OPC.		
Applicable Measurement Standards	EN50160, IEEE1159, IEEE519, IEC61000-4-15,IEC61000-4-7, IEC61000-4-30 Class A, IEC62053-22/23 Class 0.2		
Applicable EMC Standards	EN55011 Group 1 Class A, EN61000-6-2, IEC60255EN60439-1 (clauses 7.9.1, 7.9.3, 7.9.4, 7.10.3, 7.10.4),FCC Part 15 Subpart B Class A, IEC61000-3-3		

For detailed specification please visit the product webpage

G4500 – Portable power quality analyzer

Advanced portable power quality analyzer embedded with PQZIP technology for continuous waveform recording.

The G4500 portable power quality analyzer designed to help you troubleshoot power quality issues with ease. The detailed information helps you to find the root cause of power quality issues.

General specifications

	G4500
Voltage sampling rate, maximum samples/cycle	1,024
Voltage harmonics (individual, even, odd, total) up to –	511th
Current sampling rate, maximum samples/cycle	256
Type of Analog to Digital Converter	16/20[1] bit
Internal Memory	32GB
Transient Detection, Microseconds (50Hz/60Hz)	19.5/16.3µs
Ethernet Ports	3
Power Over Ethernet (PoE- Out)	1
Voltage Ride Through on Power Loss (up to)	25sec
Applicable Measurement Standards	EN50160, IEEE1159, IEEE519, IEC61000-4-15, IEC61000-4-7, IEC61000-4-30 Class A
Applicable EMC Standards	EN61326, CFR47FCC, CISPR11 Group 1, FCC PART 15 Subpart B, EN61010-2, IEC61000-3-3, IEC61000-4-2, IEC61000-4-3, IEC61000-4-4, IEC61000-4-5, IEC61000-4-6, IEC61000-4-11

For detailed specification please visit the product webpage

PureBB – Handheld power quality analyzer

Configuration Free power quality analyzer embedded with PQZIP Technology for continuous waveform recording. The device is available in 2 versions: Single Phase, 3-Phase.

General specifications

PRODUCT SERIES	3 PHASE	1 PHASE
Voltage sampling rate, maximum samples/cycle	256	256
Voltage harmonics (individual, even, odd, total) up to –	127th	127th
Current sampling rate, maximum samples/cycle	256	256
Type of Analog to Digital Converter	16	16
Internal Memory	8GB*	8GB*
Transient Detection, Microseconds (50Hz/60Hz)	78.1/65.1µs	78.1/65.1µs
Ethernet Ports	Available in extension module	-
Voltage Ride Through on Power Loss (up to)	25sec	25sec
Applicable Measurement Standards	EN50160, IEEE1159, IEEE519, IEC61000-4-15, IEC61000-4-7, IEC61000-4-30 Class A	
Applicable EMC Standards	EN 55011, FCC Part 15, IEC 61000-2-2, IEC 61000-3-3, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6, IEC 61000-4-11	

For detailed specification please visit the product webpage

G5 – Multi-functional recorder

The G5 is a distributed multi-functional recorder that continuously records all waveform signals at sampling rate of 1,024 samples per cycle. The G5 designed as a substation IED and include the following functionalities: Digital Fault Recorder, Phasor Measurement Unit, Power Quality Monitoring, Sequence of Event Recording, Dynamic System Monitoring, Impedance based Fault, Location, Energy Billing Measurement, Merging Unit.

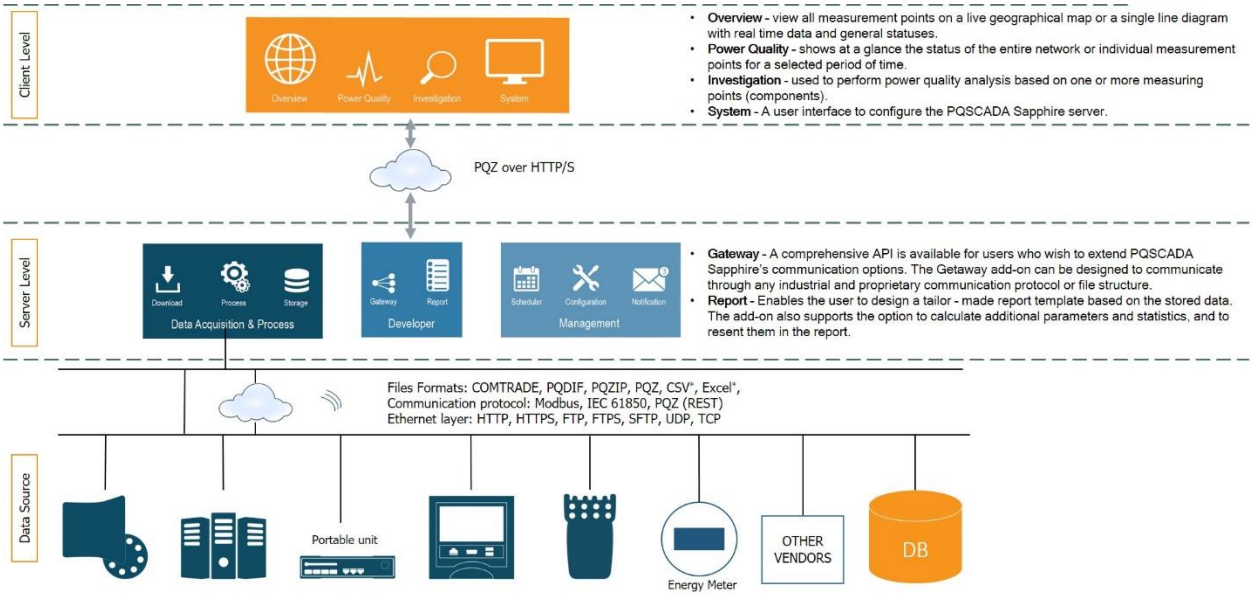
General specifications

<table>
<tr><th></th><th>G5</th></tr>
<tr><td>Voltage sampling rate, maximum samples/cycle</td><td>256/512/1,024 - selectable</td></tr>
<tr><td>Voltage harmonics (individual, even, odd, total) up to –</td><td>127th, 256th, 511th</td></tr>
<tr><td>Current sampling rate, maximum samples/cycle</td><td>256/512/1,024 - selectable</td></tr>
<tr><td>Type of Analog to Digital Converter</td><td>24 bit</td></tr>
<tr><td>Internal Memory</td><td>32GB</td></tr>
<tr><td>Transient Detection, Microseconds (50Hz/60Hz)</td><td>19.5/16.3µs</td></tr>
<tr><td>PMU (IEEE C37.118)</td><td><table><tr><th>Performance Class</th><th>Max reporting rate 50Hz</th><th>Max reporting rate 60Hz</th></tr><tr><td>P</td><td>200/sec</td><td>240/sec</td></tr><tr><td>M</td><td>100/sec</td><td>120/sec</td></tr></table></td></tr>
<tr><td>SFP Ethernet Ports</td><td>2</td></tr>
<tr><td>Communication protocols</td><td>IEC 61850 publisher: MMS, GOOSE, SV,
IEC 61850 GOOSE subscriber,
C37.118 (PMU)
Modbus TCP/IP, DNP 3</td></tr>
<tr><td>Voltage Ride Through on Power Loss (up to)</td><td>25sec</td></tr>
<tr><td>Applicable Measurement Standards</td><td>IEEE C37.118 – 2011/2014 synchro-phasor, EN50160, IEEE1159, IEEE519, IEC61000-4-15, IEC61000-4-7, IEC61000-4-30 Class A</td></tr>
<tr><td>Applicable EMC Standards</td><td>IEC 61000-4-9 Class 4, IEC 61000-4-10 Class 5, IEC 60255-26 section 8.2, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-18, IEC 61000-4-6, IEC 61000-4-8, IEC 61000-4-16, IEC 61000-4-11, IEC 60255-21-1:1988, IEC 60255-21-2:1988, IEC 60255-21-3:1988</td></tr>
</table>

For detailed specification please visit the product webpage

PQSCADA Sapphire – Power management software

Elspec PQSCADA Sapphire allows all Fault Recorders, Power Quality Analyzers, Revenue Meters and all other IED to be analyzed in a single and unified system. PQSCADA Sapphire is an expandable platform – further capabilities can be easily added later with add-ons, or developed independently through the use of API to meet your custom needs and applications.



PQSCADA Sapphire is available in 3 editions as follow:

EXPRESS (FREE)	PROFESSIONAL	ENTERPRISE
Import/Export PQZIP	Import/Export PQZIP	Import/Export PQZIP
Import/Export PQZ	Import/Export PQZ	Import/Export PQZ
Import/Export COMTRADE	Import/Export COMTRADE	Import/Export COMTRADE
Import/Export PQDIF	Import/Export PQDIF	Import/Export PQDIF
Export to Excel	Export to Excel	Export to Excel
Export to CSV	Export to CSV	Export to CSV
-	MODBUS TCP/IP	MODBUS TCP/IP
-	IEC 61850	IEC 61850
up-to 2 sites per investigation	Unlimited	Unlimited
Trend chart	Trend chart	Trend chart
Grid chart	Grid chart	Grid chart
Summary chart	Summary chart	Summary chart
Spectrum chart	Spectrum chart	Spectrum chart
Statistics chart	Statistics chart	Statistics chart
Event chart	Event chart	Event chart
Scatter events chart	Scatter events chart	Scatter events chart
-	Scatter parameter chart	Scatter parameter chart
-	Cyclic histogram chart	Cyclic histogram chart
-	Phasors chart	Phasors chart
-	-	Schedule tasks
-	-	Triggered tasks
-	-	enhanced security module
-	-	Run as system service
-	-	Client/server architecture
-	-	Servers hierarchy
-	Overview module	Overview module
-	Tags	Tags
-	-	Email notifications
-	-	SMS notifications
-	-	Push events to Sapphire App

For detailed specification please visit the product webpage

Selected key customers and projects

The continuous waveform recording is a worldwide success and already implemented in various interesting projects. It is also well established in the renewable energy sector – about 30% of all wind power generation is equipped with Elspec analyzers. Following is a shortlist of project and OEM partners with Elspec:

Customer		Product	Description
Siemens Gamesa	OEM	G4400	1,000+ units installed with annual growth of 100 units.
Vestas	OEM	G4400	1,000+ units installed with annual growth of 150 units.
Nordex	OEM	G4400	300+ units installed with annual growth of 50 units.
Ørsted	Ongoing projects	G4400/G5	Elspec is the major power quality analyzer for offshore wind farm project. 300+ units installed and growing
Viesgo	Project	G400/G5	The main power quality analyzer to test compliance with grid code. PQSCADA Sapphire manage and control legacy (other vendors) PQ analyzers of the entire grid. 300+ units installed
Vattenfal	Ongoing projects	G4400	Elspec is the major power quality analyzer for offshore wind farm projects. 300+ units installed and growing
Statnet (Norway)	Project	G4400 + G5	100 units as mixed of G4400 and G5 installed on MV, HV and EHV grid.
ASCO (Schneider Electric)	OEM	G4400	1,000+ units installed with annual growth of 150 units.
Power Core (Australia)	Project	G5	The G5 is the main recorder for the innovative Rapid Earth Fault Current Limiter Program (REFCL) project. 40 units already installed and commissioned.
Ausnet services (Australia)	Project	G5	The G5 is the main recorder for the innovative Rapid Earth Fault Current Limiter Program (REFCL) project. 40 units already installed and commissioned.
Israel Electric Company (IECo)	Project	PureBB	Elspec awarded to supply hundreds of devices to continuously monitor the Israeli HV network.
Israel Electric Company (IECo)	Project	G5	19 DFRs was installed in the major generation facility.
EMS (Serbian national TSO)	Project	G5	G5 DFR was installed on the Serbian transmission substation
CFE (Mexico)	Project	G4400	CFE specify the G4400 as the main power quality analyzer in Mexico. Any renewable generation who wish to be connected to the grid, must install G4400 in the PCC. More than 300 units installed by 2020.