PQ Secure

Technical manual UP-2210

English version 24.0

UNIPOWER
Sweden

Introduction

The PQ Secure system and hardware documentation is divided into the following documents:

Hardware Installation and configuration manual	*Installation and configuration procedures for the meter and the realtime software*
PQ Secure SQL user and software manual	*Installation and use of the database system software*
PQ Secure Light user and software manual	*Installation and use of the Light system software*
UP-xxxx Technical manual	*Technical specifications and details for the meter*

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1 SAFETY INFORMATION AND UNDERTAKING

Information about personal safety during installation and use of the PQ Secure system can be found in the PQ Secure installation manual, which also includes information about liabilities and warranties.

2 TECHNICAL SPECIFICATION UP-2210

2.1 IEC 62586

UP2210 complies to IEC 62586-1 and IEC 62586-2

Type of instrument according to 7.2 (IEC 62586-1)

UP2210	PQI-A-FI1-H

Table 2 – Definition of class A products

	Fixed installed		Portable	
	Indoor application	**Outdoor application**	**Indoor application**	**Outdoor application**
EMC environment G	PQI-A-FI1 PQI-A-FI2	PQI-A-FO	PQI-A-PI	PQI-A-PO
EMC environment H	PQI-A-FI1-H PQI-A-FI2-H	PQI-A-FO-H	PQI-A-PI-H	PQI-A-PO-H
NOTE FI1 is an indoor environment with uncontrolled temperature variations, while FI2 is an indoor environment with controlled temperature variations				

Instrument characteristics according to 7.3 (IEC 62586-1)

Function symbols	Function	Class according to IEC 61000-4-30 (A or S)	Range	Additional information
f	Power frequency	Class A	42,5 – 69 Hz	
U	Magnitude of the supply voltage	Class A	50 V ≤ U_{din} ≤ 230 V	0 – 500 V RMS
P_{st}, P_{lt}	Flicker	Class A	0,2 to 10	0,1 - 20
U_{dip}, U_{swl}	Supply voltage dips and swells	Class A	N/A	0 – 500 V
U_{int}	Supply voltage interruptions	Class A	N/A	0 – 100%
$U_0,\ U_2$	Supply voltage unbalance	Class A	0,5 – 100%	User selectable
U_h	Voltage harmonics	Class A	10% to 200% of Class 3 of IEC 61000-2-4	
U_{ih}	Voltage interharmonics	Class A	10% to 200% of Class 3 of IEC 61000-2-4	
MSV	Mains signalling voltage	Class A	0% to 15% U_{din}	
Under/over	Under/over deviation	N/A	N/A	
RVC	Rapid Voltage Changes	Class A	0,5% < Urvc < 10%	
I	Magnitude of current	Class A	1% I_n to full scale	0 to 6A 0 to 30 A
$i_0,\ i_2$	Current unbalance	Class A	0,5% to 100%	
I_h	Harmonic currents	Class A	10% to 200% of Class 3 of IEC 61000-2-4	

I_{ih}	Inter-harmonic currents	Class A	10% to 200% of Class 3 of IEC 61000-2-4	

2.2 Voltage channels

Inputs	4 isolated inputs + reference
Range	0 - 500 V AC [1] +/- 707 V DC [1]
Resolution	24 bits
Basic Sampling rate	5000 samples/cycle @50 Hz 4167 samples/cycle @60 Hz
Input impedance	4 Mohm // 10pF (applies for meters with serial number 22110001 and higher, i.e. year model 2018 and later)
BurdenTypically	0,001 VA
Bandwidth	40 kHz
Filters	Analogue anti-aliasing filters
Accuracy	Better than 0,1% Udin, IEC 61000-4-30 Class A
Connector size	Cable dimension 0,2 – 2,5 mm^2, 24 – 12 AWG

Maximum continuous overvoltage: 1500 V.
Measurement category: CAT IV 300V, CAT III 500V

[1] Optional other range

2.3 High speed voltage channels

Range	+/- 2,8 kV peak level
Transient detection	Fast transients up to 31 000 samples/cycle @50 Hz 26 000 samples/cycle @60 Hz
Bandwidth	3,1 MHz
Filters	Analogue anti-aliasing filters
Accuracy	2% of read value + 0,1% of range

2.4 Current Channels

Inputs	4 isolated inputs
Range	0-30A AC (optional other range)
Resolution	24 bits
Basic Sampling rate	5000 samples/cycle @50 Hz 4167 samples/cycle @60 Hz
Input impedance	0,002 ohm
BurdenTypically	0,05 VA at 5A
Bandwidth	40 kHz
Accuracy	Better than 0,1%, IEC 61000-4-30 Class A
Connector size	Cable dimension 0,5 - 16 mm^2, 20 – 6 AWG

Current inputs max rating is 300A for 1 sec. Max 30 A continuously.

2.5 High speed current channels

Range	+/- 30 A peak level
Transient detection	Fast transients up to 31 000 samples/cycle @ 50 Hz 26 000 samples/cycle @60 Hz

Bandwidth	3,1 MHz
Filters	Analogue anti-aliasing filters
Accuracy	2% of read value + 0,1% of range

2.6 Digital inputs

Inputs	Up to 16 opto-isolated inputs (optional)
Input level	0-150 VDC. Low level <5 VDC, high level >15 VDC 0-250 VDC. Low level <50 VDC, high level >100 VDC (optional)
Connector size	Max cable dimension 0,2 – 2,5 mm^2, 24 – 12 AWG

2.7 Digital outputs

Outputs	3 relay outputs (optional) N.O.
Max output voltage	250 VAC
Load current	Max 10/5A resistive/inductive
Connector size	Cable dimension 0,2 – 2,5 mm^2, 24 – 12 AWG

2.8 System health output (Running status)

Output	System health output (optional). N.O / N.C.
Max output voltage	250 VAC
Load current	Max 10/5A resistive/inductive
Connector size	Cable dimension 0,2 – 2,5 mm^2, 24 – 12 AWG

2.9 S0 interface

Output	1 opto isolated S0 output for energy pulses (optional). 1000 pulses/kWh.
Connector size	Cable dimension 0,2 – 2,5 mm^2, 24 – 12 AWG

2.10 Temperature inputs

Inputs	2 Pt-100 sensor inputs. Range -100°C to +200°C (optional)
Uncertainty	+/-0,5°
Connector size	Cable dimension 0,2 – 2,5 mm^2, 24 – 12 AWG

2.11 External GPS input

Optional. Supports IRIG-B, NMEA (TTL/RS-232), PPS, Pulse per second (TTL)

2.12 External display/GPS port

RJ45 port for external display or external GPS (optional).

2.13 Transducer input

Transducer input for current clamps and other applications (optional).

2.14 Isolation

Chassis and communication ports are isolated from measurement inputs according to IEC 60255.

2.15 Sampling synchronisation, PLL

To obtain maximal accuracy the instrument is synchronized with the power frequency using a built-in phase-locked loop (PLL).

2.16 Anti-alias filters in accordance with IEC 61000-4-30 (IEC 61000-4-7)

The voltage and current inputs have low pass anti-alias filters in accordance with IEC 61000-4-30 Class A (IEC 61000-4-7). This is mandatory for any digital sampling instrument in order not to produce false measurements.

2.17 Power and energy

Complies with accuracy class 0.2S in accordance with IEC 62053-22. The Power is measured in four quadrants. Reactive power/energy same accuracy as class 0.2S / IEC 62053-22, i.e. better than IEC 62053-23.

2.18 Memory capacity

Storage length (in days) depending on settings and memory size.
32 MB - 16 GB available.
32 MB non-volatile flash memory (standard). 32 MB allowing 60 days of measurements with typical advanced capture mode, >100 days with EN50160 configuration.

Optional 256 MB non-volatile flash memory allows 1 year of measurements with typical advanced capture mode, 3 ½ years with EN50160 configuration.

No hard disk or moving parts.

2.19 Standards

Complies with IEC 61000-4-30 ed.3 Class A.
Complies with IEC 61000-4-7 Class I (harmonics)
Complies with IEC 61000-4-15 Class F1 (flicker).

Product is CE-marked according to EC/EEA directive 2009/125. Product is also complying with the RoHS (2011/65/EU) and WEEE (2012/19/EU) directives.

Complies with IEC 62586-1 and IEC 62586-2.
This covers, personal safety, EMC, environment and accuracy. Equal to, or better than IEC 61010-1, IEC 61000-6-5, IEC 61000-6-2 and IEC 61000-6-4.

Fulfils requirements for measurements in accordance with EN 50160,
IEC 61000-2-2, IEC 61000-2-12, EIFS, NRS 048, ZS 387 and others.

2.20 Patents

Covered by one or more of the following patents:
European pat.no. EP1581816, US pat.no. US 7,640,118 B2, Swedish pat.no. SE525331,
Chinese pat.no. L200380109063.0, German pat.no. EP11341, U.K pat.no. 1581816,
French pat.no. B542303FR

2.21 Calibration and self-test

To assure maximum reliability, the meter regularly performs automatic self-tests. There is an automatic watchdog monitoring that the unit operates correctly.
The instrument is designed with high stability components. With fixed mounting, the design of the meter allows a recommended 10 years calibration interval under normal operating conditions. We recommend that a statistical verification is done every 5 years without removing the meter.

2.22 Communication ports

1 DB9M RS-232 port	Used for direct communication or to a modem (External modem or GSM-modem are optional).
1 RS-485 port	(optional).
1 RJ-45 port	100Base-T/10Base-T Ethernet communication (optional).
1 USB-B port	

The meter can also interface with other systems using either Modbus TCP/serial, DNP 3.0 or PQDif (IEEE 1159.3). IEC 61850 (IEC 61850-90-17) optional.

2.23 Power Supply

Can be replaced by user without removing the meter.
85-264 VAC or 88-365V DC in standard edition (42-70 Hz)
Other DC ranges are optional - for battery connection etc.
Isolation category: CAT IV 150V, CAT III 300V

2.24 UPS

30 minutes battery power (optional).

2.25 Power consumption

Less than 10 VA (all versions).

2.26 Additional time synchronization

GPS, NTP, NMEA 0183 or IRIG-B synchronization. Separate GPS module available for direct connection to meters.

2.27 Size and weight

215 x 310 x 70 mm	Width x Height x Depth
1430 g	Weight

2.28 Environmental conditions

PQI-A-FI1-H according to IEC 62586-1:2017

-25ºC to +55ºC	Operating temperature
-25ºC to +65ºC	Maximum operating temperature
-40 to +80°C	Storage temperature
5%-95%	Relative humidity, non-condensing
Protection class	IP20 IEC 60529. IP 54 or IP65 casing optional.
Altitude	0 – 4000 m

2.29 Electrical Network Configuration

The meter can be connected in all types of electrical network configurations. The meter support single phase, Four-wire wye, Three-wire Delta, single phase and Split phase. For each type of connection, the meter can be configured for measuring direct or via VT and CT.

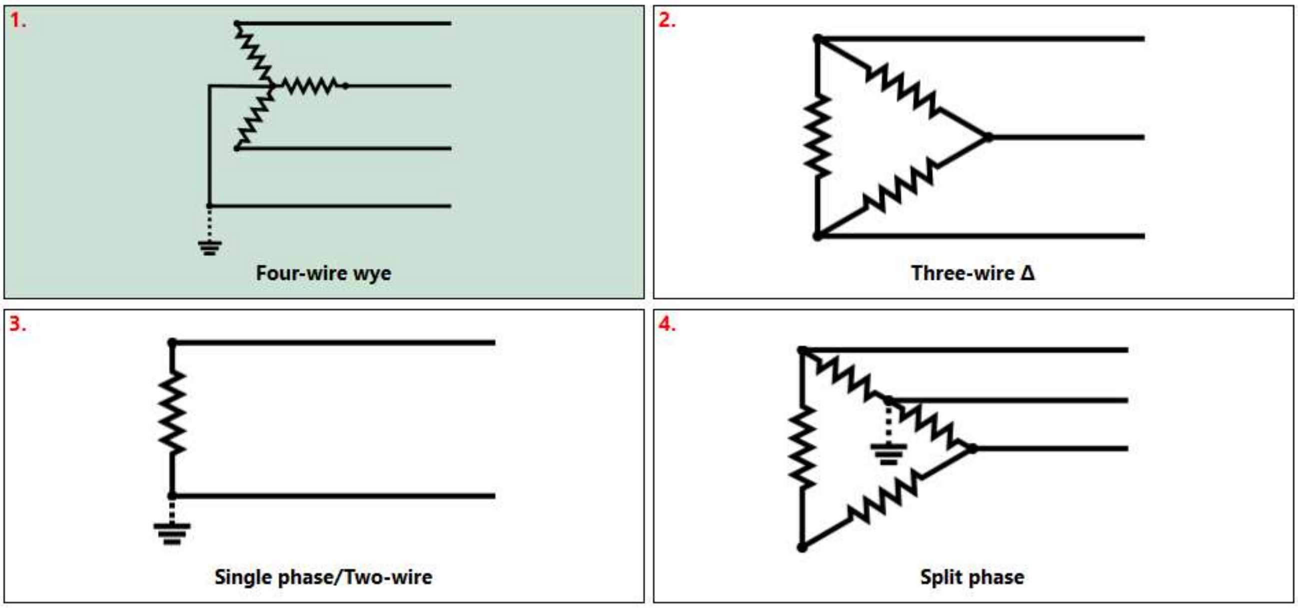

Figure 1

Example of PT/CT configuration on high voltage.

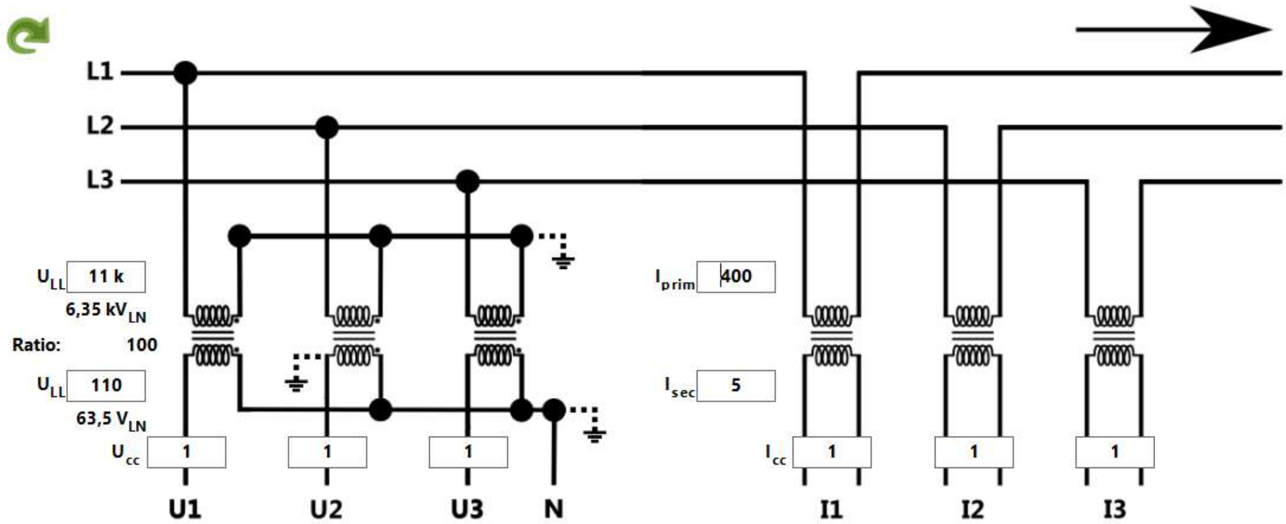

Figure 2

3 MEASURED AND CALCULATED PARAMETERS

3.1 System related measurements

3.1.1 Harmonic bandwidth extension HBE

The harmonic bandwidth extension is used for Voltage Transformer frequency correction. The compensation is applied for each harmonic component, both amplitude and phase angle error. The setting is done in PQ Online and stored in the meter. (Optional)

3.1.2 PQ Control

The PQ Control function will allow the user to activate the relay outputs based on Power Quality events. PQ related parameters that can be used are, Disturbance, Sag/Swell, Transient, Lost signal from PT or VT, Unbalance Negative, Unbalance Zero, THD U, TDD I, Pst, Plt and Individual Harmonics. When more than one output is activated the meter applies a logic OR function between the parameters. The response time can be set to fast, normal and weekly 95% value. (Optional)

3.1.3 Phasor Measurement

Optional

3.2 Event Recording

3.2.1 Sags/Swells Disturbance detection

Sags/swells are events with a duration that is a significant part of one cycle and thus affects the RMS value of the signal.

Trigging of sags/swells is performed on the four voltage channels RMS values. RMS trend information from all channels can be recorded up to 30 seconds. Waveform data up to 10 seconds can also be recorded. The pre- and post- trig times are user configurable. Pre-trig up to 10 seconds possible.
With the intelligent auto stop function activated the recording stops when the voltage is back within limits and unnecessary storage of normal values can be avoided. The number of presentation samples per cycle is user selectable when using waveform storage and can be set from 16 to 256 samples per cycle. The built in, norm compliant, hysteresis function ensures that a single sag/swell event doesn't trig the meter multiple times.

Memory capacity:

Type of sag and recording legth	*No. of sags with 32 MB*	*No. of sags with 256 MB*
Sag/swell events	>100 000	>800 000
RMS, 1 sec recording	1100	9800
RMS, 2,5 sec recording	450	8100
Waveform, 1 sec recording, 16 samples/cycle	140	1300
Waveform, 1 sec recording, 32 samples/cycle	70	1250
Waveform, 1 sec recording, 64 samples/cycle	35	325
Waveform, 1 sec recording, 128 samples/cycle	32	160
Waveform, 1 sec recording, 256 samples/cycle	32	80

Doubling the recording length will double the memory usage.

3.2.2 Transient Disturbance detection

Transients are disturbances with duration less than a cycle. Transients are captured in a number of different ways.

3.2.2.1 Switching transient detection

Typical application for this module is to find switching transients e.g. when connecting a capacitor bank.
Trigging is done by *waveform compare* (trig if current cycle differs from previous cycle). Waveform for voltage and current channels are recorded with 409,6 points/cycle. Recording contains one cycle pre-event and four cycles post-event. All transient types share the same memory.

Memory capacity:

Number of transients	*32 MB*	*256 MB*
Transient events	>100 000	>800 000
Transient waveforms	60	480

3.2.2.2 Fast transient detection

Typical application for this module is lightning surge analysis or fast switching monitoring.
Two recording triggers available:

Medium speed

Recording is trigged if high value is exceeded. Waveform from voltage and current channels will be recorded during 1 ms with up to 5 000 samples per cycle.

Memory capacity:

Number of transients	*32 MB*	*256 MB*
Transient events	>100 000	>800 000
Transient waveforms	480	3900

High speed

Recording is trigged if high value is exceeded. Waveform from voltage and current channels will be recorded during 100 us with up to 31 000 samples per cycle.

Memory capacity:

Number of transients	*32 MB*	*256 MB*
Transient events	>100 000	>800 000
Transient waveforms	480	3900

3.2.3 Digital Event Recorder, 16DI

The digital inputs can be used as an event recorder. Every change of the digital inputs will create an event with time stamp and individual text label. An alarm or email alarm can be trigged by the digital event. The digital inputs can also be used for trigging a sag or transient recording.

Number of digital events…	*32 MB*	*256 MB*
Amount	>100 000	>800 000

3.2.4 Fault recorder

The digital inputs can trig the fault recorder. The duration of the recording is user configurable. The waveform or rms-values from all 8 input channels are recorded as well as the status of the digital channels. The fault recorder can be used for protection verification.

Memory capacity:

Number of recordings with…	*32 MB*	*256 MB*
RMS, 1 sec recording	900	7980
RMS, 2,5 sec recording	360	3280
Waveform, 1 sec recording, 16 samples/cycle	100	1040

3.2.5 SlowScan Disturbance detection

The SlowScan recorder stores voltage, current, power and frequency data 0 -100 times per second. The storage interval can be set up to 300 seconds and the pre-trig up to 40 seconds. The SlowScan recorder can be trigged by voltage level, current rate of change (dI/dt), frequency, frequency rate of change (df/dt), Power rate of change (dP/dt) and reactive power rate of change (dQ/dt). The SlowScan can be used for detecting net oscillation, frequency variations, power variations or be used for long term sag recording.

Memory capacity:

Number of recordings with…	*32 MB*		*256 MB*	
	10 v/s	*100 v/s*	*10 v/s*	*100 v/s*
60 seconds recording	100	32	920	180

3.2.6 Event parameters

Sags, Swells and Interruptions are measured according to the standard IEC 61000-4-30 Class A.

Type of event	**Stored information**
Sags/swells: - U1-U3 - U4 - Interruption - Usum - I1-I3 - I4 - Isum	Trig time, trig phase, duration, level (depth), direction of disturbance (if applicable)
Sags/swells begin	Trig time, trig phase, duration, level (depth), direction of disturbance. Longer sag than recording time.
Sags/swells end	Trig time, trig phase, total sag/swell duration, level (depth), direction of disturbance. End of long sag/swell.
Sags/swells earth fault	Trig time, trig phase, sag/swell duration, level (depth), direction of disturbance. Trig on U4 with open delta measurement.
Transients	Trig time, trig phase, duration, maximum value
SlowScan	Trig time, type of trig, trig level
RVC	Trig time, trig phase, reference level, max deviation, stationary deviation and duration
Signalling	Trig time, duration, minimum/maximum values
Digital input	Trig time, channel, level

3.2.7 RVC, Rapid Voltage Change

An RVC is defined as a change in voltage between two stable levels. The change is less than 10% of the nominal voltage otherwise it is defined as a voltage dip (sag) or swell. Every RVC greater than 3% creates an event in the event list.

The RVC has three parameters: the maximum depth (ΔU_{max}), the stationary change (ΔU_{SS}) and the duration.

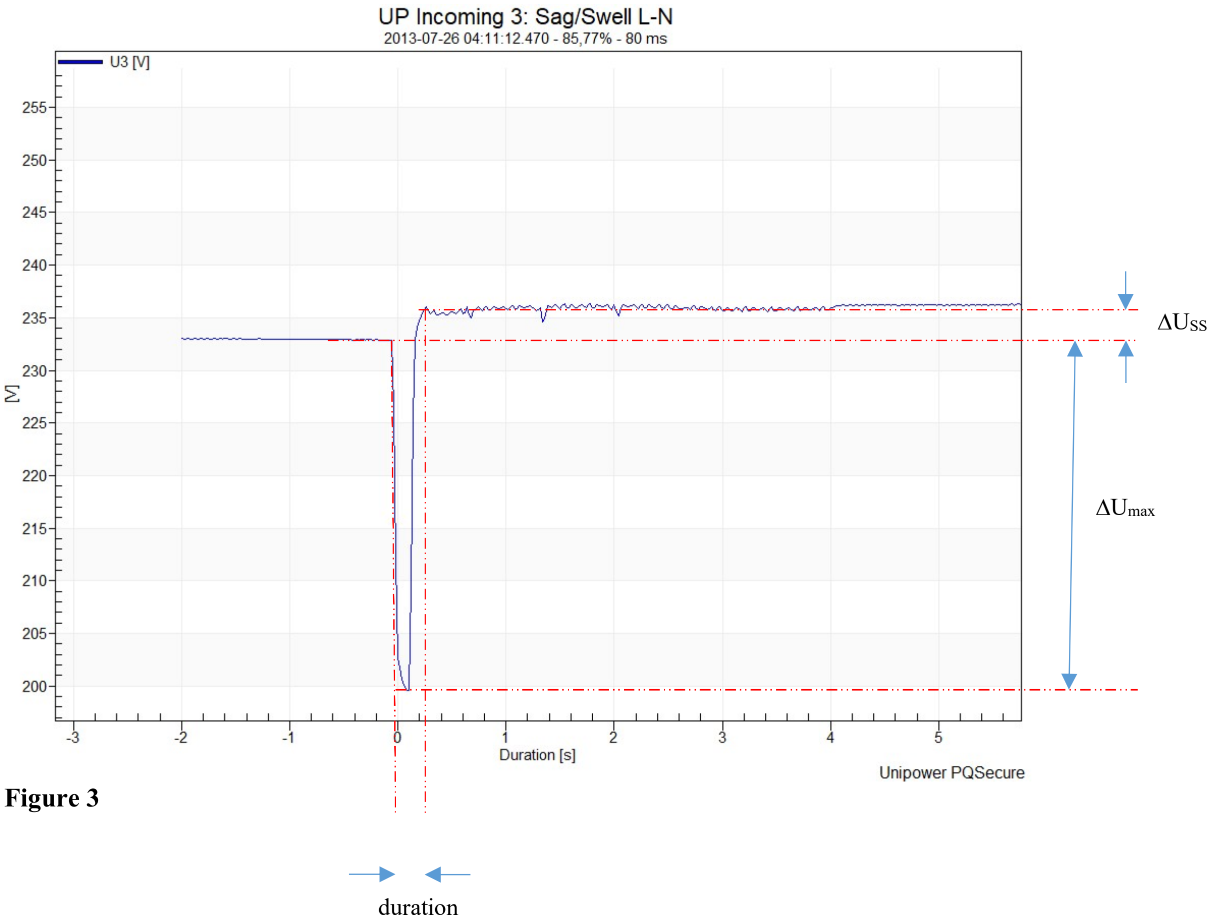

Figure 3

3.3 Statistical Parameters

The unit measures and calculates numerous parameters continuously. After a *storage interval* the parameters described below are stored in the memory. The storage interval can be set arbitrary from 1 second to several hours. Each group of parameters can have different, individual storage intervals.

3.3.1 Voltage parameters

The voltage is measured according to the standard IEC 61000-4-30 Class A.

Parameter	Description	Channel
U1Ave	Voltage RMS during the interval	1
U1Min	Lowest RMS of the voltage during the interval U_{rms} (½)	1
U1Max	Highest RMS of the voltage during the interval U_{rms} (½)	1
U2Ave	Voltage RMS during the interval	2
U2Min	Lowest RMS of the voltage during the interval U_{rms} (½)	2
U2Max	Highest RMS of the voltage during the interval U_{rms} (½)	2
U3Ave	Voltage RMS during the interval	3
U3Min	Lowest RMS of the voltage during the interval U_{rms} (½)	3
U3Max	Highest RMS of the voltage during the interval U_{rms} (½)	3
UNGAve	Voltage RMS during the interval	4
UNGMin	Lowest RMS of the voltage during the interval U_{rms} (½)	4
UNGMax	Highest RMS of the voltage during the interval U_{rms} (½)	4
U12Ave	Phase-Phase voltage RMS during the interval	1-2
U12Min	Lowest phase-Phase voltage RMS during the interval U_{rms} (½)	1-2
U12Max	Highest phase-Phase voltage during the interval U_{rms} (½)	1-2
U23Ave	Phase-phase voltage RMS during the interval	2-3
U23Min	Lowest phase-phase voltage RMS during the interval U_{rms} (½)	2-3
U23Max	Highest phase-phase voltage during the interval U_{rms} (½)	2-3
U31Ave	Phase-phase voltage RMS during the interval	3-1
U31Min	Lowest phase-phase voltage RMS during the interval U_{rms} (½)	3-1
U31Max	Highest phase-phase voltage during the interval U_{rms} (½)	3-1
Usum Ave	RMS Sum of U1-U3 voltage during the interval	1,2,3
Usum Min	Lowest RMS Sum of U1-U3 voltage during the interval U_{rms} (½)	1,2,3
Usum Max	Highest RMS Sum of U1-U3 voltage during the interval U_{rms} (½)	1,2,3
UB	Voltage unbalance (negative phase sequence in percent of positive phase sequence)	
UBPos	Positive phase sequence [V]	
UBNeg	Negative phase sequence [V]	
UBZero	Zero phase sequence [V]	

3.3.2 Symmetrical components and extended Unbalance with independent storage interval.

The Unbalance is measured according to the standard IEC 61000-4-30 Class A.

Parameter	Description
U_2	Negative phase sequence/positive phase sequence, [%]
U_0	Zero phase sequence/positive phase sequence, [%]
$U_{2\ max}$	Maximum Negative phase sequence/positive phase sequence, [%]
$U_{0\ max}$	Maximum Zero phase sequence/positive phase sequence, [%]
UBPos	Positive phase sequence [V]
UBNeg	Negative phase sequence [V]
UBZero	Zero phase sequence [V]
UBPosPhase	Positive sequence phase angle [°]
UBNegPhase	Negative sequence phase angle [°]
UBZeroPhase	Zero sequence phase angle [°]
UBPosMax	Maximum Positive sequence [V]
UBNegMax	Maximum Negative sequence [V]
UBZeroMax	Maximum Zero sequence [V]
I_2	Negative phase sequence/positive phase sequence, [%]
I_0	Zero phase sequence/positive phase sequence, [%]
$I_{2\ max}$	Maximum Negative phase sequence/positive phase sequence, [%]
$I_{0\ max}$	Maximum Zero phase sequence/positive phase sequence, [%]
IBPos	Positive sequence [A]
IBNeg	Negative sequence [A]
IBZero	Zero sequence [A]
IBPosPhase	Positive sequence phase angle [°]
IBNegPhase	Negative sequence phase angle [°]
IBZeroPhase	Zero sequence phase angle [°]
IBPosMax	Positive phase sequence [A]
IBNegMax	Negative phase sequence [A]
IBZeroMax	Zero phase sequence [A]

3.3.3 Frequency parameters

The frequency is measured according to the standard IEC 61000-4-30 Class A.

Parameter	Description
Fave	Average of frequency during the interval
Fmin	Lowest 10-second average of the frequency during the interval
Fmax	Highest 10-second average of the frequency during the interval
N_total	Total amount of 10 seconds values during the measure interval
N_good	Total amount of 10 seconds values during the interval that are within preset limits of frequency
Fmin fast	Lowest average of the frequency during 0.2s
Fmax fast	Highest average of the frequency during 0.2s
dF/dt	Max frequency rate of change, configurable integration time

3.3.4 Current parameters

The current is measured according to the standard IEC 61000-4-30 Class A.

Parameter	Description	Channel
I1Ave	RMS value of the current during the interval	1
I1Min	Lowest RMS of the current during the interval I_{rms} (½)	1
I1Max	Highest RMS of the current during the interval I_{rms} (½)	1

I2Ave	RMS value of the current during the interval	2
I2Min	Lowest RMS of the current during the interval I_{rms} (½)	2
I2Max	Highest RMS of the current during the interval I_{rms} (½)	2
I3Ave	RMS value of the current during the interval	3
I3Min	Lowest RMS of the current during the interval I_{rms} (½)	3
I3Max	Highest RMS of the current during the interval I_{rms} (½)	3
INAve	RMS value of the current during the interval	4
INMin	Lowest RMS of the current during the interval I_{rms} (½)	4
INMax	Highest RMS of the current during the interval I_{rms} (½)	4
ISum Ave	RMS value of the Sum of I1-I4, current. Earth leakage.	1-4
ISum Min	Lowest RMS, Sum of I1-I4, interval I_{rms} (½)	1-4
ISum Max	Highest RMS, Sum of I1-I4, interval I_{rms} (½)	1-4
IB	Current unbalance (negative phase sequence in percent of positive phase sequence)	
IBPos	Positive phase sequence [A]	
IBNeg	Negative phase sequence [A]	
IBZero	Zero phase sequence [A]	

3.3.5 Signalling

Signalling is measured according to the standard EN 50160

Parameter	Description
S1-S25	Highest 3 second RMS values of signal voltages in bands of 100 Hz from DC to 50*fundamental frequency (2,5 kHz at 50 Hz fundamental)

3.3.6 Flicker parameters

Flicker is measured according to the standard IEC 61000-4-30 Class A
(IEC 61000-4-15). Instantaneous Flicker Level (IFL) is calculated for realtime display.
PST (short term flicker level) and PLT (long term flicker level) are calculated for long term statistics.

3.3.7 Power parameters

Complies with accuracy class 0.2S in accordance with IEC 62053-22. The Power is measured in all four quadrants. Power parameters are calculated per phase and total values depending on configuration method.

Active average power $P = \frac{1}{T}\int_{t=0}^{T} u_t i_t \, dt$

Reactive average power $Q = \frac{1}{T}\int_{t=0}^{T} u_t i_{t+90^\circ} \, dt$

Apparent average power $S=U_{rms} * I_{rms}$

Power factor $PF = abs\left(\frac{P}{S}\right)$

Cos φ (fundamental) $DPF = abs\left(\frac{P_1}{S_1}\right)$

3.3.8 Individual harmonic amplitude

The amplitudes are measured according to the standard
IEC 61000-4-30 ed.2 Class A (IEC 61000-4-7 Class I).
RMS value of each voltage harmonic subgroup $U_{sg,n}$ from DC to 100th harmonic calculated for channels U1-U4 and I1-I4.

3.3.9 Individual inter harmonic amplitude

The inter harmonic amplitudes are measured according to the standard
IEC 61000-4-30 ed.3 Class A (IEC 61000-4-7 Class I).
RMS value of each voltage interharmonic subgroup $U_{isg,n}$ 1 to 100th harmonic calculated for channels U1-U4 and I1-I4.

3.3.10 Individual 3 sec maximum harmonic amplitude

The amplitudes are measured according to the standard
IEC 61000-4-30 ed.3 Class A (IEC 61000-4-7 Class I).
3 sec maximum RMS value of each voltage harmonic subgroup $U_{sg,n}$ from DC to 100th harmonic calculated for channels U1-U4 and I1-I4.

3.3.11 Individual harmonic phase angles

The phase angles are measured according to the standard IEC 61000-4-7.
Phase angle in degrees relative to the fundamental on channel U1 for each voltage harmonic up to 100th for channels U1-U4 and I1-I4.

3.3.12 Individual harmonic power

The power harmonics are measured according to the standard IEC 61000-4-7.
Active mean power for each harmonic from DC to 50th per phase 1, 2 and 3 as well as total 3-phase power.

3.3.13 Supraharmonics 2-9kHz

Stores supraharmonics are measured according to the standard IEC 61000-4-7. The parameters are stored as the highest three second supraharmonic.

3.3.14 Total Harmonic Distortion (THD)

Harmonic distortion is calculated from individual harmonics measured according to the standard IEC 61000-4-30 ed.2 Class A (IEC 61000-4-7 Class I).

THDF

Harmonic distortion in relation to the fundamental according to THDS in IEC 61000-4-7. Calculated for U1-U4 and I1-I4.
(THDF = THD **F**undamental)

$$THDF = THDS = \sqrt{\sum_{n=2}^{n}\left(\frac{G_{sgn}}{G_{sg1}}\right)^2}$$

If EN50160 is selected n=40 otherwise n=50

THDR

Harmonic distortion in relation to the channel RMS-value. THDR = THD **R**MS. Calculated for U1-U4 and I1-I4.

$$THDR = \sqrt{\sum_{n=2}^{n} \left(\frac{G_{sgn}}{U_{rms}}\right)^2}$$

If EN50160 is selected n=40 otherwise n=50

THDOdd

Distortion of all odd harmonics (3, 5, 7, …, n) in relation to the fundamental. Same method as THDF but only odd harmonics. Calculated for U1-U4 and I1-I4.
If EN50160 is selected n=39 otherwise n=49.

THDEven

Distortion of all even harmonics (2, 4, 6, …, n) in relation to the fundamental. Same method as THDF but only odd harmonics. Calculated for U1-U4 and I1-I4.
If EN50160 is selected n=40 otherwise n=50.

THDInter

Distortion of all inter-harmonics (TID) < harmonic n in relation to the fundamental. Same method as THDF but only inter-harmonic components. Calculated for U1-U4 and I1-I4.
If EN50160 is selected n=40 otherwise n=50

TDD

Distortion of all harmonics in relation to an absolute value. Calculated for U1-U4 and I1-I4.
TDD = **T**otal **D**emand **D**istortion.

$TDD_U = \sqrt{\sum_{n=2}^{n} \left(\frac{G_{sgn}}{U_{ref}}\right)^2}$ where U_{ref} is a reference voltage.

$TDD_I = \sqrt{\sum_{n=2}^{n} \left(\frac{G_{sgn}}{I_{ref}}\right)^2}$ where I_{ref} is a reference current.

If EN50160 is selected n=40 otherwise n=50

THDF2650

Distortion of high frequency harmonics (26^{th} –100^{th}) in relation to the fundamental. Same method as THDF but only includes harmonics 26 to 100. Calculated for U1-U4 and I1-I4.

3.3.15 K-factor for transformers

The K-factor is a value that indicates the increase in eddy current loss. It can be used when dimensioning transformers. K factor is calculated for channels I1-I4.

$$K = \sum_{h=1}^{h_{max}} \left(\frac{I_h}{I_1}\right)^2 h^2$$

Index 1= fundamental
If EN50160 is selected h_{max}=40 otherwise h_{max} =50

Also *Factor K*, according to British Standard BS 7821 can be calculated. This is user configurable in the meter settings.