SATEC
Powerful Solutions

expertmeter™

High Performance Analyzer

PM180

EN 50160:2010
Power Quality Recorder

Application Note

BB0180 REV.A1

Table of Contents

1 General

The PM180 provides two user-selectable power quality recording options compliant with either the EN 50160:2007, or EN 50160:2010/IEC 61000-4-30 power quality standards. This application note outlines specific features provided by the EN 50160:2010 compliant PQ recorder.

The accompanying PAS configuration and data acquisition software provides a user with a means for remote configuring the PQ recorder, monitoring, retrieving and reporting EN 50160:2010 compliance statistics data.

See the PM180 Operation Manual for basic information on configuring and operating EN 50160 PQ recorders and available data logging options.

See Section 2 Configuring the EN 50160:2010 PQ Recorder on how to select and configure the PM180 PQ recorder to get EN 50160:2010/IEC 61000-4-30 compliant measurements and statistics reports.

1.1 Features

The EN 50160:2010 PQ recorder provides a user with accurate power quality measurements and statistical reports compliant with the EN 50160:2010 European standard. The recorder also provides detailed time-stamped event, data and waveform information to allow easy diagnosing and resolving power quality incidents.

The EN 50160:2010 PQ recorder features:

- IEC 61000-4-30 class A performance compliance
- Monitoring, detecting and recording power quality incidents for all voltage characteristics listed by EN 50160:2010
- Collecting statistical information upon EN 50160:2010 indices including percentiles, maximum values over a period of time and indicative statistics for voltage events
- Printable EN 50160:2010 compliance reports with selectable voltage characteristics, accompanied by optional user information and company logo
- Configurable power quality indices including compliance limits, hysteresis and weekly/daily percentiles in accordance with the requirements of the particular installation

Reference documents:

1) EN 50160:2010 Voltage characteristics of electricity supplied by public electricity networks, July 2010, CENELEC.
2) CLC/TR 50422:2003 Guide for the application of the European Standard EN 50160, June 2005.
3) IEC 61000-4-30 Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Power quality measurements, Edition 3.0, 2015-02.
4) IEC 61000-4-7 Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, 2nd edition, 2002-08.
5) IEC 61000-4-15 Electromagnetic compatibility (EMC) – Part 4-30: Testing and measurement techniques – Flickermeter – Functional and design specifications, Edition 2.0, 2010-08.
6) IEC/TR 61000-2-8 Electromagnetic compatibility (EMC) – Part 2-8: Environment – Voltage dips and short interruptions on public electric power supply systems with statistical measurement results, 2002-11.
7) IEC TS 62749 Assessment of power quality – Characteristics of electricity supplied by public networks, Edition 1.0, 2015-04
8) IEC 62586-1 Power quality measurements in power supply systems – Part 1: Power quality instruments (PQI), Edition 2.0, 2017-03

9) IEC 62586-2 Power quality measurements in power supply systems – Part 2: Functional tests and uncertainty requirements, Edition 2.0, 2017-03

1.2 Measurement Techniques

1.2.1 Power Quality Monitoring and Recording

The PM180 PQ recorder measures, evaluates and collects power quality information as defined and described in EN 50160:2010. A detailed description of the evaluation techniques used by the PM180 is given in Annex A.

All voltage characteristics listed in EN 50160 are measured using methods compliant with IEC 61000-4-30 Class A measurements. Whenever IEC 61000-4-30 techniques conflict with EN 50160:2010 normative requirements, a user is given an option to choose a preferable method.

Monitoring Thresholds and Compliance Limits

Since PQ monitoring is intended both for network power quality assessment and for troubleshooting of power quality related problems, the PQ recorder provides collecting of power quality compliance statistics and individual recording of all power quality related events based on predefined detection thresholds and standard-compliant limits.

The monitoring thresholds and compliance limits are normally based on power quality indices provided by EN 50160:2010, but can be changed by the user via the EN 50160:2010 PQ Recorder setup to meet his particular installation's requirements.

For voltage parameters that are characterized by statistical power quality indices like percentiles over a period of time, or for which only indicative statistics is collected, like dips, swells and interruptions, the detection thresholds are defined by high and low normally permissible limits parameters.

For voltage characteristics which compliance with the standard is also characterized by maximum and minimum values over a period of time, like frequency and supply voltage variations, the compliance limits are extended by the high and low maximum permissible limits parameters.

The percentile ranks for evaluation of percentiles are factory set to the indices compliant with EN 50160:2010 but can be set to any value to meet a particular installation or a different power quality standard.

PQ Event Recording

Whenever a monitored parameter exceeds its monitoring/detection threshold, a power quality related event is recorded to the PQ event log file provided with indication of the affected parameter, channel, start and end timestamps and a maximum/minimum magnitude recorded during the event.

For voltage characteristics provided with dual compliance limits, a user can choose which one is to be used as a detection threshold for monitoring PQ related events.

Any monitored parameter can be individually enabled or disabled for event recoding via the EN 50160:2010 PQ Recorder setup, as well as event recording can be globally disabled or enabled in the device. Disabling of PQ event recording, partially or entirely, does not affect evaluation of statistical power quality data collected for EN 50160:2010 compliance reports.

Disturbance Waveforms Recording

Power quality events can be accompanied by voltage and current waveforms recorded at the beginning, during and after the event. The number of pre-event and post-event cycles and the desired sample rate can be configured via the Waveform Recorder setup.

Waveform log files #7 and #8 are used by default for recording power quality related waveforms, but those can be changed to any other log file via the EN 50160:2010 PQ Recorder setup. In presence of the fast transient module, transient waveforms are re-directed to Waveform Log #6 that is automatically re-configured in this case for a higher sample rate.

Waveform recording is enabled by default for voltage dips, swells, interruptions and transients and can be individually enabled for other power quality parameters via the EN 50160:2010 PQ Recorder setup.

Data Trend Recording

For troubleshooting and testing reasons, the PQ recorder provides an additional feature that allows synchronous recording a set of selected measured data, like RMS volts and currents, signaling voltages, harmonics characteristics, and others, before, during and after a power quality event while using different time envelopes dependent on the event duration.

The recorder can start at half-cycle measurements and, as an event continues more time, to automatically move to longer time envelopes of up to 10-min aggregated measurements, and then return to a faster sample rate at the end of the event. The recording duration for each time envelope and the number of cycles to be recorded before and after the event can be configured via the EN 50160:2010 PQ Recorder setup.

Data log file #14 is dedicated for PQ event data trends. By default, no data trending is enabled in the PM180, but can be individually enabled and configured for any parameter using desired time aggregation intervals.

See Annex E for the list of parameters available for data trends synchronized with the PQ recorder.

Compliance Statistics Recording

EN 50160:2010 compliance statistics are automatically collected during weekly/daily evaluation periods unless evaluation is intentionally disabled via the EN 50160:2010 Advanced Setup. At the end of every evaluation period, collected statistical data is recorded to the dedicated log files. For testing reasons, intermediate statistics can be retrieved online and inspected at any time during the current evaluation period without affecting final compliance reports.

Data log files #10 and #11 are automatically configured in the PM180 for a 260-week statistics recording based on weekly evaluation periods, or for 260 days assuming daily statistics evaluation. The file size can be changed via the Log Memory setup dialog in case that data should be stored in the device for a longer time.

A weekly or daily evaluation period for collecting and recording statistical data can be selected, and the week day and time on which a calendar week starts can be configured via the EN 50160:2010 Advanced Setup.

1.2.2 Special Features

Flagging

During a voltage event like a dip, swell or interruption, the measurements for other voltage characteristics might produce unreliable values. The flagging concept avoids counting a single event more than once in different voltage parameters.

If, during a given time interval, a voltage event is detected, all voltage characteristics aggregated during this interval are flagged and are not included into statistical data. If, during a given time interval, any value is flagged, the aggregated value which includes that value is also be flagged.

Flagged data is not included into the EN 50160:2010 compliance statistics and PQ incidents are normally not recorded to the PQ event log file. For testing or troubleshooting reasons, recording flagged data can be enabled via the EN 50160:2010 Advanced Setup.

When enabled, flagged events appear in the PQ event log reports being marked by an asterisk.

Polyphase Aggregation

In a three-phase system, polyphase aggregation is applied to voltage dips and swells. A voltage dip or a swell is counted as one equivalent polyphase event regardless of the shape and number of phases affected and is characterized by a single duration.

The dip/swell magnitude on each affected phase during a polyphase event is individually recorded to the PQ event log file.

Time Aggregation

Reclosing operations can result in multiple voltage dips or interruptions from the same primary event. It can be misleading to count these disturbances as separate events.

To take account of this effect, the concept of time aggregation is applied for statistical analysis of voltage dips, swells and interruptions. Multiple successive events occurring within a limited interval of time may be counted as an equivalent event with equivalent magnitude and duration. For example, all voltage dips within a defined time interval can be counted as one single event whose magnitude and duration are those of the most severe dip observed during this interval.

Time aggregation is normally disabled in the PM180 and can be enabled by specifying a non-zero time aggregation interval from 1 to 180 s via the EN 50160:2010 Advanced Setup.

Regardless of applying time aggregation, each individual voltage event with its magnitude and duration is recorded to the device PQ event log file to allow further troubleshooting power quality related problems.

1.2.3 IEC 61000-4-30 Related Features

For use in specific troubleshooting or statistical applications based on IEC 61000-3-40 methods but requiring a different set of power quality parameters or power quality indices than those listed in EN 50160, as well as for IEC 61000-4-30 compliance testing reasons, the PM180 provides additional measurements like magnitude of coincident currents, harmonic and interharmonic currents, and data aggregation over time intervals listed in IEC 61000-4-30.

Data Aggregation

Though the EN 50160:2010 power quality indices require measurement aggregation over well-defined time intervals for each voltage characteristic, the PM180 also provides measurement aggregation over time intervals listed in IEC 61000-4-30, mostly for testing reasons.

10/12−cycle, 150/180-cycle, 10-min and 2-hour aggregated power quality related data, like voltages, currents, frequency, unbalance and total harmonics and interharmonics, are available for monitoring and recording.

The integration interval for harmonic and interharmonic voltages and currents intended for monitoring can be selected via the EN 50160:2010 Advanced Setup. By default, harmonic and interharmonic voltage and current readings represent data measured over non-overlapping 10/12-cycle intervals.

Coincident Currents

Current and current harmonic and interharmonic measurements are not listed by EN 5010:2010 indices and not evaluated for EN 50160:2010 compliance statistics, but provided as a supplement to voltage measurements.

Coincident currents can be recorded in the PQ event log along with the corresponding voltage channels for voltage dips, swells, interruptions and voltage variations with same timing determined by corresponding voltage event. Recording coincident currents is normally disabled and can be enabled via the EN 50160:2010 Advanced Setup.

Time Stamping

For testing reasons, where power quality related data is to be accompanied by a timestamp, the PM180 provides a synchronous polyphase timestamp for latest available 10/12-cycle measurements that can also be applied to all other composite intervals based on these measurements, as well as per channel timestamps for Urms(1/2) related voltage measurements commencing at a fundamental zero crossing. They are available for monitoring and recording via the present online PQ data group of parameters (see Annex D).

Block Numbering

Block numbering of 10/12-cycle and 150/180-cycle measurements within each 10-min interval is provided for IEC 61000-4-30 testing reasons (see Annex D).

The block numbers are updated when new data evaluated over the corresponding aggregation interval is available. Block numbers can be effectively used for synchronous and non-overlapping recording of the related power quality data by taking them as setpoint triggers along with a delta operator that responds to a trigger parameter change.

Flagging Information

Flagging information is given for all aggregation intervals and is indicated by the corresponding parameters in the present PQ data group (see Annex D). It can be used for testing reasons or accompany power quality related data while monitoring and recording.

Each flag holds its status until the corresponding aggregation interval is validated.

2 Configuring the EN 50160:2010 PQ Recorder

See the PM180 Operation Manual for common instructions on configuring your device. The following sections outline specific implementation details for operating the EN 50160:2010 PQ recorder.

2.1 EN 50160:2010 Recording Option

To get EN 50160:2010/IEC 61000-4-30 compliant measurements and statistics reports, select the EN 50160:2010 PQ option via the General Setup/Device Options setup dialog.

2.2 Clearing EN 50160:2010 Evaluation Counters

The present contents of the EN 50160 evaluation counters may include undesirable statistical data collected during device testing and deployment that can appear in compliance statistics reports. It is recommended to clear PQ counters before starting your EN 50160 evaluation.

To clear the EN 50160 evaluation counters, select Reset from the Monitor menu, click Clear Operation/Event Counters, check the PQ Counters box, and then click OK and confirm your command.

2.3 General Power Quality Related Settings

The following device settings affect EN 50160 evaluation and should be checked prior to running the PQ recorder.

Reference Voltage

As the general approach of EN 50160, all voltage characteristics are referenced to the nominal network voltage that shall be specified by the secondary line-to-line voltage parameter via the Basic setup before running the PQ recorder.

Reference Frequency

The nominal line frequency is used as a reference for evaluation of power frequency and for selecting the appropriate measurement time interval for all power quality related measurements. It also affects characteristics of digital filters used by some evaluation methods like flicker measurements.

2.4 Configuring the EN 50160:2010 PQ Event Recorder

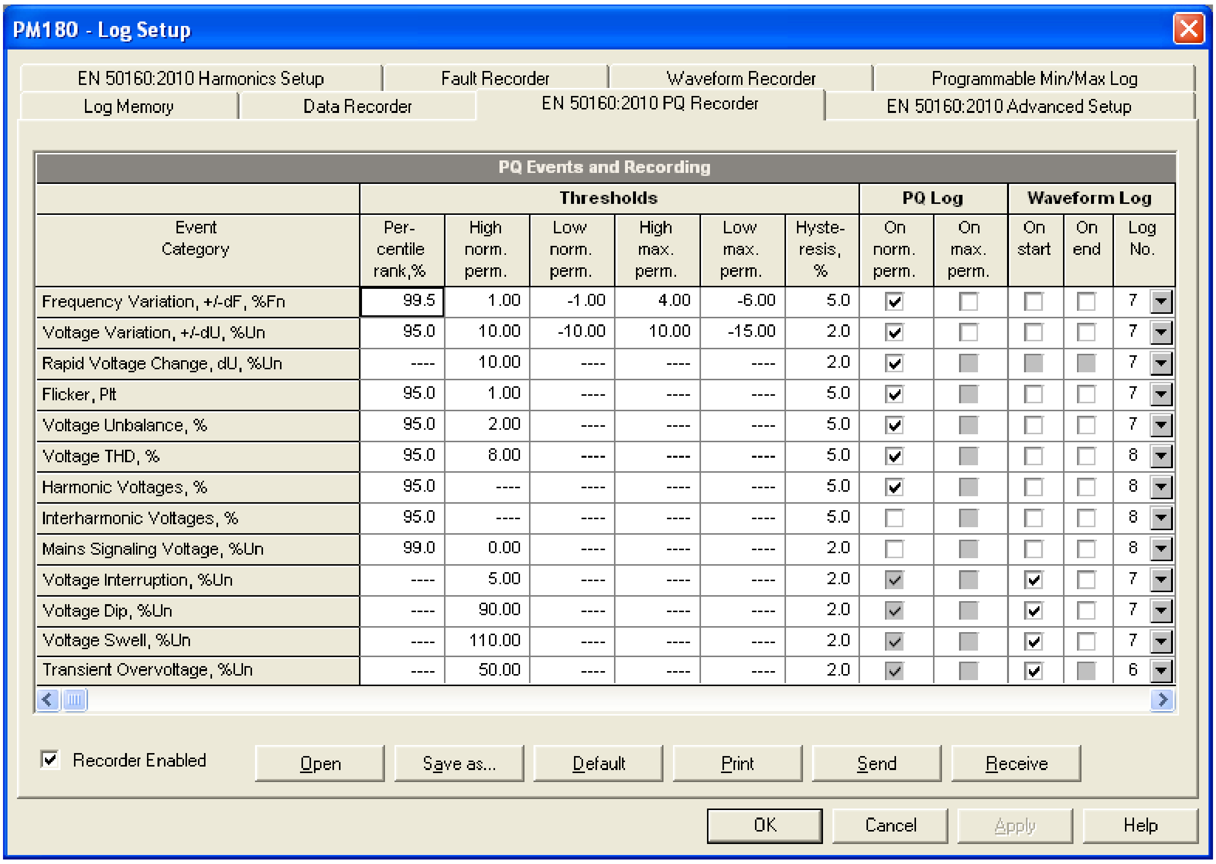
To configure the EN 50160:2010 PQ recorder, select Memory/Log in the Meter Setup Menu and then click on the EN 50160:2010 PQ Recorder tab.

This setup allows you to adjust the detection thresholds and compliance limits for specific voltage characteristics and to select and configure options for related event, waveform and data trend recording.

The picture below shows the PQ recorder setup dialog with the default factory settings. Use the horizontal scroll bar to move between the two parts of the dialog window.

See Table 2-1 for the available configuration options. See Section 1.2.1 Power Quality Monitoring and Recording for information on how your settings may affect operation of the PQ recorder.

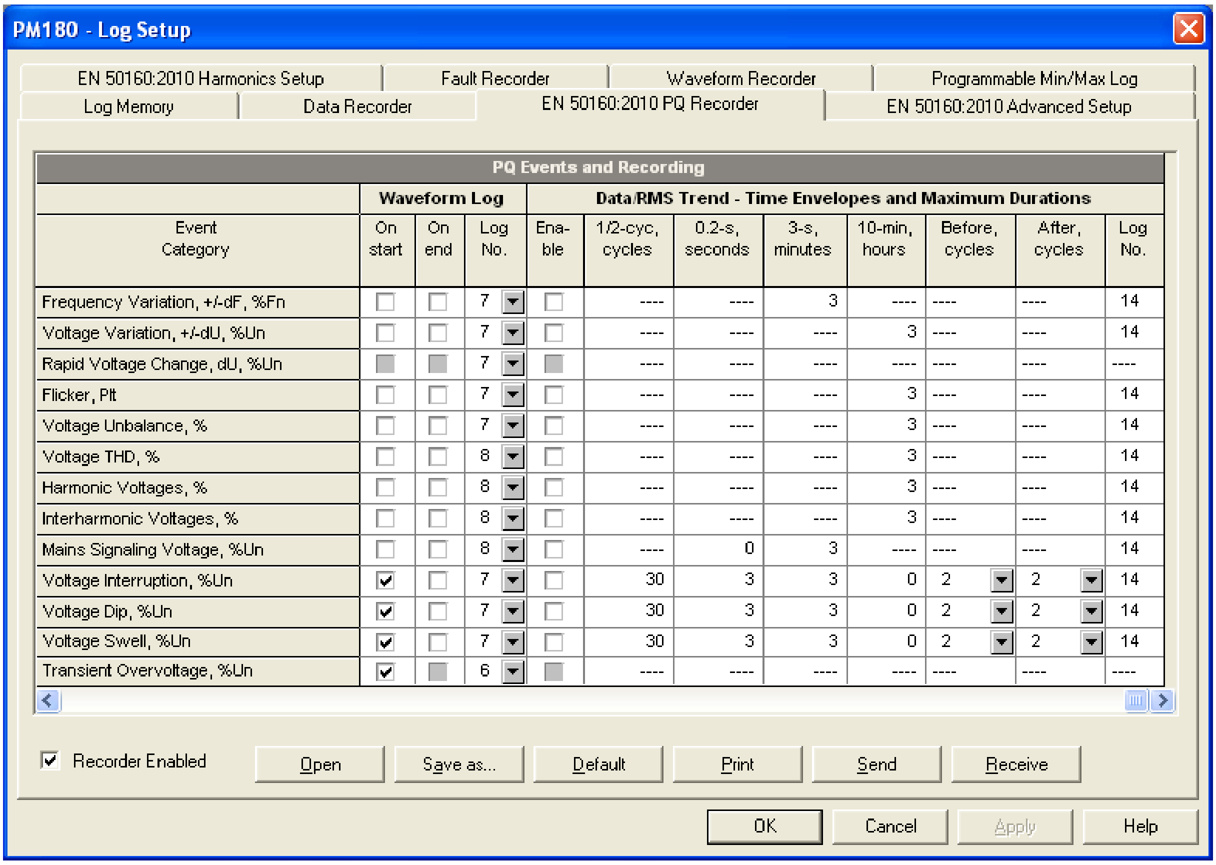
NOTE: When testing the device for compliance with the corresponding standards, some tests may cause generating a large amount of power quality related events that can put an excessive load on the device recorders and thus affect operation of other features in your device. To avoid undesirable effects, you can uncheck the Recorder Enabled box to temporary disable operation of the EN 50160:2010 PQ recorder.



PQ Events and Recording

Event Category	Thresholds						PQ Log		Waveform Log		
	Per-centile rank,%	High norm. perm.	Low norm. perm.	High max. perm.	Low max. perm.	Hyste-resis, %	On norm. perm.	On max. perm.	On start	On end	Log No.
Frequency Variation, +/-dF, %Fn	99.5	1.00	-1.00	4.00	-6.00	5.0	☑	☐	☐	☐	7
Voltage Variation, +/-dU, %Un	95.0	10.00	-10.00	10.00	-15.00	2.0	☑	☐	☐	☐	7
Rapid Voltage Change, dU, %Un	----	10.00	----	----	----	2.0	☑	▨	▨	▨	7
Flicker, Plt	95.0	1.00	----	----	----	5.0	☑	▨	☐	☐	7
Voltage Unbalance, %	95.0	2.00	----	----	----	5.0	☑	▨	☐	☐	7
Voltage THD, %	95.0	8.00	----	----	----	5.0	☑	▨	☐	☐	8
Harmonic Voltages, %	95.0	----	----	----	----	5.0	☑	▨	☐	☐	8
Interharmonic Voltages, %	95.0	----	----	----	----	5.0	☐	▨	☐	☐	8
Mains Signaling Voltage, %Un	99.0	0.00	----	----	----	2.0	☐	▨	☐	☐	8
Voltage Interruption, %Un	----	5.00	----	----	----	2.0	☑	▨	☑	☐	7
Voltage Dip, %Un	----	90.00	----	----	----	2.0	☑	▨	☑	☐	7
Voltage Swell, %Un	----	110.00	----	----	----	2.0	☑	▨	☑	☐	7
Transient Overvoltage, %Un	----	50.00	----	----	----	2.0	☑	▨	☑	▨	6

☑ Recorder Enabled



PQ Events and Recording

Event Category	Waveform Log			Data/RMS Trend - Time Envelopes and Maximum Durations							
	On start	On end	Log No.	Ena-ble	1/2-cyc, cycles	0.2-s, seconds	3-s, minutes	10-min, hours	Before, cycles	After, cycles	Log No.
Frequency Variation, +/-dF, %Fn	☐	☐	7	☐	----	----	3	----	----	----	14
Voltage Variation, +/-dU, %Un	☐	☐	7	☐	----	----	----	3	----	----	14
Rapid Voltage Change, dU, %Un	▨	▨	7	▨	----	----	----	----	----	----	----
Flicker, Plt	☐	☐	7	☐	----	----	----	3	----	----	14
Voltage Unbalance, %	☐	☐	7	☐	----	----	----	3	----	----	14
Voltage THD, %	☐	☐	8	☐	----	----	----	3	----	----	14
Harmonic Voltages, %	☐	☐	8	☐	----	----	----	3	----	----	14
Interharmonic Voltages, %	☐	☐	8	☐	----	----	----	3	----	----	14
Mains Signaling Voltage, %Un	☐	☐	8	☐	----	0	3	----	----	----	14
Voltage Interruption, %Un	☑	☐	7	☐	30	3	3	0	2	2	14
Voltage Dip, %Un	☑	☐	7	☐	30	3	3	0	2	2	14
Voltage Swell, %Un	☑	☐	7	☐	30	3	3	0	2	2	14
Transient Overvoltage, %Un	☑	▨	6	▨	----	----	----	----	----	----	----

☑ Recorder Enabled

Table 2-1 EN 50160:2010 PQ recorder setup options

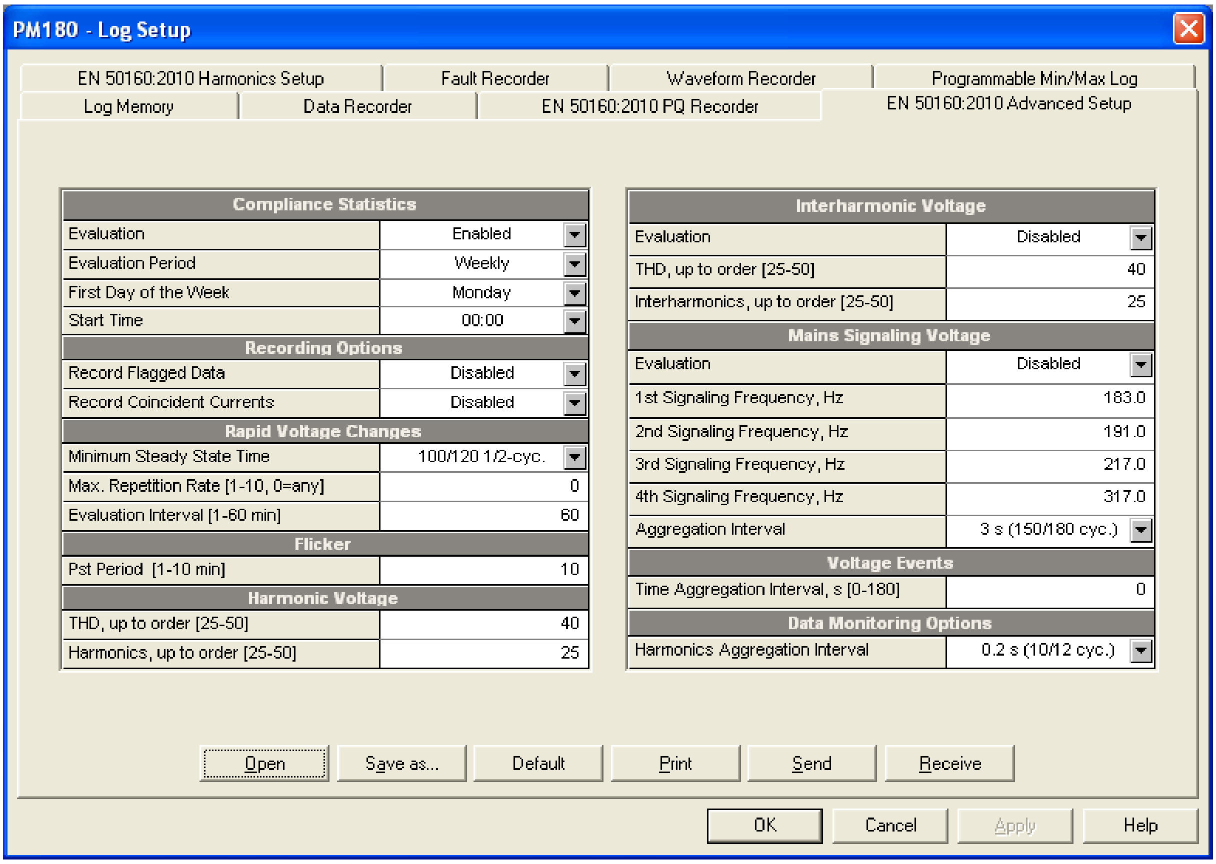
Option	Range	Description
Thresholds		
Percentile rank, %	0-100.0%	Defines the percentile rank for evaluation percentiles over a period of time
High norm. perm.	-20.00-200.00%	High normally permissible limit. Defines the higher detection threshold and a compliance (percentile) limit for parameter evaluation, in percent of the reference value
Low norm. perm.	-20.00-200.00%	Low normally permissible limit. Defines the lower detection threshold and a compliance (percentile) limit for parameter evaluation, in percent of the reference value
High max. perm.	-20.00-200.00%	High maximum permissible limit. Defines the maximum allowed compliance limit for parameter evaluation, in percent of the reference value
Low max. perm.	-20.00-200.00%	Low maximum permissible limit. Defines the minimum allowed compliance limit for parameter evaluation, in percent of the reference value
Hysteresis, %	0-50.0%	Defines the hysteresis for a PQ parameter, in percent of the reference value or threshold
PQ Log		
On norm. perm.	Checked Unchecked	Enables recording power quality related events for a specific voltage characteristic on exceeding the normally permissible limit
On max. perm.	Checked Unchecked	Enables recording power quality related events for a specific voltage characteristic on exceeding the maximum permissible limit
Waveform Log		
On start	Checked Unchecked	Enables coincident waveform recording on detection of a power quality event
On end	Checked Unchecked	Enables triggering waveform recording after a power quality event ends
Log No.	1-8	Specifies a waveform log file for waveform recording
Data/RMS trend – Time envelopes and Maximum Durations		
Enable	Checked Unchecked	Enables recording of a coincident data trend during power quality related events
1/2-cyc, cycles	0-1000 cycles	Maximum duration of data recording at a half-cycle rate
0.2-s, seconds	0-1000 s	Maximum duration of data recording at a 0.2-second rate
3-s, minutes	0-1000 minutes	Maximum duration of data recording at a 3-second rate
10-min, hours	0-1000 hours	Maximum duration of data recording at a 10-minute rate
Before, Cycles	0-20 cycles	The number of cycles to be recorded prior to the event at a half-cycle rate
After, Cycles	0-20 cycles	The number of cycles to be recorded after the event at a half-cycle rate
Log No.	14	Indicates a data log file for coincident data recording

2.5 Configuring EN 50160:2010 Advanced Options

To configure the EN 50160:2010 recording options or enable additional recording features, select Memory/Log in the Meter Setup Menu and then click on the EN 50160:2010 Advanced Options tab.

The picture below shows a setup dialog screen with the default factory settings. See Table 2-2 for the available options and their limits.

See Section 1.2 Measurement Techniques for information on the advanced recording options and operation of the PQ recorder.



Compliance Statistics	
Evaluation	Enabled
Evaluation Period	Weekly
First Day of the Week	Monday
Start Time	00:00
Recording Options	
Record Flagged Data	Disabled
Record Coincident Currents	Disabled
Rapid Voltage Changes	
Minimum Steady State Time	100/120 1/2-cyc.
Max. Repetition Rate [1-10, 0=any]	0
Evaluation Interval [1-60 min]	60
Flicker	
Pst Period [1-10 min]	10
Harmonic Voltage	
THD, up to order [25-50]	40
Harmonics, up to order [25-50]	25

Interharmonic Voltage	
Evaluation	Disabled
THD, up to order [25-50]	40
Interharmonics, up to order [25-50]	25
Mains Signaling Voltage	
Evaluation	Disabled
1st Signaling Frequency, Hz	183.0
2nd Signaling Frequency, Hz	191.0
3rd Signaling Frequency, Hz	217.0
4th Signaling Frequency, Hz	317.0
Aggregation Interval	3 s (150/180 cyc.)
Voltage Events	
Time Aggregation Interval, s [0-180]	0
Data Monitoring Options	
Harmonics Aggregation Interval	0.2 s (10/12 cyc.)

Table 2-2 EN 50160:2010 advanced setup options

Option	Range	Default	Description
Compliance Statistics			
Evaluation	Disabled, Enabled	Enabled	Enables the EN 50160:2010 statistics evaluation
Evaluation Period	Daily, Weekly	Weekly	Defines the EN 50160:2010 statistics evaluation period
First Day of the Week	Sunday-Saturday	Sunday	Defines the first day of the week for statistics evaluated on a weekly basis
Start Time	00:00-23:00	00:00	Defines the start time of the evaluation period
Recording Options			
Record Flagged Data	Disabled, Enabled	Disabled	Enables recording flagged events to the PQ event log. Fagged data is marked by an asterisk in the PQ log reports.
Record Coincident Currents	Disabled, Enabled	Disabled	Enables recording coincident currents. If enabled, the corresponding currents with same timing will be recorded to the PQ event log along with the corresponding voltage channels in case of a voltage dip, swell or voltage variation event.
Rapid Voltage Changes			
Minimum Steady State Time	3 s, 1 s, 100/120 1/2-cyc. - IEC 61000-4-30 compliant	100/120 1/2-cyc.	Defines the minimum time interval for voltages to stay within the detection threshold to be considered a steady-state condition, and the corresponding voltage change detection method

Option	Range	Default	Description
Max. Repetition Rate	0=any, 1-10	0 (any)	Defines the maximum repetition rate in variations per evaluation interval (equal or less than) for rapid voltage changes. Voltage changes at higher rates will not be classified since they would be subject for flicker evaluation
Evaluation Interval	1-60 min	60	Defines the time interval for periodic evaluation of rapid voltage changes. If the maximum repetition rate is set to a non-zero value, the evaluation and recording of the rapid voltage changes will be done at the end of each evaluation interval.
Flicker			
Pst Period	1-10 min	10 min	Defines the period of time for the short-term flicker evaluation. The standard setting of 10 minutes can be temporarily changed in the device for testing purposes
Harmonic Voltage			
THD, up to order	25-50	40	Defines the highest harmonic order included in the THD evaluation
Harmonics, up to order	25-50	25	Defines the highest harmonic order for evaluation of the harmonic voltages
Interharmonic Voltage			
Evaluation	Disabled, Enabled	Disabled	Enables the evaluation of interharmonic voltages
THD, up to order	25-50	40	Defines the highest interharmonic order included in the interharmonic THD evaluation
Interharmonics, up to order	25-50	25	Defines the highest interharmonic order for evaluation of the interharmonic voltages
Mains Signaling Voltage			
Evaluation	Disabled, Enabled	Disabled	Enables the evaluation of the mains signaling voltages
1st Signaling Frequency	110-3000 Hz	183.0 Hz	Specifies the mains signaling frequency for the compliance evaluation
2nd Signaling Frequency	110-3000 Hz	191.0 Hz	Specifies the mains signaling frequency for the compliance evaluation
3rd Signaling Frequency	110-3000 Hz	217.0 Hz	Specifies the mains signaling frequency for the compliance evaluation
4th Signaling Frequency	110-3000 Hz	317.0 Hz	Specifies the mains signaling frequency for the compliance evaluation
Aggregation Interval	3 s (150/180 cyc.) − EN 50160 compliant, 0.2 s (10/12 cyc.) − IEC 61000-4-30 compliant	3 s (150/180 cyc.)	Defines the aggregation time for interharmonic bins used in mains signaling voltage measurements
Voltage Events			
Time Aggregation Interval	0-180 s	0	Defines the aggregation time for time-aggregated voltage events: voltage interruptions, dips and swells. Time aggregation does not apply with a zero interval.
Data Monitoring Options			
Harmonics Aggregation Interval	0.2 s (10/12 cyc.) 3 s (150/180 cyc.) 10 min 2 h	0.2 s (10/12 cyc.)	Defines the aggregation interval for monitoring voltage and current harmonics and interharmonics. The default 10/12-cycle interval can be changed to higher values for testing purposes. The setting only applies to direct harmonic and interharmonic readings and does not affect EN 50160 evaluation statistics.

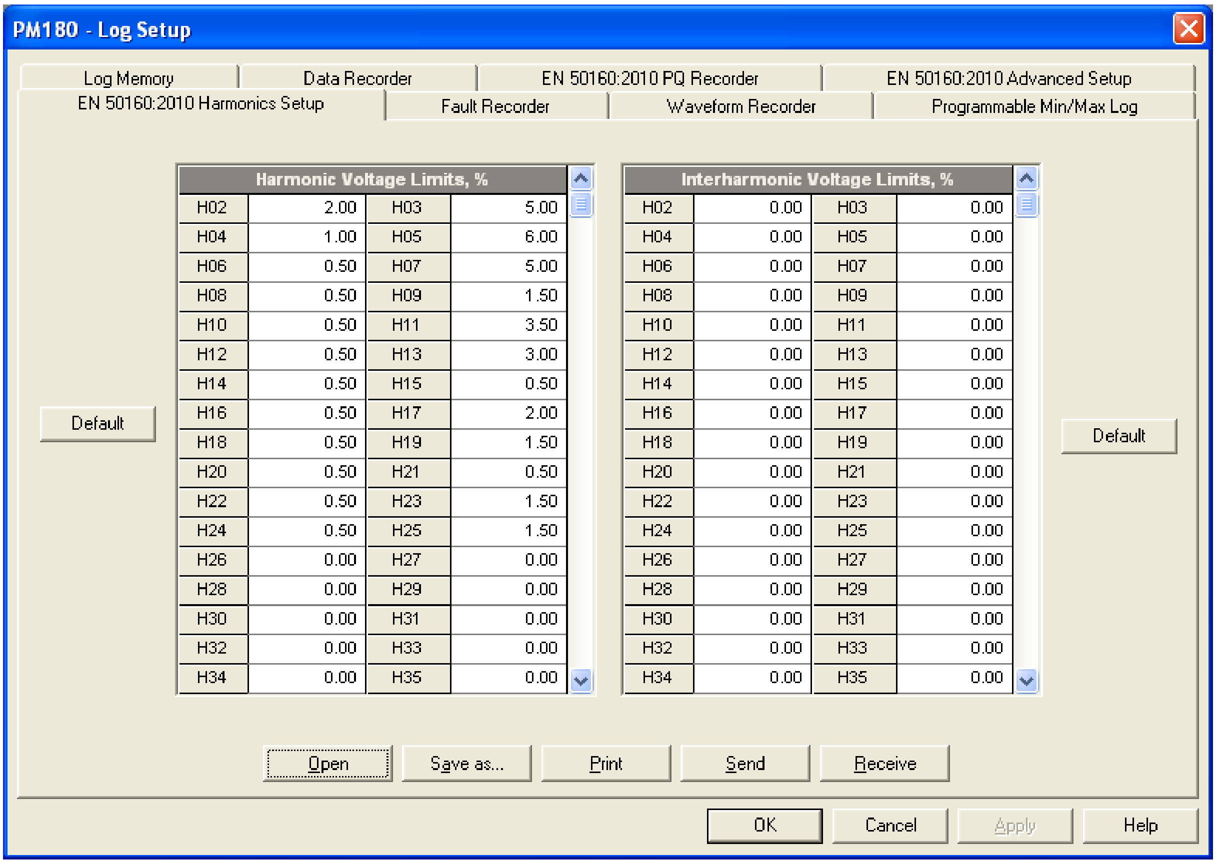
2.6 Configuring EN 50160:2010 Harmonics Limits

To configure the EN 50160:2010 harmonics and interharmonics compliance limits, select Memory/Log in the Meter Setup Menu and then click on the EN 50160:2010 Harmonics Setup tab.

This setup allows you to define or change detection thresholds and standard compliance limits for individual voltage harmonics and interharmonics.

Since compliance indices for interharmonics are not defined in EN 50160:2010, the interharmonic compliance limits are not provided and interharmonics evaluation in your device is disabled by default. To allow collecting interharmonics compliance statistics, define the compliance limits for individual interharmonics using your local power quality indices and enable interharmonics evaluation via the EN 50160:2010 Advanced Setup.

The picture below shows factory pre-configured settings compliant with EN 50160:2010 power quality indices.



Harmonic Voltage Limits, %

H02	2.00	H03	5.00
H04	1.00	H05	6.00
H06	0.50	H07	5.00
H08	0.50	H09	1.50
H10	0.50	H11	3.50
H12	0.50	H13	3.00
H14	0.50	H15	0.50
H16	0.50	H17	2.00
H18	0.50	H19	1.50
H20	0.50	H21	0.50
H22	0.50	H23	1.50
H24	0.50	H25	1.50
H26	0.00	H27	0.00
H28	0.00	H29	0.00
H30	0.00	H31	0.00
H32	0.00	H33	0.00
H34	0.00	H35	0.00

Interharmonic Voltage Limits, %

H02	0.00	H03	0.00
H04	0.00	H05	0.00
H06	0.00	H07	0.00
H08	0.00	H09	0.00
H10	0.00	H11	0.00
H12	0.00	H13	0.00
H14	0.00	H15	0.00
H16	0.00	H17	0.00
H18	0.00	H19	0.00
H20	0.00	H21	0.00
H22	0.00	H23	0.00
H24	0.00	H25	0.00
H26	0.00	H27	0.00
H28	0.00	H29	0.00
H30	0.00	H31	0.00
H32	0.00	H33	0.00
H34	0.00	H35	0.00

The default settings contain values of individual harmonic voltages specified by the standard for low-voltage networks. To automatically pre-set compliance limits for a medium-voltage or high-voltage network, ensure that the nominal voltage and PT ratio settings in your device's Basic Setup match the actual network characteristics, and then click on the Default button.

3 Operating the EN 50160:2010 PQ Recorder

3.1.1 Retrieving EN 50160:2010 Event and Statistics Files

See the PM180 Operation Manual for information on retrieving EN 50160:2010 compliant PQ event log, compliance statistics and online statistics files.

3.1.2 Getting EN 50160:2010 PQ Event Reports

See the PM180 Operation Manual for detailed information on how to get PQ event reports and on available viewing and printing options.

Annex F provides an example of the EN 50160:2010 PQ event report.

3.1.3 Getting EN 50160:2010 Compliance Reports

See the PM180 Operation Manual for information on viewing, editing and printing options for EN 50160:2010 compliance statistics and online statistics reports.

An example of the EN 50160:2010 compliance report is given in Annex G.

Annex A EN 50160:2010 Evaluation and Recording

A.1 EN 50160:2010 Background

Scope of EN 50160:2010

EN 50160:2010 defines main characteristics of the voltage in public low, medium and high voltage electricity networks, which can be expected to remain within limits or values specified by the standard. The different aspects covered by the standard are exclusively related to the following voltage characteristics: frequency, magnitude, waveform and symmetry of the line voltages

The standard is applicable only under normal operating conditions including correct operation of the protection devices in the case of a fault in the network (blowing of a fuse, operation of a circuit-breaker etc.) or changes in network configuration. The standard does not apply under abnormal conditions like maintenance and construction works or other exceptional situations, in particular exceptional weather conditions, power shortages, third party interference or industrial actions.

The voltage characteristics are evaluated using a statistical approach. The standard and its referenced publications specify for each voltage characteristic:

- Method of evaluation
- Time aggregation interval for measurements
- Observation period
- Statistical indication of the probability of not exceeding a specified limit (percentiles)
- Compliance limits or indicative values within which any customer can expect a voltage characteristic to remain

The voltage characteristics covered by the standard are divided into two groups:

1) Characteristics for which limit values are specified.

2) Characteristics for which only indicative values are given.

Measurement methods to be applied in the standard are described in IEC 61000-4-30, IEC 61000-4-7 and IEC 61000-4-15. Some indicative values for voltage dips and short interruptions are given in IEC/TR 61000-2-8.

Voltage Characteristics

For the following voltage characteristics, the standard provides definite limits that can be complied with for most of the time considering the possibility of relatively rare excursions beyond limits:

1) Power frequency

2) Supply voltage variations

3) Single rapid voltage changes

4) Flicker

5) Supply voltage unbalance

6) Harmonic voltages

7) Interharmonic voltages

8) Mains signaling voltages

Table A-1 indicates the time aggregation intervals applied to different voltage parameters and reference compliance limits specified by the standard for the characteristics with definite limits. Limits are set with a view to compliance for a percentage of the observation time.

Table A-1 Reference compliance limits for voltage characteristics

Voltage characteristic	Aggregation interval	Compliance, % of the time	Observation period
Power frequency	10 s	Synchronous connection: ±1% for 99.5% of a year +4/-6% for 100% of the time Asynchronous connection: ±2% for 95% of a week ±15% for 100% of the time	Week, year
Supply voltage variations	10 min	Low voltage: ±10% Un for 95% of the time +10%/-15% Un for 100% of the time Medium voltage: ±10% Un for 99% of the time ±15% Un for 100% of the time High voltage: Subject to individual contracts	Week
Single rapid voltage changes		≤4-5% Un (up to 10% Un), only indicative values are given	Day
Flicker	10 min	Plt ≤ 1 for 95% of the time	Week
Voltage unbalance	10 min	≤2-3% for 95% of the time	Week
THD	10 min	Low and medium voltage: ≤ 8 for 95% of the time High voltage: Under consideration	Week
Harmonic voltages	10 min	EN 50160:2010, Tables 1, 4, 7 depending on the supply network voltage	Week
Interharmonic voltages	10 min	Under consideration	Week
Mains signaling voltage	3 s	Within "Meister-curve" for 99% of the time, EN 50160:2010, Figures 1, 2	Day

Generally, an observation period of one week is chosen because it is the shortest interval to obtain reproducible measurement results. Limits are set with a view to compliance for a percentage of the observation time, e.g. 95% of the observations in any period of one week.

In the case of supply voltage and power frequency variations, further limits are specified within which the average measurements shall remain for 100% of the time.

Compliance limits for supply voltage variations, single rapid voltage changes and signaling voltages are given in percentage of the network nominal voltage. Compliance limits for power frequency are given in percentage of the nominal network frequency.

NOTES:

1. For single rapid voltage changes, only indicative values are given for the time being.
2. For some specific parameters, national regulations may define stricter limits.
3. Compliance limits given in the standard may be superseded in total or in part by the terms of a contract between the user and the network operator.

Voltage Events

For the remaining characteristics of the voltage, by their unpredictable nature, the standard gives only indicative values, which are intended to provide users with information on the range of magnitude which can be expected. Those are called voltage events and comprise:

1) Short and long voltage interruptions

2) Voltage dips

3) Voltage swells

4) Transient overvoltages

Table A-2 shows typical detection thresholds and durations for the voltage events specified by the standard.

Table A-2 Reference thresholds and durations for voltage events

Voltage event	Threshold and duration	Observation period
Short voltage interruptions	<5% Un on all phases, <= 3 min	Year
Long voltage interruptions	<5% Un on all phases, > 3 min	Year
Voltage dips	<90% Un on any phase, <= 1 min	Year
Voltage swells	>110% Un, <= 1 min	Year
Transient overvoltages	>20% Un, peak, <= 10 ms	Year

The basic measurement for detecting voltage interruptions, dips and swells is Urms(1/2) − a value of the RMS voltage measured over 1 cycle, commencing at a fundamental zero crossing and refreshed each half-cycle. Typical hysteresis for voltage events is 2% Un.

Voltage events are classified by their duration and magnitude in percentage of the nominal network voltage. Collected voltage dips and swells event statistics are classified and represented according to the tables 2, 3, 5, 6, 8, and 9 given in EN 50160:2010.

A.2 EN 50160:2010 Evaluation Techniques

This section describes methods used for evaluating voltage characteristics to ensure compliance with the standard.

Power Frequency

Method of Evaluation

The basic frequency measurement is the mean value of the frequency over fixed time intervals of 10 seconds under normal operating conditions.

A frequency variation is not evaluated if the supply voltage crosses a voltage tolerance limit (±20% Un) or the calculation interval is flagged.

Target Values

The compliance limits for frequency variations given in the EN 50160:2010 are as follows:

For synchronous connections:

50Hz ±1% for 99.5% of a year

50Hz +4/-6% for 100% of the time

For asynchronous connections:

50Hz ±2% for 95% of a week

50Hz ±15% for 100% of the time

The same limits are used for 60Hz systems.

Supply Voltage Variations

This characteristic defines slow variations of steady state supply voltage magnitude.

Method of Evaluation

The basic supply voltage magnitude measurement is the RMS value of the steady state voltage over a period of 10 minutes under normal operating conditions.

A voltage variation is not evaluated if the supply voltage crosses a voltage tolerance limit (±20% Un) or the calculation interval is flagged.

Target Values

The compliance limits for voltage variations given in the EN 50160:2010 are as follows:

Low voltage networks:

±10% Un for 95% of a week

+10%/-15% Un for 100% of the time

Medium voltage networks:

±10% Un for 99% of a week

±15% Un for 100% of the time

High voltage networks:

Subject to individual contracts

Single Rapid Voltage Changes

Rapid voltage changes are sudden but relatively weak voltage variations between two steady state voltage levels. The maximum rate of rapid voltage changes in normally once per hour or less. Voltage variations repeating more than once an hour are usually accounted by flicker. To avoid counting excessive flicker by rapid voltage changes, the maximum rate of voltage changes in variations (1 to 10) per an evaluation interval (from 1 min to an hour) can be limited and configured in the meter via the EN 50160:2010 Advanced Setup.

Method of Evaluation

The PQ recorder provides two methods for evaluation of rapid voltage changes based either on RMS value of voltage over a period of 1 or 3 seconds, or on the arithmetic mean of 100/120 consecutive Urms(1/2) values that is compliant with the IEC 61000-4-30 class A evaluation method. The desired method can be selected via the EN 50160:2010 Advanced Setup by defining the minimum steady-state measurement time for detecting a voltage change.

Option 1: The recorder establishes the maximum difference of the RMS voltage between two intervals selected from three consecutive 3-second or 1-second intervals and compares it with the target compliance limit.

Option 2: The voltage change is detected as guided in IEC 61000-4-30 Clause 5.11.2 by establishing a difference between every Urms(1/2) measurement and the arithmetic mean of the preceding 100/120 Urms(1/2) values and comparing it with the target compliance limit (detection threshold). Along with the steady-state voltage change included into statistics, the recorder provides also an indication of the maximum difference between any of the Urms(1/2) values during the event and the final steady-state voltage level.

The rate of rapid voltage changes is not limited by default. To limit evaluation of voltage changes caused by flicker, define a non-zero maximum allowed repetition rate and a time period for counting a rate of changes.

A rapid voltage change is not classified if the rate of changes exceeds the predefined value (if defined), or crosses a dip or swell threshold, as it would be considered a voltage dip or a voltage swell.

Target Values

Under normal operating conditions the magnitude of rapid voltage changes (once per hour or less) should generally not exceed 5% of nominal voltage in LV networks, and 4% in MV networks. In some circumstances, like in systems where equipment switching must be carried out to meet supply system or load requirements, it can reach 10%Un in LV networks, and 6%Un in MV networks.

Flicker

Flicker expresses the visual discomfort caused by repetitive changes of brightness in lightning subjected to fluctuations of the supply voltage. Flicker is indicated by the long-term flicker severity parameter Plt, which is evaluated every 2 hours.

Method of Evaluation

The basic measurement is the short-term flicker severity indicator Pst, evaluated each 10 minutes by instrumentation complying with IEC 61000-4-15. The indicative long-term flicker severity Plt is evaluated from 12 consecutive Pst values commencing at even-numbered 2-hour intervals. For testing purposes, the Pst period can be temporarily changed in the meter in the range of 1 to 10 minutes via the EN 50160:2010 Advanced Setup.

Pst values are not classified during intervals when the supply voltage magnitude exceeds a voltage tolerance limit (±20% Un) or the calculation interval is flagged.

Plt is not evaluated if any of the included Pst intervals is flagged.

Target Values

The flicker compliance limit given in the EN 50160:2010 is:

Plt ≤ 1 for 95% of a week

The Plt compliance limit can be changed in the meter via the EN50160 PQ Recorder setup.

Voltage Unbalance

This characteristic defines the magnitude and/or phase asymmetries of three-phase steady state supply voltage.

Method of Evaluation

The basic measurement is the RMS value of the steady state voltage unbalance over a period of 10 minutes under normal operating conditions. It is defined via symmetrical components as the negative sequence component expressed in percent of the positive sequence component.

Voltage unbalance is not evaluated if the supply voltage crosses a voltage tolerance limit (±20% Un) or the calculation interval is flagged.

Target Values

The compliance limit for voltage unbalance given in the EN 50160:2010 is:

≤ 2% (≤ 3% in some areas) for 95% of a week

Harmonic Voltages

Method of Evaluation

The basic measurements are individual harmonic voltages expressed in percent of the fundamental voltage and the total harmonic distortion factor (THD) aggregated over a period of 10 minutes.

Harmonic voltages are evaluated by instrumentation complying with IEC 61000-4-7 Clause 5.6 and based on 10/12-cycle gapless subgroup measurements. The THD is calculated as the subgroup total harmonic distortion.

Individual harmonic voltages are normally evaluated up to order 25 and the THD is calculated including all harmonics up to order 40 as required by EN 50160:2010. The order of the highest harmonic for both can be configured from 25 to 50 via the EN 50160:2010 Advanced Setup.

Harmonic voltages are not evaluated if the supply voltage crosses a voltage tolerance limit (±20% Un) or the calculation interval is flagged.

Target Values

The ranges of harmonic voltages given in the EN50160 are:

Low voltage networks:

THD ≤ 8 for 95% of a week

Individual harmonic voltages shall be less than or equal to the values given in Table 1 EN 50160:2010 for 95% of a week.

Medium voltage networks:

THD ≤ 8 for 95% of a week

Individual harmonic voltages shall be less than or equal to the values given in Table 4 EN 50160:2010 for 95% of a week.

High voltage networks:

THD limit is under consideration

Individual harmonic voltages shall be less than or equal to the indicative values given in Table 7 EN 50160:2010 for 95% of a week.

Compliance limits for the THD and individual harmonics can be changed in the meter via the EN 50160:2010 PQ Recorder setup and via the EN 50160:2010 Harmonics setup.

Interharmonic Voltages

Method of Evaluation

This feature is normally disabled in the meter and may be enabled via the EN 50160:2010 Advanced Setup.

The basic measurements are individual interharmonic voltages expressed in percent of the fundamental voltage aggregated over a period of 10 minutes.

Interharmonic voltages are evaluated by instrumentation complying with IEC 61000-4-7 Clause 5.6 and based on 10/12-cycle gapless interharmonic centered subgroup measurements. The total interharmonic distortion is calculated as the subgroup total interharmonic distortion.

The highest interharmonic order for evaluating individual interharmonic voltages and total interharmonic distortion can be selected in the meter via the EN50160 Advanced setup.

Interharmonic voltages are not evaluated if the supply voltage crosses a voltage tolerance limit (±20% Un) or the calculation interval is flagged.

Target Values

EN 50160:2010 compliance limits for interharmonic voltages are still under consideration. User assigned levels can be configured via the EN 50160:2010 Harmonics setup.

Mains Signaling Voltage

This characteristic defines the magnitude of the signal voltages used in some countries for signal transmission over public supply networks. The meter can evaluate ripple control signaling voltages in a frequency range from 100 Hz to 3 kHz.

Method of Evaluation

This feature is normally disabled in the meter since it is not commonly used. It can be enabled and up to 4 signaling frequencies can be selected for monitoring via the EN 50160:2010 Advanced Setup.

The basic measurements for mains signaling voltage can be selected by the aggregation interval setting via the EN 50160:2010 Advanced Setup:

Option 1: 3-second (150/180-cycle) mean value of signal voltages, EN 50160:2010 compliant.

Option 2: 10/12-cycle value of signal voltages, IEC 61000-4-30 compliant.

In both cases, the measurement method is based on the root of the sum of the squares of the 4 nearest 10/12-cycle RMS value interharmonic bins.

The EN 50160:2010 detection thresholds and compliance levels for signaling voltages are given by the so-called "Meister-curve" which defines the maximum permissible ripple control voltages in LV and MV networks.

Set to zero the detection threshold for signaling voltages in the EN 50160:2010 PQ recorder setup (factory default) to force using the Meister-curve compliance levels.

For IEC 61000-4-30 testing reasons, the detection threshold can be set to a constant level by defining a non-zero threshold value in percent of the nominal voltage.

Signaling voltages are not evaluated if the supply voltage crosses a voltage tolerance limit (±20% Un) or the calculation interval is flagged.

Target Values

The 3-second mean value of the signal voltages shall be less or equal to the specified limits for 99% of a day.

For HV networks, no values are given for mains signaling voltages.

Voltage Interruptions

Voltage interruptions correspond to temporary loss of supply voltage on all phases lasting less than or equal to 3 minutes in the event of short interruptions, and more than 3 minutes for long interruptions.

Method of Evaluation

The voltage interruption is detected when the voltages on all phases fall below the interruption threshold (IEC 61000-4-30) that is specified by the EN 50160:2010 at a level of 5%Un. The interruption threshold can be changed in the meter via the EN 50160:2010 PQ Recorder setup.

Time aggregation of multiple successive interruptions can be applied.

The basic voltage measurement for voltage interruptions is Urms(1/2).

Statistical Survey

Statistical data is classified by interruption duration. EN 50160:2010 does not provide a classification method for voltage interruptions. Some indicative data can be found in IEC/TR 61000-2-8. The PM180 EN 50160:2010 PQ recorder classifies interruptions according to Table A-3.

Table A-3 Classification of voltage interruptions according to durations

Residual voltage u, %Un	Duration t, s						
	t <= 0.5	0.5 < t <= 1	1 < t <= 5	5 < t <= 20	20 < t <=60	60 < t <= 180	180 < t
5 > u							

Voltage Dips

A voltage dip is a sudden reduction of the RMS voltage below 90% of the nominal value, followed by a return to a value higher than 90% of the nominal in a time varying from 10 ms to 60 s.

Method of Evaluation

A voltage dip is counted as one polyphase event regardless of the shape and of the number of phases affected (IEC 61000-4-30). An event can begin on one phase and end on another phase. The fault magnitude is recorded separately for each phase involved. The event duration is measured from the instant at which the voltage falls below the start threshold on one of the phases to that at which it becomes greater than the end threshold on all affected phases including a threshold hysteresis.

Time aggregation of multiple successive voltage dips can be applied.

The basic voltage dip measurement is Urms(1/2).

Statistical Survey

The PM180 provides statistical evaluation of voltage dips using the classification recommended by EN 50160:2010. Dips are classified by residual voltage magnitude and duration according to Table A-4.

Table A-4 Classification of dips according to residual voltage and duration

Residual voltage, u %Un	Duration t, s				
	0.01 <= t <= 0.2	0.2 < t <= 0.5	0.5 < t <= 1	1 < t <= 5	5 < t <= 60
90 > u >= 80					
80 > u >= 70					

Residual voltage, u %Un	Duration t, s				
	0.01 <= t <= 0.2	0.2 < t <= 0.5	0.5 < t <= 1	1 < t <= 5	5 < t <= 60
70 > u >= 40					
40 > u >= 5					
5 > u					

Voltage Swells

Voltage swells are sudden rises of the voltage RMS value of more than 110% of nominal voltage. Voltage swells may last between 10 milliseconds and one minute.

Method of Evaluation

A swell is counted as one polyphase event regardless of the shape and of the number of phases affected (IEC 61000-4-30). An event can begin on one phase and end on another phase. The fault magnitude is recorded separately for each phase involved. The event duration is measured from the instant at which the voltage rises above the start threshold on one of the phases to that at which it becomes lower than the end threshold on all affected phases including a threshold hysteresis.

Time aggregation of multiple successive voltage swells can be applied.

The basic voltage measurement is Urms(1/2).

Statistical Survey

The PM180 provides statistical evaluation of voltage swells using the classification recommended by EN 50160:2010. Swells are classified by voltage magnitude and duration according to Table A-5.

Table A-5 Classification of swells according to maximum voltage and duration

Swell voltage, u %Un	Duration t, s		
	0.01 <= t <= 0.5	0.5 < t <= 5	5 < t <= 60
u >= 120			
120 > u > 110			

Transient Overvoltages

Transient overvoltages correspond to disturbances of very short duration, lasting typically less than one half-cycle, i.e. a few microseconds to several milliseconds.

Method of Evaluation

Transient overvoltages are detected as impulsive or low frequency oscillatory transients with a rise time less than 0.5 ms and duration from 20 us with the fast transient module option and from 75 us without it, and up to a half cycle. The impulse magnitude is referenced to the nominal voltage amplitude (1.414 Un). The meter can detect transient overvoltages with a magnitude of up to 2 kV with the fast transient module option or up to 700V without it.

Statistical Survey

Statistical data is classified by transient magnitude and duration. EN 50160:2010 does not provide a classification method for transient overvoltages. The PM180 EN 50160:2010 PQ classifies transient overvoltages according to Table A-6.

Table A-6 Classification of transient overvoltages according to magnitude and duration

Transient voltage, u %Un peak	Duration t, ms					
	t <= 0.1	0.1 < t <= 0.2	0.2 < t <= 0.5	0.5 < t <= 1	1 < t <= 5	5 < t <= 10
u > 800						
800 >= u > 400						
400 >= u > 200						
200 >= u > 100						
100 >= u > 20						

Annex B EN 50160:2010 Compliance Statistics Log

Field No.	Field Label	Description
		Section 0 - Frequency Variation
1	Nnv	Number of non-valid 10-sec intervals
2	N	Number of valid 10-sec intervals
3	N1	Number of values exceeded percentile limit
4	N2	Number of values exceeded maximum permissible limit
5	df min1	Low percentile of frequency variation, +/-%Fn
6	df max1	High percentile of frequency variation, +/-%Fn
7	df min2	Minimum frequency variation, +/-%Fn
8	df max2	Maximum frequency variation, +/-%Fn
9	df lim1 low	Low percentile limit of frequency variation, %Fn
10	df lim1 high	High percentile limit of frequency variation, %Fn
11	df lim2 low	Low maximum limit of frequency variation, %Fn
12	df lim2 high	High maximum limit of frequency variation, %Fn
13	PercRank	Compliance percentile rank, %
		Section 1 - Voltage Variations
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	V1 N1	Number of values exceeded percentile limit on phase A/AB
4	V1 N2	Number of values exceeded maximum limit on phase A/AB
5	V1 dU min1	Low percentile of voltage variation on phase A/AB, +/-%Un
6	V1 dU max1	High percentile of voltage variation on phase A/AB, +/-%Un
7	V1 dU min2	Minimum voltage variation on phase A/AB, +/-%Un
8	V1 dU max2	Maximum voltage variation on phase A/AB, +/-%Un
9	V2 N1	Number of values exceeded percentile limit on phase B/BC
10	V2 N2	Number of values exceeded maximum limit on phase B/BC
11	V2 dU min1	Low percentile of voltage variation on phase B/BC, +/-%Un
12	V2 dU max1	High percentile of voltage variation on phase B/BC, +/-%Un
13	V2 dU min2	Minimum voltage variation on phase B/BC, +/-%Un
14	V2 dU max2	Maximum voltage variation on phase B/BC, +/-%Un
15	V3 N1	Number of values exceeded percentile limit on phase C/CA
16	V3 N2	Number of values exceeded maximum limit on phase C/CA
17	V3 dU min1	Low percentile of voltage variation on phase C/CA, +/-%Un
18	V3 dU max1	High percentile of voltage variation on phase C/CA, +/-%Un
19	V3 dU min2	Minimum voltage variation on phase C/CA, +/-%Un
20	V3 dU max2	Maximum voltage variation on phase C/CA, +/-%Un
21	dU lim1 low	Low percentile limit of voltage variation, %Un
22	dU lim1 high	High percentile limit of voltage variation, %Un
23	dU lim2 low	Low maximum limit of voltage variation, %Un
24	dU lim2 high	High maximum limit of voltage variation, %Un
25	PercRank	Compliance percentile rank, %
		Section 2 - Rapid Voltage Changes
1	N1	Number of polyphase incidents
2	V1 N1	Number of incidents on phase A/AB
3	V1 dU	Maximum voltage change on phase A/AB, %Un
4	V2 N1	Number of incidents on phase B/BC
5	V2 dU	Maximum voltage change on phase B/BC, %Un
6	V3 N1	Number of incidents on phase C/CA
7	V3 dU	Maximum voltage change on phase C/CA, %Un
8	dU lim	Maximum permissible limit of voltage changes, Un%
		Section 3 - Flicker
1	Nnv	Number of non-valid 2-hour intervals
2	N	Number of valid 2-hour intervals
3	V1 Plt N1	Number of Plt values exceeded percentile limit on phase A/AB
4	V1 Plt max1	High percentile of Plt on phase A/AB
5	V1 Plt max2	Maximum Plt on phase A/AB
6	V2 Plt N1	Number of Plt values exceeded percentile limit on phase B/BC

Field No.	Field Label	Description
7	V2 Plt max1	High percentile of Plt on phase B/BC
8	V2 Plt max2	Maximum Plt on phase B/BC
9	V3 Plt N1	Number of Plt values exceeded percentile limit on phase C/CA
10	V3 Plt max1	High percentile of Plt on phase C/CA
11	V3 Plt max2	Maximum Plt on phase C/CA
12	Plt lim	High percentile limit of Plt
13	PercRank	Compliance percentile rank, %
		Section 4 - Voltage Unbalance
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	Vunb N1	Number of voltage unbalance values exceeded percentile limit
4	Vunb max1	High percentile of voltage unbalance, %
5	Vunb max2	Maximum voltage unbalance, %
6	Vunb lim	High percentile limit of voltage unbalance, %
7	PercRank	Compliance percentile rank, %
		Section 5 - Voltage THD
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	V1 N1	Number of THD values exceeded percentile limit on phase A/AB
4	V1 THD max1	High percentile of THD on phase A/AB, %
5	V1 THD max2	Maximum THD on phase A/AB, %
6	V2 N1	Number of THD values exceeded percentile limit on phase B/BC
7	V2 THD max1	High percentile of THD on phase B/BC, %
8	V2 THD max2	Maximum THD on phase B/BC, %
9	V3 N1	Number of THD values exceeded percentile limit on phase C/CA
10	V3 THD max1	High percentile of THD on phase C/CA, %
11	V3 THD max2	Maximum THD on phase C/CA, %
12	THD lim	High percentile limit of THD, %
13	PercRank	Compliance percentile rank, %
		Section 6 - Signaling Voltage
1	Nnv	Number of non-valid intervals
2	N	Number of valid intervals
3	V1 Sig1 N1	Number of 1st signaling voltage incidents on phase A/AB
4	V1 Sig1	Maximum 1st signaling voltage magnitude on phase A/AB, %Un
5	V1 Sig2 N1	Number of 2nd signaling voltage incidents on phase A/AB
6	V1 Sig2	Maximum 2nd signaling voltage magnitude on phase A/AB, %Un
7	V1 Sig3 N1	Number of 3rd signaling voltage incidents on phase A/AB
8	V1 Sig3	Maximum 3rd signaling voltage magnitude on phase A/AB, %Un
9	V1 Sig4 N1	Number of 4th signaling voltage incidents on phase A/AB
10	V1 Sig4	Maximum 4th signaling voltage magnitude on phase A/AB, %Un
11	V2 Sig1 N1	Number of 1st signaling voltage incidents on phase B/BC
12	V2 Sig1	Maximum 1st signaling voltage magnitude on phase B/BC, %Un
13	V2 Sig2 N1	Number of 2nd signaling voltage incidents on phase B/BC
14	V2 Sig2	Maximum 2nd signaling voltage magnitude on phase B/BC, %Un
15	V2 Sig3 N1	Number of 3rd signaling voltage incidents on phase B/BC
16	V2 Sig3	Maximum 3rd signaling voltage magnitude on phase B/BC, %Un
17	V2 Sig4 N1	Number of 4th signaling voltage incidents on phase B/BC
18	V2 Sig4	Maximum 4th signaling voltage magnitude on phase B/BC, %Un
19	V3 Sig1 N1	Number of 1st signaling voltage incidents on phase C/CA
20	V3 Sig1	Maximum 1st signaling voltage magnitude on phase C/CA, %Un
21	V3 Sig2 N1	Number of 2nd signaling voltage incidents on phase C/CA
22	V3 Sig2	Maximum 2nd signaling voltage magnitude on phase C/CA, %Un
23	V3 Sig3 N1	Number of 3rd signaling voltage incidents on phase C/CA
24	V3 Sig3	Maximum 3rd signaling voltage magnitude on phase C/CA, %Un
25	V3 Sig4 N1	Number of 4th signaling voltage incidents on phase C/CA
26	V3 Sig4	Maximum 4th signaling voltage magnitude on phase C/CA, %Un
27	Sig1 frq	1st signaling frequency
28	Sig2 frq	2nd signaling frequency
29	Sig3 frq	3rd signaling frequency
30	Sig4 frq	4th signaling frequency
31	V Sig1 lim	Maximum permissible 1st signaling voltage magnitude, %Un

Field No.	Field Label	Description
32	V Sig2 lim	Maximum permissible 2nd signaling voltage magnitude, %Un
33	V Sig3 lim	Maximum permissible 3rd signaling voltage magnitude, %Un
34	V Sig4 lim	Maximum permissible 4th signaling voltage magnitude, %Un
35	PercRank	Compliance percentile rank, %
		Section 7 - Voltage Interruptions (indicative statistics)
1	N1 0,5s	Number of short polyphase interruptions <=500ms
2	N2 1s	Number of short polyphase interruptions <=1s
3	N3 5s	Number of short polyphase interruptions <=5s
4	N4 20s	Number of short polyphase interruptions <=20s
5	N5 60s	Number of short polyphase interruptions <=60s
6	N6 180s	Number of short polyphase interruptions <=180s
7	N7 >180s	Number of long polyphase interruptions >180s
8	V min	Minimum residual voltage, %Un
9	dt max	Maximum duration of a short polyphase interruption
10	dt tot	Total duration of short polyphase interruptions
		Section 8 - Voltage Dips (indicative statistics)
1	N11 90%/0,2s	Number of polyphase dips <90% and duration <=0.2 s
2	N12 90%/0,5s	Number of polyphase dips <90% and duration <=0.5 s
3	N13 90%/1s	Number of polyphase dips <90% and duration <=1 s
4	N14 90%/5s	Number of polyphase dips <90% and duration <=5 s
5	N15 90%/60s	Number of polyphase dips <90% and duration <=60 s
6	N21 80%/0,2s	Number of polyphase dips <80% and duration <=0.2 s
7	N22 80%/0,5s	Number of polyphase dips <80% and duration <=0.5 s
8	N23 80%/1s	Number of polyphase dips <80% and duration <=1 s
9	N24 80%/5s	Number of polyphase dips <80% and duration <=5 s
10	N25 80%/60s	Number of polyphase dips <80% and duration <=60 s
11	N31 70%/0,2s	Number of polyphase dips <70% and duration <=0.2 s
12	N32 70%/0,5s	Number of polyphase dips <70% and duration <=0.5 s
13	N33 70%/1s	Number of polyphase dips <70% and duration <=1 s
14	N34 70%/5s	Number of polyphase dips <70% and duration <=5 s
15	N35 70%/60s	Number of polyphase dips <70% and duration <=60 s
16	N41 40%/0,2s	Number of polyphase dips <40% and duration <=0.2 s
17	N42 40%/0,5s	Number of polyphase dips <40% and duration <=0.5 s
18	N43 40%/1s	Number of polyphase dips <40% and duration <=1 s
19	N44 40%/5s	Number of polyphase dips <40% and duration <=5 s
20	N45 40%/60s	Number of polyphase dips <40% and duration <=60 s
21	N51 5%/0,2s	Number of polyphase dips <5% and duration <=0.2 s
22	N52 5%/0,5s	Number of polyphase dips <5% and duration <=0.5 s
23	N53 5%/1s	Number of polyphase dips <5% and duration <=1 s
24	N54 5%/5s	Number of polyphase dips <5% and duration <=5 s
25	N55 5%/60s	Number of polyphase dips <5% and duration <=60 s
26	dt max 90%	Maximum duration of a polyphase dip < 90%
27	dt max 85%	Maximum duration of a polyphase dip < 80%
28	dt max 70%	Maximum duration of a polyphase dip < 70%
29	dt max 40%	Maximum duration of a polyphase dip < 40%
30	dt max 10%	Maximum duration of a polyphase dip < 5%
31	V min 0.2s	Minimum residual voltage of dips with duration <=0.2 s, %Un
32	V min 0.5s	Minimum residual voltage of dips with duration <=0.5 s, %Un
33	V min 1s	Minimum residual voltage of dips with duration <=1 s, %Un
34	V min 5s	Minimum residual voltage of dips with duration <=5 s, %Un
35	V min 60s	Minimum residual voltage of dips with duration <=60 s, %Un
36	dt tot	Total duration of polyphase dips
		Section 9 - Voltage Swells (indicative statistics)
1	N11 120%/0,5s	Number of polyphase swells >=120% and duration <=0.5 s
2	N12 120%/5s	Number of polyphase swells >=120% and duration <=5 s
3	N13 120%/60s	Number of polyphase swells >=120% and duration <=60 s
4	N21 110%/0,5s	Number of polyphase swells >110% and duration <=0.5 s
5	N22 110%/5s	Number of polyphase swells >110% and duration <=5 s
6	N23 110%/60s	Number of polyphase swells >110% and duration <=60 s
7	dt max 120%	Maximum duration of polyphase swells >=120%
8	dt max 110%	Maximum duration of polyphase swells >110%

Field No.	Field Label	Description
9	V max 0,5s	Maximum polyphase swell voltage with duration <=0.5 s, %Un
10	V max 5s	Maximum polyphase swell voltage with duration <=5 s, %Un
11	V max 60s	Maximum polyphase swell voltage with duration <=60 s, %Un
12	dt tot	Total duration of polyphase swells
		Section 10 - Transient Overvoltages (indicative statistics)
1	N11 20%/0,1ms	Number of polyphase impulses >20% and duration <=0.1 ms
2	N12 20%/0,2ms	Number of polyphase impulses >20% and duration <=0.2 ms
3	N13 20%/0,5ms	Number of polyphase impulses >20% and duration <=0.5 ms
4	N14 20%/1ms	Number of polyphase impulses >20% and duration <=1 ms
5	N15 20%/5ms	Number of polyphase impulses >20% and duration <=5 ms
6	N16 20%/10ms	Number of polyphase impulses >20% and duration <=10 ms
7	N21 100%/0,1ms	Number of polyphase impulses >100% and duration <=0.1 ms
8	N22 100%/0,2ms	Number of polyphase impulses >100% and duration <=0.2 ms
9	N23 100%/0,5ms	Number of polyphase impulses >100% and duration <=0.5 ms
10	N24 100%/1ms	Number of polyphase impulses >100% and duration <=1 ms
11	N25 100%/5ms	Number of polyphase impulses >100% and duration <=5 ms
12	N26 100%/10ms	Number of polyphase impulses >100% and duration <=10 ms
13	N31 200%/0,1ms	Number of polyphase impulses >200% and duration <=0.1 ms
14	N32 200%/0,2ms	Number of polyphase impulses >200% and duration <=0.2 ms
15	N33 200%/0,5ms	Number of polyphase impulses >200% and duration <=0.5 ms
16	N34 200%/1ms	Number of polyphase impulses >200% and duration <=1 ms
17	N35 200%/5ms	Number of polyphase impulses >200% and duration <=5 ms
18	N36 200%/10ms	Number of polyphase impulses >200% and duration <=10 ms
19	N41 400%/0,1ms	Number of polyphase impulses >400% and duration <=0.1 ms
20	N42 400%/0,2ms	Number of polyphase impulses >400% and duration <=0.2 ms
21	N43 400%/0.5ms	Number of polyphase impulses >400% and duration <=0.5 ms
22	N44 400%/1ms	Number of polyphase impulses >400% and duration <=1 ms
23	N45 400%/5ms	Number of polyphase impulses >400% and duration <=5 ms
24	N46 400%/10ms	Number of polyphase impulses >400% and duration <=10 ms
25	N51 800%/0,1ms	Number of polyphase impulses >800% and duration <=0.1 ms
26	N52 800%/0,2ms	Number of polyphase impulses >800% and duration <=0.2 ms
27	N53 800%/0.5ms	Number of polyphase impulses >800% and duration <=0.5 ms
28	N54 800%/1ms	Number of polyphase impulses >800% and duration <=1 ms
29	N55 800%/5ms	Number of polyphase impulses >800% and duration <=5 ms
30	N56 800%/10ms	Number of polyphase impulses >800% and duration <=10 ms
31	V max 0,1ms	Maximum impulsive voltage with duration <=0.1 ms, %Un peak
32	V max 0,2ms	Maximum impulsive voltage with duration <=0.2 ms, %Un peak
33	V max 0,5ms	Maximum impulsive voltage with duration <=0.5 ms, %Un peak
34	V max 1ms	Maximum impulsive voltage with duration <=1 ms, %Un peak
35	V max 5ms	Maximum impulsive voltage with duration <=5 ms, %Un peak
36	V max 10ms	Maximum impulsive voltage with duration <=10 ms, %Un peak

Annex C EN 50160:2010 Harmonics Compliance Statistics Log

Field No.	Field Label	Description
		Section 0 – V1 Harmonic Compliance
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	H02 N1	Number of H02 values exceeded percentile limit on phase A/AB
4	H03 N1	Number of H03 values exceeded percentile limit on phase A/AB
	...	
51	H50 N1	Number of H50 values exceeded percentile limit on phase A/AB
52	PercRank	Compliance percentile rank, %
		Section 1 – V2 Harmonic Compliance
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	H02 N1	Number of H02 values exceeded percentile limit on phase B/BC
4	H03 N1	Number of H03 values exceeded percentile limit on phase B/BC
	...	
51	H50 N1	Number of H50 values exceeded percentile limit on phase B/BC
52	PercRank	Compliance percentile rank, %
		Section 2 – V3 Harmonic Compliance
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	H02 N1	Number of H02 values exceeded percentile limit on phase C/CA
4	H03 N1	Number of H03 values exceeded percentile limit on phase C/CA
	...	
51	H50 N1	Number of H50 values exceeded percentile limit on phase C/CA
52	PercRank	Compliance percentile rank, %
		Section 3 – V1 Harmonic Voltages
1	%H02 max1	High percentile probability value of H02 on phase A/AB, %
2	%H03 max1	High percentile probability value of H03 on phase A/AB, %
	...	
49	%H50 max1	High percentile probability value of H50 on phase A/AB, %
50	%H02 max2	Maximum value of H02 on phase A/AB, %
51	%H03 max2	Maximum value of H03 on phase A/AB, %
	...	
98	%H50 max2	Maximum value of H50 on phase A/AB, %
		Section 4 – V2 Harmonic Voltages
1	%H02 max1	High percentile probability value of H02 on phase B/BC, %
2	%H03 max1	High percentile probability value of H03 on phase B/BC, %
	...	
49	%H50 max1	High percentile probability value of H50 on phase B/BC, %
50	%H02 max2	Maximum value of H02 on phase B/BC, %
51	%H03 max2	Maximum value of H03 on phase B/BC, %
	...	
98	%H50 max2	Maximum value of H50 on phase B/BC, %
		Section 5 – V3 Harmonic Voltages
1	%H02 max1	High percentile probability value of H02 on phase C/CA, %
2	%H03 max1	High percentile probability value of H03 on phase C/CA, %
	...	
49	%H50 max1	High percentile probability value of H50 on phase C/CA, %
50	%H02 max2	Maximum value of H02 on phase C/CA, %
51	%H03 max2	Maximum value of H03 on phase C/CA, %
	...	
98	%H50 max2	Maximum value of H50 on phase C/CA, %
		Section 6 - V1 Interharmonic Compliance
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	H02 N1	Number of H02 values exceeded percentile limit on phase A/AB
4	H03 N1	Number of H03 values exceeded percentile limit on phase A/AB

Field No.	Field Label	Description
	...	
51	H50 N1	Number of H50 values exceeded percentile limit on phase A/AB
52	PercRank	Compliance percentile rank, %
		Section 7 – V2 Interharmonic Compliance
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	H02 N1	Number of H02 values exceeded percentile limit on phase B/BC
4	H03 N1	Number of H03 values exceeded percentile limit on phase B/BC
	...	
51	H50 N1	Number of H50 values exceeded percentile limit on phase B/BC
52	PercRank	Compliance percentile rank, %
		Section 8 – V3 Interharmonic Compliance
1	Nnv	Number of non-valid 10-min intervals
2	N	Number of valid 10-min intervals
3	H02 N1	Number of H02 values exceeded percentile limit on phase C/CA
4	H03 N1	Number of H03 values exceeded percentile limit on phase C/CA
	...	
51	H50 N1	Number of H50 values exceeded percentile limit on phase C/CA
52	PercRank	Compliance percentile rank, %
		Section 9 – V1 Interharmonic Voltages
1	%H02 max1	High percentile probability value of H02 on phase A/AB, %
2	%H03 max1	High percentile probability value of H03 on phase A/AB, %
	...	
49	%H50 max1	High percentile probability value of H50 on phase A/AB, %
50	%H02 max2	Maximum value of H02 on phase A/AB, %
51	%H03 max2	Maximum value of H03 on phase A/AB, %
	...	
98	%H50 max2	Maximum value of H50 on phase A/AB, %
		Section 10 - V2 Interharmonic Voltages
1	%H02 max1	High percentile probability value of H02 on phase B/BC, %
2	%H03 max1	High percentile probability value of H03 on phase B/BC, %
	...	
49	%H50 max1	High percentile probability value of H50 on phase B/BC, %
50	%H02 max2	Maximum value of H02 on phase B/BC, %
51	%H03 max2	Maximum value of H03 on phase B/BC, %
	...	
98	%H50 max2	Maximum value of H50 on phase B/BC, %
		Section 11 - V3 Interharmonic Voltages
1	%H02 max1	High percentile probability value of H02 on phase C/CA, %
2	%H03 max1	High percentile probability value of H03 on phase C/CA, %
	...	
49	%H50 max1	High percentile probability value of H50 on phase C/CA, %
50	%H02 max2	Maximum value of H02 on phase C/CA, %
51	%H03 max2	Maximum value of H03 on phase C/CA, %
	...	
98	%H50 max2	Maximum value of H50 on phase C/CA, %

Annex D Online PQ Data

Field Label	Description
	Last recorded EN 50160:2010 voltage incidents data
V1 Var%	V1 Voltage variation, +/-%Un
V2 Var%	V2 Voltage variation, +/-%Un
V3 Var%	V3 Voltage variation, +/-%Un
V1 dUss	V1 Steady state voltage change, %Un
V1 dUmax	V1 Maximum voltage change, %Un
V2 dUss	V2 Steady state voltage change, %Un
V2 dUmax	V2 Maximum voltage change, %Un
V3 dUss	V3 Steady state voltage change, %Un
V4 dUmax	V3 Maximum voltage change, %Un
V1 Pst	V1 Voltage Pst
V2 Pst	V2 Voltage Pst
V3 Pst	V3 Voltage Pst
V1 Plt	V1 Voltage Plt
V2 Plt	V2 Voltage Plt
V3 Plt	V3 Voltage Plt
V1 THD	V1 Voltage THD, %
V2 THD	V2 Voltage THD, %
V3 THD	V3 Voltage THD, %
NSeq Unb%	Negative-sequence voltage unbalance, %
ZSeq Unb%	Zero-sequence voltage unbalance, %
Freq Var%	Frequency variation, +/-%Fn
V1 Int	Short voltage interruption, V1 residual voltage, %Un
V2 Int	Short voltage interruption, V2 residual voltage, %Un
V3 Int	Short voltage interruption, V3 residual voltage, %Un
Int dt	Short voltage interruption, duration, ms
V1 Dip	Voltage dip, V1 residual voltage, %Un
V2 Dip	Voltage dip, V2 residual voltage, %Un
V3 Dip	Voltage dip, V3 residual voltage, %Un
Dip dt	Voltage dip, duration, ms
V1 Swl	Voltage swell, V1 voltage, %Un
V2 Swl	Voltage swell, V2 voltage, %Un
V3 Swl	Voltage swell, V2 voltage, %Un
Swl dt	Voltage swell, duration, ms
V1 Imp	V1 Transient overvoltage, %Un peak
V1 Imp dt	V1 Transient duration, µs
V2 Imp	V2 Transient overvoltage, %Un peak
V2 Imp dt	V2 Transient duration, µs
V3 Imp	V3 Transient overvoltage, %Un peak
V3 Imp dt	V3 Transient duration, µs
V1 Sig%	V1 signaling voltage, %Un
V2 Sig%	V2 signaling voltage, %Un
V3 Sig%	V3 signaling voltage, %Un
	Present IEC 61000-4-30 measurements and indication data
V1 rms(1/2)	V1 rms(1/2) commencing at fundamental zero crossing
V2 rms(1/2)	V2 rms(1/2) commencing at fundamental zero crossing
V3 rms(1/2)	V3 rms(1/2) commencing at fundamental zero crossing
V1 rms(1/2) Tm	V1 rms(1/2) timestamp, seconds
V1 rms(1/2) Tmmcs	V1 rms(1/2) timestamp, fractional second, µs
V2 rms(1/2) Tm	V2 rms(1/2) timestamp, seconds
V2 rms(1/2) Tmmcs	V2 rms(1/2) timestamp, fractional second, µs
V3 rms(1/2) Tm	V3 rms(1/2) timestamp, seconds
V3 rms(1/2) Tmmcs	V3 rms(1/2) timestamp, fractional second, µs
I1 rms(1/2)	I1 rms(1/2) coincident current
I2 rms(1/2)	I2 rms(1/2) coincident current
I3 rms(1/2)	I3 rms(1/2) coincident current
10/12c Tm	10/12-cycle block timestamp, seconds

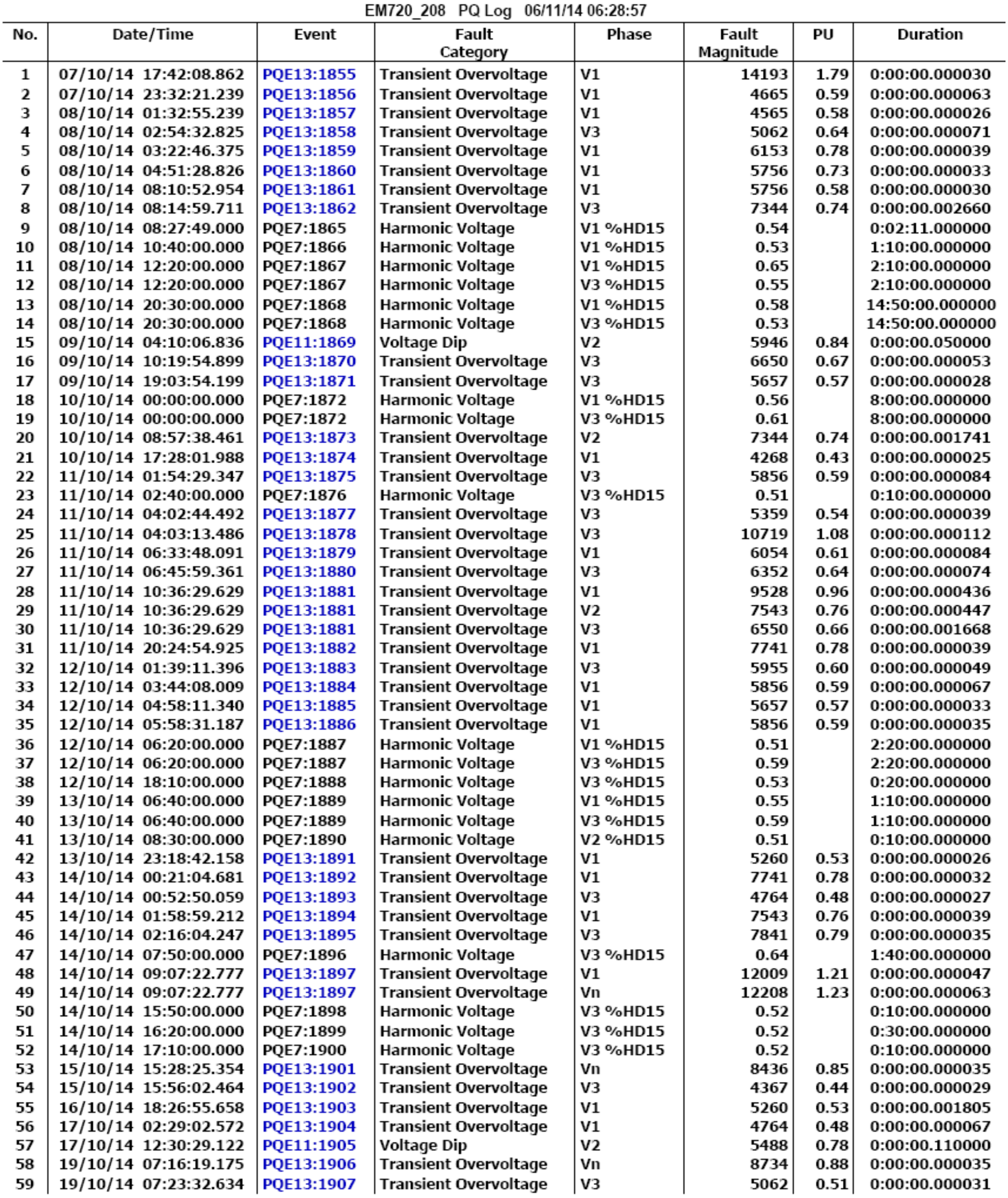
Field Label	Description
10/12c Tmmcs	10/12-cycle block timestamp, fractional second
10/12c BlockNo	10/12-cycle block number (1-3000)
150/180c BlockNo	150/180-cycle block number (1-200)
10/12c Flag	10/12-cycle interval flag (0=valid, 1=flagged)
150/180c Flag	150/180-cycle interval flag (0=valid, 1=flagged)
10s Flag	10-s interval flag (0=valid, 1=flagged)
10m Flag	10-min interval flag (0=valid, 1=flagged)
2h Flag	2-hour interval flag (0=valid, 1=flagged)

Annex E Generic Parameters Group

Field Label	Description
V1	V1 voltage
V2	V2 voltage
V3	V3 voltage
V4	V4 voltage
V12	V12 voltage
V23	V23 voltage
V31	V31 voltage
I1	I1 current
I2	I2 current
I3	I3 current
I4	I4 current
In	In current
I1x	I1x current (extended range)
I2x	I2x current (extended range)
I3x	I3x current (extended range)
I4x	I4x current (extended range)
Inx	Inx current (extended range)
V ZERO-SEQ	Zero-sequence voltage
I ZERO-SEQ	Zero-sequence current
Ix ZERO-SEQ	Ix Zero-sequence current (extended range)
V UNB%	Voltage unbalance
I UNB%	Current unbalance
Ix UNB%	Ix current unbalance (extended range)
FREQ	Frequency
V1 THD	V1 THD
V2 THD	V2 THD
V3 THD	V3 THD
V4 THD	V4 THD
I1 THD	I1 THD
I2 THD	I2 THD
I3 THD	I3 THD
I4 THD	I4 THD
V1 THD/I	V1 interharmonic THD
V2 THD/I	V2 interharmonic THD
V3 THD/I	V3 interharmonic THD
V4 THD/I	V4 interharmonic THD
I1 THD/I	I1 interharmonic THD
I2 THD/I	I2 interharmonic THD
I3 THD/I	I3 interharmonic THD
I4 THD/I	I4 interharmonic THD
I1 TDD	I1 TDD
I2 TDD	I2 TDD
I3 TDD	I3 TDD
I4 TDD	I4 TDD
I1 KF	I1 K-Factor
I2 KF	I2 K-Factor
I3 KF	I3 K-Factor
I4 KF	I4 K-Factor
V1 CF	V1 Crest Factor
V2 CF	V2 Crest Factor
V3 CF	V3 Crest Factor
V4 CF	V4 Crest Factor
I1 CF	I1 Crest Factor
I2 CF	I2 Crest Factor
I3 CF	I3 Crest Factor
I4 CF	I4 Crest Factor
V1 rms(1/2)	V1 rms(1/2), commencing at fundamental zero crossing

Field Label	Description
V2 rms(1/2)	V2 rms(1/2), commencing at fundamental zero crossing
V3 rms(1/2)	V3 rms(1/2), commencing at fundamental zero crossing
I1 rms(1/2)	I1 rms(1/2) coincident current
I2 rms(1/2)	I2 rms(1/2) coincident current
I3 rms(1/2)	I3 rms(1/2) coincident current
V1 Sig%	V1 signaling voltage magnitude, %Un
V2 Sig%	V2 signaling voltage magnitude, %Un
V3 Sig%	V3 signaling voltage magnitude, %Un

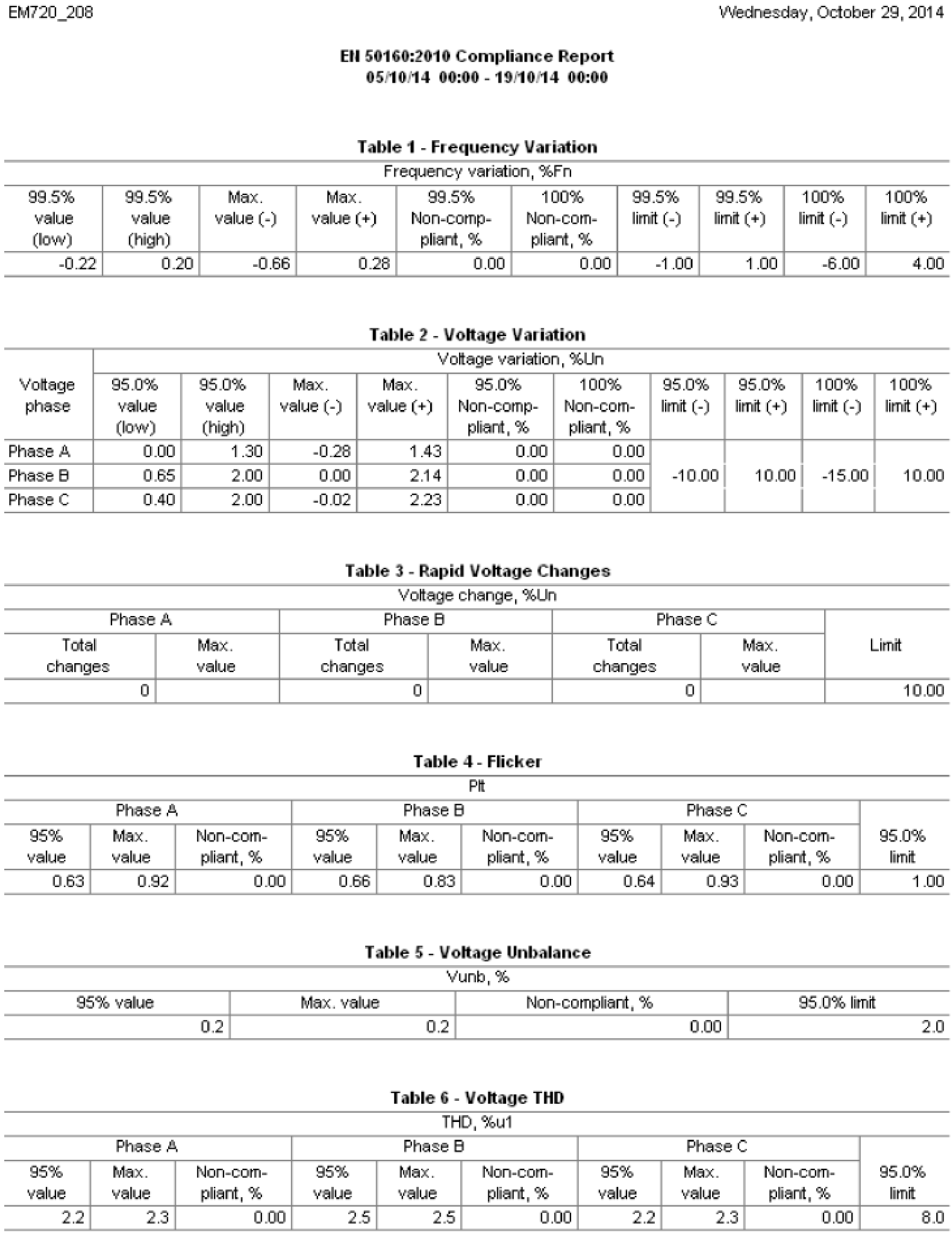
Annex F EN 50160:2010 PQ Event Log Report



EM720_208 PQ Log 06/11/14 06:28:57

No.	Date/Time	Event	Fault Category	Phase	Fault Magnitude	PU	Duration
1	07/10/14 17:42:08.862	PQE13:1855	Transient Overvoltage	V1	14193	1.79	0:00:00.000030
2	07/10/14 23:32:21.239	PQE13:1856	Transient Overvoltage	V1	4665	0.59	0:00:00.000063
3	08/10/14 01:32:55.239	PQE13:1857	Transient Overvoltage	V1	4565	0.58	0:00:00.000026
4	08/10/14 02:54:32.825	PQE13:1858	Transient Overvoltage	V3	5062	0.64	0:00:00.000071
5	08/10/14 03:22:46.375	PQE13:1859	Transient Overvoltage	V1	6153	0.78	0:00:00.000039
6	08/10/14 04:51:28.826	PQE13:1860	Transient Overvoltage	V1	5756	0.73	0:00:00.000033
7	08/10/14 08:10:52.954	PQE13:1861	Transient Overvoltage	V1	5756	0.58	0:00:00.000030
8	08/10/14 08:14:59.711	PQE13:1862	Transient Overvoltage	V3	7344	0.74	0:00:00.002660
9	08/10/14 08:27:49.000	PQE7:1865	Harmonic Voltage	V1 %HD15	0.54		0:02:11.000000
10	08/10/14 10:40:00.000	PQE7:1866	Harmonic Voltage	V1 %HD15	0.53		1:10:00.000000
11	08/10/14 12:20:00.000	PQE7:1867	Harmonic Voltage	V1 %HD15	0.65		2:10:00.000000
12	08/10/14 12:20:00.000	PQE7:1867	Harmonic Voltage	V3 %HD15	0.55		2:10:00.000000
13	08/10/14 20:30:00.000	PQE7:1868	Harmonic Voltage	V1 %HD15	0.58		14:50:00.000000
14	08/10/14 20:30:00.000	PQE7:1868	Harmonic Voltage	V3 %HD15	0.53		14:50:00.000000
15	09/10/14 04:10:06.836	PQE11:1869	Voltage Dip	V2	5946	0.84	0:00:00.050000
16	09/10/14 10:19:54.899	PQE13:1870	Transient Overvoltage	V3	6650	0.67	0:00:00.000053
17	09/10/14 19:03:54.199	PQE13:1871	Transient Overvoltage	V3	5657	0.57	0:00:00.000028
18	10/10/14 00:00:00.000	PQE7:1872	Harmonic Voltage	V1 %HD15	0.56		8:00:00.000000
19	10/10/14 00:00:00.000	PQE7:1872	Harmonic Voltage	V3 %HD15	0.61		8:00:00.000000
20	10/10/14 08:57:38.461	PQE13:1873	Transient Overvoltage	V2	7344	0.74	0:00:00.001741
21	10/10/14 17:28:01.988	PQE13:1874	Transient Overvoltage	V1	4268	0.43	0:00:00.000025
22	11/10/14 01:54:29.347	PQE13:1875	Transient Overvoltage	V3	5856	0.59	0:00:00.000084
23	11/10/14 02:40:00.000	PQE7:1876	Harmonic Voltage	V3 %HD15	0.51		0:10:00.000000
24	11/10/14 04:02:44.492	PQE13:1877	Transient Overvoltage	V3	5359	0.54	0:00:00.000039
25	11/10/14 04:03:13.486	PQE13:1878	Transient Overvoltage	V3	10719	1.08	0:00:00.000112
26	11/10/14 06:33:48.091	PQE13:1879	Transient Overvoltage	V1	6054	0.61	0:00:00.000084
27	11/10/14 06:45:59.361	PQE13:1880	Transient Overvoltage	V3	6352	0.64	0:00:00.000074
28	11/10/14 10:36:29.629	PQE13:1881	Transient Overvoltage	V1	9528	0.96	0:00:00.000436
29	11/10/14 10:36:29.629	PQE13:1881	Transient Overvoltage	V2	7543	0.76	0:00:00.000447
30	11/10/14 10:36:29.629	PQE13:1881	Transient Overvoltage	V3	6550	0.66	0:00:00.001668
31	11/10/14 20:24:54.925	PQE13:1882	Transient Overvoltage	V1	7741	0.78	0:00:00.000039
32	12/10/14 01:39:11.396	PQE13:1883	Transient Overvoltage	V3	5955	0.60	0:00:00.000049
33	12/10/14 03:44:08.009	PQE13:1884	Transient Overvoltage	V1	5856	0.59	0:00:00.000067
34	12/10/14 04:58:11.340	PQE13:1885	Transient Overvoltage	V1	5657	0.57	0:00:00.000033
35	12/10/14 05:58:31.187	PQE13:1886	Transient Overvoltage	V1	5856	0.59	0:00:00.000035
36	12/10/14 06:20:00.000	PQE7:1887	Harmonic Voltage	V1 %HD15	0.51		2:20:00.000000
37	12/10/14 06:20:00.000	PQE7:1887	Harmonic Voltage	V3 %HD15	0.59		2:20:00.000000
38	12/10/14 18:10:00.000	PQE7:1888	Harmonic Voltage	V3 %HD15	0.53		0:20:00.000000
39	13/10/14 06:40:00.000	PQE7:1889	Harmonic Voltage	V1 %HD15	0.55		1:10:00.000000
40	13/10/14 06:40:00.000	PQE7:1889	Harmonic Voltage	V3 %HD15	0.59		1:10:00.000000
41	13/10/14 08:30:00.000	PQE7:1890	Harmonic Voltage	V2 %HD15	0.51		0:10:00.000000
42	13/10/14 23:18:42.158	PQE13:1891	Transient Overvoltage	V1	5260	0.53	0:00:00.000026
43	14/10/14 00:21:04.681	PQE13:1892	Transient Overvoltage	V1	7741	0.78	0:00:00.000032
44	14/10/14 00:52:50.059	PQE13:1893	Transient Overvoltage	V3	4764	0.48	0:00:00.000027
45	14/10/14 01:58:59.212	PQE13:1894	Transient Overvoltage	V1	7543	0.76	0:00:00.000039
46	14/10/14 02:16:04.247	PQE13:1895	Transient Overvoltage	V3	7841	0.79	0:00:00.000035
47	14/10/14 07:50:00.000	PQE7:1896	Harmonic Voltage	V3 %HD15	0.64		1:40:00.000000
48	14/10/14 09:07:22.777	PQE13:1897	Transient Overvoltage	V1	12009	1.21	0:00:00.000047
49	14/10/14 09:07:22.777	PQE13:1897	Transient Overvoltage	Vn	12208	1.23	0:00:00.000063
50	14/10/14 15:50:00.000	PQE7:1898	Harmonic Voltage	V3 %HD15	0.52		0:10:00.000000
51	14/10/14 16:20:00.000	PQE7:1899	Harmonic Voltage	V3 %HD15	0.52		0:30:00.000000
52	14/10/14 17:10:00.000	PQE7:1900	Harmonic Voltage	V3 %HD15	0.52		0:10:00.000000
53	15/10/14 15:28:25.354	PQE13:1901	Transient Overvoltage	Vn	8436	0.85	0:00:00.000035
54	15/10/14 15:56:02.464	PQE13:1902	Transient Overvoltage	V3	4367	0.44	0:00:00.000029
55	16/10/14 18:26:55.658	PQE13:1903	Transient Overvoltage	V1	5260	0.53	0:00:00.001805
56	17/10/14 02:29:02.572	PQE13:1904	Transient Overvoltage	V1	4764	0.48	0:00:00.000067
57	17/10/14 12:30:29.122	PQE11:1905	Voltage Dip	V2	5488	0.78	0:00:00.110000
58	19/10/14 07:16:19.175	PQE13:1906	Transient Overvoltage	Vn	8734	0.88	0:00:00.000035
59	19/10/14 07:23:32.634	PQE13:1907	Transient Overvoltage	V3	5062	0.51	0:00:00.000031

Annex G EN 50160:2010 Compliance Report



EM720_208

Wednesday, October 29, 2014

EN 50160:2010 Compliance Report
05/10/14 00:00 - 19/10/14 00:00

Table 1 - Frequency Variation

Frequency variation, %Fn									
99.5% value (low)	99.5% value (high)	Max. value (-)	Max. value (+)	99.5% Non-compliant, %	100% Non-compliant, %	99.5% limit (-)	99.5% limit (+)	100% limit (-)	100% limit (+)
-0.22	0.20	-0.66	0.28	0.00	0.00	-1.00	1.00	-6.00	4.00

Table 2 - Voltage Variation

Voltage phase	Voltage variation, %Un									
	95.0% value (low)	95.0% value (high)	Max. value (-)	Max. value (+)	95.0% Non-compliant, %	100% Non-compliant, %	95.0% limit (-)	95.0% limit (+)	100% limit (-)	100% limit (+)
Phase A	0.00	1.30	-0.28	1.43	0.00	0.00	-10.00	10.00	-15.00	10.00
Phase B	0.65	2.00	0.00	2.14	0.00	0.00				
Phase C	0.40	2.00	-0.02	2.23	0.00	0.00				

Table 3 - Rapid Voltage Changes

Voltage change, %Un						
Phase A		Phase B		Phase C		Limit
Total changes	Max. value	Total changes	Max. value	Total changes	Max. value	
0		0		0		10.00

Table 4 - Flicker

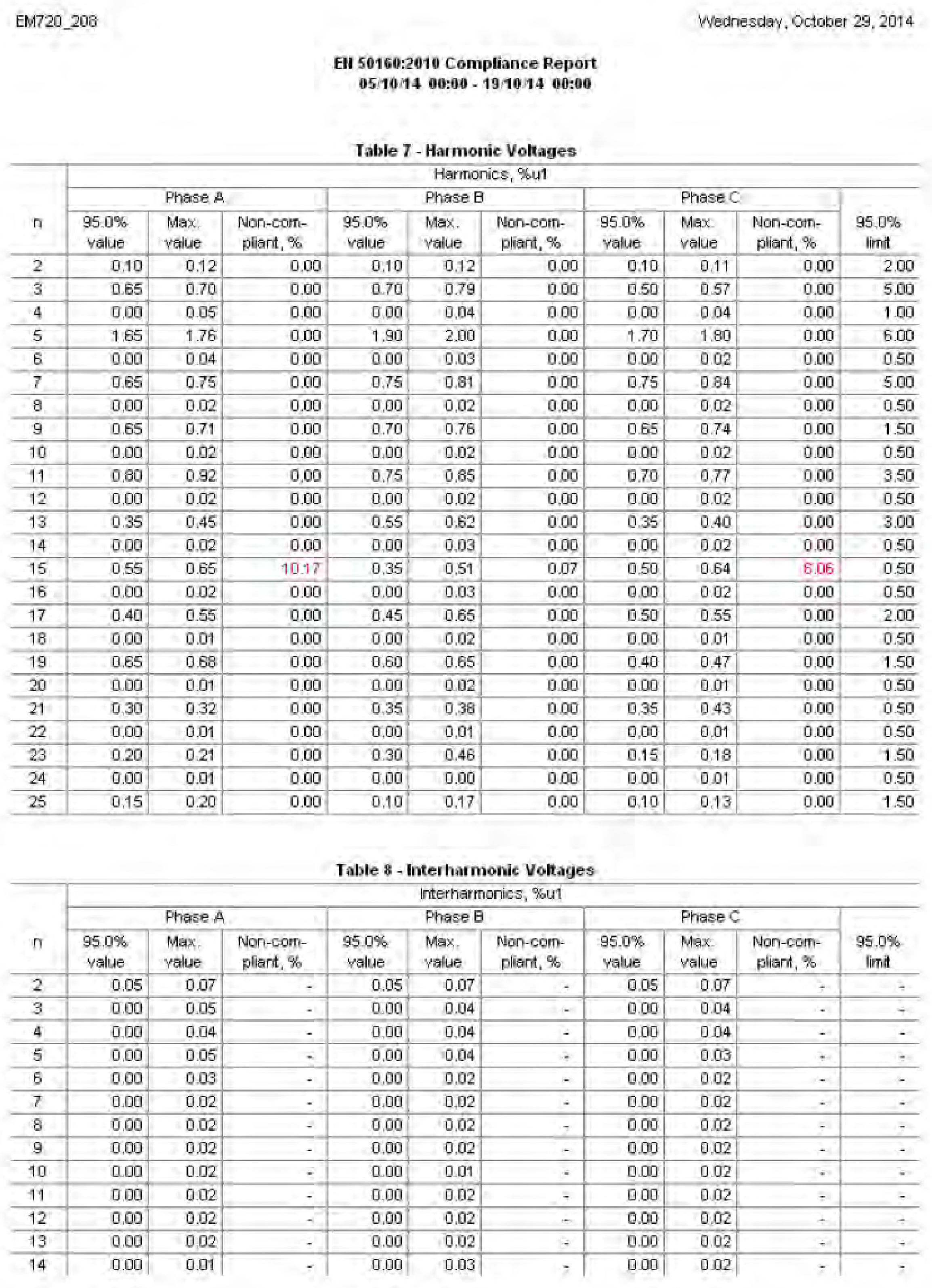
Plt									
Phase A			Phase B			Phase C			95.0% limit
95% value	Max. value	Non-compliant, %	95% value	Max. value	Non-compliant, %	95% value	Max. value	Non-compliant, %	
0.63	0.92	0.00	0.66	0.83	0.00	0.64	0.93	0.00	1.00

Table 5 - Voltage Unbalance

Vunb, %			
95% value	Max. value	Non-compliant, %	95.0% limit
0.2	0.2	0.00	2.0

Table 6 - Voltage THD

THD, %u1									
Phase A			Phase B			Phase C			95.0% limit
95% value	Max. value	Non-compliant, %	95% value	Max. value	Non-compliant, %	95% value	Max. value	Non-compliant, %	
2.2	2.3	0.00	2.5	2.5	0.00	2.2	2.3	0.00	8.0



EM720_208

Wednesday, October 29, 2014

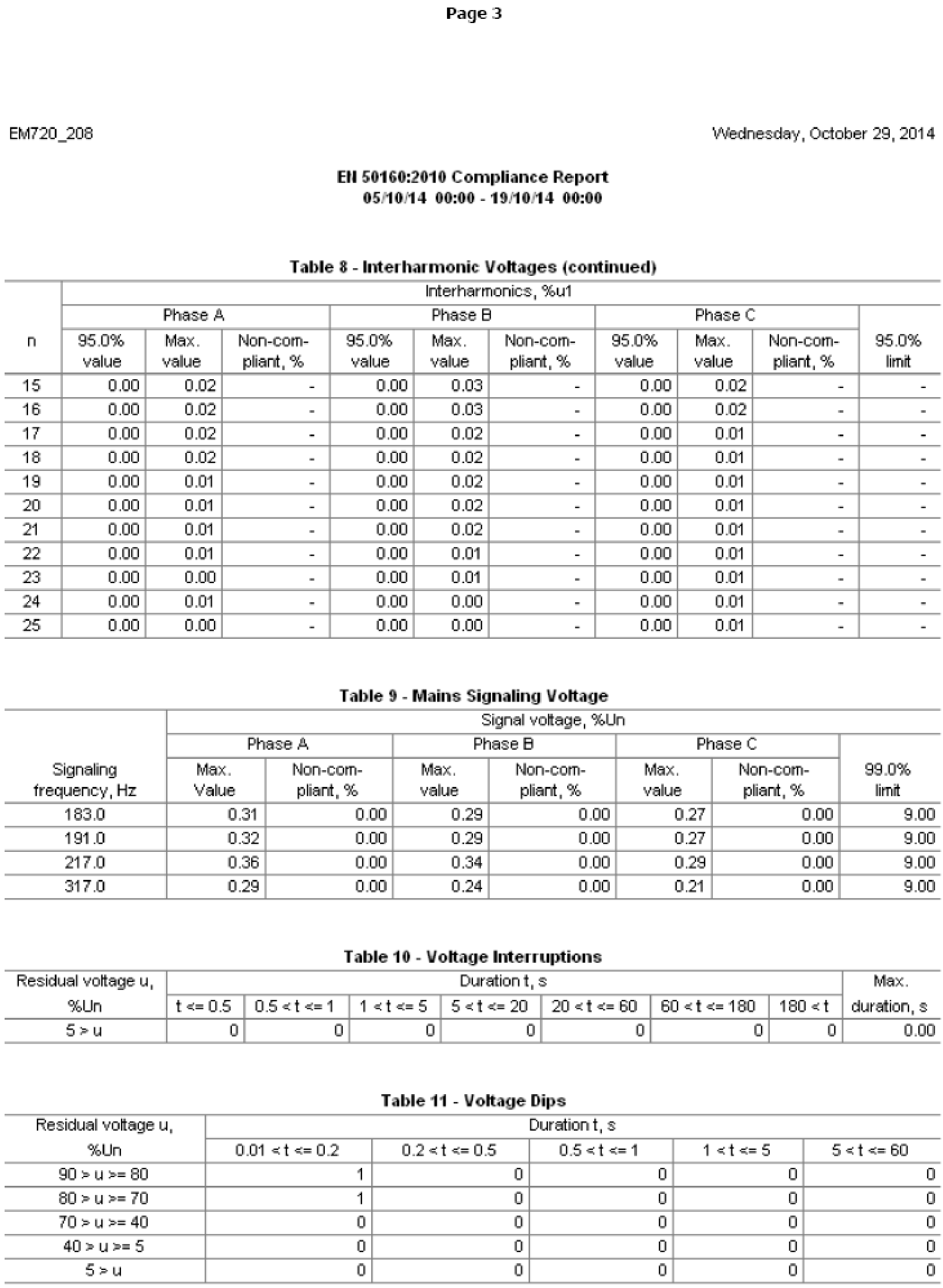
EN 50160:2010 Compliance Report
05/10/14 00:00 - 19/10/14 00:00

Table 7 - Harmonic Voltages

	Harmonics, %u1									
	Phase A			Phase B			Phase C			
n	95.0% value	Max. value	Non-compliant, %	95.0% value	Max. value	Non-compliant, %	95.0% value	Max. value	Non-compliant, %	95.0% limit
2	0.10	0.12	0.00	0.10	0.12	0.00	0.10	0.11	0.00	2.00
3	0.65	0.70	0.00	0.70	0.79	0.00	0.50	0.57	0.00	5.00
4	0.00	0.05	0.00	0.00	0.04	0.00	0.00	0.04	0.00	1.00
5	1.65	1.76	0.00	1.90	2.00	0.00	1.70	1.80	0.00	6.00
6	0.00	0.04	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.50
7	0.65	0.75	0.00	0.75	0.81	0.00	0.75	0.84	0.00	5.00
8	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.50
9	0.65	0.71	0.00	0.70	0.76	0.00	0.65	0.74	0.00	1.50
10	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.50
11	0.80	0.92	0.00	0.75	0.85	0.00	0.70	0.77	0.00	3.50
12	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.50
13	0.35	0.45	0.00	0.55	0.62	0.00	0.35	0.40	0.00	3.00
14	0.00	0.02	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.50
15	0.55	0.65	10.17	0.35	0.51	0.07	0.50	0.64	6.06	0.50
16	0.00	0.02	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.50
17	0.40	0.55	0.00	0.45	0.65	0.00	0.50	0.55	0.00	2.00
18	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.50
19	0.65	0.68	0.00	0.60	0.65	0.00	0.40	0.47	0.00	1.50
20	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.50
21	0.30	0.32	0.00	0.35	0.38	0.00	0.35	0.43	0.00	0.50
22	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.50
23	0.20	0.21	0.00	0.30	0.46	0.00	0.15	0.18	0.00	1.50
24	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.50
25	0.15	0.20	0.00	0.10	0.17	0.00	0.10	0.13	0.00	1.50

Table 8 - Interharmonic Voltages

	Interharmonics, %u1									
	Phase A			Phase B			Phase C			
n	95.0% value	Max. value	Non-compliant, %	95.0% value	Max. value	Non-compliant, %	95.0% value	Max. value	Non-compliant, %	95.0% limit
2	0.05	0.07	-	0.05	0.07	-	0.05	0.07	-	-
3	0.00	0.05	-	0.00	0.04	-	0.00	0.04	-	-
4	0.00	0.04	-	0.00	0.04	-	0.00	0.04	-	-
5	0.00	0.05	-	0.00	0.04	-	0.00	0.03	-	-
6	0.00	0.03	-	0.00	0.02	-	0.00	0.02	-	-
7	0.00	0.02	-	0.00	0.02	-	0.00	0.02	-	-
8	0.00	0.02	-	0.00	0.02	-	0.00	0.02	-	-
9	0.00	0.02	-	0.00	0.02	-	0.00	0.02	-	-
10	0.00	0.02	-	0.00	0.01	-	0.00	0.02	-	-
11	0.00	0.02	-	0.00	0.02	-	0.00	0.02	-	-
12	0.00	0.02	-	0.00	0.02	-	0.00	0.02	-	-
13	0.00	0.02	-	0.00	0.02	-	0.00	0.02	-	-
14	0.00	0.01	-	0.00	0.03	-	0.00	0.02	-	-



Page 3

EM720_208 Wednesday, October 29, 2014

EN 50160:2010 Compliance Report
05/10/14 00:00 - 19/10/14 00:00

Table 8 - Interharmonic Voltages (continued)

n	Interharmonics, %u1									
	Phase A			Phase B			Phase C			
	95.0% value	Max. value	Non-compliant, %	95.0% value	Max. value	Non-compliant, %	95.0% value	Max. value	Non-compliant, %	95.0% limit
15	0.00	0.02	-	0.00	0.03	-	0.00	0.02	-	-
16	0.00	0.02	-	0.00	0.03	-	0.00	0.02	-	-
17	0.00	0.02	-	0.00	0.02	-	0.00	0.01	-	-
18	0.00	0.02	-	0.00	0.02	-	0.00	0.01	-	-
19	0.00	0.01	-	0.00	0.02	-	0.00	0.01	-	-
20	0.00	0.01	-	0.00	0.02	-	0.00	0.01	-	-
21	0.00	0.01	-	0.00	0.02	-	0.00	0.01	-	-
22	0.00	0.01	-	0.00	0.01	-	0.00	0.01	-	-
23	0.00	0.00	-	0.00	0.01	-	0.00	0.01	-	-
24	0.00	0.01	-	0.00	0.00	-	0.00	0.01	-	-
25	0.00	0.00	-	0.00	0.00	-	0.00	0.01	-	-

Table 9 - Mains Signaling Voltage

Signaling frequency, Hz	Signal voltage, %Un						
	Phase A		Phase B		Phase C		
	Max. Value	Non-compliant, %	Max. value	Non-compliant, %	Max. value	Non-compliant, %	99.0% limit
183.0	0.31	0.00	0.29	0.00	0.27	0.00	9.00
191.0	0.32	0.00	0.29	0.00	0.27	0.00	9.00
217.0	0.36	0.00	0.34	0.00	0.29	0.00	9.00
317.0	0.29	0.00	0.24	0.00	0.21	0.00	9.00

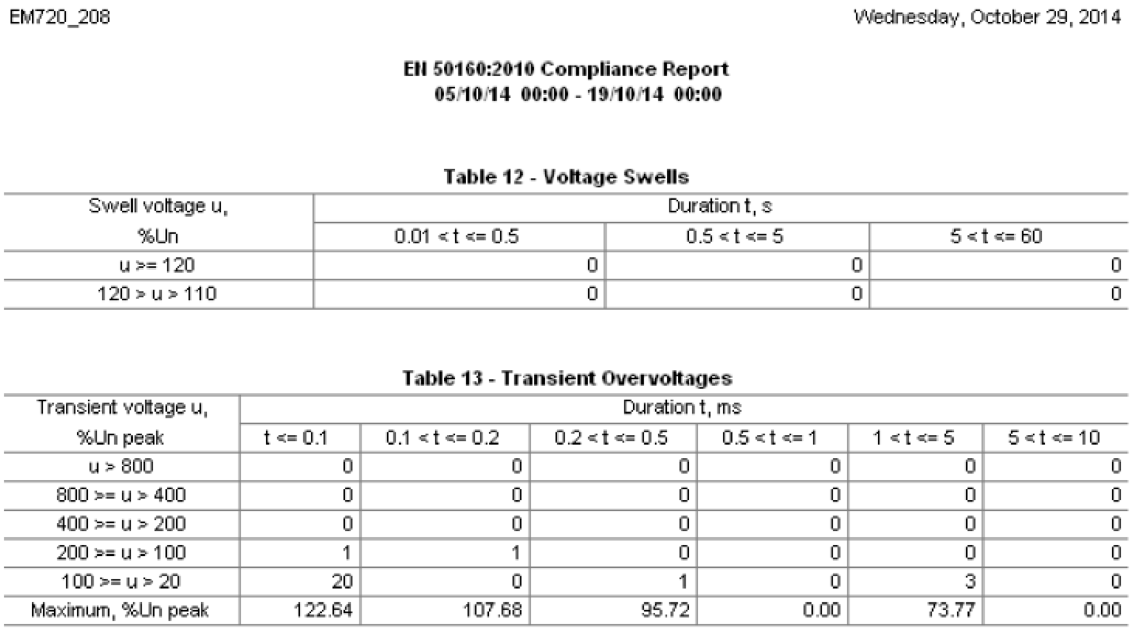
Table 10 - Voltage Interruptions

Residual voltage u, %Un	Duration t, s							Max. duration, s
	t <= 0.5	0.5 < t <= 1	1 < t <= 5	5 < t <= 20	20 < t <= 60	60 < t <= 180	180 < t	
5 > u	0	0	0	0	0	0	0	0.00

Table 11 - Voltage Dips

Residual voltage u, %Un	Duration t, s				
	0.01 < t <= 0.2	0.2 < t <= 0.5	0.5 < t <= 1	1 < t <= 5	5 < t <= 60
90 > u >= 80	1	0	0	0	0
80 > u >= 70	1	0	0	0	0
70 > u >= 40	0	0	0	0	0
40 > u >= 5	0	0	0	0	0
5 > u	0	0	0	0	0

Page 4



EM720_208 Wednesday, October 29, 2014

EN 50160:2010 Compliance Report
05/10/14 00:00 - 19/10/14 00:00

Table 12 - Voltage Swells

Swell voltage u, %Un	Duration t, s		
	0.01 < t <= 0.5	0.5 < t <= 5	5 < t <= 60
u >= 120	0	0	0
120 > u > 110	0	0	0

Table 13 - Transient Overvoltages

Transient voltage u, %Un peak	Duration t, ms					
	t <= 0.1	0.1 < t <= 0.2	0.2 < t <= 0.5	0.5 < t <= 1	1 < t <= 5	5 < t <= 10
u > 800	0	0	0	0	0	0
800 >= u > 400	0	0	0	0	0	0
400 >= u > 200	0	0	0	0	0	0
200 >= u > 100	1	1	0	0	0	0
100 >= u > 20	20	0	1	0	3	0
Maximum, %Un peak	122.64	107.68	95.72	0.00	73.77	0.00