

Power quality: ION meters and EN50160

EN50160 is a European standard that defines the voltage characteristics of the electricity supplied by public distribution systems. It provides the limits within which any customer can expect voltage characteristics to remain. This technical note summarizes the EN50160 data and statistics measured by the PowerLogic™ ION™ meters that monitor compliance to the EN50160 Edition 2 standard. A description of the EN50160 counters and external controls is also provided.

Visit the following website for a copy of the *Measurement Guide for Voltage Characteristics*: <http://www.eurelectric.org/CatPub/Document.aspx?FolderID=1536&DocumentID=5585>

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- ◆ Your meter's technical documentation
- ◆ *ION Reference*

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Hazard categories and special symbols

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service or maintain it. The following special messages may appear throughout this manual or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury.

CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, can result in minor or moderate injury.

CAUTION

CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, can result in equipment damage.



NOTE

Provides additional information to clarify or simplify a procedure.

Please Note

Electrical equipment should be installed, operated, serviced and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

Introduction

The following meters are configured to measure the supply voltage and present EN50160 statistics according to a set of guidelines defined by Eurelectric (UNIPED - 1995 Edition):

- ◆ ION7650 meters with the EN50160 ordering option.
- ◆ ION8650A and ION8650B meters (only the ION8650A provides interharmonics statistics) .
- ◆ ION8800A and ION8800B meters (only the ION8800A provides interharmonics statistics).
- ◆ ION8600A meters with the power quality template (only the ION8600A provides interharmonics statistics).

Depending on the device and its framework, you can view EN50160 statistical information using the front panel and/or the meter diagrams in the Vista component of ION Enterprise™. The meters can also provide many EN50160 parameters to Modbus™ systems. Refer to the meter's *User Guide* more information.

If your meter requires a power quality template to provide EN50160 information, this can be downloaded from www.schneider-electric.com.



NOTE

The meter's control power should be supplied with a UPS (Uninterruptible Power Supply) in order to ensure proper operation of the EN50160 framework during power outage situations. Failure to follow this guideline may result in missing data for the EN50160 report.

Default EN50160 measurements

The EN50160 standard divides voltage characteristics into 10 distinct components. Each component has operating conditions and requirements for samples to be considered valid (such as a measured voltage between $\pm 15\%$ of nominal).

The factory configured meter uses a counter-based (N , N_1 , N_2 ...) scheme to evaluate the compliance of each component within a defined observation period. Counter statistics are provided for current and previous observation periods; a brief description of each counter is also provided. The Data Logging section for each component provides a number of data log viewers for counter and parameter data. The following sections describe the data and statistics provided for each EN50160 measurement.



NOTE

Refer to “EN50160 external controls” on page 23 for details on enabling EN50160 parameter data logging.

Power frequency

The frequency measurement is a mean value over fixed 10-second intervals. The nominal value for frequency is 50 Hz (or 60 Hz, depending on model number).

- ◆ Observation period of one week with fixed steps of 10 seconds.
- ◆ N = number of 10-second intervals in which the supply voltage is within $\pm 15\%$ of nominal.
- ◆ N_1 = number of intervals in which the frequency differs more than 0.5 Hz from nominal and the supply voltage is within $\pm 15\%$ of nominal.
- ◆ N_2 = number of intervals in which the frequency is +2 Hz or -3 Hz from nominal and the supply voltage is within $\pm 15\%$ of nominal.

Power frequency complies with the standard if $N_1/N \leq 5\%$ and $N_2 = 0$ during the observation period (1 week by default).

EN50160 data (current observation period): The meter generates the N , N_1 and N_2 counts described above. These counters are reset at the beginning of the next observation period.

EN50160 data (previous observation period): The meter stores the N , N_1 and N_2 counter values at the end of each observation period before these counters are reset. These registers are also stored in a data recorder for each observation period.

Events: The meter creates a message in the Event log every time the N_1 and N_2 counters increase.

Parameter data: The meter can be enabled to record the 10-minute mean, $\frac{1}{2}$ cycle minimum and $\frac{1}{2}$ cycle maximum values of frequency into a data recorder every 10 minutes.

Power frequency default measurements

Register label	Source module type	Description
Freq N*	Signal Limit Evaluation	number of valid intervals (voltage on all phases within +/- 15% of nominal)
Freq N invld*		number of invalid intervals
Freq N1*		number of valid intervals in which the frequency deviates from the nominal by more than +/-1%
Freq N2*		number of valid intervals in which the frequency deviates from the nominal by more than +4% or -6%
PO Freq N	Store	Freq N of the previous Observation Period
PO Freq N1		Freq N1 of the previous Observation Period
PO Freq N2		Freq N2 of the previous Observation Period
Freq mean-ep	Sliding Window Demand	average Frequency over 10s (used for display purposes)
Freq mn-op	Minimum	minimum mean Frequency (Freq mean-ep) over 1week (used for display purposes)
Freq mx-op	Maximum	maximum mean Frequency (Freq mean-ep) over 1week (used for display purpose)
Freq N1/N	Arithmetic	N1/N ratio
Freq N2/N		N2/N ratio
PO Freq N1/N		N1/N ratio of the previous Observation Period
PO Freq N2/N		N2/N ratio of the previous Observation Period

* This data is recorded once a week by the EN50160 Frq/Mg data recorder.

Optionally, the data below can be recorded every 10 minutes by the EN50160 Prm-f/V data recorder.

Register label	Description
PQ Freq mean	average Frequency over 10 minutes
PQ Freq low	minimum Frequency over 10 minutes (HS measurement)
PQ Freq high	maximum Frequency over 10 minutes (HS measurement)

Magnitude of voltage supply

Each measurement is the mean of the RMS (root mean square) voltage for each phase over fixed 10-minute intervals. The nominal value is defined by the Sag/Swell module's *Nom Volts* setup register.



NOTE

Nom Volts is typically setup when the meter is placed into service; if *Nom Volts* has not been set, enter a value for your system's nominal voltage. This value is used in all EN50160 compliance calculations.

- ◆ Observation period of one week with fixed steps of 10 minutes.

- ◆ **N** = number of 10-minute intervals in which the supply voltage is within ±15% of nominal.
- ◆ **N₁** = number of intervals in which the supply voltage differs more than 10% from nominal and supply voltage is within ±15% of nominal.

Supply voltage complies with the standard if $N_1/N \leq 5\%$ during the observation period (1 week by default).

EN50160 data (current observation period): The meter generates the N and N₁ counts for each phase as described above. These counters are reset at the beginning of the next observation period.

EN50160 data (previous observation period): The meter stores the N and N₁ counter values at the end of each observation period before these counters are reset. These registers are also stored in a data recorder for each observation period.

Events: The meter creates a message in the Event log every time the N₁ counter for each phase increases.

Parameter data: The meter can be enabled to record the 10-minute mean, ½ cycle minimum and ½ cycle maximum values of supply voltage for each phase into a data recorder every 10 minutes.

Voltage magnitude default measurements

Register	Source module type	Description
V1-Mag N*	Signal Limit Evaluation	number of valid intervals (voltage on phase 1 within +/- 15% of nominal)
V1-Mag N invld*		number of invalid intervals
V1-Mag N1*		number of valid intervals in which the voltage deviates from nominal by more than +/-10%
V2-Mag N*		number of valid intervals (voltage on phase 2 within +/- 15% of nominal)
V2-Mag N invld*		number of invalid intervals
V2-Mag N1*		number of valid intervals in which the voltage deviates from nominal by more than +/- 10%
V3-Mag N*		number of valid intervals (voltage on phase 3 within +/- 15% of nominal)
V3-Mag N invld*		number of invalid intervals
V3-Mag N1*		number of valid intervals in which the voltage deviates from nominal by more than +/- 10%
PO V1-Mag N	Store	V1-Mag N of the previous Observation Period
PO V1-Mag N1		V1-Mag N1 of the previous Observation Period
PO V2-Mag N		V2-Mag N of the previous Observation Period
PO V2-Mag N1		V2-Mag N1 of the previous Observation Period
PO V3-Mag N		V3-Mag N of the previous Observation Period
PO V3-Mag N1		V3-Mag N1 of the previous Observation Period
V1 mean	Sliding Window Demand	average voltage on phase 1 over 10m (used for display purposes)
V1 mean mn	Minimum	minimum of average voltage V1 (V1 mean) over 1 week (used for display purposes)

Register	Source module type	Description
V1 mean mx	Maximum	maximum of average voltage V1 (V1 mean) over 1 week (used for display purposes)
V2 mean	Sliding Window Demand	average voltage on phase 2 over 10m (used for display purposes)
V2 mean mn	Minimum	minimum of average voltage V2 (V2 mean) over 1 week (used for display purposes)
V2 mean mx	Maximum	maximum of average voltage V2 (V2 mean) over 1 week (used for display purposes)
V3 mean	Sliding Window Demand	average voltage on phase 3 over 10m (used for display purposes)
V3 mean mn	Minimum	minimum of average voltage V3 (V3 mean) over 1 week (used for display purposes)
V3 mean mx	Maximum	maximum of average voltage V3 (V3 mean) over 1 week (used for display purposes)
V1-Mag N1/N	Arithmetic	N1/N ratio
V2-Mag N1/N		N1/N ratio
V3-Mag N1/N		N1/N ratio
PO V1-Mag N1/N		N1/N ratio of the previous Observation Period
PO V2-Mag N1/N		N1/N ratio of the previous Observation Period
PO V3-Mag N1/N		N1/N ratio of the previous Observation Period

* This data is recorded once a week by the EN50160 Frq/Mg data recorder.

Optionally, the data below can be recorded every 10 minutes by the EN50160 Prm-f/V data recorder:

Parameter	Description
PQ V1 mean	average voltage on phase 1 over 10 minutes
PQ V1 low	minimum voltage on phase 1 over 10 minutes (HS measurement)
PQ V1 high	maximum voltage on phase 1 over 10 minutes (HS measurement)
PQ V2 mean	average voltage on phase 2 over 10 minutes
PQ V2 low	minimum voltage on phase 2 over 10 minutes (HS measurement)
PQ V2 high	maximum voltage on phase 2 over 10 minutes (HS measurement)
PQ V3 mean	average voltage on phase 3 over 10 minutes
PQ V3 low	minimum voltage on phase 3 over 10 minutes (HS measurement)
PQ V3 high	maximum voltage on phase 3 over 10 minutes (HS measurement)

Flicker

The flicker values Pst (short-term) and Plt (long-term) are generated according to IEC 61000-4-15.

- ◆ Observation period of one week with fixed Pst intervals of 10 minutes. A Pst value is considered valid only if the supply voltage is within $\pm 15\%$ of nominal and/or there is no voltage dip $\geq 15\%$.

- ◆ **N** = number of Plt values collected during the observation period (based on 12 valid consecutive Pst values).
- ◆ **N₁** = number of intervals in which Plt > 1.

Flicker complies with the standard if $N_1/N \leq 5\%$ during the observation period (1 week by default).



NOTE

Flicker is typically caused by rapid repeated application of large loads. This causes a series of small voltage dips which can affect the performance of nearby devices that are voltage sensitive. A voltage flicker problem can often be observed by noticing that lights are flickering.

EN50160 data (current observation period): The meter generates the N and N₁ counts for each phase as described above. These counters are reset at the beginning of the next observation period.

EN50160 data (previous observation period): The meter stores the N and N₁ counter values at the end of each observation period before these counters are reset. These registers are also stored in a data recorder for each observation period.

Events: The meter creates a message in the Event log every time the N₁ counter for each phase increases.

Parameter data: The meter can be enabled to record Pst and Plt values in a data recorder at the interval used to generate these values (10 minutes and 10 x 12 = 2 hours, respectively).

Flicker default measurements

Register label	Source module type	Description
V1-Flick Pst	Flicker	Pst value for voltage on phase 1
V2-Flick Pst		Pst value for voltage on phase 2
V3-Flick Pst		Pst value for voltage on phase 3
V1-Flick Plt		Plt value for voltage on phase 1
V2-Flick Plt		Plt value for voltage on phase 2
V3-Flick Plt		Plt value for voltage on phase 3

Register label	Source module type	Description
V1-Flick N*	Signal Limit Evaluation	number of valid intervals (voltage on phase 1 within +/- 15% of nominal and no dip >= 15%)
V1-Flick N invd*		number of invalid intervals
V1-Flick N1*		number of valid intervals in which Plt on phase 1 is greater than 1
V2-Flick N*		number of valid intervals (voltage on phase 2 within +/- 15% of nominal and no dip >= 15%)
V2-Flick N invd*		number of invalid intervals
V2-Flick N1*		number of valid intervals in which Plt on phase 2 is greater than 1
V3-Flick N*		number of valid intervals (voltage on phase 3 within +/- 15% of nominal and no dip >= 15%)
V3-Flick N invd*		number of invalid intervals
V3-Flick N1*		number of valid intervals in which Plt on phase 3 is greater than 1
PO V1-Flick N	Store	V1-Flick N of the previous Observation Period
PO V1 Flick N1		V1-Flick N1 of the previous Observation Period
PO V2-Flick N		V2-Flick N of the previous Observation Period
PO V2 Flick N1		V2-Flick N1 of the previous Observation Period
PO V3-Flick N		V3-Flick N of the previous Observation Period
PO V3 Flick N1		V3-Flick N1 of the previous Observation Period
V1 Pst mn	Minimum	minimum Pst value for phase 1 over 1 week (used for display purposes)
V1 Pst mx	Maximum	maximum Pst value for phase 1 over 1 week (used for display purposes)
V2 Pst mn	Minimum	minimum Pst value for phase 2 over 1week (used for display purposes)
V2 Pst mx	Maximum	maximum Pst value for phase 2 over 1 week (used for display purposes)
V3 Pst mn	Minimum	minimum Pst value for phase 3 over 1week (used for display purposes)
V3 Pst mx	Maximum	maximum Pst value for phase 3 over 1 week (used for display purposes)
V1-Flick N1/N	Arithmetic	N1/N ratio
V2-Flick N1/N		N1/N ratio
V3-Flick N1/N		N1/N ratio
PO V1-Flick N1/N		N1/N ratio of the previous Observation Period
PO V2-Flick N1/N		N1/N ratio of the previous Observation Period
PO V3-Flick N1/N		N1/N ratio of the previous Observation Period

* This data is recorded once a week by the EN50160 Flicker data recorder.

Optionally, the data below can be recorded every 10 minutes by the EN50160 Prm-Flk data recorder.

Register Label	Description
V1-Flick Pst	Pst value for voltage on phase 1
V2-Flick Pst	Pst value for voltage on phase 2
V3-Flick Pst	Pst value for voltage on phase 3

Register Label	Description
V1-Flick Plt	Plt value for voltage on phase 1
V2-Flick Plt	Plt value for voltage on phase 2
V3-Flick Plt	Plt value for voltage on phase 3

Supply voltage dips

The voltage dip is based on half-cycle RMS measurements. The duration of the dip corresponds to the period during which the RMS value remains less than 90% of the nominal voltage. The depth of the dip is defined as the difference (expressed in % of nominal voltage) between the minimum RMS voltage over the course of the dip and the nominal voltage.

The observation period is 1 week. No evaluation criteria are suggested by either the EN 50160 standard or the UNIPEDA *Measurement Guide for Voltage Characteristics*; you should apply your own criteria to the data captured by the meter. The table below defines the classification scheme for counters Nij:

Depth (d%) Duration (t)	10ms ≤ t < 100ms	100ms ≤ t < 500ms	500ms ≤ t < 1s	1s < t < 3s	3s ≤ t < 20s	20s ≤ t < 1min
10 < d < 15	N ₁₁	N ₂₁	N ₃₁	N ₄₁	N ₅₁	N ₆₁
15 ≤ d < 30	N ₁₂	N ₂₂	N ₃₂	N ₄₂	N ₅₂	N ₆₂
30 ≤ d < 60	N ₁₃	N ₂₃	N ₃₃	N ₄₃	N ₅₃	N ₆₃
60 < d < 99	N ₁₄	N ₂₄	N ₃₄	N ₄₄	N ₅₄	N ₆₄

EN50160 data (current observation period): The meter maintains the counters listed in the table above for each phase. These counters are reset on a weekly basis.

EN50160 data (previous observation period): The meter stores the counter values listed in the table above for each phase on a weekly basis before these counters are reset. These registers are also stored in a data recorder on a weekly basis.

Events: The meter creates a message in the Event log every time one of the counters increases.

Parameter data: The meter can be enabled to record the minimum RMS voltage for each phase during a dip, the duration of the dip and the timestamp for when the dip occurred.

Voltage dips default measurements

Values from the current observation period (in the first four columns) are found in Bin modules. They are also logged weekly by the EN50160 Vlt Dp1 to EN50160 Vlt Dp5 data recorder modules. Values from previous observation (PO) period are found in Store modules.

Register labels							
V1-Dip N11	V1-Dip N12	V1-Dip N13	V1-Dip N14	PO V1-Dip N11	PO V1-Dip N12	PO V1-Dip N13	PO V1-Dip N14
V1-Dip N21	V1-Dip N22	V1-Dip N23	V1-Dip N24	PO V1-Dip N21	PO V1-Dip N22	PO V1-Dip N23	PO V1-Dip N24
V1-Dip N31	V1-Dip N32	V1-Dip N33	V1-Dip N34	PO V1-Dip N31	PO V1-Dip N32	PO V1-Dip N33	PO V1-Dip N34
V1-Dip N41	V1-Dip N42	V1-Dip N43	V1-Dip N44	PO V1-Dip N41	PO V1-Dip N42	PO V1-Dip N43	PO V1-Dip N44
V1-Dip N51	V1-Dip N52	V1-Dip N53	V1-Dip N54	PO V1-Dip N51	PO V1-Dip N52	PO V1-Dip N53	PO V1-Dip N54
V1-Dip N61	V1-Dip N62	V1-Dip N63	V1-Dip N64	PO V1-Dip N61	PO V1-Dip N62	PO V1-Dip N63	PO V1-Dip N64
V2-Dip N11	V2-Dip N12	V2-Dip N13	V2-Dip N14	PO V2-Dip N11	PO V2-Dip N12	PO V2-Dip N13	PO V2-Dip N14
V2-Dip N21	V2-Dip N22	V2-Dip N23	V2-Dip N24	PO V2-Dip N21	PO V2-Dip N22	PO V2-Dip N23	PO V2-Dip N24
V2-Dip N31	V2-Dip N32	V2-Dip N33	V2-Dip N34	PO V2-Dip N31	PO V2-Dip N32	PO V2-Dip N33	PO V2-Dip N34
V2-Dip N41	V2-Dip N42	V2-Dip N43	V2-Dip N44	PO V2-Dip N41	PO V2-Dip N42	PO V2-Dip N43	PO V2-Dip N44
V2-Dip N51	V2-Dip N52	V2-Dip N53	V2-Dip N54	PO V2-Dip N51	PO V2-Dip N52	PO V2-Dip N53	PO V2-Dip N54
V2-Dip N61	V2-Dip N62	V2-Dip N63	V2-Dip N64	PO V2-Dip N61	PO V2-Dip N62	PO V2-Dip N63	PO V2-Dip N64
V3-Dip N11	V3-Dip N12	V3-Dip N13	V3-Dip N14	PO V3-Dip N11	PO V3-Dip N12	PO V3-Dip N13	PO V3-Dip N14
V3-Dip N21	V3-Dip N22	V3-Dip N23	V3-Dip N24	PO V3-Dip N21	PO V3-Dip N22	PO V3-Dip N23	PO V3-Dip N24
V3-Dip N31	V3-Dip N32	V3-Dip N33	V3-Dip N34	PO V3-Dip N31	PO V3-Dip N32	PO V3-Dip N33	PO V3-Dip N34
V3-Dip N41	V3-Dip N42	V3-Dip N43	V3-Dip N44	PO V3-Dip N41	PO V3-Dip N42	PO V3-Dip N43	PO V3-Dip N44
V3-Dip N51	V3-Dip N52	V3-Dip N53	V3-Dip N54	PO V3-Dip N51	PO V3-Dip N52	PO V3-Dip N53	PO V3-Dip N54
V3-Dip N61	V3-Dip N62	V3-Dip N63	V3-Dip N64	PO V3-Dip N61	PO V3-Dip N62	PO V3-Dip N63	PO V3-Dip N64

The following Minimum module output registers are used for display purposes:

Register label	Description
V1-Dip mn %	greatest voltage dip on phase 1 (=lowest voltage) over 1 week
V2-Dip mn %	greatest voltage dip on phase 2 (=lowest voltage) over 1 week
V3-Dip mn %	greatest voltage dip on phase 3 (=lowest voltage) over 1 week

Optionally, the following data can be recorded at every dip event by the EN50160 Prm-VDp data recorder.

Register label	Description
V1-Dip [%]	voltage dip on phase 1
V2-Dip [%]	voltage dip on phase 2
V3-Dip [%]	voltage dip on phase 3

Register label	Description
V1-Dip duration	dip duration on phase 1
V2-Dip duration	dip duration on phase 2
V3-Dip duration	dip duration on phase 3

Short and long interruptions

Interruption detection is based on half-cycle RMS measurements. The duration of the interruption corresponds to the period during which the RMS value remains less than 1% of the nominal voltage.

The observation period is 1 week. No evaluation criteria are suggested by either the EN50160 standard or the UNIPEDE *Measurement Guide for Voltage Characteristics*; you should apply your own criteria to the data captured by the meter.

The table below defines the classification scheme for counters N_i :

Duration of Interruptions	duration < 1s	1s <= duration < 3 min	duration >= 3 min
Number of Interruptions	N_1	N_2	N_3

EN50160 data (current observation period): The meter maintains the counters listed in the table above for each phase. These counters are reset on a weekly basis.

EN50160 data (previous observation period): The meter stores the counter values listed in the table above for each phase on a weekly basis before these counters are reset. These registers are also stored in a data recorder on a weekly basis.

Events: The meter creates a message in the Event log every time one of the counters increases.

Parameter data: The meter can be enabled to record the duration of the interruption and the timestamp for when the interruption occurred.

Interruptions default measurements

Counters from the current observation period are located in Bin modules. They also recorded weekly by the EN50160 Intrpt data recorder. Counters are from the previous observation (PO) period are located in Store modules.

Register Label (Current Observation Period)		
V1-Intrpt N1	V1-Intrpt N2	V1-Intrpt N3
V2-Intrpt N1	V2-Intrpt N2	V2-Intrpt N3
V3-Intrpt N1	V3-Intrpt N2	V3-Intrpt N3

Register Label (Previous Observation Period)		
PO V1-Intrpt N1	PO V1-Intrpt N2	PO V1-Intrpt N3
PO V2-Intrpt N1	PO V2-Intrpt N2	PO V2-Intrpt N3
PO V3-Intrpt N1	PO V3-Intrpt N2	PO V3-Intrpt N3

Optionally, the data below can be recorded at every interruption event by the EN50160 Prm-VIr data recorder:

Register label	Description
V1-Irpt durtn	interruption duration on phase 1
V2-Irpt durtn	interruption duration on phase 2
V3-Irpt durtn	interruption duration on phase 3

Temporary overvoltages

Overvoltage detection is based on half-cycle RMS measurements. The duration of the overvoltage corresponds to the period during which the RMS value remains more than 110% of the nominal voltage. The magnitude of the overvoltage is defined as the ratio (expressed as a percentage) between the maximum RMS voltage during the overvoltage and the nominal voltage.

The observation period is 1 week. No evaluation criteria are suggested by either the EN50160 standard or the UNIPEDE *Measurement Guide for Voltage Characteristics*; you should apply your own criteria to the data captured by the meter. The table below defines the classification scheme for counters Nij:

Overvoltages / Duration "t"	t < 1s	1s <= t < 1 min	t >= 1 min
110 < magnitude <= 120 %	N ₁₁	N ₂₁	N ₃₁
120 < magnitude <= 140 %	N ₁₂	N ₂₁	N ₃₂
140 < magnitude <= 160 %	N ₁₃	N ₂₃	N ₃₃
160 < magnitude <= 200 %	N ₁₄	N ₂₄	N ₃₄
magnitude > 200 %	N ₁₅	N ₂₅	N ₃₅

EN50160 data (current observation period): The meter maintains the counters listed in the table above for each phase. These counters are reset on a weekly basis.

EN50160 data (previous observation period): The meter stores the counter values listed in the table above for each phase on a weekly basis before these counters are reset. These registers are also stored in a data recorder on a weekly basis.

Events: The meter creates a message in the Event log every time one of the counters increases.

Parameter data: The meter can be enabled to record the maximum RMS voltage for each phase during an overvoltage, the duration of the overvoltage and the timestamp for when the overvoltage occurred.

Overvoltages default measurements

The data below is from the current observation period; values are all located in Bin modules. They are also recorded weekly by the EN50160 Ovrvt1, EN50160 Ovrvt2 and EN50160 Ovrvt3 data recorders.

Register labels				
V1-Ovrvt N11	V1-Ovrvt N12	V1-Ovrvt N13	V1-Ovrvt N14	V1-Ovrvt N15
V1-Ovrvt N21	V1-Ovrvt N22	V1-Ovrvt N23	V1-Ovrvt N24	V1-Ovrvt N25
V1-Ovrvt N31	V1-Ovrvt N32	V1-Ovrvt N33	V1-Ovrvt N34	V1-Ovrvt N35
V2-Ovrvt N11	V2-Ovrvt N12	V2-Ovrvt N13	V2-Ovrvt N14	V2-Ovrvt N15
V2-Ovrvt N21	V2-Ovrvt N22	V2-Ovrvt N23	V2-Ovrvt N24	V2-Ovrvt N25
V2-Ovrvt N31	V2-Ovrvt N32	V2-Ovrvt N33	V2-Ovrvt N34	V2-Ovrvt N35
V3-Ovrvt N11	V3-Ovrvt N12	V3-Ovrvt N13	V3-Ovrvt N14	V3-Ovrvt N15
V3-Ovrvt N21	V3-Ovrvt N22	V3-Ovrvt N23	V3-Ovrvt N24	V3-Ovrvt N25
V3-Ovrvt N31	V3-Ovrvt N32	V3-Ovrvt N33	V3-Ovrvt N34	V3-Ovrvt N35

The following counters are from the Previous Observation period (PO). These values are all located in Store modules.

Register labels				
PO V1-Ovrvt N11	PO V1-Ovrvt N12	PO V1-Ovrvt N13	PO V1-Ovrvt N14	PO V1-Ovrvt N15
PO V1-Ovrvt N21	PO V1-Ovrvt N22	PO V1-Ovrvt N23	PO V1-Ovrvt N24	PO V1-Ovrvt N25
PO V1-Ovrvt N31	PO V1-Ovrvt N32	PO V1-Ovrvt N33	PO V1-Ovrvt N34	PO V1-Ovrvt N35
PO V2-Ovrvt N11	PO V2-Ovrvt N12	PO V2-Ovrvt N13	PO V2-Ovrvt N14	PO V2-Ovrvt N15
PO V2-Ovrvt N21	PO V2-Ovrvt N22	PO V2-Ovrvt N23	PO V2-Ovrvt N24	PO V2-Ovrvt N25
PO V2-Ovrvt N31	PO V2-Ovrvt N32	PO V2-Ovrvt N33	PO V2-Ovrvt N34	PO V2-Ovrvt N35
PO V3-Ovrvt N11	PO V3-Ovrvt N12	PO V3-Ovrvt N13	PO V3-Ovrvt N14	PO V3-Ovrvt N15
PO V3-Ovrvt N21	PO V3-Ovrvt N22	PO V3-Ovrvt N23	PO V3-Ovrvt N24	PO V3-Ovrvt N25
PO V3-Ovrvt N31	PO V3-Ovrvt N32	PO V3-Ovrvt N33	PO V3-Ovrvt N34	PO V3-Ovrvt N35

The Maximum module output registers are used for display purposes:

Register label	Description
V1-Ovrvt mx %	greatest over-voltage on phase 1 over 1 week
V2-Ovrvt mx %	greatest over-voltage on phase 2 over 1 week
V3-Ovrvt mx %	greatest over-voltage on phase 3 over 1 week

Optionally, the data below can be recorded at the end of every overvoltage event by the EN50160 Prm-OV data recorder.

Register label	Description
V1-Ovrvt [%]	overvoltage on phase 1
V2-Ovrvt [%]	overvoltage on phase 2
V3-Ovrvt [%]	overvoltage on phase 3
V1-Ovrvt durtn	overvoltage duration on phase 1
V2-Ovrvt durtn	overvoltage duration on phase 2
V3-Ovrvt durtn	overvoltage duration on phase 3

Supply voltage unbalance

Each basic measurement is the true RMS value over a fixed 10-minute period (see the UNIPED *Measurement Guide for Voltage Characteristic* for more details).

- ◆ Observation period of one week with fixed steps of 10 minutes.
- ◆ **N** = number of 10-minute intervals in which the supply voltage is within $\pm 15\%$ of nominal.
- ◆ **N₁** = number of intervals in which the voltage unbalance exceeds 2% (3% in some areas) and the supply voltage is within $\pm 15\%$ of nominal.

Voltage unbalance complies with the standard if $N_1/N \leq 5\%$ during the observation period (1 week by default). Each measurement is the RMS unbalance voltage:

$$V_{\text{UNBAL}\%} = \frac{\text{negative sequence voltage}}{\text{positive sequence voltage}}$$

EN50160 data (current observation period): The meter generates the N and N₁ counts as described above. These counters are reset at the beginning of the next observation period.

EN50160 data (previous observation period): The meter stores the N and N₁ counter values at the end of each observation period before these counters are reset. These registers are also stored in a data recorder for each observation period.

Events: A message is created in the Event log every time the N₁ counter increases.

Voltage unbalance default measurements

Register label	Module type	Description
Vubal N*	Signal Limit Evaluation	Number of valid intervals (voltage on all phases within +/- 15% of nominal)
Vunbal N invld*		Number of invalid intervals
Vunbal N1*		Number of valid intervals in which the voltage unbalance exceeds 2%
PO Vunbal N	Store	Vunbal N of the previous Observation Period
PO Vunbal N1		Vunbal N1 of the previous Observation Period
Vunbal mean	Sliding Window Demand	Average voltage unbalance over 10 minutes (used for display purposes)
Vunbl mean mn	Minimum	Minimum average voltage unbalance over 1 week (used for display purposes)
Vunbl mean mx	Maximum	Maximum average voltage unbalance over 1 week (used for display purposes)
Vunbal N1/N	Arithmetic	N1/N ratio
PO Vunbal N1/N		N1/N ratio of the previous Observation Period

* This data is recorded once every week by the EN50160 Vunbal data recorder.

Harmonic voltage

All harmonic measurements are performed as defined by IEC 61000-4-30.

- ◆ Observation period of one week with fixed steps of 10 minutes.
- ◆ **N** = number of 10-minute intervals in which the supply voltage is within ±15% of nominal.
- ◆ **N₁** = number of intervals in which one or more of the individual harmonic levels defined in the table below are exceeded and the supply voltage is within ±15% of nominal. Levels for individual harmonics (for each phase) up to the 25th are defined in the table below.
- ◆ **N₂** = number of intervals in which the THD value for one or more of the voltage phases exceeds 8% and the supply voltage is within ±15% of nominal. The THD calculation will include all harmonics up to the 40thd (ION8600A, ION8650B and ION8800B meters) or 50thd (ION7650, ION8650A and ION8800A meters).

Harmonic voltage complies with the standard if $N_1/N \leq 5\%$ and $N_2/N \leq 5\%$ during the observation period (1 week by default).

Odd Harmonics						Even Harmonics	
Not Multiples of 3				Multiples of 3		Order	Threshold
Order	Threshold	Order	Threshold	Order	Threshold		
5	6%	17	2%	3	5%	2	2%
7	5%	19	1.5%	9	1.5%	4	1%
11	3.5%	23	1.5%	15	0.5%	6...24	0.5%
13	3%	25	1.5%	21	0.5%		

EN50160 data (current observation period): The meter generates the N, N₁ and N₂ counts described above for each phase. These counters are reset at the beginning of the next observation period.

EN50160 data (previous observation period): The meter stores the N, N₁ and N₂ counter values at the end of each observation period before these counters are reset. These registers are also stored in a data recorder for each observation period.

Events: The meter creates a message in the Event log every time the N₁ and N₂ counters increase.

Parameter data: The meter can be enabled to record the 10-minute mean, minimum and maximum values of THD, TO(odd)HD and TE(even)HD for each voltage phase into a data recorder every 10 minutes.

Harmonics Default Measurements

Register label	Source module	Description
V1-Hrm N*	Harmonics Evaluation	number of valid intervals (voltage on phase 1 within +/- 15% of nominal)
V1-Hrm N invld*		number of invalid intervals
V1-Hrm N1*		number of intervals in which one or more individual harmonics on phase 1 exceed their limits
V1-Hrm N2*		number of intervals in which the THD value on phase 1 exceeds the limit
V2-Hrm N*		number of valid intervals (voltage on phase 2 within +/- 15% of nominal)
V2-Hrm N invld*		number of invalid intervals
V2-Hrm N1*		number of intervals in which one or more individual harmonics on phase 2 exceed their limits
V2-Hrm N2*		number of intervals in which the THD value on phase 2 exceeds the limit
V3-Hrm N*		number of valid intervals (voltage on phase 3 within +/- 15% of nominal)
V3-Hrm N invld*		number of invalid intervals
V3-Hrm N1*		number of intervals in which one or more individual harmonics on phase 3 exceed their limits
V3-Hrm N2*		number of intervals in which the THD value on phase 3 exceeds the limit
PO V1-Hrm N	Store	V1-Hrm N of the previous Observation Period
PO V1-Hrm N1		V1-Hrm N1 of the previous Observation Period
PO V1-Hrm N2		V1-Hrm N2 of the previous Observation Period
PO V2-Hrm N		V2-Hrm N of the previous Observation Period
PO V2-Hrm N1		V2-Hrm N1 of the previous Observation Period
PO V2-Hrm N2		V2-Hrm N2 of the previous Observation Period
PO V3-Hrm N		V3-Hrm N of the previous Observation Period
PO V3-Hrm N1		V3-Hrm N1 of the previous Observation Period
PO V3-Hrm N2		V3-Hrm N2 of the previous Observation Period

Register label	Source module	Description
V1 THD mean	Sliding Window Demand	average THD on phase 1 over 10 minutes (used for display purposes)
V2 THD mean		average THD on phase 2 over 10 minutes (used for display purposes)
V3 THD mean		average THD on phase 3 over 10 minutes (used for display purposes)
V1 THD mean mn	Minimum	minimum average THD on phase 1 over 1 week (used for display purposes)
V2 THD mean mn		minimum average THD on phase 2 over 1 week (used for display purposes)
V3 THD mean mn		minimum average THD on phase 3 over 1 week (used for display purposes)
V1 THD mean mx	Maximum	maximum average THD on phase 1 over 10 minutes (used for display purposes)
V2 THD mean mx		maximum average THD on phase 2 over 1 week (used for display purposes)
V3 THD mean mx		maximum average THD on phase 3 over 1 week (used for display purposes)
V1-Hrm N1/N	Arithmetic	N1/N ratio
V1-Hrm N2/N		N2/N ratio
V2-Hrm N1/N		N1/N ratio
V2-Hrm N2/N		N2/N ratio
V3-Hrm N1/N		N1/N ratio
V3-Hrm N2/N		N2/N ratio
PO V1-Hrm N1/N		N1/N ratio of previous Observation Period
PO V1-Hrm N2/N		N2/N ratio of previous Observation Period
PO V2-Hrm N1/N		N1/N ratio of previous Observation Period
PO V2-Hrm N2/N		N2/N ratio of previous Observation Period
PO V3-Hrm N1/N		N1/N ratio of previous Observation Period
PO V3-Hrm N2/N		N2/N ratio of previous Observation Period

* This data is recorded by the EN50160 Hrm Vlt data recorder once a week.

Optionally, the following data is recorded once every 10 minutes by the EN50160 PrmHrm1 and EN50160 PrmHrm2 data recorders.

Register label	Description	Register label	Description
PQ V1 THD mean	average THD on phase 1 over 10 minutes	PQ V2 TOHD mx	maximum TOHD on phase 1 over 10 minutes
PQ V1 THD mn	minimum THD on phase 1 over 10 minutes	PQ V2 TEHD mean	average TEHD on phase 1 over 10 minutes
PQ V1 THD mx	maximum THD on phase 1 over 10 minutes	PQ V2 TEHD mn	minimum TEHD on phase 1 over 10 minutes
PQ V1 TOHD mean	average TOHD on phase 1 over 10 minutes	PQ V2 TEHD mx	maximum TEHD on phase 1 over 10 minutes
PQ V1 TOHD mn	minimum TOHD on phase 1 over 10 minutes	PQ V3 THD mean	average THD on phase 3 over 10 minutes
PQ V1 TOHD mx	maximum TOHD on phase 1 over 10 minutes	PQ V3 THD mn	minimum THD on phase 3 over 10 minutes

Register label	Description	Register label	Description
PQ V1 TEHD mean	average TEHD on phase 1 over 10 minutes	PQ V3 THD mx	maximum THD on phase 3 over 10 minutes
PQ V1 TEHD mn	minimum TEHD on phase 1 over 10 minutes	PQ V3 TOHD mean	average TOHD on phase 1 over 10 minutes
PQ V1 TEHD mx	maximum TEHD on phase 1 over 10 minutes	PQ V3 TOHD mn	minimum TOHD on phase 1 over 10 minutes
PQ V2 THD mean	average THD on phase 2 over 10 minutes	PQ V3 TOHD mx	maximum TOHD on phase 1 over 10 minutes
PQ V2 THD mn	minimum THD on phase 2 over 10 minutes	PQ V3 TEHD mean	average TEHD on phase 1 over 10 minutes
PQ V2 THD mx	maximum THD on phase 2 over 10 minutes	PQ V3 TEHD mn	minimum TEHD on phase 1 over 10 minutes
PQ V2 TOHD mean	average TOHD on phase 1 over 10 minutes	PQ V3 TEHD mx	maximum TEHD on phase 1 over 10 minutes
PQ V2 TOHD mn	minimum TOHD on phase 1 over 10 minutes		

Interharmonic voltage

Interharmonics are the entire *band* of frequencies between two successive integer multiples of the fundamental. All harmonic measurements are performed as defined in IEC 61000-4-30.

- ◆ Observation period of one week with fixed steps of 10 minutes.
- ◆ **N** = number of 10-minute intervals in which the supply voltage is within $\pm 15\%$ of nominal.
- ◆ **N₁** = number of intervals in which one or more of the interharmonic levels defined in the table below are exceeded and the supply voltage is within $\pm 15\%$ of nominal. Levels for interharmonic bands up to the 25th harmonic are defined in the table below.

Apply your own compliance evaluation criteria to the interharmonic statistics provided by the meter.

In the table below, order 2 specifies all frequencies between the fundamental and the 2nd harmonic; order 3 specifies all frequencies between the 2nd harmonic and the 3rd; etc.

Odd Harmonics						Even Harmonics	
Not Multiples of 3				Multiples of 3		Order	Threshold
Order	Threshold	Order	Threshold	Order	Threshold		
5	6%	17	2%	3	5%	2	2%
7	5%	19	1.5%	9	1.5%	4	1%
11	3.5%	23	1.5%	15	0.5%	6...24	0.5%
13	3%	25	1.5%	21	0.5%		

EN50160 data (current observation period): The meter generates the N and N₁ counts described above for each phase. These counters are reset at the beginning of the next observation period.

EN50160 data (previous observation period): The meter stores the N and N₁ counter values at the end of each observation period before these counters are reset. These registers are also stored in a data recorder for each observation period.

Events: The meter creates a message in the Event log every time the N₁ counter increases.

Voltage interharmonics default measurements

Register label	Source module	Description
V1-Inthrm N*	Harmonics Evaluation	number of valid intervals (voltage on phase 1 within +/- 15% of nominal)
V1-Inthrm N ivd*		number of invalid intervals
V1-Inthrm N1*		number of intervals in which one or more individual harmonics on phase 1 exceed their limits
V2-Inthrm N*		number of valid intervals (voltage on phase 2 within +/- 15% of nominal)
V2-Inthrm N ivd*		number of invalid intervals
V2-Inthrm N1*		number of intervals in which one or more individual harmonics on phase 2 exceed their limits
V3-Inthrm N*		number of valid intervals (voltage on phase 3 within +/- 15% of nominal)
V3-Inthrm N ivd*		number of invalid intervals
V3-Inthrm N1*		number of intervals in which one or more individual harmonics on phase 3 exceed their limits
PO V1-Inthrm N	Store	V1-Inthrm N of the previous Observation Period
PO V1-Inthrm N1		V1-Inthrm N1 of the previous Observation Period
PO V2-Inthrm N		V2-Inthrm N of the previous Observation Period
PO V2-Inthrm N1		V2-Inthrm N1 of the previous Observation Period
PO V3-Inthrm N		V3-Inthrm N of the previous Observation Period
PO V3-Inthrm N1		V3-Inthrm N1 of the previous Observation Period
V1-Inthrm N1/N	Arithmetic	N1/N ratio
V2-Inthrm N1/N		N1/N ratio
V3-Inthrm N1/N		N1/N ratio
PO V1-Ihrm N1/N		N1/N ratio of previous Observation Period
PO V2-Ihrm N1/N		N1/N ratio of previous Observation Period
PO V3-Ihrm N1/N		N1/N ratio of previous Observation Period

* This data is recorded weekly by the EN50160 Ihm Vlt data recorder.

Mains signaling voltage

In some countries, power transmission and distribution systems are also used to carry communication signals. If the magnitude of these signals becomes too large, they have the potential to interfere with the operation of electrical equipment in much the same way that excessive harmonic and interharmonic voltages do. The purpose of this measurement component is to ensure that these signals do not exceed defined levels.

EN50160 defines three types of mains signals:

1. **Ripple control:** frequencies between 110 to 3000 Hz
2. **Power line carrier:** frequencies between 3 to 148.5 kHz
3. **Marking signals:** short transients superimposed at select points on the voltage waveform

The meter can monitor ripple control signals between 110 Hz and 3000 Hz. The meter performs signaling voltage measurements using interharmonic voltages near the user-defined signaling frequencies. You can specify three frequencies to be monitored; the default is 1060 Hz.



NOTE

Some common ripple control frequencies in Europe include 183 Hz, 191 Hz, 425 Hz and 1060 Hz.

The signaling voltage measurement is the mean voltage (not RMS) over a fixed interval of 3 seconds.

- ◆ Observation period of one day with fixed steps of 3 seconds.
- ◆ **N** = number of 3-second intervals in which the supply voltage is within $\pm 15\%$ of nominal.
- ◆ **N₁** = number of intervals in which the mean value of the signalling voltage exceeds the curve defined in the EN50160 standard and the supply voltage is within $\pm 15\%$ of nominal.

Mains signaling voltage complies with the standard if $N_1/N \leq 1\%$ during the observation period (1 day by default).

EN50160 data (current observation period): The meter generates the N and N₁ counts for each phase as described above. These counters are reset at the beginning of the next observation period.

EN50160 data (previous observation period): The meter stores the N and N₁ counter values at the end of each observation period before these counters are reset. These 6 registers are also stored in a data recorder for each observation period.

Events: The meter creates a message in the Event log every time the N₁ counter for each phase increases.

Mains Signaling Evaluation module settings

To enable EN50160 mains signal voltage monitoring, you must specify the signal frequency of interest and the allowable signal voltage threshold for each of the three voltage phases. These parameters are held in the *Frequency* and *Limit* setup registers of their respective Mains Signaling Evaluation modules.

The allowable *Frequency* range is 5 Hz to 2500 Hz (default is 1060 Hz). If this register is set to 0 Hz, then no evaluation will be performed. The voltage threshold defined by the *Limit* setup register must be expressed as a percentage of the fundamental (default is 100%). Refer to the *ION Reference* for more details about this module.

Mains signaling default measurements

Register label	Source module	Description
V1-MSignal N*	Mains Signalling Evaluation	number of valid intervals (voltage on phase 1 within +/- 15% of nominal)
V1-MSignl N ivd*		number of invalid intervals
V1-MSignal N1*		number of valid intervals in which the signaling voltage on phase 1 exceeds a user defined limit
V2-MSignal N*		number of valid intervals (voltage on phase 2 within +/- 15% of nominal)
V2-MSignl N ivd*		number of invalid intervals
V2-MSignal N1*		number of valid intervals in which the signaling voltage on phase 2 exceeds a user defined limit
V3-MSignal N*		number of valid intervals (voltage on phase 3 within +/- 15% of nominal)
V3-MSignl N ivd*		number of invalid intervals
V3-MSignal N1*		number of valid intervals in which the signaling voltage on phase 3 exceeds a user defined limit
PO V1-MSignal N	Store	PO V1-MSignal N of the previous Observation Period
PO V1-MSgnal N1		PO V1-MSgnal N1 of the previous Observation Period
PO V2-MSignal N		PO V2-MSignal N of the previous Observation Period
PO V2-MSgnal N1		PO V2 MSgnal N1 of the previous Observation Period
PO V3-MSignal N		PO V3-MSignal N of the previous Observation Period
PO V3-MSgnal N1		PO V3-MSgnal N1 of the previous Observation Period
V1-MSig N1/N	Arithmetic	N1/N ratio
V2-MSig N1/N		N1/N ratio
V3-MSig N1/N		N1/N ratio
PO V1-MSig N1/N		N1/N ratio of previous Observation Period
PO V2-MSig N1/N		N1/N ratio of previous Observation Period
PO V3-MSig N1/N		N1/N ratio of previous Observation Period

* This data is recorded weekly by the EN50160 MSignal data recorder.

EN50160 external controls

Enabling the EN50160 calculations

EN50160 statistics (counters N, N₁, etc.) monitoring and logging are enabled when:

- ◆ External Boolean module "EN50160 Enable" is ON (=1). You can set this value in the EN50160 Power Quality diagram in the Vista component of ION Enterprise.
- ◆ The Sag/Swell module's "Nominal Voltage" setup register has a value greater than 0. You can set this value from the meter's front panel as well as in ION Setup or the Designer or Vista components of ION Enterprise.

In addition to the above, **EN50160 parameter logging** (logging of the EN50160 voltage measurements themselves) is enabled when:

- ◆ External Boolean module "PQ Prm Rc Enbl" is also ON (=1). To conserve memory, parameter data logging can be disabled (OFF). You can set this value in the EN50160 Power Quality diagram in the Vista component of ION Enterprise.

EN50160 reset

EN50160 statistics (counters) and parameter data are cleared from the meter when the External Pulse module "EN50160 Reset" is triggered. You can trigger this reset using the front panel or in the EN50160 Power Quality diagram in the Vista component of ION Enterprise.

The logged EN50160 quantities (data logs) are preserved.

EN50160 synchronization mode & synchronization timing

You can configure a **Free** or **Scheduled** synchronization mode for the EN50160 data acquisition. If you select Scheduled, then you can opt for Synchronization Timing to start at midnight of the present day, or at midnight of the coming Saturday. If you select Free, then EN50160 statistics and data start accumulating after the first EN50160 Reset (see above).

By default, all cumulative EN50160 parameters are scheduled to synchronize every Saturday at midnight. Use the EN50160 Power Quality diagram in the Vista component of ION Enterprise to alter these settings through links to two External Boolean modules:

- ◆ Synchronization Mode: PQ Sync Mode (External Boolean 23)
- ◆ Synchronization Timing: PQ Sync Tdy/Sat (External Boolean 24)