Power Quality Monitoring with MAVOLOG 10

MAVOLOG 10

Reasons and Basis for Monitoring of Power Quality
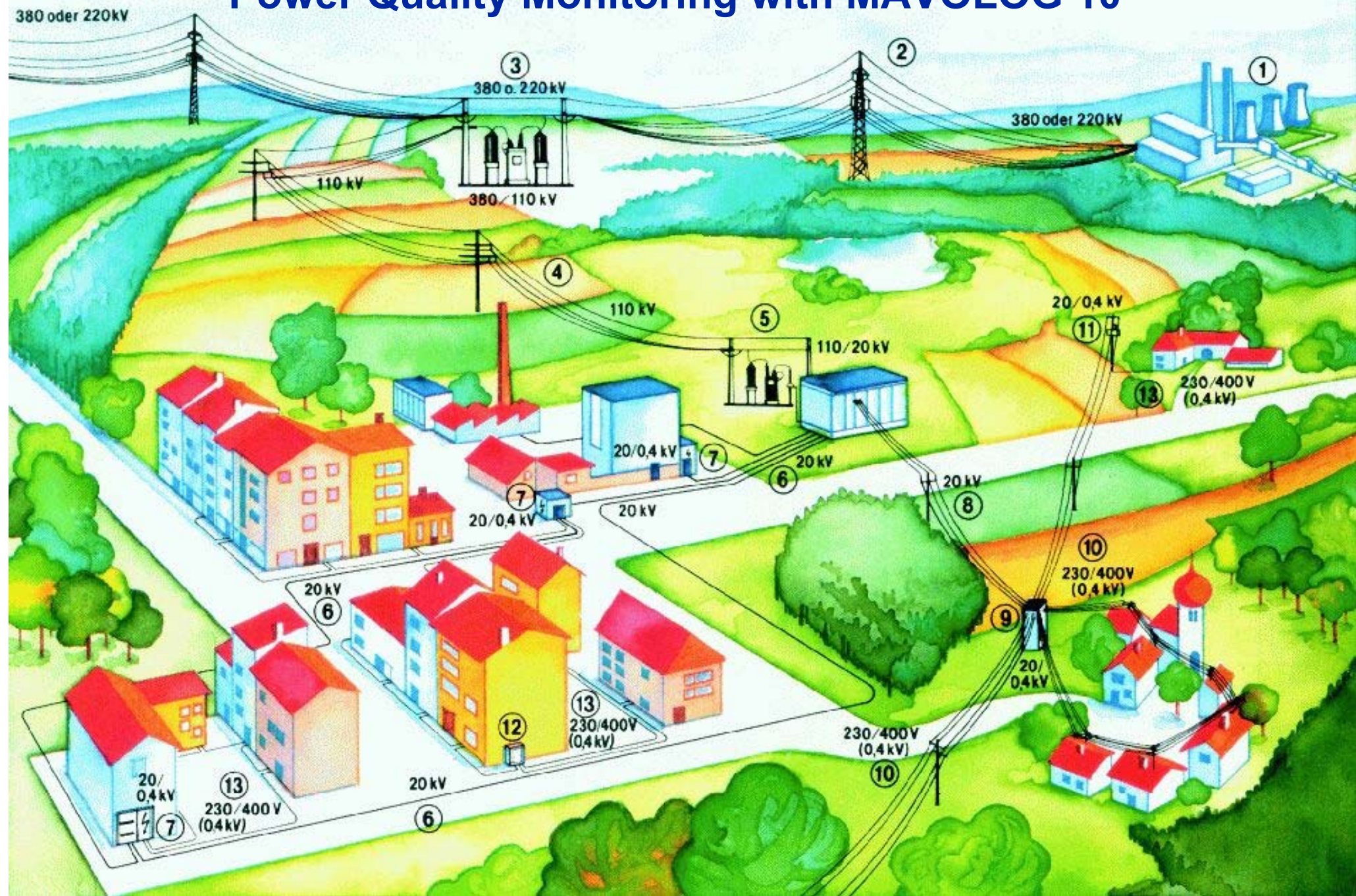
General
- Consciousness for Power Quality increases worldwide
- Privatisation of power utilities and de-regulation of energy market
- Increasing number of non-linear consumers leads to rising voltage disturbances
- Disturbances create power losses and malfunctions of appliances

New Regulations inside European Community
- Since 1995: Law for Product Liability
- Since 1996: Law for Electro-Magnetic Compatibility
- Since 1998: Law for Economy of Energy

The European „Mains Quality" standard EN 50160
- Voltage characteristics of electricity supplied by public distribution systems
- Definition of parameters and quality criteria for medium and low voltage three-phase networks
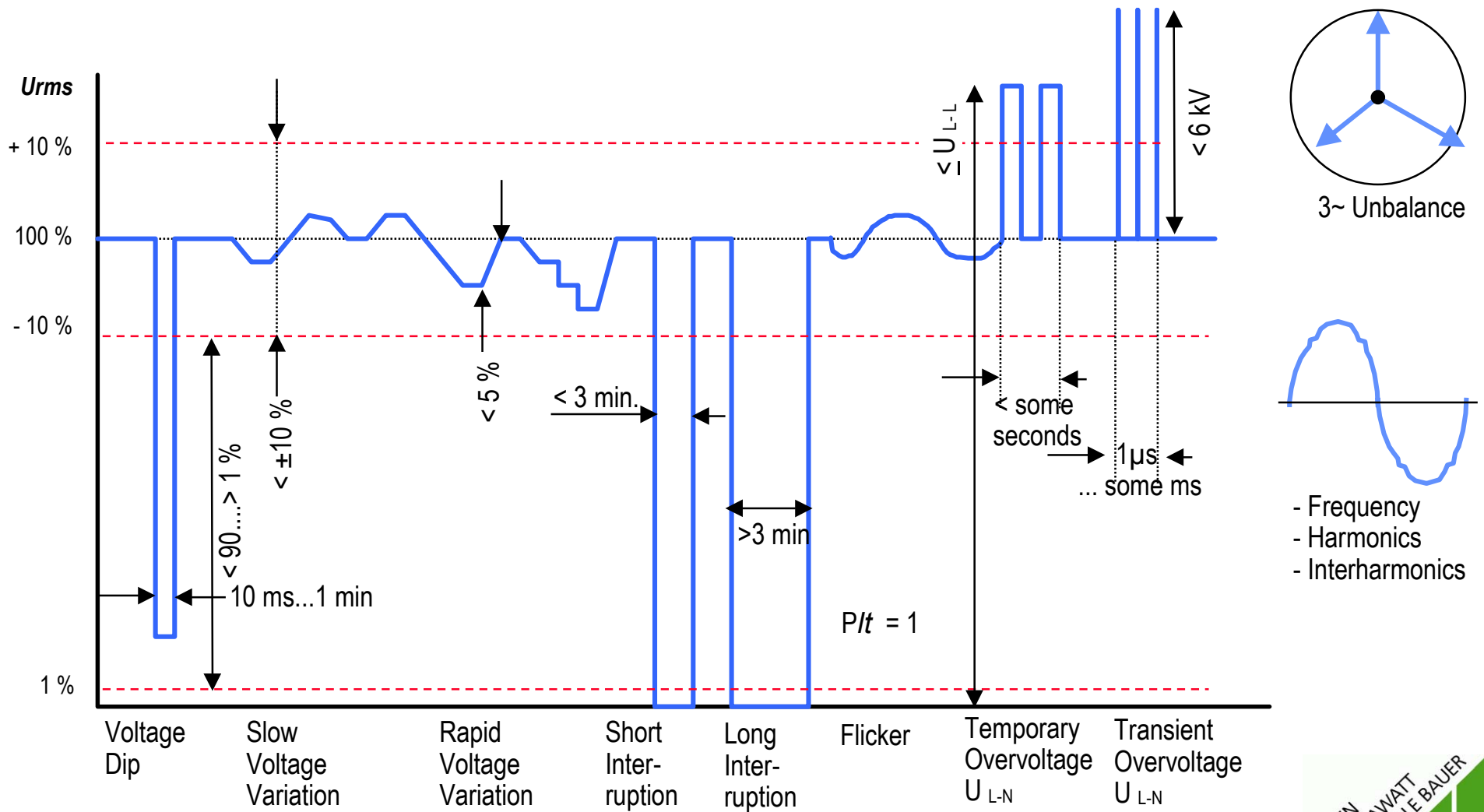- Description of random events like voltage dips and interruptions

The EMC standards IEC 61000 / EN 61000
- EN 61000-2   Compatibility levels
    - 2-2 Compatibility levels for low-frequency conducted disturbances
- EN 61000-3 Limits, Emission Levels
    - 3-2 Limit values for harmonic current from instruments with <16A per phase
    - 3-3 Limitation of voltage fluctuations and flicker in low-voltage supply systems
- EN 61000-4 Testing and measuring techniques

Urms

+ 10 %
100 %
- 10 %
1 %

< 90...> 1 %
< ±10 %
< 5 %
< 3 min.
>3 min
10 ms...1 min
PIt = 1
< U L-L
< 6 kV
< some seconds
1µs ... some ms

Voltage Dip | Slow Voltage Variation | Rapid Voltage Variation | Short Inter-ruption | Long Inter-ruption | Flicker | Temporary Overvoltage U L-N | Transient Overvoltage U L-N

3~ Unbalance

- Frequency
- Harmonics
- Interharmonics

MAVOLOG 10

EN 50160 Quality Criteria at a Glance

Author:
GOSSEN-METRAWATT / VMS / HG

| Parameter	Characteristic	Measuring cycle	Campaign duration	Evaluation by MAVOLOG 10	
Frequency	50 Hz $\pm$0,5 Hz during 95% of a week; 50 Hz +4% / -6% continuously	10-sec mean value	1 week	✔	**Characteristics with definite thresholds for normal operating conditions**
Slow voltage variation	Un $\pm$10 % during 95% of a week; Un +10/-15 % continuously	10-min mean value	1 week	✔	
Flicker	Long-term flicker severity Plt < 1 during 95% of a week	2 h (acc. EN 61000-4-15)	1 week	✔	
Unbalance	< 2 % during 95% of a week	10-min mean value	1 week	✔	
Harmonics $U_{H2} ... U_{H40}$	< definite individual limits and THD < 8% during 95% of a week	10-min mean value for each harmonic (acc. EN 61000-4-7)	1 week	✔	
Interharmonics	TBD	TBD	1 week	—	
Signalling voltages	< frequency dependent limits during 99 % of a day	3-sec mean value	1 day	—	
Voltage dips	number <10 ... 1000 / year; of which >50% with duration <1s	10-ms rms value 40%Un $\leq U_{10ms} \leq$ 90%Un	1 year	✔	**Characteristics with indicative thresholds**
Short voltage interruptions	number <10 ... 1000 / year; of which >70% with duration <1s	10-ms rms value $U_{10ms} \leq$ 1%Un	1 year	✔	
Long voltage interruptions	number <10 ... 50 / year with duration >3 min		1 year	✔	
Temporary overvoltage (L-N)	number <10 ... 1000 / year; of which >70% with duration <1s	10-ms rms value U_{10ms} >110%Un	1 year	✔	
Transient overvoltage (L-N)	< 6 kV / μs ... ms			—	

GOSSEN METRAWATT CAMILLE BAUER

MAVOLOG 10
The Mains Analyzer

Author:
GOSSEN-METRAWATT / VMS / HG

L3
L2
L1
N
PE
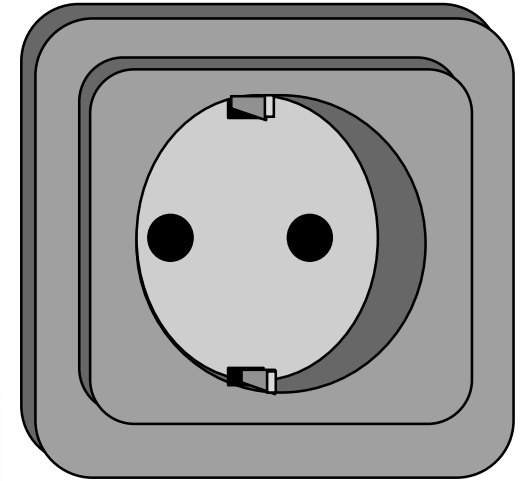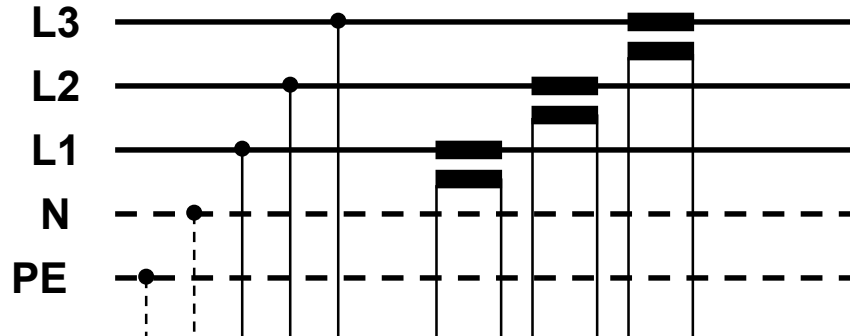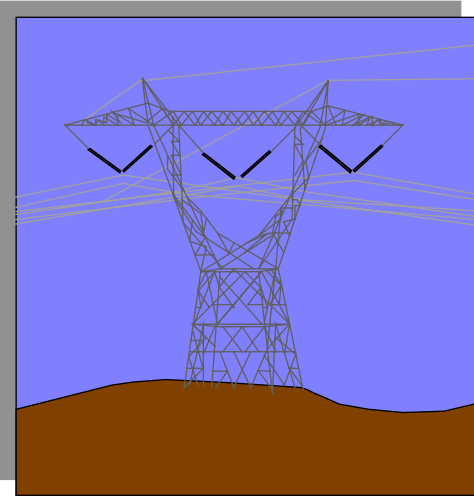
Events Logger

- **Over/Undervoltage**
- **Voltage Unbalance**
- **Voltage Dips & Swells**
- **Over/Underfrequency**
- ◆ **Harmonics, THD, Flicker**

MainsQuality Analyzer

- **EN 50 160 Limits**
- **NRS 048-2** (SouthAfrica) **Dips Classification**

MAVOLOG 10 S

A B 1 2 + –
RS 485 Relay U_H 24V
        max 50V

CE ⚠

230/400 V AC   max. 5 A AC
U_{L1} U_{L2} U_{L3} U_N I_{L1} I_{L2} I_{L3}
                                    + – + – + –

Interval Recorder

- **Voltages**   V
- **Frequency**   Hz
- ■ **Currents**   A
- ■ **Power**   W, VA, var
- ■ **Energy**   Wh, varh
- ◆ **Harmonics, THD** V, A, %
- ◆ **Flicker** P_{st}, P_{lt}

● with all models   ■ with S-model only   ◆ optional

GOSSEN METRAWATT CAMILLE BAUER

MAVOLOG 10
The System Components

Author:
GOSSEN-METRAWATT / VMS / HG

MAVOLOG PS/C
Power **S**upply and
Interface **C**onverter

MAVOLOG BP
Battery **P**ack

MAVOLOG 10
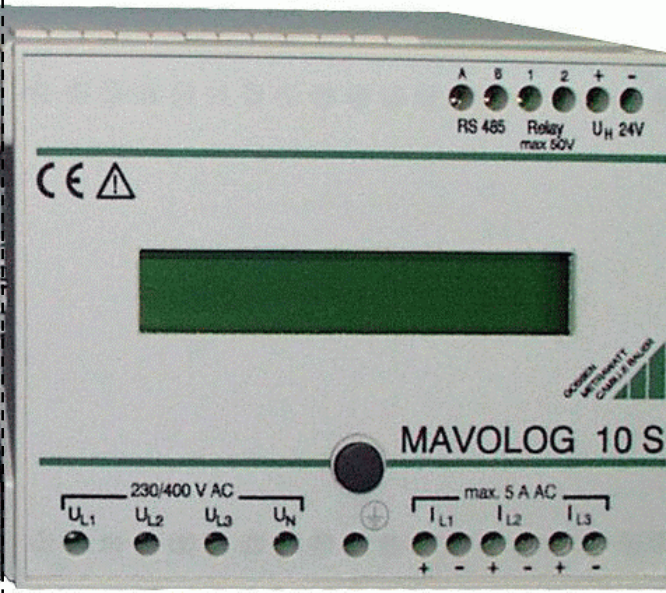**3-phase Mains Analyser**

METRAwin 10 & PC.doc-Access for MAVOLOG

- Supply unit for five MAVOLOG 10
  IN: 230 V AC
  OUT: 24 V DC

- Bidirectional RS232 to RS485 converter

- For uninterrupted supply during AC fail

- 1 h hold-up time

- Integrated charge controller

- Four models with or without
  - current measuring inputs
  - single-line LC display
  - flicker and harmonics analysis
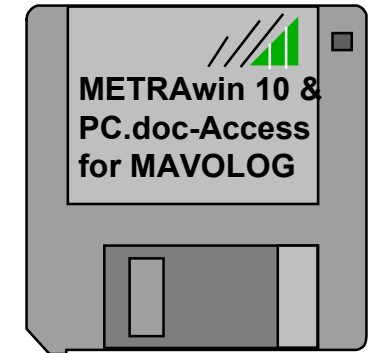
- **METRAwin 10**
  - device setup
  - data readout
  - data analysis

- **PC.doc-Access**
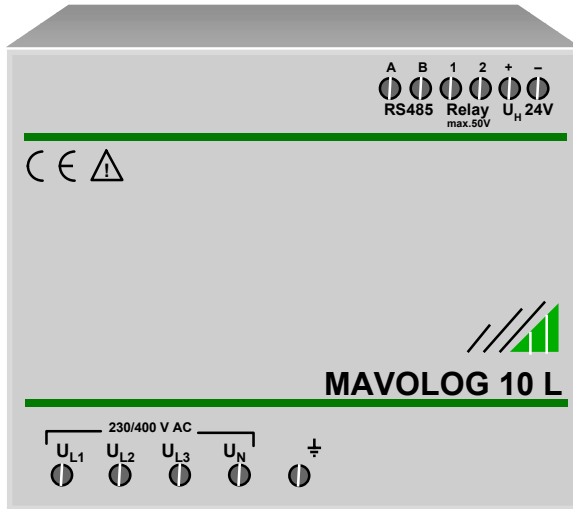 - database
  - graph. presentation
  - protocols

MAVOLOG 10
The Different Models

Author:

Author:
GOSSEN-METRAWATT / VMS / HG

MAVOLOG 10L +FFT/FSA   MAVOLOG 10N +FFT/FSA   MAVOLOG 10S +FFT/FSA

MAVOLOG 10 L

MAVOLOG 10 N — U1N   231,6V

MAVOLOG 10 S — P1   18.05kW
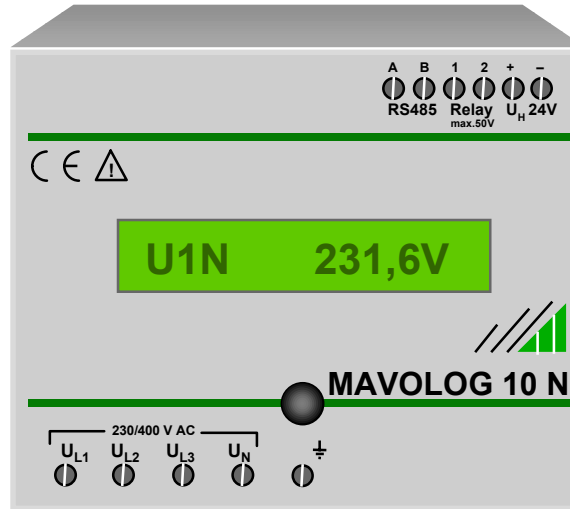
Simultanuous
Interval Recorder,
Events Logger,
Mains Quality Analyzer for
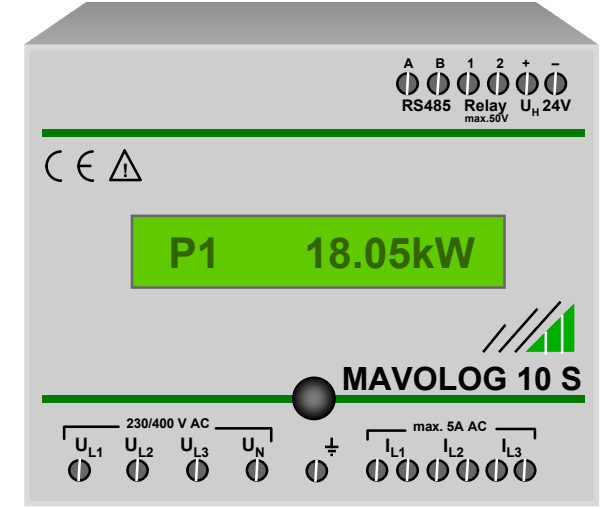- Voltages U_{L-N} & U_{N-PE} or U_{L-L}
- Frequency **f**

Extension vs. MAVOLOG 10L:
Single-line LC display
for on-site readout of
- measured or analysed values of 10 selectable quantities
- device setup parameters

Extension vs. MAVOLOG 10N:
Three current inputs
for measurement of
- Currents I_L & I_N,
- Power P_L, P_Σ, S_Σ, Q_Σ,
- Energy WP_Σ, WQ_Σ, WS_Σ

- Harmonics Analysis $U_{H\,01\ldots40}$, ($I_{H\,01\ldots40}$) & **THD** (according to EN 61000-4-7)
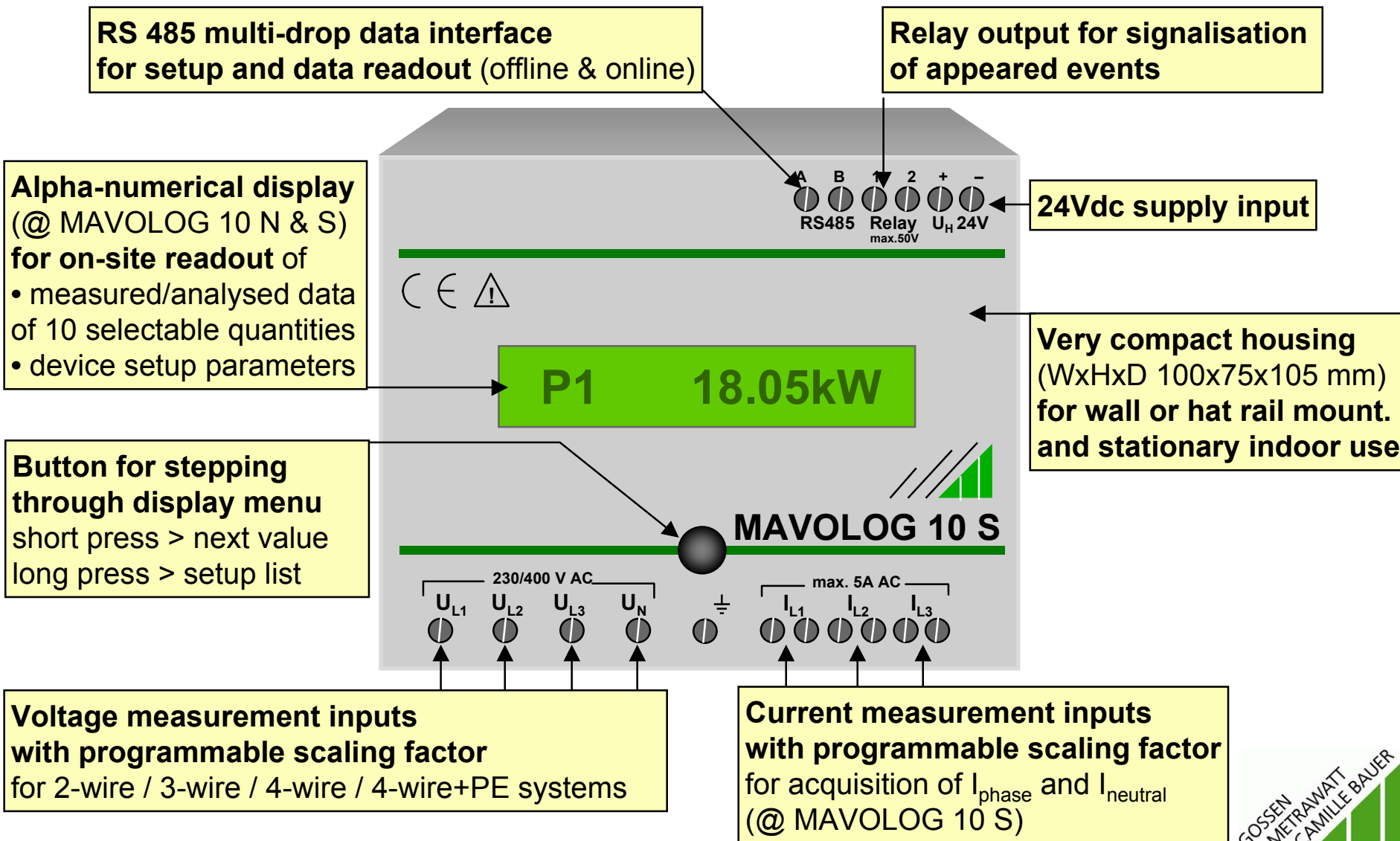- Flicker Analysis P_{st}, P_{lt} (according to EN 61000-4-15)

MAVOLOG 10S also available without Harmonics (FFT) & Flicker (FSA) Analysis

GOSSEN METRAWATT CAMILLE B.

RS 485 multi-drop data interface for setup and data readout (offline & online)

Relay output for signalisation of appeared events

Alpha-numerical display (@ MAVOLOG 10 N & S) **for on-site readout** of
• measured/analysed data of 10 selectable quantities
• device setup parameters

24Vdc supply input

A B 1 2 + −
RS485 Relay U_H 24V
max.50V

P1   18.05kW

Very compact housing (WxHxD 100x75x105 mm) **for wall or hat rail mount. and stationary indoor use**

MAVOLOG 10 S

Button for stepping through display menu
short press > next value
long press > setup list

230/400 V AC
U_{L1} U_{L2} U_{L3} U_N

max. 5A AC
I_{L1} I_{L2} I_{L3}

Voltage measurement inputs with programmable scaling factor
for 2-wire / 3-wire / 4-wire / 4-wire+PE systems

Current measurement inputs with programmable scaling factor
for acquisition of I_{phase} and $I_{neutral}$
(@ MAVOLOG 10 S)

GOSSEN METRAWATT CAMILLE BAUER

MAVOLOG 10
The Inner Values

Author:
GOSSEN-METRAWATT / VMS / HG

dual range:
0...100...130 Vac
0...400...520 Vac;
max. 600 V CAT III;
45 - 65 Hz;
Z_i = 2.4 MΩ

sampling rate:
6.4 kHz @ 50 Hz

dual range:
0...1...1.2 Aac
0...5... 6 Aac;
max. 12 A contin.,
max. 50 A @1s;
Z_i = 40 mΩ typ.

measurem. uncertainty
voltage: Class 0.2
current: Class 0.2
power: Class 0.4
       @ I >5% f.s.

PE
U_N
U_{L1}
U_{L2}
U_{L3}

I_{L1}
I_{L2}
I_{L3}

12 Bit ADC & DSP

Serial Interface

LC Display

Display Control

Flash Memory

Real-time Clock

DC / DC
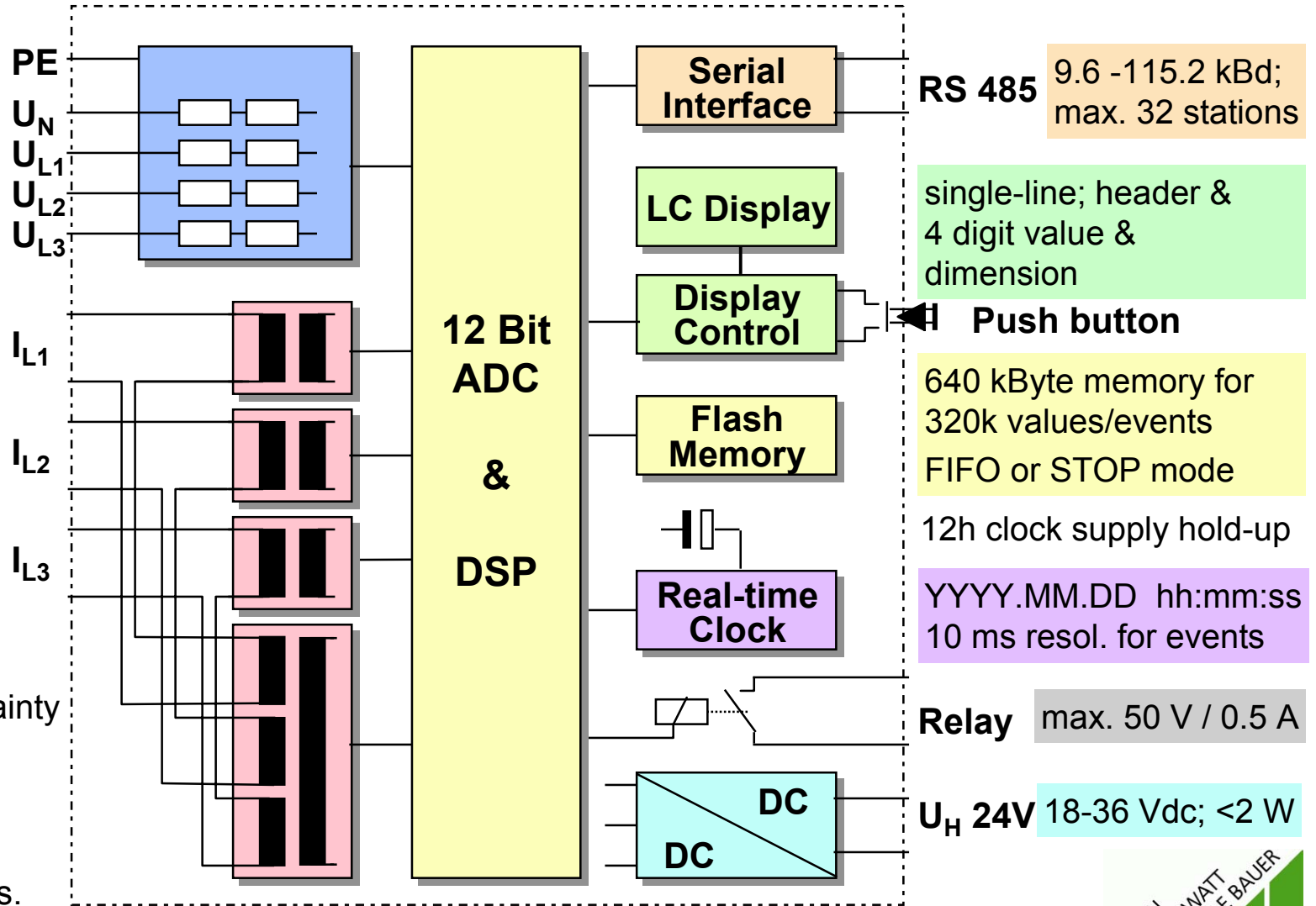
RS 485

9.6 -115.2 kBd;
max. 32 stations

single-line; header &
4 digit value &
dimension

Push button

640 kByte memory for
320k values/events
FIFO or STOP mode

12h clock supply hold-up

YYYY.MM.DD hh:mm:ss
10 ms resol. for events

Relay max. 50 V / 0.5 A

U_H **24V** 18-36 Vdc; <2 W

GOSSEN METRAWATT CAMILLE BAUER

MAVOLOG 10
Signal and Data Processing

Author:
GOSSEN-METRAWATT / VMS / HG

Legend:
- at N and S models only
- at S models only
- at FFT&Flicker option
- adjustable parameters

Signal inputs: U_{1N} U_{2N} U_{3N} U_{N-PE} — I_1 I_2 I_3 I_N

6.4 kHz — U Signals 4 Ch. Sampling — Y or Δ system | I Signals 4 Ch. Sampling — 2 or 3 transf.

10 ms — half-cycle RMS values: f | U | I | P — Uratio / Iratio

160ms/3s — FFT Harmonics Analysis: $U_{H01...40}$ | THD_U | $I_{H01...40}$ | THD_I

1 s — 1s MEAN values: f | U | I | P | Q | S

10 min — Flicker Analysis: Pst / Plt

10ms..3s — Dips & Swells Detection/Classif. — 2s window

Relay

1/10 s, 1/10/15min, 1h / 24h — Variable Interval Data Evaluation: mean | min | max | instant.

10 min — EN 50160 Criteria Monitoring — Thresholds

Alarm Control

max. 40 quantities

max.10 quantities — RS485online

max.10 quantities — DISPLAY

INTERVAL MEMORY — STATISTIC MEMORY — EVENTS MEMORY — SIGNAL MEMORY

GOSSEN METRAWATT CAMILLE BAUER

MAVOLOG 10
Flexible Memory Organisation

Author:
GOSSEN-METRAWATT / VMS / HG

Recording Capacity   @   selected Memory Configuration

e.g. for 20 param's being recorded every 10 minutes over 55 days and >600 events including the voltage dip/swell signal

50% Interval Data | **50% Event+Signal Data**

or

e.g. for 40 param's being recorded every 10 minutes over 27 days and >25,000 events

50% Interval Data | **50% Event Data**

or

Over 500 events, each one including the 10ms-rms values of all three voltage signals over a 2 second time window

100% Event + Signal Data

or

Over 50,000 events with Date, Time, Event type, Phase and Measured value

100% Event Data

or

e.g. for 40 parameters being recorded every 15 minutes over 83 days

100% Interval Data

Statistics Data (<1kB)

Daily Maxima Data (<1kB)

Non-volatile Flash Memory 640 kB (=320,000 values)

Interval and Events memory can be set for RING or STOP mode

MAVOLOG 10 L / N / S
Interval Recorder Data (1)

Measured Quantities	Header	Unit	Mean	Min	Max	Inst.
RMS values of phase-to-neutral voltages	U1N, U2N, U3N, UΣ	V	●	●	●	●
RMS values of phase-to-phase voltages	U12, U23, U31	V	●	●	●	●
RMS value of neutral-to-earth voltage	UNPE	V	●	●	●	●
Unbalance factor of voltages	USYM	%	●	●	●	●
Frequency (of U_{L1})	f	Hz	●	●	●	●

Measured Quantities of FFT/FSA

	Header	Unit	Mean	Min	Max	Inst.
1st to 40th harmonic voltage per phase	U1H01 ... U1H40, U2H01 ... U2H40, U3H01 ... U3H40	V	●	●	●	●
Total harmonic distortion per phase voltage	U1THD,U2THD,U3THD	%	●	●	●	●
Short-term flicker level per phase voltage	U1Pst, U2Pst, U3Pst	-	●	●	●	●
Long-term flicker level per phase voltage	U1Plt, U2Plt, U3Plt	-	●	●	●	●

Mean	Mean value over interval period	**Available storage intervals**	● available
Min	Minimum value during interval period	1 / 10 second(s)	○ available but non-sensical
Max	Maximum value during interval period	1 / 5 / 10 / 15 minute(s)	
Inst.	Instantaneous value at end of interval	1 / 24 hour(s)	

GOSSEN METRAWATT CAMILLE BAUER

Measured Quantities	Header	Unit	Mean	Min	Max	Inst.
RMS values of phase currents	I1, I2, I3, IΣ	A	●	●	●	●
RMS values of neutral line current	IN	A	●	●	●	●
Active power, per phase and collective	P1, P2, P3, PΣ	W	●	●	●	●
Reactive power, collective	QΣ	var	●	●	●	●
Apparent power, collective	SΣ	VA	●	●	●	●
Active energy, collective	WPΣ	Wh	❍	❍	❍	●
Reactive energy, collective	WQΣ	varh	❍	❍	❍	●
Apparent energy, collective	WSΣ	VAh	❍	❍	❍	●
Power factor, collective	PFΣ	-	●	●	●	●

Measured Quantities of FFT/FSA

1st to 40th harmonic current per phase	I1H01 ... I1H40, I2H01 ... I2H40, I3H01 ... I3H40	V	●	●	●	●
Total harmonic distortion per phase current	I1THD, I2THD, I3THD	%	●	●	●	●

Event Trigger Criteria: EN 50160 characteristics

Event Thresholds: ● = user adjustable ▲ = fixed, according to EN 50160

Registered Event Informations: Date, Time, Type of Event, Phase, Measured Value(s)

● **@ voltage dips with duration $\leq$ 3 s :**
  - ■ Date, Time, Dip Cat., Phase, Dip Magnitude [% of U_{nom}], Dip Duration [x.xx s], {U/I Signal}

● **@ voltage failure (=outage with duration > 3 s) :**
  - ■ Date, Time, „*Voltage Failure*", Phase, Dip Magn. of initial 3s [% of U_{nom}], Duration [xx.xx s], {U/I Signal}

● **@ voltage swells :**
  - ■ Date, Time, „*Swell* ", Phase, Swell Magnitude [% of U_{nom}], Swell Duration [x.xx s], {U/I Signal}

● **@ out-of-tolerance of the 10 minute mean value of U_L :**
  - ■ Date, Time, „*10-min.-Undervolt*age", Phase, 10-min. mean value [% of U_{nom}]
  - ■ Date, Time, „*10-min.-Overvolt*age", Phase, 10-min. mean value [% of U_{nom}]

● **@ over-voltage of the 10 minute mean value of U_{N-PE} :**
  - ■ Date, Time, „*N-PE-Overvoltage*", 10-min. mean value of U_{N-PE} [% of U_{nom}]

● **@ out-of-tolerance of the 10 minute mean value of voltage unbalance :**
  - ■ Date, Time, „*Unbalance*", 10-min. mean value of U-unbalance [% of U_{nom}]

▲ **@ out-of-tolerance of the long term flicker severity P_{lt}:**
  - ■ Date, Time, „*Flicker*", Phase, Flicker Severity (x.xx)

▲ **@ out-of-tolerance of the 10 minute mean value of THD_U or voltage harmonic U_{H01} ... U_{H40} :**
  - ■ Date, Time, „*UxTHD*" or „*UxH*yy ", 10-min. mean value of THD/harmonic [% of U_{nom}]
    (x = phase, yy = order of harmonic)

[ ] = unit ; { } = if enabled, optionally stored in signal memory for a time window of 2 s
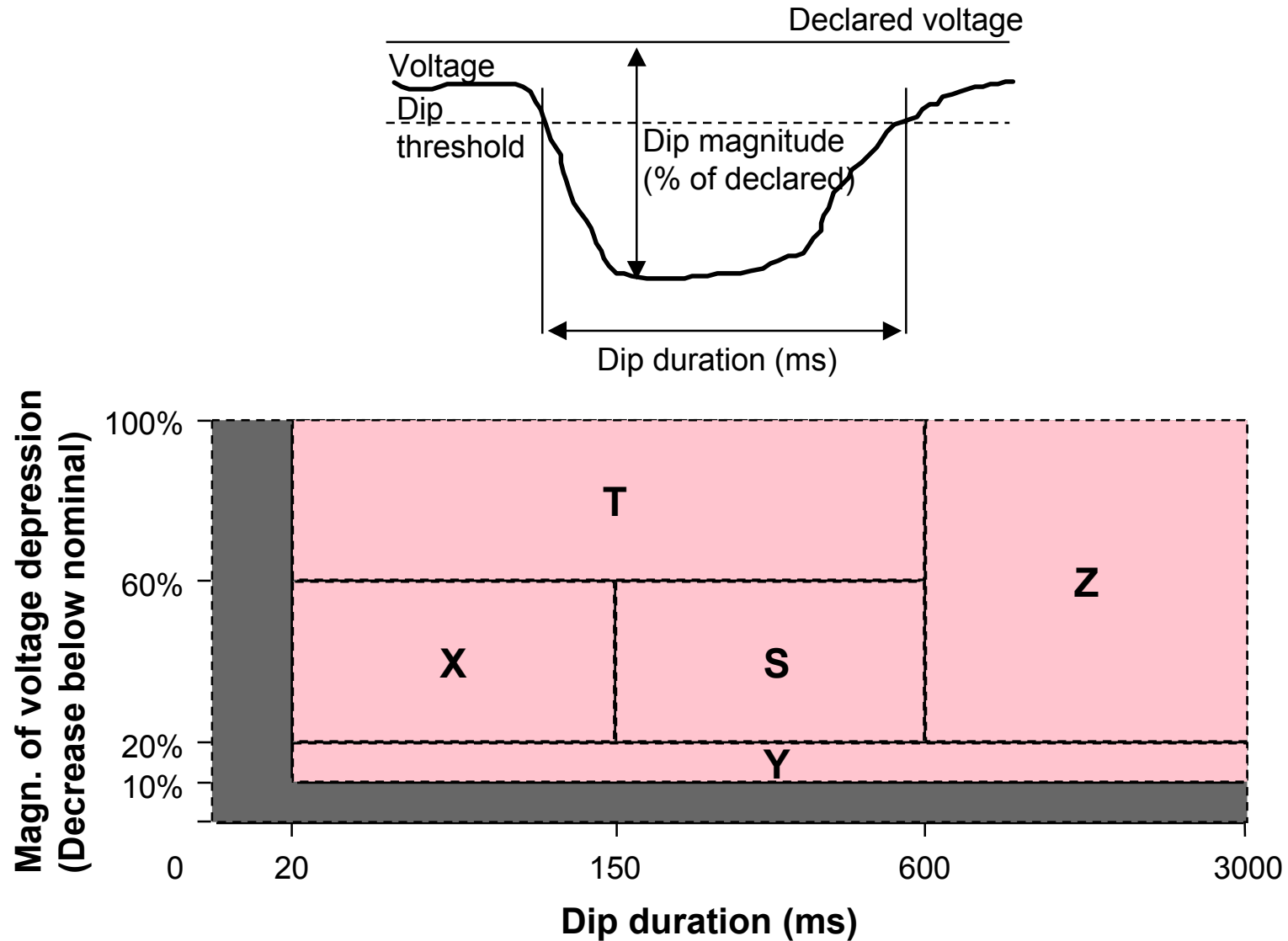
Signal recording trigger: voltage interruption, voltage dip, voltage swell

Recorded signal data: 200 10ms-rms values (50 before and 150 after trigger event) of voltage or voltage and current of all or of respective phase(s)

Presentation in METRA*win* 10   graphically

numerically

Author:
GOSSEN-METRAWATT / VMS / HG

Incremental counters for statistical evaluation of events: How many times
How long
How many days with out of limits time > 5%

Parameter / Event	Thresholds	Counters		
		No. of events	Time duration	>5% Days
Monitoring time since Reset		-	1	-
Aux. supply interruption		1	1	-
Undervoltage	$U_{rms(10min)}$ < adjustable limit	-	1 per phase	1
Overvoltage	$U_{rms(10min)}$ > adjustable limit	-	1 per phase	1
N-PE Overvoltage	$U_{rms(10min)}$ > adjustable limit	-	1	1
Unbalance over limit	$U_{(10min)}$ > adjustable limit	-	1	1
Underfrequency	$f_{(10sec)}$ < adjustable limit	-	1	1
Overfrequency	$f_{(10sec)}$ > adjustable limit	-	1	1
Flicker over limit	P_{lt} > 1.00	-	1 per phase	1 per phase
THD over limit	$THD\text{-}U_{(10min)}$ > 8%	1 per phase	-	-
Harmonics 2-40 over limit	$U_{Hn(10min)}$ > EN50160 limit	39 per phase	-	-
Voltage interruption	$U_{rms(10ms)}$ < adj. limit for t>3s	1 per phase	1 per phase	-
Voltage dips total	$U_{rms(10ms)}$ <adj. limit for t<3s	1 per phase	-	-
Voltage dips classified	to NRS048-2	5 per phase	-	-
Voltage swells	$U_{rms(10ms)}$ > adjustable limit	1 per phase	-	-

Day values saved at 24:00 for the expired day

(95%-Extremes = values which were not exceeded for 95% time during previous day)

- **Voltage 95%-maximum [% of U_{nom}]**
- **Voltage 95%-minimum [% of U_{nom}]**
- **N-PE Voltage 95%-maximum [% of U_{nom}]**
- **Unbalance 95%-maximum [%]**
- **Flicker 95%-maximum [-]**
- **THD_U 95%-maximum [% of U_{nom}]**
- **Harmonics U_{H2} .. U_{H40} 95%-maximum [% of U_{nom}]**
- **Counts of voltage dips**
- **Counts of voltage swells**
- **Counts of voltage interruptions**

Current / Power maxima [*] (= highest measured values since last reset)

- **Current maximum $I_{L1(1sec)}$ [A_{rms}]**
- **Current maximum $I_{L2(1sec)}$ [A_{rms}]**
- **Current maximum $I_{L3(1sec)}$ [A_{rms}]**
- **Active power maximum $P\Sigma_{(1sec)}$ [W]**
- **Reactive power maximum $Q\Sigma_{(1sec)}$ [var]**
- **Apparent power maximum $S\Sigma_{(1sec)}$ [VA]**

Energy meters[*] (= accumulated values since last reset)

- **Active energy WP [Wh]**
- **Reactive energy WQ [varh]**

[*] on MAVOLOG 10S models only

Author:
GOSSEN-METRAWATT / VMS / HG

- **Signal type:**   Relay contact (max. 50V, 0.5A)
  idle state programmable (normally closed or normally open)

- **Alarm trigger:**   Each „Event" (OR function)

- **Alarm reset:**   - „manually" by remote command
  or
  - automatically after xx seconds (xx = 1 ... 65 534 s)

- **Application**:   **Active Event Message to fax machine or mobile phone**
  Several dial-up modems (like MAVOLOG DFÜ) offer a binary input for
  self-dialing and messaging. When the MAVOLOG Event Alarm activates
  this input, then the modem will dial to a pre-defined phone number
  and send a pre-programmed SMS like „Mains Event in location XYZ".

MAVOLOG 10
The Software Components

Author:
GOSSEN-METRAWATT / VMS / HG

L3
L2
L1
N
PE
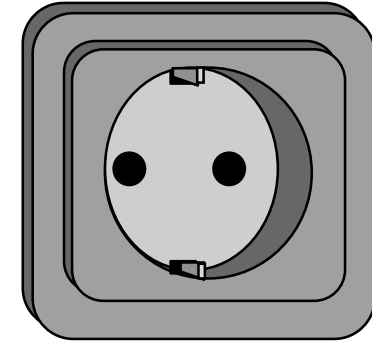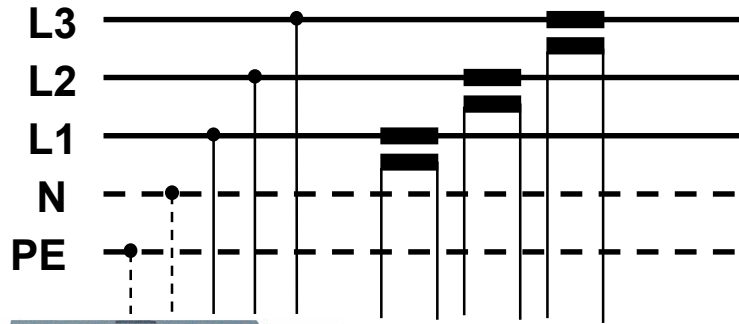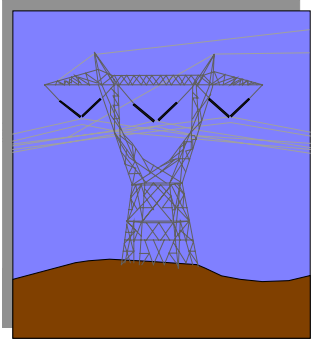
Data Logging and Processing

Setup | Read-out

METRAwin 10 for MAVOLOG
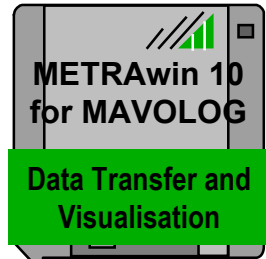
Data Transfer and Visualisation

Meas. data

PC.doc-access for MAVOLOG

Scheduled data request
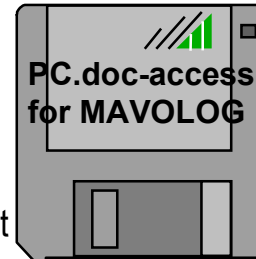
Database

Microsoft Access.lnk

Graphical Analysis

Microsoft Excel.lnk

Reports, Protocols

Microsoft Winword.lnk

GOSSEN METRAWATT CAMILLE BAUER

MAVOLOG 10
The Software Functions

Microsoft Access.lnk

METRAwin 10 for MAVOLOG

PC.doc-access for MAVOLOG

Microsoft Excel.lnk

Microsoft Winword.lnk
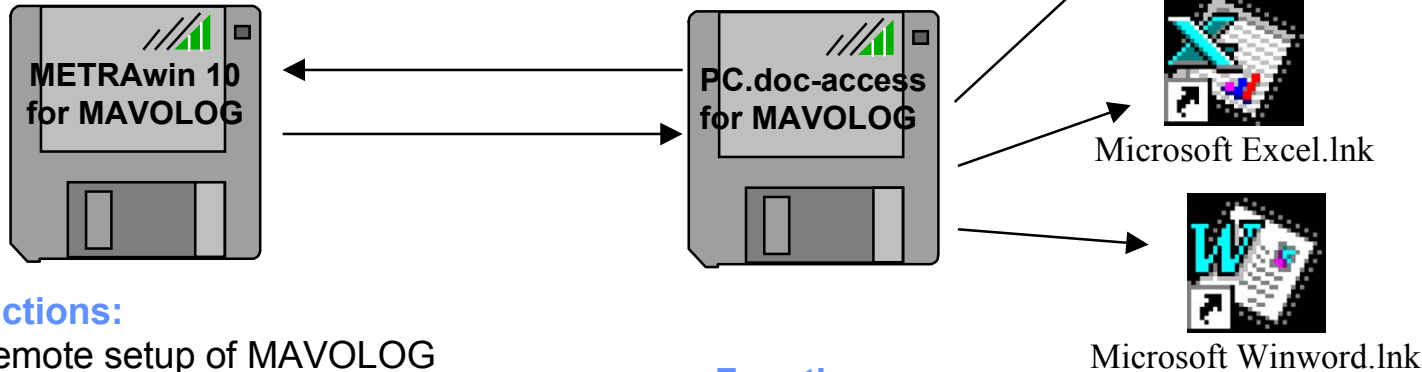
Functions:
- Remote setup of MAVOLOG
- Read-out of MAVOLOG setup
- Memory intialisation
- Read-out of stored data
- Visualisation and printing of statistical data (daily or total)
- Graphical presentation and printing of interval data
- Listing and printing of event data
- Graphical presentation and printing of event signals
- Graphical presentation and printing of harmonics data
- Online reading, visualisation and printing of up to 10 selectable quantities
- Data export to dBase file

Functions:
- Management of customer and system data
- Read-in of data from METRAwin 10 (scheduler controlled)
- Sorting of all customer/system data and measurement files
- Sorting of measured interval data
    - by ascending/descending values
    - by cumulative frequency distribution
- Evaluation of Min/Max/95% values
- Evaluation of data by certain limits
    - for time period (for statistical data)
    - for value range (for interval data)
- Protocol generation with pass/fail result under MS WORD
- Graphical presentation under MS EXCEL

Device Setup Windows for Connection, Thresholds, Memory Mode and Interval Memory Parameters

Online Read-out and Recording

Digital or Analog Multimeter Display of up to 4 Channels

FFT Harmonics „Snapshot"

Bar-graph display of all harmonics at moment of memory readout

Intervall Memory Data or Online Recording

Y-t Recorder Display of up to 4 Channels

Events & Signal Memory Data

Listing of events

in case of Voltage Dip/Swell/Fail: Y-t graphs of voltage(s)/current(s)

Daily & Maxima Memory Data

Total power consumption and peak values of currents and power since last Reset

Statistics Memory Data

Listing of counts and total Out-of-tolerance time for each individual event since last Reset

PC.doc-ACCESS for MAVOLOG 10
Data Base & Analysis Software

Author:
GOSSEN-METRAWATT / VMS / HG

Data Management

Customer and system data can be entered to which the measurement data are related

Display of recorded interval data sorted by ascending values

Graphical Presentation

Mavolog 10 Sorted Measurements:19904101 15.7.1999 12:50:00 - 20.7.1999 09:30:00

Legend:
— Measurement value
— 5% value
— 95% value

Distribution of the values of recorded interval data

Stochastical Evaluation

Stochastic MAVOLOG 10: 19904101 15.7.1999 12:50:00 - 20.7.1999 09:30:00

Data are exported to MS Word for printing protocols

Documentation

Mavolog 10 Statistik-Protokoll

Statistical analysis of recorded interval data in bar-graph mode

Statistical Analysis

MAVOLOG EN50160 Interval Statistics

Legend:
- Min
- P5%
- Avg
- P95%
- Max

MAVOLOG 10   Page 24   Version 13.09.2001

P1   18.05kW

RS232

PC /
Modem /
Repeater

3~
400/230V

N
L1
L2
L3

3~
20 kV

L1
L2
L3

Modem A: e.g. WESTERMO TD32

Modem B: e.g. WESTERMO MD62 / MD63

Modem C analogue: e.g. Mavolog DFÜ
      ISDN: e.g. INSYS ISDN-TA

Modem D: e.g. INSYS GSM 2.0

MAVOLOG 10 Mobile-Set
The Portable Version

Author:
GOSSEN-METRAWATT / VMS / HG

The
MAVOLOG 10 Mobile-Set
consists of

▪**MAVOLOG 10S+FFT/FSA**
Mains Analyzer

▪**MAVOLOG PS/C**
Power Supply & Converter
(RS485 ←→ RS232)

▪**MAVOLOG BP**
Battery Pack

mounted into a

▪**Carrying Case**
37 cm x 15 cm x 30 cm

Included accessories:

▪**Connection Cables** for
- mains supply,
- voltage measurement
  inputs incl. crocodile clips,
- RS232 interface

▪**Setup and Analysis Software**
METRAwin 10 for Mavolog

Order No.: M830W

Available Accessories

•**Z3514 Clip-on Current Transformer 2000A~/1A~**
30 Hz...1.5 kHz; 1%; hole diameter 150x64 mm

•**Z3512 Clip-on Current Transformer 1000A~/1A~**
30 Hz ... 5 kHz; 1%; hole diameter 52 mm

•**WZ12D Clip-on Current Transformer 150A~/0,15A~**
45 Hz ... 500 Hz; 2.5%; hole diameter 15 mm

MAVOLOG 10
Product Overview

Author:
GOSSEN-METRAWATT / VMS / HG

Indication	Description	Order No.
MAVOLOG 10L +FFT/FSA	3-phase Mains Voltage Analyser with Harmonics and Flicker Analysis, incl. Installation Manual	**M830S**
MAVOLOG 10N +FFT/FSA	3-phase Mains Voltage Analyser with Harmonics and Flicker Analysis and LC-Display, incl. Installation Manual	**M830P**
MAVOLOG 10S +FFT/FSA	3-phase Power and Mains Quality Analyser with Harmonics and Flicker Analysis, Power and Energy Measurement and LC-Display, incl. Installation Manual	**M830R**
MAVOLOG 10S	3-phase Power Analyser with Power and Energy Measurement and LC-Display, without Harmonics and Flicker Analysis, incl. Installation Manual	**M830V**
MAVOLOG 10 Mobil-Set	Portable 3-phase Power and Mains Quality Analyser consisting of MAVOLOG 10S+FFT/FSA**,** MAVOLOG PS/C, MAVOLOG BP mounted into rugged case; incl. Mains Cord, RS232 Cable, Voltage Test Leads with Crocodile Clips, METRAwin 10 Software; Software and Hardware Manuals	**M830W**
MAVOLOG PS/C	Power Supply Module 230Vac/24 Vdc and RS232/485 Converter for MAVOLOG 10	**Z863D**
MAVOLOG BP	Battery Pack Module for Backup Supply of MAVOLOG 10	**Z863E**
CS232/485	Battery Powered RS232/485 Converter	**Z863F**
MAVOLOG DFÜ	PTT Dial Modem for Communication with MAVOLOG via Analog Phone Lines	**Z864C**
METRAwin 10 for MAVOLOG 10	Windows Software (GB/D) for Device Setup, Data Readout and Analysis	**Z852D**
PC.doc-ACCESS for MAVOLOG 10	Database Software (GB/D) based on MICROSOFT WORD, EXCEL and ACCESS for Data Management, Analysis and Documentation of MAVOLOG Systems	**Z852F**