Power Quality Analyser
MEMOBOX 300 smart

The **MEMOBOX 300 smart** is the universal tool for power quality analysis, disturbance investigation and network optimisation on low and medium voltage power networks.
With application oriented measuring functions **MEMOBOX 300 smart** always measures the most relevant parameters for the actual application. Concerning the measuring functions there are three instrument versions available:

Q: Voltage quality analysis and locating of disturbances
P: Power measurement and network optimisation
A: Advanced, combination of P and Q function

Several hardware versions are available to meet all customer requirements:

- **Three phase voltage (3U)**
- **Three phase voltage, current, power (3U 3I)**
- **Three phase voltage, current, neutral current, power (3U 3I + N)**

All versions are available for 50 Hz or 60 Hz systems.

Measuring parameters

Channels voltage, current	3U+3I+N	3U+3I+N	3U+3I+N
Measuring function	P	Q	A
Voltage: Mean-, Min-, Max-value	L1, L2, L3	L1, L2, L3	L1, L2, L3
Phase current: Mean-, Max-value	L1, L2, L3	L1, L2, L3	L1, L2, L3
Current N: Mean-, Max-value	•	•	•
Voltage events	•	•	•
Power: P, |P|[1], Q, S, PF[2], TAN[3]	•		•, D[4]
Power total, 3-phase: P, |P|[1], Q, S, PF[2], TAN[3]	•		•, D[4]
Energy	•		•
Flicker (Pst, Plt)	•	•	•
Harmonics voltage		•, 40	•, 50
Harmonics current			•, 50
Interharmonics (5)		•	•
THD U	•	•	•
THD I	•		•
CF (crest factor) current		•	•
Unbalance		•	•
Frequency		•	•

1) |P|: Absolute value of power
2) PF: Power factor
3) TAN: Tangent phi
4) D: Distortion power

Max. number of intervals MEMOBOX 300 smart

Version	P, 3U	Q	P, U+I	A, U+I
Intervals	>30.000	>9.600	>14.200	>5.700

The maximum recording period can be calculated by multiplying the interval time defined in CODAM BASIC/PLUS with the maximum number of intervals from table.

General Data

Intrinsic error: Refers to the reference conditions and is guaranteed for two years

Quality system: developed, designed, and manufactured according to DIN ISO 9001

Recalibrationinterval: 2 years recommended

Reference conditions: 23°C ±2K, Um=230 V ±10%, 50 Hz ±0.1 Hz or 60 Hz ±0.1 Hz phase sequence L1, L2, L3, interval length: 10 minutes Star connection Power supply: 88 ...265 V AC

Environment conditions

Working tempe. range:	-10°C ... +55 C
Operating temp. range:	0°C … +35°C
Storage temp. range:	-20°C … +60°C
Reference temp. Range:	23°C ± 2K
Relative humidity:	10...80 %, no dewing
Housing:	robust, compact housing made of CYCOLOY, colour: pantone 320

Protection: IP65 as per EN 60529

Safety: IEC/EN 61010-1 600 V CAT III, 300 V CAT IV, pollution degree 2, double insulation

Type test voltage: 5.2 kV RMS, 50 Hz / 60 Hz, 5 s

EMC:

Emission:	IEC/EN 61326-1, EN55022
Immunity:	IEC/EN 61326-1

Power Supply:

Functional range:	88…400 V AC, 50 Hz / 60 Hz 100 V … 400 V DC fuse: 630 mA T, replacement in service only.
Safety:	IEC/EN 61010-1 300 V CAT IV pollution degree 2, double insulation
Via test leads:	Supply can be in parallel to measuring input up to max. 400 V
Power consumption:	max. 7 VA
Memory capacity:	4 MB Flash-EPROM
Intervals:	>5.700 intervals, >39 days with 10 min intervals
Events:	>13.000
Memory model:	linear, circular
Interface:	RS 232, 9600...115 000 Baud, automatic Baud rate selection, 3-wire communication
Dimensions:	170 mm x 125 mm x 55 mm
Weight:	appr. 1.1 kg without accessories
Measurements:	
A/D converter:	16 bit
Sampling frequency:	10.24 kHz
Anti-aliasing filter:	FIR-Filter, f_C =4.9 kHz
Frequency response:	Error < 1 % of U_N = 230 V for 40 Hz…2500 Hz
Interval length:	5, 10, 30 s, 1, 5, 10, 15, 60 minutes
Averaging time for Min/max values:	½, 1 mains period, 200 ms, 1 s, 3 s, 5 s
Time base:	resolution: 10 ms (at 50 Hz), deviation: 2s/day at 23°C

Inputs

Voltage

Input range U_l P-N:	115 V / 230 V / 480 V AC
Input range U_l P-P:	200 V / 400 V / 830 V AC
Max. overload voltage:	1.2 U_l
Input range selection:	by job programming
Connections:	P-P or P-N, 1- or 3-phase
Nominal voltage U_N:	≤ 999 kV
Input resistance:	appr. 820 kΩ per channel L_x – N
single phase (L1, L2, L3 connected):	appr. 300kΩ
Intrinsic error :	0.1 % of U_l
Voltage transformer:	ratio: <999 kV / U_l

Current input with LEM~flex

Input ranges I_l

L1, L2, L3, N:	15 / 150 / 1500 / 3000 A AC
Measuring range:	0.75 A … 3000 A AC
Intrinsic error:	<2 % of I_l
Position influence:	max. ±2% of m.v. – for distance conductor to meas. head >30 mm
Stray field influence:	<±2 A AC for I_{ext}=500 A AC and distance to measuring head >200 mm
Temperature coefficient:	< 0.05% / °C
Transformer ratio:	≤ 999 kA / ≤ I_l
Ratio selection:	by job programming
Connection:	3-phase, 3-phase+N 2-phase L1, L3 (2W-meter-method)

Current clamp input (instrument without sensors)

Input ranges I_l

L1, L2, L3, N:	0.5V nominal, 1.4 Vpeak
Intrinsic error:	<0.3 % of I_l
Overload capacity:	10 V AC max.
Input resistance:	appr. 8.2 kΩ
Transformer ratio:	≤ 999 kA / ≤ I_l
Connections:	7-pole plug 3-phase, 3-phase and Neutral 2-phase L1, L3, (2W-meter-method)

General specification

RMS measurements

Slow voltage variations

Measuring values:	Mean-value: RMS values averaged over interval length
Min-, Max-values:	Averaging with selectable averaging time 0.5 periods to 45 s
Max-value:	Max. 10ms r.m.s. value per interval
Min-value:	Min. 10ms r.m.s. value per interval

Current

Measuring values:	
Mean-value:	RMS values integrated over interval length
Max-value:	Highest RMS value per interval

Events

Dips, swells, interruptions

Limit value:	variable, lower limit: 0…95 % U_N upper limit: 105…120 % U_N set in **CODAM BASIC/PLUS** software
Range:	0...U_l + 20 %
Measuring value:	½ period RMS value
Intrinsic error:	< 2 % of U_l
Response time:	½ mains period

Flicker

Measuring value:	Flicker level (P_{lt}/P_{st}) according to IEC 61000-4-15
Intrinsic error P_{st} :	< 5 % of m.v.
Measuring range P_{st}:	0.4 … 4

Power (A-, P-versions only)

P, Q, S, |P|

Active power P:	as per EN 61036, class 2
Reactive power Q:	as per EN 61268, class 2
Distortion power D:	as per EN 61036, class 2 (A-function only)
Mean-value:	averaged over interval length
Max-value:	highest value per interval
Min-value:	smallest value per interval
Phase error:	< 0.3 degrees
Conditions:	conductor centered within clamp/LEM~flex

Harmonics

U_m, I_m, THDU, THDI as per EN 61000-4-7, class B

Voltage harmonics (A-, Q-version)

Intrinsic error:	for U_m < 3% U_N:	< 0.15% U_N
	for U_m ≥ 3% U_N:	< 5% U_m

Current harmonics (A-version)

Intrinsic error:	for I_m < 10% I_N:	< 0.5% I_N
	for I_m ≥ 10% I_N:	< 5% I_m

THD U (A-, Q-version)

Intrinsic error at U_N:	for THD U< 3%:	< 0.15%
	for THD U≥ 3%:	< 5%

THD U (P-version)

Intrinsic error at U_N:	for THD U< 3%:	< 1%
	for THD U≥ 3%:	< 5%

THD I (A-, P-version)

Intrinsic error at I_E :	for THD I< 3%:	< 2%
	for THD I ≥ 3%:	< 5%

Statistics:

Frequency:	42 classes for 10s mean values
Ripple control signals, Interharmonics:	21 classes for 3s mean values

Analysis of measurement data

Programming and analysis with PC software **CODAM PLUS**.

MEMOBOX 300 smart version P – power

Measurement values

Voltage L1, L2, L3: Phase to Phase or Phase to Neutral
- Voltage (Mean-, Min- and Max-values)
- THD U (Mean- and Max-values)
- Flicker Pst, Plt
- Voltage events (dips, swells , interruptions)

Current L1, L2, L3 and N
- Current (Mean-, Max-value), THD current

Power
- Active power P (Mean-, Min- and Max-values)
- Absolute values Active power |P| (Mean-, Min- and Max-values)
- Reactive power Q (Mean-, Min- and Max-values)
- Apparent Power S (Mean-, Min- and Max-values)
- Power Factor PF, tangent
- Energy per averaging interval

Total power
- Total power P, |P|, Q, S
- 3-wattmeter and 2-wattmeter method (Aron circuit)

Applications

Power measurement
- Long-term analysis of active, reactive and apparent power
- Long-term analysis of power factor, symmetry

Disturbance analysis
- Examination of voltage dips, flicker measurement

Network optimisation
- Load measurements, acceptance of new loads
- Adjustment of compensation systems
- Examination of voltage dips and harmonic problems
- Flicker measurement
- Examination of ripple control signals (level)
- Specific search for disturbances through correlation of relevant measurement quantities (e.g. current, voltage, and flicker) considering the time of occurrence and their periodicity.

Network optimisation
- Load measurements, capture of current peaks
- Current measurement (with flexible sensors LEM~flex 5 - 3000A)

MEMOBOX 300 smart version Q – EN50160

Measurement values

All parameters of voltage quality according to EN 50160
Voltage L1, L2, L3: Phase to Phase or Phase to Neutral
- Voltage (Mean-, Max-, Min-value)
- Voltage Harmonics 1st - 40th order
- THD U
- Interharmonics 5-2500 Hz (in steps of 0.5Hz)
- Flicker Pst, Plt
- Unbalance
- Signaling voltages
- Frequency
- Voltage events (dips, swells, interruptions)

Current L1, L2, L3 and N
- Current (Mean-, Max-Value)

Applications

Quality assurance
- Voltage quality analysis according to EN50160 over 1-week period
- Examination of measurement quantities as per standards

Disturbance analysis
- Long-term analysis of mains voltage
- Examination of voltage dips and harmonic problems
- Flicker measurement
- Examination of ripple control signals (level)
- Specific search for disturbances through correlation of relevant measurement quantities (e.g. current, voltage, and flicker) considering the time of occurrence and their periodicity.

Network optimisation
- Load measurements
- Current measurement (with flexible sensors LEM~flex 5 - 3000A)
- Capture of current peaks

MEMOBOX 300 smart version A – "Advanced"

Measurement values

All parameters of voltage quality according to EN 50160, power, energy, current harmonics
Voltage L1, L2, L3: Phase to Phase and Phase to Neutral
- Voltage (Mean-, Max-, Min-value)
- Voltage Harmonics 1st – 50th order
- THD U
- Interharmonics 5-2500 Hz (5, in steps of 0.5Hz)
- Flicker Pst, Plt
- Unbalance
- Signalling voltages
- Frequency
- Voltage events (dips, swells, interruptions)

Current L1, L2, L3 and N
- Current (Mean-, Max-Value)
- Current harmonics up to 50th order
- Crest factor and peak values of the currents

Power
- Active power P (Mean-, Min- and Max-values)
- Absolute values Active power |P| (Mean-, Min- and Max-values)
- Reactive power Q (Mean-, Min- and Max-values)
- Distortion power D (Mean-, Min- and Max-values)
- Apparent Power S (Mean-, Min- and Max-values)
- Power Factor PF, tangent
- Energy per averaging interval

Total power
- Total power P, |P|, Q, D, S
- 3-wattmeter circuit
- 2-wattmeter method (Aron circuit)
- 2 ½ element method

Applications

Quality assurance
- Voltage quality analysis according to EN 50160 over a 1-week period
- Examination of measurement quantities as per standards

Disturbance analysis
- Long-term analysis of mains voltage
- Examination of voltage dips and harmonic problems
- Flicker measurement
- Examination of ripple control signals (level)
- Specific search for disturbances through correlation of relevant measurement quantities (e.g. current, voltage, and flicker) considering the time of occurrence and their periodicity.

Power measurement
- Long-term analysis of active, reactive, distortion and apparent power
- Long-term analysis of power factor, unbalance

Network optimisation
- Load measurements, acceptance of new loads
- Adjustment of compensation systems
- Examination of voltage dips and harmonic problems
- Flicker measurement
- Examination of ripple control signals (level)
- Specific search for disturbances through correlation of relevant measurement quantities (e.g. current, voltage, and flicker) considering the time of occurrence and their periodicity.
- Current measurement (with flexible sensors LEM~flex 5 - 3000A)
- Capture of current peaks

Software CODAM PLUS

CODAM PLUS is the universal application software for **MEMOBOX 300, MEMOBOX 300 smart, MEMOBOX 800** and **MEMOBOX 808.** Job processing, verification of actual measurement values with ONLINE-function and data transfer from the **MEMOBOX** to the PC are the main functions. The user interface is intentionally kept easy, evaluations are optimised for practical applications: Graphical presentations provide an overview of power quality, statistics and measurement value tables show the details. The measured values can be exported to ASCII-files for post-processing in spread sheet calculation software.

CODAM PLUS is operative on PCs with all usual operating systems: Windows® 98/ME/NT4.0/2000/XP.

CODAM PLUS is part of the delivery of the **MEMOBOX 300 smart**.

Job processing allows for setting:

- Interval length
- Memory model
- Voltage input range, nominal voltage, nominal current
- Response time for Min-, Max-values
- Connection type (P-N, P-P)
- Thresholds for event detection, interruptions

The configuration of the **MEMOBOX 300 smart** can be done offline without a connected MEMOBOX. If a **MEMOBOX 300 smart** is connected to the PC during job processing session the connected accessory is detected automatically. Faulty scaling is impossible.
Time activated jobs, switch activated jobs and immediate jobs can be programmed.

Setup

- Internal clock (date/time)
- Define MEMOBOX 808 designation
- Parameters for data export
- Software-Updates

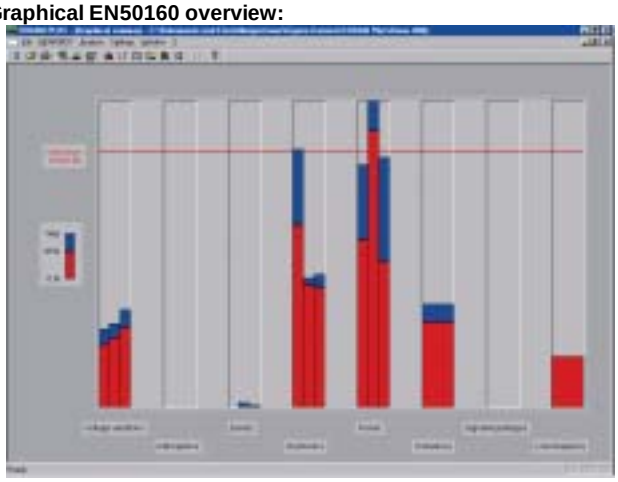
Analysis

For detailed analysis the following presentations are available:

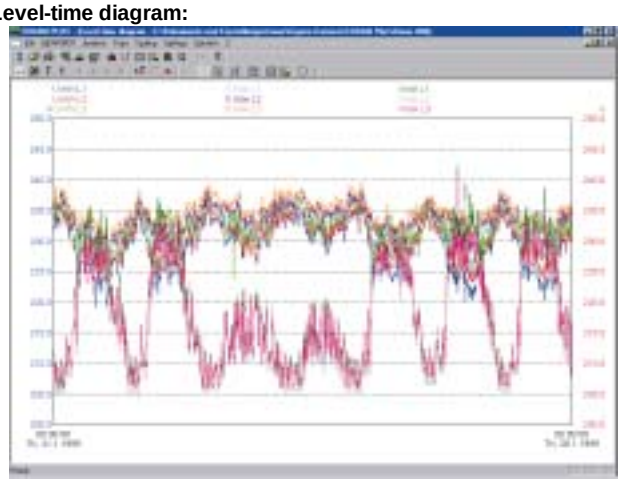
- ONLINE TEST function
- Graphical summary of all EN50160 parameters
- Level time diagrams
- table summaries
- event tables (UNIPEDE DISDIP table)
- application oriented analysis (AOA)
- list of measurement values
- cumulative frequency diagram of harmonics (A- and Q-versions)
- Statistical presentations (A- and Q-versions)
- table of all limit exceedings (A- and Q-versions)
- table of critical values (A- and Q-function)
- export to ASCII data files

The remote data transfer of measurement data via analogue modems, ISDN-modems or GSM-modems is provided.
The optional communication software PERMLINK establishes a transparent connection from the PC via the modems to the **MEMOBOX 300 smart** installed onsite.

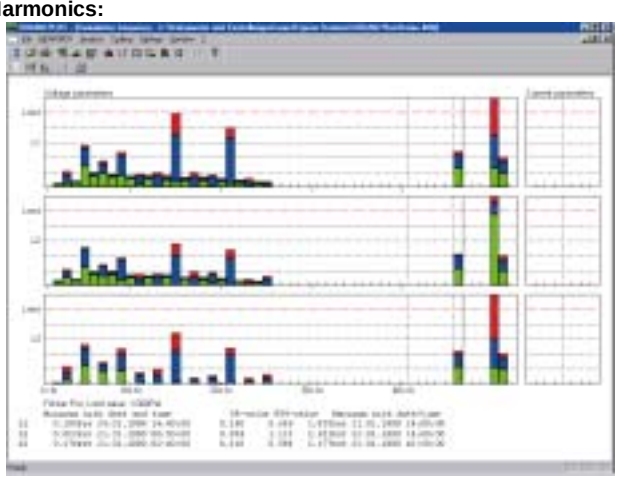
Graphical EN50160 overview:



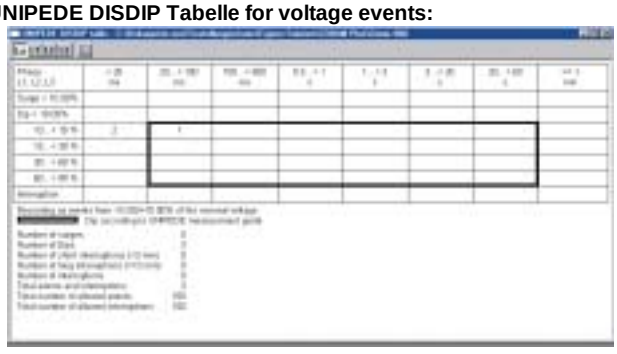
Level-time diagram:



Harmonics:



UNIPEDE DISDIP Tabelle for voltage events:



Optional accessories

Current clamp sets

Current clamp sets with measurement ranges between 1A and 1000A AC for 1-phase, 3-phase and 3-phase+N-measurements are available:

EP0450A: 1 A / 10 A, 3-phase
EP0451A: 1 A / 10 A, 3-phase + N
EP0452A: 5 A / 50 A 3-phase
EP0453A: 5 A / 50 A 3-phase + N
EP0455A: 20 A / 200 A 3-phase
EP0456A: 20 A / 200 A 3-phase + N

Technical specification

Conductor cross section:	max. 15mm diameter, 15mm x 17 mm bus bars
Intrinsic error:	< ±0.5% of m. v.
Phase angle error:	<1°
Safety:	600 V CAT Ⅲ

The clamp sets use a memory device for calibration data, and sensor identity. Thus high accuracy and small phase angle errors can be achieved – each set is calibrated individually.
One of the two measurement ranges can be selected during job processing within the **CODAM BASIC/PLUS** software.
The sensor type is detected automatically by the MEMOBOX, only ranges which are supported by the hardware can be selected.

EP0457Z: 100 A / 1000 A 3-phase
EP0458Z: 100 A / 1000 A 3-phase + N

For the ranges 100A/1000A AC special clamps with large jaw opening are provided due to the large conductor cross sections:

Technical specification

Conductor cross section:	max. 54mm diameter
Intrinsic error:	< ±0.5% of m. v.
Phase angle error:	<0.5°
Safety:	600 V CAT Ⅲ

LEM~flex-Sets

EP0403A: 15/150/1500/3000 A, 3-phase
EP0404A: 15/150/1500/3000 A, 3-phase + N

Technical specification

Measuring head length:	61cm, 2m cable
Intrinsic error:	< ±0.5% of. m. v.
Phase angle error:	<0.5°
Safety:	600 V CAT Ⅲ

Sets of flexible current sensors (LEM~flex) with measurement ranges form 15A up to 3000A AC are available in versions for 1-phase, 3-phase and 3-phase+N measurements.

The ranges for each set are: 15A/150A/1500A/3000A AC
The LEM~flex set contains a memory device with calibration data and sensor identity. Thus best precision and small phase angle errors can be achieved.

The range selection is done in **CODAM PLUS** software during job processing. The sensor type is detected by the **MEMOBOX 300 smart**, ranges hat are supported by the hardware can be selected only.

For details see the leaflet concluded to each set.

Remote data upload, remote control - PERMLINK communication-software

PERMLINK establishes a modem connection to the remote **MEMOBOX 300 smart** installed onsite**. CODAM PLUS** can operate the **MEMOBOX 300 smart** via the serial COM-port of the PC and the modem connection.
Analogue or ISDN-modems, GSM-terminals can be used to configure a **MEMOBOX 300 smart** and to upload measurement data to the PC in the control centre and to upload measurement data to the PC in the control centre, and to monitor the measurement parameters ONLINE on the PC.

PERMLINK supports modems of the following manufacturers:
US-Robotics (3Com), Zyxel, GSM-modems of SIEMENS, WAVECOM and others.

Scope of Delivery, Accessories, Service

Power Quality Analyser

MEMOBOX 300 smart (3 U) 3-phase voltage, function P, RS 232 cable, 4 dolphin clips, mains outlet adapter, operating instructions, carrying bag, software CODAM PLUS	EP0461Z
MEMOBOX 300 smart (3U + 3I, P) 3-phase voltage, current, power, measuring function P, RS232 cable, 4 dolphin clips, mains outlet adapter, operating instructions, carrying bag, software CODAM PLUS	EP0462Z
MEMOBOX 300 smart (3U + 4I, P) 3-phase voltage, current, N-current, power, measuring function P, RS232 cable, 4 dolphin clips, mains outlet adapter, operating instructions, carrying bag, software CODAM PLUS	EP0464Z
MEMOBOX 300 smart (3U Q, EN50160) 3-phase voltage, measuring function Q, RS232 cable, 4 dolphin clips, mains outlet adapter, operating instructions, carrying bag, software CODAM PLUS	EP0491Z
MEMOBOX 300 smart (3U + 3I, P + Q) 3-phase voltage, current, power, measuring function A, RS232 cable, 4 dolphin clips, mains outlet adapter, operating instructions, carrying bag, sw. CODAM PLUS	EP0492A
MEMOBOX 300 smart (3U + 3I, Q, EN50160) same as EP0492A but with measuring function Q	EP0492Z
MEMOBOX 300 smart (3U + 4I, P + Q) 3-phase voltage, current, N-current, power, energy, measuring function A, RS232 cable, 4 dolphin clips, mains outlet adapter, operating instructions, carrying bag, software CODAM PLUS	EP0494A
MEMOBOX 300 smart (3U + 4I, Q, EN50160) same as EP0494A but with measuring function Q	EP0494Z

Optional Accessories

LEM~flex 15/150/1500/3000A	3-phase, 2m cable	EP0403A
	3-phase+N, 2m cable	EP0404A
Current clamp set	1 A / 10 A, 3-phase	EP0450A
	1 A / 10 A, 3-phase+N	EP0451A
	5 A / 50 A, 3-phase	EP0452A
	5 A / 50 A, 3-phase+N	EP0453A
	20 A / 200 A, 3-phase	EP0455A
	20 A / 200 A, 3-phase+N	EP0456A
	100 A / 1000 A, 3-phase	EP0457A
	100 A / 1000 A, 3-phase+N	EP0458A
Dolphin clip black		EP0327Z
Adapter for connection to mains outlets		EP0345A
Mounting kit for pylons		EP0340A.Z
Carrying bag		EP0350A
PERMLINK communication software		E631820090

Scope of delivery, standard accessories

MEMOBOX 300 smart is delivered with a carrying bag which has room for the **MEMOBOX 300 smart,** standard- and special accessories:

The standard delivery applies to the positions EP0461Z, EP0462Z, EP0464Z, EP0491Z, EP0492A, EP0492Z, EP0494A, und EP0494Z

- **MEMOBOX 300 smart**
- Carrying bag
- Carrying, fastening belt
- Test certificate with measurement values
- Operating instructions for **MEMOBOX 300 smart**
- Operating instructions for **CODAM PLUS**
- **CODAM PLUS** software
- RS 232 serial cable, 3m
- Adapter for European outlets
- 4 dolphin clips: 3 red for L1, L2, L3,
  1 blue for N-conductor

Distributor:

www.lem.com

Printed in EU
Technical modifications reserved
Publication A25312E • 06/2005

LEM NORMA GmbH
Export department
Liebermannstraße F01
CAMPUS 21
A-2345 BRUNN AM GEBIRGE
TEL: +43(0)2236 691 502
FAX: +43(0)2236 691 400
E-mail: lna@lem.com

LEM HEME LTD.
Geneva Court
1 Penketh Place
West Pimbo
Skelmersdale, UK-Lancashire WN8 9QX
TEL: +44(0)1 695 72 07 77
FAX: +44(0)1 695 50 704
E-mail: luk@lem.com

LEM Instruments Inc.
23822 Hawthorne Boulevard #100
US-TORRANCE, CA 90505
TEL: +1 310 373 09 66
FAX: +1 310 373 90 56
E-mail: liu@lem.com

LEM Instruments, Inc.
Camino Real, 871 dpto. 502
San Isidro - Lima 27 - Perú
TEL: +51-1- 422 39 22
Mobile: +51-1- 844 55 59
FAX: +51-1- 221 64 92
E-mail: cpg@lem.com

LEM BE sa/nv
Avenue Newton, 8
B-1300 Wavre
TEL: +32 10 22 67 16
FAX: +32 10 22 69 98
E-mail: lbe@lem.com