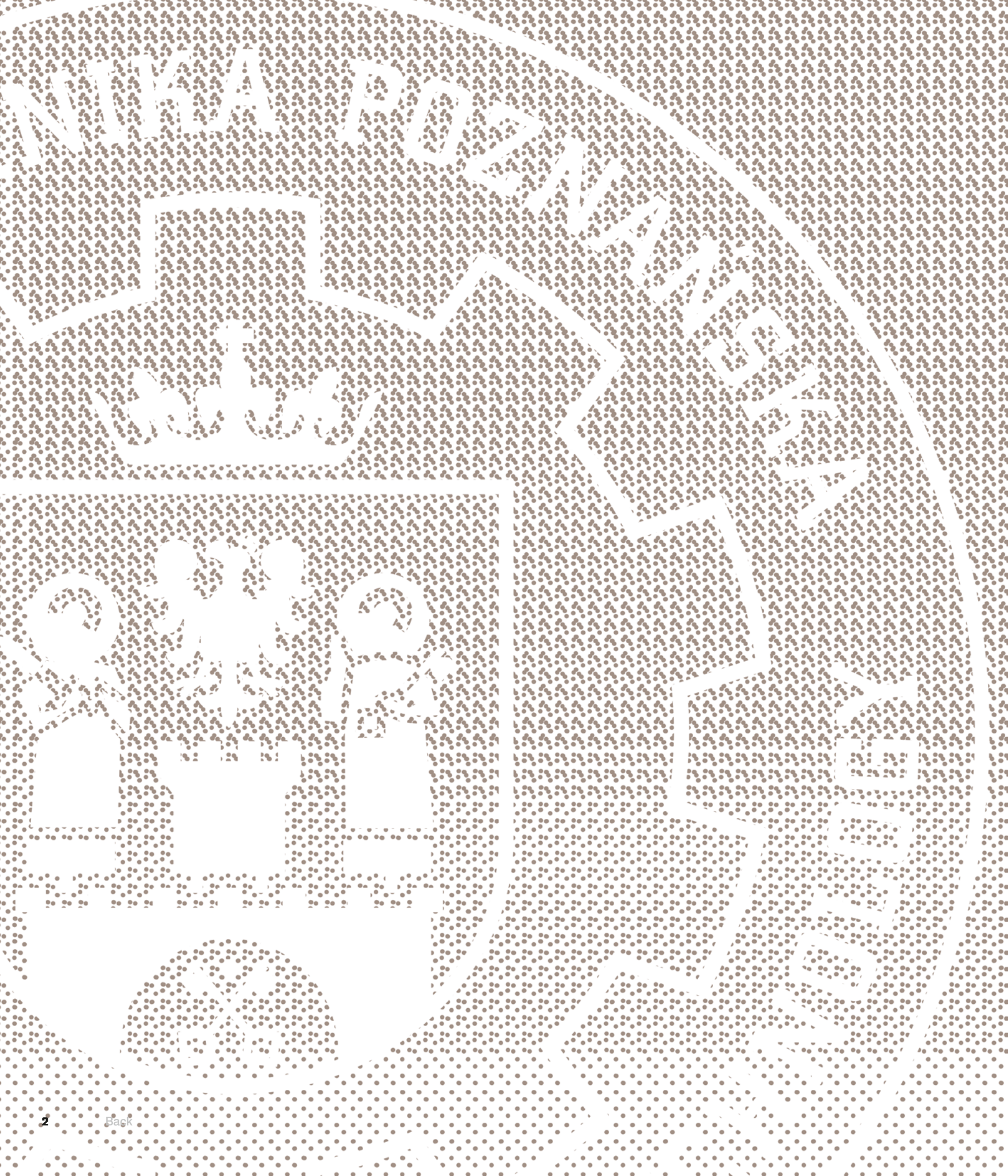


## FACULTY OF ELECTRICAL ENGINEERING

Information on the selected test equipment at the  
Faculty of Electrical Engineering, Poznan University of Technology





The Faculty of Electrical Engineering, one of the oldest and largest faculties of Poznan University of Technology, conducts classes in five fields of study. For many years, the Faculty has been intensively involved in economic cooperation with Wielkopolska and the whole country, achieving very good results. Cooperation with economic entities of the region concerns broadly understood electrical industry, i.e. electrical automation, power engineering and robotics. Experienced research staff and specialized equipment not only allow for successful joint research projects but also creates new construction and technology tools. The following catalog contains a wide range of modern equipment used in scientific research and industrial practice.

I kindly invite you to cooperate with us.

Zbigniew Nadolny, Dc.S., Eng.  
Dean of the Faculty of Electrical Engineering



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# Packet of professional software of ANSYS for analysis of coupled phenomena problems in 3D systems

## TECHNICAL SPECIFICATIONS:

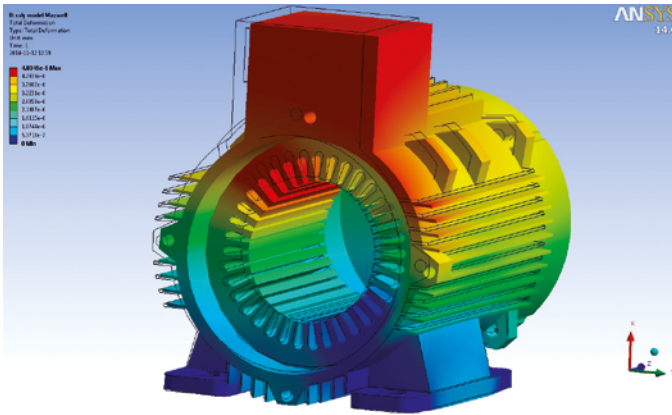
License packet of Ansys Academic Associate  
including tools/packages:

- Ansys CFX, Ansys Fluent, Ansys Mechanical, Ansys Maxwell, Ansys Design space, Ansys Autodyn, Ansys Polyflow, and others
- add-on: Ansys Academic Associate HPC

- Software is installed on professional workstation HP Z800:
  - processors: 2 x Intel Xeon
  - W5580@3,2 GHz
  - memory RAM: 64 GB (DDR3 ECC-R)
  - graphic: Nvidia Quadro 4000 2GB
  - OS: Windows 7 Professional x64
  - HDD: 3 x 1TB

## KEYWORDS

- numerical analysis
- coupled phenomena modeling
- finite element method



## APPLICATION:

Packet contains Multiphysics license in Associate version allows to perform coupled phenomena analyses in 3D systems by the academic units for industry partners

Software allows for modeling among others of:

- mechanical stresses
- thermal phenomena
- fluid dynamics and electromagnetic phenomena taking into account motion and electrical circuits equations

# Thermal Imaging Camera FLIR System E50

## TECHNICAL SPECIFICATIONS:

- spectral range (7,5–13 m)
- temperature ranges: -20 °C – +120 °C, 0°C – +650 °C
- Image resolution 240 x 180 pixels
- thermal resolution (N.E.T.D)<0,05 °C
- manual focus
- minimum distance to the object 0,2 m (lens f=18 mm)
- macro pictures (with lens t197200wd33 mm)
- correction of the influence of ambient temperature, the distance to the object, temperature and humidity of the atmosphere
- the registration of the measurement results (thermal images) in the flash memory
- the possibility of recording the videos
- the transmission of thermal image with analog link (composite)
- built-in video camera



## APPLICATION:

- thermovision examinations of the electrical, electronic and mechanical circuits (elements)
- contactless temperature measurement
- the evaluation of temperature distribution

## KEYWORDS

- thermovision
- temperature measurement
- the temperature field
- diagnostic testing of the electrical and electronic circuits



# LMK 98-4 luminance distribution CCD camera system

APPLICATION :

- The LMK measuring system is very well suited to make measurements in an urban environment in public places and streets in order to make data for the lighting design in cities available. Glare evaluation, determination of the visibility distance of local lighting installations. Determination of the luminance distribution according to EN 13201 for streets and tunnels.
- In interior lighting the LMK measuring system allows spatially resolved measurements for verifying existing norms and design projects to be made in a simple and fast way with regard to full illumination, ergonomics and well-being. Determination of contrast and glare evaluation of window surfaces and video workstations located in the vicinity of windows (e.g. CRF measurement, UGR determination). Determination of the luminance distribution with regard to ergonomic and economic aspects of workplaces; evaluation of circadian action potentials of artificial lighting with regard to the health and well-being of humans.

KEYWORDS

- luminance
- luminance distribution
- measurements in an urban environment in public places and streets



TECHNICAL SPECIFICATIONS :

- sensor Sony CCD DX4, resolution 1360 x 1040, 12 bit
- full size filter matched to V(λ)-function for measuring luminances, accuracy f1 <3,5%
- measuring quantities: luminance [cd/m²]
- integration times: 100us – 15 s
- repeatability L<0,1%
- software LabSoft
- replaceable lenses 8 mm, 25 mm i 50 mm
- ND filters



# Power Quality Analyzer Fluke 434/PWR

TECHNICAL SPECIFICATIONS :

- voltage inputs:
  - 5 inputs – 3 x phase, 1 neutral, 1 ground
  - maximum RMS voltage – 1000 V (phase)
  - voltage measuring range – from 1 to 1000 V
  - maximum peak voltage – 6 kV
  - input impedance – 4 MΩ / 5 pF
- current inputs:
  - 4 inputs – 3 phase, 1 neutral
  - type – current clamps i5s (5 A) and i400s (40/400 A)
  - i5s clamps – measuring range: 0,01-6 A, maximum non-destructive current: 70 A, input impedance – 1 MΩ / 47 pF
  - i400s clamps – measuring range: 0,5-40/5-400 A, maximum non-destructive current: 1000 A, input impedance – 1 MΩ
- measuring of higher harmonics and inter-harmonics up to 50th, frequency range (usage) – 40 Hz - 10 kHz
- measuring and monitoring all power energy parameters – voltage, current, frequency, active, reactive and apparent power and energy, power factor, phase shift, higher harmonics and inter-harmonics, dips and swells, voltage and current drops, flickers, unbalance, transients and inrush current
- internal memory – up to 10 dataset or monitors (monitoring time up to 7 days) and up to 50 print screens
- PC connection – USB cable (safety wireless connection with analyzer by IrDA)
- ability to work on battery – up to 7 hours

APPLICATION :

The study and analysis of power quality parameters. Power quality analyzer can help in locating, predicting, preventing and solving power quality problems in three-phase and single-phase power distribution systems. In addition, energy losses can be calculated based on the value of harmonics and asymmetries. Ability to determine the origin of energy losses in the electrical installations. Executing the expertises in terms of power quality parameters.

KEYWORDS

- power quality
- measurement of power and energy
- voltage higher harmonics
- flicker
- unbalance
- transients
- inrush current
- voltage dips and swells

# Broadband multichannel recorder of currents and voltages waveforms type ALS-M801

## TECHNICAL SPECIFICATIONS:

- number of channels: 4-voltage, 4-current
- measurement range (maximal values): 400 / 800 V, 25 A
- metrologic class: 1.0 – voltage channels (DC - 20 kHz), 0.5 – current channels (DC - 200 kHz)
- integrated LCD display (20x4 positions) and keyboard (8 keys)
- HD capacity: 300 GB
- communication Interfaces: RS - 232 (1x), USB (4x), ETHERNET (1x), JTAG (DSP)
- powering: 230V / 50 Hz

## KEYWORDS

- parameters of electricity
- waveforms recording
- personal computer
- measurement transducer



## APPLICATION:

- ALS-M801 is the microcomputer development system being designed to record currents and voltages waveforms as well as for the analysis of parameters of electricity in 4 - wire industrial networks. The system includes a PC mini-ITX standard equipped with the specialized DSP/PCI card – with the SHARC® DSP Analog Devices signal processor on-board. It contains the broadband isolated transducers for measuring currents and voltages. The integrated user's console enables the direct output of measurement results on the display (LCD) and set-up parameters of signal processing algorithms.
- The open architecture allows customer to implement its own control algorithms and independent use of the signals from the transducers. The high capacity hard disk enables the recording of data with large number of signal samples. The WINDOWS operating system allows user to maintain the specialized programs for processing of the collected data.
- The system is equipped with typical industrial communication interfaces like e.g.: RS-232, USB, and ETHERNET. The JTAG interface makes possible direct communication with the DSP.



## TECHNICAL SPECIFICATIONS:

- internal memory: 400 blocks
- weight: 600 g (without battery)
- dimensions: 270 x 90 x 65 mm
- ambient temperature: -20 °C...+50 °C
- operating temperature: -5 °C...+45 °C
- display: graphic 160 x 240 pixels
- power supply: 6 V / 1.2 A
- battery 3.7 V / 2.2 Ah,

# Combustion Analyzer

## APPLICATION:

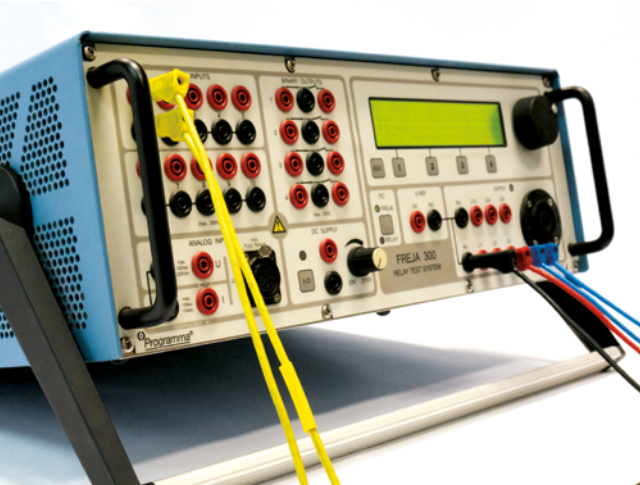
- Measures:
  - flue gas temperature
  - air temperature
  - O<sub>2</sub>, CO, CO<sub>2</sub> NO<sub>x</sub>
  - draft
  - pressure
  - stack losses
  - the stoichiometric air to fuel ratio  $\lambda$
  - efficiency of the combustion process

## KEYWORDS

- high heating value
- low heating value
- conventional fuels



# Freja 300 Relay Testing System



### TECHNICAL SPECIFICATIONS:

- operation in local or remote mode
- generation of the AC or DC signals
- current signals generation - 3 x 15 A (87 VA)
- voltage signals generation - 3 x 150 V (82 VA)
- each output can be independently controlled
- 5 inputs and 5 binary outputs
- static and dynamic tests (ramping)
- Simulation of the disturbances – creation of signals
- is based on the COMTRADE file
- (Registration of real network disturbances
- or EMTP simulations)

### APPLICATION:

Tests of the secondary protection relay circuits .  
Tests include all basic power system protection devices.

Freja system is equipped with specialized instruments for examination, among others, overcurrent protection, distance protection, differential protection, voltage and frequency relays

### KEYWORDS

- testing of protective relays
- power system protection
- disturbance simulation



# Calorimeter KL-12Mn

### TECHNICAL SPECIFICATIONS:

- test pressure of calorimetric bomb 19,62 mPa
- test pressure of calorimetric bomb: 0,35 dm³
- capacity of calorimetric vessel: 4,4 dm³
- capacity of calorimetric jacket: 15,5 dm³
- supply voltage: 220v ±10%
- dimensions: 1400 x 700 x 750 mm
- weight w/o water - 75 kg
- accuracy of temperature digital readout - 0,001 k

Parameters of resistance wire used  
for combustion:

- diameter <= 0,2 mm
- length - 100 mm
- weight < 10 mg
- heat of combustion - 6698,9 kj/kg

### KEYWORDS

- high heating value
- low heating value
- conventional fuels

### APPLICATION:

Calorimeter is designed to measure the heat of combustion of solid and liquid fuels such as:

- Peat
- brown coal
- hard coal
- brown coal briquette
- hard coal briquette
- coke
- semi-coke
- fine coal (also mixed with other substances)
- oil-derivative fuels and other liquid and semi-liquid ones
- biofuels
- biomass (in a form of: granulated products briquettes, chips, pellets)
- waste materials
- different inexplusive organic and synthetic substances in solid and liquid form

The measuring method is compliant with Polish Standard. The measurement consists in complete combustion of fuel sample in pressurized oxygen atmosphere. The fuel sample is placed in a special calorimetric bomb immersed in water. In this way the measurement of water temperature increase is carried out. The heat of combustion is calculated automatically and displayed on computer's monitor. The measuring accuracy of temperature increase is 0,001°.

# Mobile Laboratory of Power Transformer Diagnostics



APPLICATION :

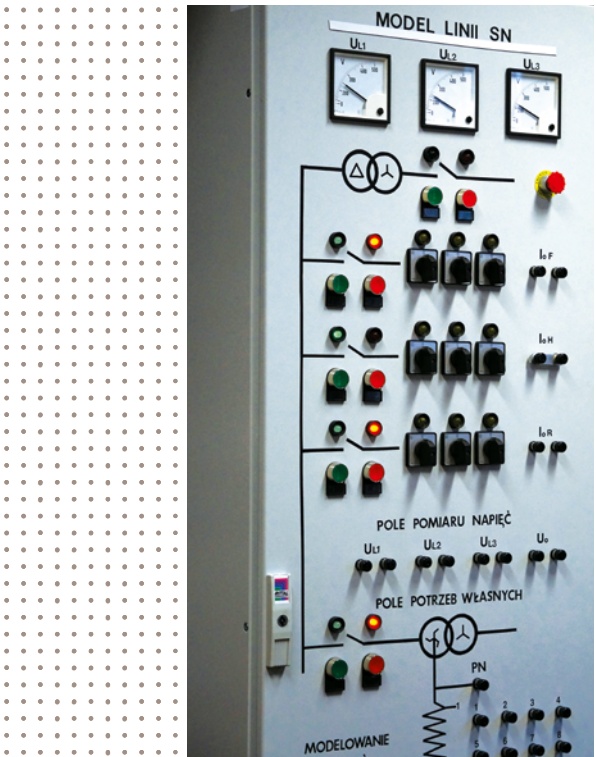
- evaluation of moisture content in oil-paper insulation systems with polarisation methods (RVM, FDS, PDC)
- measurement of water content in cellulose insulation and oil on the basis of Karl-Fischer reaction
- investigation of insulating systems with the use of high voltage dielectric spectroscopy (frequency range 0.001-100 Hz, voltage up to 30 kV)
- detection identification, localisation and on-line monitoring of partial discharges with acoustic emission method
- measurement of partial discharges with electrical method
- detection of power transformer winding deformations with SFRA method
- analysis of gases dissolved in insulating oil with DGA method
- thermovision

Additionally:

- measurement of insulation resistance
- measurement of winding resistance
- measurements and analysis of on-load tap changer parameters
- measurement of electric and magnetic field intensity
- measurement of radiointerferences,
- measurements of degree of polymerisation of cellulose
- power transformer insulation diagnostics on the bases of insulating oil properties
- spectrophotometry

KEYWORDS

- power transformer diagnostics
- measurement of water content
- measurements of partial discharges
- investigation of insulating liquids



TECHNICAL SPECIFICATIONS :

Model includes:

- power transformer (Yd11) and earthing transformer (Zy11)
- MV network with 25 A earth fault capacitive current (3 MV overhead line models with earth fault capacitive current: 15 A, 7 A, 3 A)
- 12 tap Petersen coil connected to neutral point of earthing transformer – inductive current between 14 A and 25 A,
- primary forcing resistors for cooperation with Petersen coil
- the possibility to change neutral point of MV network grounding method
- the possibility to
- the ability to specify a different ground-fault compensation factor
- network attenuation factor  $d_0 = 0,05$

# Model of the MV Network

APPLICATION :

Examination of the earth fault protection in MV network, in particular line field protections working in networks with various methods of the neutral point grounding. Studies in the physical model are supported by the measurement and data recording devices, in particular the components of the zero voltage and current.

KEYWORDS

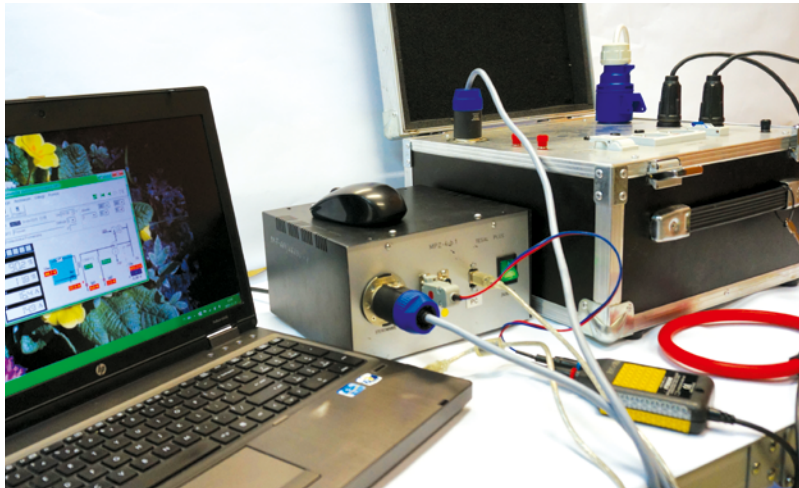
- MV network
- earth fault
- earth fault parameters measuring
- earth fault protection testing
- power system protection
- simulation of disturbances



# MPZ-4 Earth Fault Parameters Meter

APPLICATION :

Measurement of parameters of the earth fault in compensated MV networks, primarily capacitive earth fault current and earth-fault compensation factor. The device allows for measurements of these parameters without the need for a real earth fault in the network.



TECHNICAL SPECIFICATIONS :

- portable device cooperating with the PC
- MPZ forcing system is connected to the low voltage windings of the Petersen coil and causes short-term appearance of the zero sequence voltage of 10% of the phase voltage value
- measurement of the propagation component of zero current is carried by Rogowski coil
- uses the method described in patent PL 150320

KEYWORDS

- MV network
- capacitive earth-fault current
- earth-fault compensation factor
- earth-fault parameters measurement



TECHNICAL SPECIFICATIONS :

Portable low resistance meter. It allows measurements using a current range of 100 mA to 100 A, in the range from 10  $\mu\Omega$  to 20  $\Omega$ .

The meter allows, among other things, automatic detection of circuit continuity and measurements in single and continuous mode.

It features a high resolution of measurements down to 1 n $\Omega$  and high accuracy 0.25 % of reading. It is built in a rugged carrying case, with a high protection degree IP 64.

# Low resistance ohmmeter MicroOhm MI3252

APPLICATION :

Measurement of the resistance of:

- high, middle and low voltage circuit breakers
- high current bus bar joints
- cable splices
- welding joints

KEYWORDS

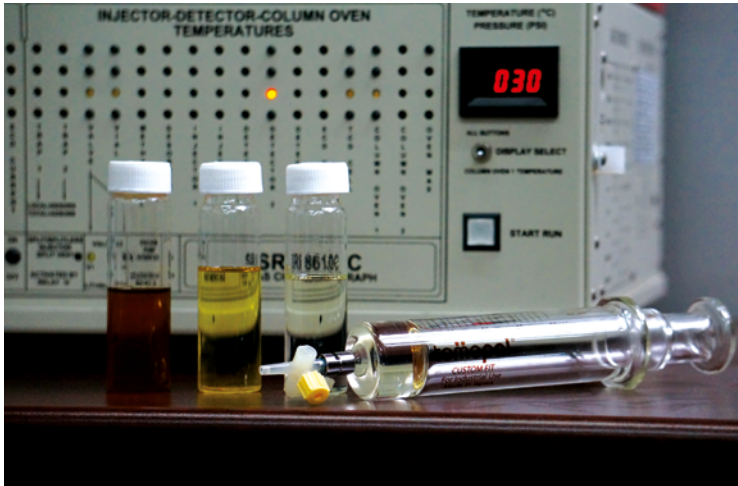
- resistance measure
- low resistance meter
- electrical contacts
- electric joints

# SRI 8610C

## Gas Chromatograph TOGA

APPLICATION :

Qualitative  
and quantitative analysis  
of gases dissolved in mineral  
oil according to IEC 60567  
and IEC 60599 standards.



TECHNICAL SPECIFICATIONS:

- detectors: FID – flame ionization detector and TCD – thermal conductivity detector
- analysed gases: CO, CO<sub>2</sub>, CH<sub>4</sub>, C<sub>2</sub>H<sub>2</sub>, C<sub>2</sub>H<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, C<sub>3</sub>H<sub>6</sub>, C<sub>3</sub>H<sub>8</sub>, H<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>
- PeakSimple - chromatography software

KEYWORDS

- DGA method
- dissolved gas analysis in oil

# Metrohm 831 KF Coulometer

## for measurement of water content by means of Karl Fischer titration method

TECHNICAL SPECIFICATIONS:

- coulometer including titration cell and generator
- electrode with diaphragm
- automatic drift compensation



APPLICATION :

Water content measurement  
in electro-insulating liquids  
and cellulosic materials  
according to the IEC 60814  
standard

KEYWORDS

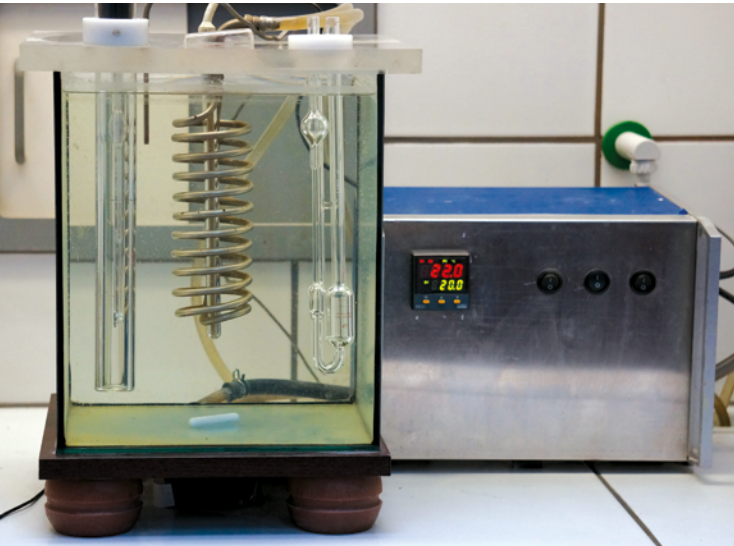
- Karl Fischer titration method
- coulometric method
- measurement of water content in oil and cellulose



# Measurement setup for determination of polymerization degree of cellulose

## TECHNICAL SPECIFICATIONS:

- Measuring system equipped with:
- Soxhlet apparatus
  - laboratory shaker
  - 831 KF Coulometer for measurements of water content by means of Karl Fischer titration method
  - Ubbelohde viscometer
  - water bath for measurement of kinematic viscosity at  $20 \pm 0,1^{\circ}\text{C}$



## APPLICATION:

Measurement of the average viscometric degree of polymerization of new and aged cellulosic electrically insulating materials according to the IEC 60450 standard

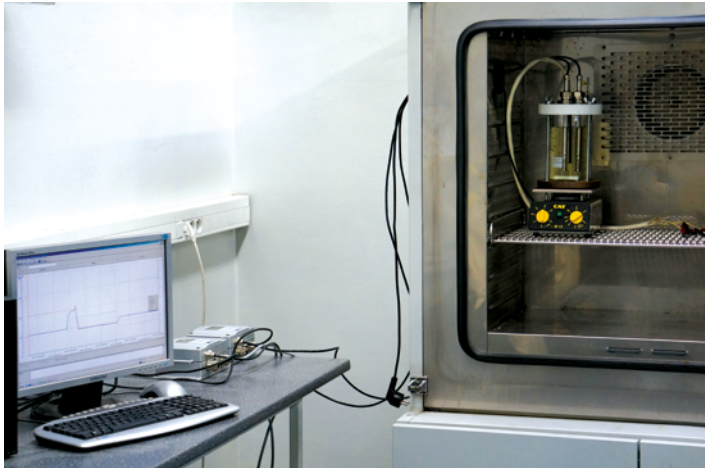
## KEYWORDS

- polymerization degree of cellulose
- viscometric method

# Measurement setup for determination of water solubility coefficients of electro-insulating liquids

## TECHNICAL SPECIFICATIONS:

- Measuring system equipped with:
- MMT 330 Vaisala moisture and temperature transmitter with capacitive sensor
  - tightly closed vessel for thermal conditioning of electro-insulating liquids,
  - Binder MKF 240 climatic chamber
  - 831 KF Coulometer for measurements of water content by means of Karl Fischer titration method



## APPLICATION:

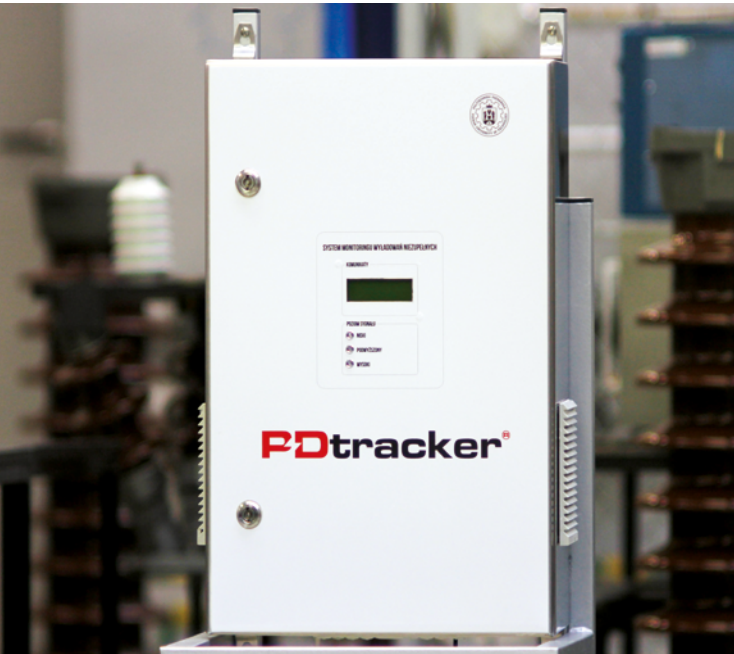
Determination of water solubility coefficients of electro-insulating liquids. These coefficients are necessary for proper calculation of the water content in ppm by weight on the basis of relative water saturation which was measured by means of capacitive probe. Such a probes are used for monitoring water content in transformer insulating liquids.

## KEYWORDS

- capacitive probe
- measurement of water content in electro-insulating liquids
- monitoring of water content in electro-insulating liquids

# PDtracker

- online partial discharge monitoring system for power transformers



APPLICATION:

Long-term and short-term online partial discharge monitoring of power transformers using acoustic emission (AE) and electromagnetic (HF/UHF) methods.

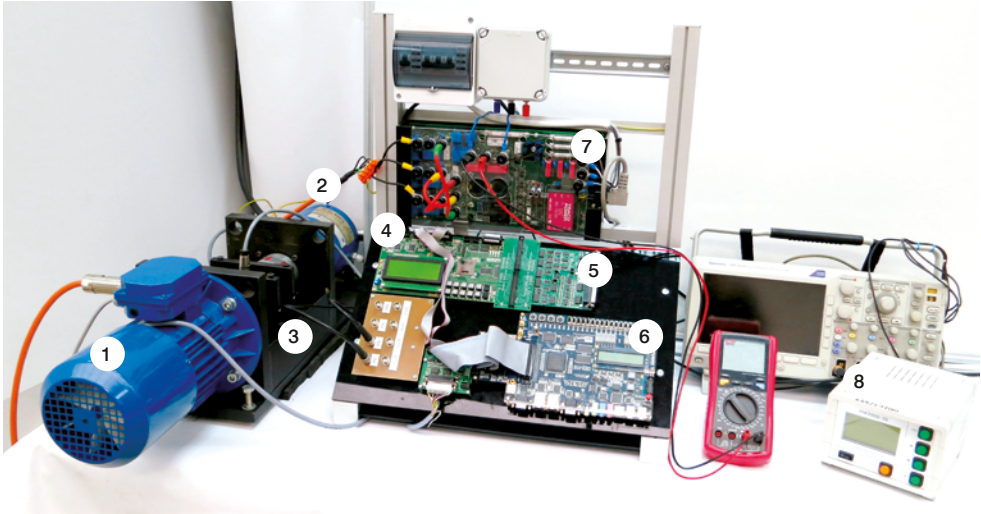
TECHNICAL SPECIFICATIONS:

- bandwidth of acoustic emission signals: 20 kHz - 1 MHz
- bandwidth of electromagnetic signals: 400 kHz - 10 MHz
- determination of partial discharge parameters: number of pulses (PD intensity), mean and peak amplitude, signal energy
- short-term (daily) and long-term (weekly, monthly) trend analysis
- generation of warnings and alarms
- automatic generation of measurement reports
- 3D localization of partial discharge sources
- automatic recognition of high voltage insulation defects

KEYWORDS

- monitoring of power transformer
- partial discharge detection and localization
- acoustic emission
- ultrasonic electrical inspection

# Laboratory bench for research on fault-tolerant control algorithms of electrical drive



- 1) permanent magnet synchronous motor
- 2) brushless DC motor
- 3) torque sensor
- 4) DSP system
- 5) DSP extension card
- 6) FPGA system
- 7) power electronic converter
- 8) torque sensor interface

APPLICATION:

Research on fault-tolerant algorithms of control of electrical drive. Possibility of design and experimental verification of control structures of torque, position and speed for permanent magnet synchronous motors and brushless motors.

KEYWORDS

- electrical drive
- fault-tolerant control
- permanent magnet synchronous motor
- brushless DC motor
- signal processor
- FPGA
- DSP



TECHNICAL SPECIFICATIONS:

Power supply:

230V, 3 x 400V

EA-PS 8360-10T (360V, 10A, 1kW) adjustable laboratory-class power supply

PMSM SKhm80-4b/EN/3PTC motor

(nominal motor power: 0.75kW, rated voltage: 3 x 400V, 50Hz, nominal speed: 1500 rpm,  
position sensor: absolute 14-bit, Gray code)

BLDC PMSg30-6B motor

(nominal motor power: 0.75kW, nominal voltage: 3 x 310V, nominal speed: 3000 rpm,  
position sensor: sine-cosine)

Inverter: LabInverter P3-5.0 / 550MFE

number of branches of the bridge: 3

Maximum DC circuit peak-load voltage: 700V

peak-load power value of the bridge’s branch: 50A

DSP ALS-G3-1369:

ADSP-21369 signal processor (800 MIPS, 2400 MFLOPS, 2 Mb SRAM)

A/C converters: AD7656BST (16-bit, 12 parallel-sampled channels, 250 kSps)

C/A converter: AD7835 (14-bit, 4 buffered output channels)

ADZS-HPUSB-ICE emulation probe for SHARC signal processors by Analog Devices

FPGA DE2 DE2-115:

Cyclone IV 4CE115 programmable logic unit (114k logic elements, 4 PLLs)

Memory: 128MB (32M x 32bit) SDRAM, 2MB (1M x 16) SRAM, 8MB (4M x 16) Flash expansion card:

GPIO-HSTC/HSMC

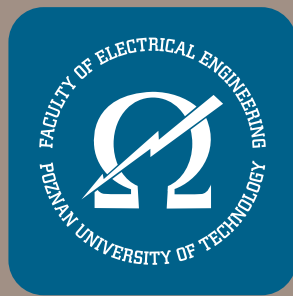
accessories:

- four-channel oscilloscope
- set of multimeters
- thermal imaging camera
- Load controller - Unidrive

Contact

4	Packet of professional software of ANSYS for analysis of coupled phenomena problems in 3D systems Cezary Jędrzycka, PhD Eng. +48 61 665 2396 cezary.jedryczka@put.poznan.pl	10	Freja 300 Relay Testing System Bartosz Olejnik, MSc. Eng. +48 61 665 2270 bartosz.olejnik@put.poznan.pl Bogdan Staszak, PhD Eng. +48 61 665 2635 bogdan.staszak@put.poznan.pl	16	SRI 8610C Gas Chromatograph TOGA Piotr Przybyłek, PhD Eng. +48 61 665 2018 piotr.przybylek@put.poznan.pl
5	Thermal Imaging Camera FLIR System E50 Arkadiusz Hulewicz, PhD Eng. +48 61 665 2546 arkadiusz.hulewicz@put.poznan.pl	11	Calorimeter KL-12Mn Bartosz Ceran, MSc Eng. +48 61 665 2523 bartosz.ceran@put.poznan.pl Robert Wróblewski, PhD Eng. +48 61 665 2523 robert.wroblewski@put.poznan.pl	17	Metrohm 831 KF Coulometer for measurement of water content by means of Karl Fischer titration method Piotr Przybyłek, PhD Eng. +48 61 665 2018 piotr.przybylek@put.poznan.pl
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POZNAN UNIVERSITY OF TECHNOLOGY