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TECHNICAL TRAINING EQUIPMENT FOR :

Section1:
MODERN POWER TRAINING LAB
(Section A to E)

Section2:
INSTALATION TRAINING LAB

Section3:
ELECTRICAL MACHINES LAB

Section4:
MODERN HIGH VOLTAGE LAB

MODERN POWER TRAINING LAB
Section 1:

Item Description

Note: For a complete modern power/ protection lab, the following items are essential
A- Panel trainers for generation, transmission and distribution
B- Power analyzing and measurement
C- Panel trainers for different type of relays and protective devices
Optional- Accessories and test equipment

A- Complete Power Simulating System for Training

1 Power/ Electrical Simulation System for training (Generation, Transmission, Distribution) including:
- Electrical Generation System Simulator type CE-PE
- Electrical Transmission System Simulator type SLE/2
- Electrical Distribution System Simulator type IDLE/3

B- Power analyzing and measurement

2 - Electrical Power Analyser (for measuring: A-V- W-VAR- Wh- VARh-cosØ) for single and three phase measurements as well as power analyzing type APR-FR/ARM-2 with USB interface and software

C- Panel trainers for different type of relays and protective devices (protection Lab)

3 Modern/ Digital protective relay trainer type RE/1 with interface and software

4 Modern/ Digital protective relay trainer type RE/2 with interface and software

5 Directional relay trainer type RE/3

6 Distance protection relay trainer type RE/4, (including Siemens relay type 7SA6101-2AC02-6FAO)

7 Frequency Relay Trainer type RE/5

8 Earth/ safety and differential circuit breaker trainer type SELDIF

9 Digital protection trainer with PLC/ Fieldbus study model (Siemens)type MAQ-NET with software type LOG-STEP

Optional- Accessories and test equipment

10 Digital True RMS bench multimeter type 1604

11 Multi-function installation tester type MFT1720

12 Single and three phase power supply with built in digital instrument type 180

13 Resistive load type RHP05

14 Inductive load type LH10

15 Capacitive load type CH05

16 Relay test set type Sverker780, with Win software

D- Power quality and power factor correction training systems

1 Harmonics analyzer HARMOVAR + network analyzer type 6830

2 Power factor correction system type MAQCOS

E- Alternative/ renewable energy training system

1 Solar Central Unit with network injection and isolated site type SOL-1 complete with electrical cabinet, 2 photovoltic solar panels and link cable

2 Housing Component Panel on wheels type HABITAT-1

3 Data acquisition system type ACQUI-SOL complete with sensors, interfaces and software

4	Artificial Solar Source type SOL-ARTI
5	Simulation of Solar Panel type DC10
6	Solar Analyser type VA200 complete with accessories and software
7	Solar Pumping Station type SOLPUITS
8	Wind turbine simulator type EOLYP

INSTALATION TRAINING LAB Section 2:

Item	Description
1	Source switching kit type KI-COMS
2	Asynchronous motor start-up kit type KI-CABDEM
3	SYSTEM CONSOLE type PUP695
4	Home energy use panel type ECODOM-C, ECODOM-A
5	Jumper wires panel type BASIFIL-1
6	Access control system type GES-2
7	Intruder alarm control system type GES-3
8	Security lighting control system type GES-4
9	Entry access and video access control system type GES-5
10	Fire alarm control system type GES-6
11	Anti-intrusion unit on BUS wire type GES-7
12	Anti-intrusion unit on telephone line type GES-8
13	Wireless anti-intrusion unit type GES-9
14	Didactic lift type ASC89
15	RESIDENTIAL INSTALLATION TRAINER TYPE PANN-RESID

16 STUDY AND TESTING ON DISTRIBUTION SYSTEMS (position of neutral conductor) TYPE PANN/DISTRIB

17 Clamp meter type DCM340

18 Earth clamp meter type type DET24C

19 Digital multi meter type AVO410

20 Multifunction instalation tester MFT1800

ELECTRICAL MACHINE LAB
Section 3:

Item Description

1 DEMO AC+DC

2 PACK AC1

3 PACK AC2

4 PACK DC1

Options (if required):

1opt Fault finding in motor type MOTODIAG

HIGH VOLTAGE LAB
Section 4

Item Description

Technical offer No:A-108935-00 (MIT 2012)

Options:

PD surveyor for partial detection, mobile fences, Test objects (DG100, oil testing vessel/ cap, spark gap unit VF2)

MODERN POWER TRAINING LAB Section 1:

A- Complete Power Simulating System for Training

ITEM A1

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SYSTEM SUITABLE TO SIMULATE THE ELECTRICAL ENERGY'S CYCLE

- **PRODUCTION**
- **TRANSMISSION**
- **DISTRIBUTION**

This innovative system is formed by three different autonomous simulators (type CE-PE; type SLE/2; type IDLE/3) studied to work in serial connection or alone.
With the suggested measuring instruments and the programs supplied with them it is possible to transfer the data measured on a Personal Computer and analyse them or realize graphics to study in a modern and complete way all the problems about the production, the transmission, and the distribution of the electrical energy.
With this system it is possible also to study the level of the quality of the electrical networks, harmonics and with implementation electrical and magnetic field at 50 Hz

Every simulator, if used alone needs of n.2 APR-FR/ARM-2.
To use the three simulators in serial connection No.2 APR-FR/ARM-2 are enough.

TYPE CE- PE DIDACTIC KIT TO STUDY:
THE PRODUCTION OF ELECTRICAL ENERGY

Dimensions: 1000 x 400 x 350 mm **Weight: 40 kg. about**

The module simulates a power-station. It allows: parallel with the networks, generation of active and reactive power. The production mechanism is faithfully simulated and does not need any rotating motors. It includes the principal electric protections used in a plant.

DESCRIPTION
This module simulates a plant for the production of the energy.
It is fundamentally composed by:

- An adjustable voltage autotransformer (it simulates the electric generator)

- A step-up transformer
- Start/stop push button (Switch ON/OFF of generator)
- Contactor of start/stop generator
- Terminals for insertion of measuring instruments in the side of generator (Point A)
- Elevator transformer that can be connected at star or triangle
- Terminals to insert measuring instruments in the side of high voltage (point B)

A group of parallel with the line composed by:

- Digital voltmeter for the side of the power-station
- Zero digital voltmeter between power-station and line
- Group No.3 lamps
- Parallel circuit breaker, parallel switch

Line simulator composed by:

- Insulating transformer
- R-L circuit of the line.

With this module it is also possible:

- To simulate the following groups of transformers: Yy0; Yy6; Dy5; Dy11.
- To calibrate different electrical protections (for example: max. current relays, max. power relays, anti-inversion energy way relays and so on). To obtain this function it is necessary to buy No. 2 APR-FR/ARM-2

USE OF SIMULATOR

Section 1 – Use of the section GENERATOR and MEASUREMENT GROUP
Section 2 – Parallel with mains
Section 3 – Improve the protections
Section 4 – To feed SLE/2

APR/FR-ARM

MEASUREMENTS

Proper terminals to allow connecting measuring meters.

PACKING LIST

- **Equipment TYPE CE- PE**
- **Kit of cables of different lengths**
- **Instruction manual and driven experiences**

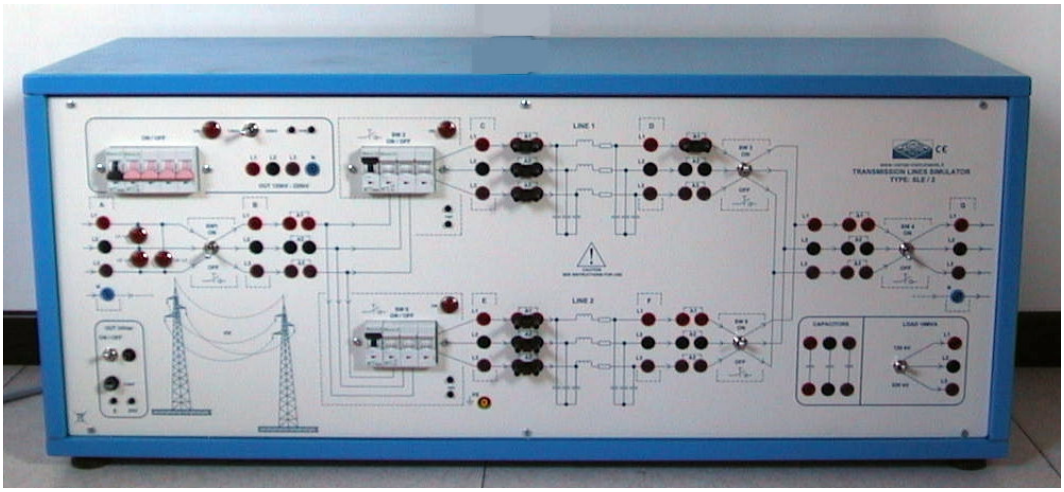
SUGGESTED ACCESSORIES

- No.2 digital interfaced instrument A-V- W-VAR- Wh- VARh- cosØ for single and three-phase measurements (type APR-FR/ARM-2)

- n.1 trolley for the easy turret shifting

trolley

TYPE SLE/2 DIDACTIC KIT TO STUDY:
TRANSMISSION OF THE ELECTRICAL ENERGY



Dimensions: 1000 x 400 x 350 mm **Weight: 45 kg. about**

The module simulates a high voltage line. The simulator is suitable to study the thee-phase transmission lines to transport energy. Study of the lines working at no-load and at load, change of voltage, voltage drops, losses in line, fluxes of active and reactive power, phasing, lines parallel.
This equipment can be used alone since it is self-powered and is equipped with internal load and phasing capacitors or it can be used together with the simulators of electrical station type CE-PE/2 and the simulator of installation of distribution; in this way it is possible to simulate a complete process of production, transmission and distribution of electrical energy.
As option, it is available a kit for study electrical and magnetic field at 50 Hz.

<u>This teaching unit simulates two overhead transmission lines, at 120 kV or 220 KV and 70 km long.</u>

INTERNAL LOAD: available Three terminals at receiving bus-bar allow connecting a real external load with the lines in parallel.
CAPACITOR BANK FOR POWER FACTOR IMPROVEMENT

It allows studying:

- ✓ **No-load lines - Lines on open circuit**
- ✓ **Load lines with determination of changes of voltage, losses and line efficiency**
- ✓ **Lines working in short-circuits**
- ✓ **Lines in parallel**
- ✓ **Phasing**
- ✓ **Improvement of power factor;**
- ✓ **Convenience to transport energy at high voltage**
- ✓ **Increase of voltage owing to a capacitive load**
- ✓ **Implementation of protections of max current, max power, energy inversion (the equipment APR/FR is required).**
- ✓ **Various**

DESCRIPTION
The lines are represented by 'π' model with concentrated parameters:
Line 1: simulated transmitted power 16 MVA; Resistance for phase - Inductance for phase - Capacitance for phase
Line 2: simulated transmitted power 20 MVA; Resistance for phase - Inductance for phase - Capacitance for phase

The kit includes:
General magnetothermic switch
Feeling transformer with outputs that can be selected at 120 /220V (it simulates the input of the power from an electrical station at 120 or 220 kV)
Line switch SW1 (it acts on the 2 lines)
Magnetotermic line switch SW2 starting from line 1
No. 2 electrical lines, each one is equivalent to a high voltage line of approx 70 km length.
Line switch SW5 starting from line 2
Line switch SW3 arriving at line 1
Line switch SW6 arriving at line 1
Output switch SW4
Electrical load with power of approx 160 VA (it simulates a power equivalent to 16 MVA)

USE OF SIMULATOR
Introduction – Choice of the type of feeling
Section 1 – No-load line
Section 2 – Load line (120 V)
Section 2 A – Load line (120 V) WITH PHASING
Section 3 – Load line (220 V) WITHOUT PHASING
Section 3 a – Load line (220 V) WITH PHASING
Section 4 – Parallel of the lines Experience of parallel of lines
Section 5 – Overvoltage due to capacitive load
Section 6 – To implement protections


APR/FR-ARM

MEASUREMENTS
Proper terminals to allow connecting measuring meters.
With the trainer SLE/2 it is possible to study the protections of max current, max power, inversion of energy direction by buying No. 2 APR-FR/ARM-2 below suggested.

PACKING LIST

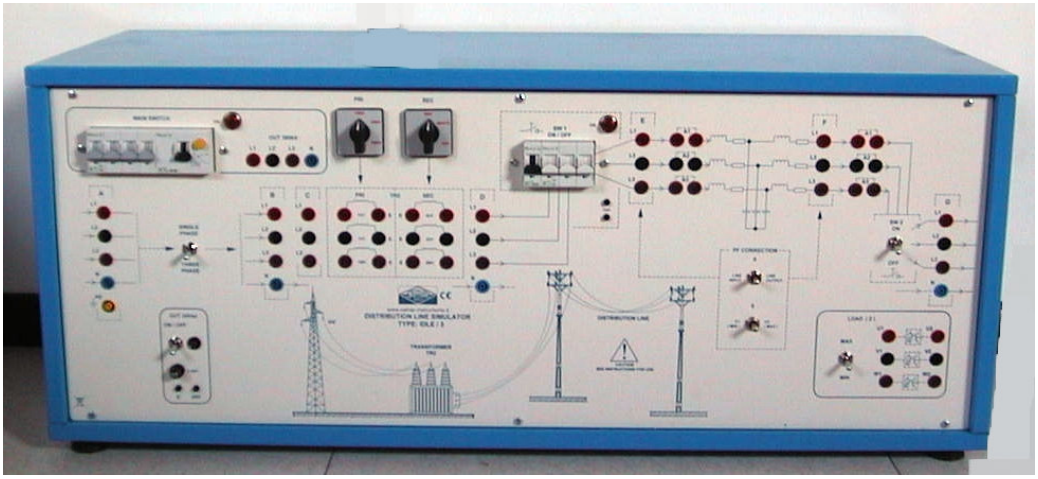
- **Equipment TYPE SLE/2**
- **Kit of cables of different lengths**
- **Instruction manual and driven experiences**

SUGGESTED ACCESSORIES
- No.2 digital interfaced instrument A-V- W-VAR- Wh- VARh- cosØ for single and three-phase measurements (type APR-FR/ARM-2)

- n.1 trolley for the easy turret shifting


trolley

TYPE IDLE/3 DIDACTIC KIT TO STUDY:
DISTRIBUTION OF THE ELECTRICAL ENERGY
MEDIUM VOLTAGE



Dimensions: 1000 x 400 x 350 mm **Weight: 40 kg. about**

The module simulates a medium voltage line for distribution. The simulator is suitable to study the thee-phase transmission lines to distribute energy at medium voltage.
It includes the line protections and the over voltage dischargers, insulation transformer. Study of the lines working at no-load and at load, change of voltage, voltage drops, losses in line, fluxes of active and reactive power, phasing. Analysis of convenience to carry energy at high voltage.
This equipment can be used alone since it is self-powered and is equipped with internal load and phasing capacitors or it can be used together with the simulators of electrical station type CE-PE/2 and the simulator of transmission line SLE/2; in this way it is possible to simulate a complete process of production, transmission and distribution of electrical energy.

This teaching unit simulates a cabin to lower the voltage from 120-220-380 KV to 30- 30/√ 3 – 10 KV and a 3-phase line overhead distribution at 30- 30/√ 3 – 10 K and 30 km long.

These are the experiences that can be performed:

- ✓ No-load lines
- ✓ Load lines with determination of changes of voltage, losses and line efficiency; Line voltage drop as function of load, Line loss as function of load
- ✓ balanced and unbalanced 3-phase systems;
- ✓ Lines working in short-circuits
- ✓ Phasing
- ✓ Improvement of power factor
- ✓ Convenience to transport energy at high voltage
- ✓ Increase of voltage owing to a capacitive load
- ✓ Various

Implementation of protections of max current, max power, energy inversion (the equipment APR/FR-ARM-2 is required).

DESCRIPTION
The line is represented by T model with concentrated parameters: Resistance per phase, Inductance per phase, Earth capacitance
3phase or single-phase mains voltage: max voltage: 400 V.
With single-phase power supply the unit is utilized to study a simple single-phase line.
Automatic magneto-thermostatic power switch.
Earth leakage ciruit breaker.
A 2-position switch provides the unit as 3-phase or single-phase line.
With single phase it is necessary to supply R and N terminals.
A 3-position switch provides the change of line input voltage:

- Position 1: mains voltage V
- Position 2: mains voltage V/√3
- Position 3: mains voltage V/3

A HV/MV three-phase transformer

The kit includes:
General magnetotermic differential switch C16
Output at voltage 380 V (it simulates the input of power from a transmission line of 380 kV)
Selector SINGLE PHASE / THREE PHASE to choose the type of line.
Transformer TR2 with primary voltages (for Y connection) of 120 – 220 – 380 V and secondary voltages (for Y connection) of 69 – 127 – 220 V
N° 2 switches to change the range of transformer.
Magnetotermic switch with release coil line SW1 starting from line 1
Simulated electrical line that is equivalent to a medium voltage line of approx 30
Section POWER FACTOR CORRECTION composed by No. 3 capacitors of 10 µF and n° 3 capacitors of 20 µF that can be inserted by means of selectors MIN/MAX and LINE INPUT / LINE OUTPUT.

IMPROVEMENT OF POWER FACTOR
A 3-position switch provides the connection of a star-connected internal bank of condensers in parallel with sending or receiving line end, and off. Another switch provides two sections 10 and 20µF, so that the amount of correction can be varied to suit load conditions.

INTERNAL LOAD
The internal load consists of ohmic-inductive impedances.
A 3-position switch per phase allows to include and change the load (half or full load and off) to carry out a balanced or unbalanced load. A 3-position switch allows connecting the load impedances in mesh or star and off.

EXTERNAL LOAD (supplied on request)
Three pairs of terminals allow connecting an external load, that, by proper auxiliary connections can be connected in star or mesh. A 2-position switch per phase allows including or excluding the phase load.

USE OF THE SIMULATOR

INTRODUCTION – Choose of the type of feeding.
Limits of voltage and current
CE-PE/2 → SLE/2 → IDLE/3 that is a complete model of generation, transmission and distribution of electrical energy.
SINGLE-PHASE LINE
Section 1 – Three-phase no-load line. Switch on V
Section 2 – Load three-phase line (Selector on V)
Section 3 – Load three-phase line (SELECTOR ON $V/\sqrt{3}$)
Section 3a – To implement protections
Earth fault of a three-phase line with insulated neutral
To implement a protection against the earth failure.

APR/FR-ARM

MEASUREMENTS

Proper terminals at the sending and receiving line ends allow connecting measuring meters.
With the trainer IDLE/3 it is possible to study the protections of max current, max power, inversion of energy direction by buying No. 2 APR-FR/ARM-2 below suggested.

PACKING LIST

- **Equipment TYPE IDLE/3**
- **Kit of cables of different lengths**
- **Instruction manual and driven experiences**

SUGGESTED ACCESSORIES

No.2 digital interfaced instrument A-V- W-VAR- Wh- VARh- cosØ for single and three-phase measurements (type APR-FR/ARM-2)

- n.1 trolley for the easy turret shifting

trolley

ANALYSIS ELECTRICAL NETWORK, TROUBLES AND HARMONICS

The module study and measure the quality of the electric energy, relief of the harmonicas, take the relative corrective provisions to obtain acceptable wave forms for the good working of the electric and electronic equipment fed by the electrical network. It is possible: realization of the typical circuits, acquisition of the wave forms: tension, current, evaluation of the harmonic distortions and the level of the troubles, use of filters to simulate troubles or improve the situation after the analysis of the electric energy and the tracking of troubles.

ELECTRIC ENERGY ANALYSIS- ENERGY SAVING – MEASURE BY INTERNET

POWER ANALYSER AND HARMONICS

Multifunction instruments with graphic display for local and telecontrol measurements type APR/FR-ARM (alternative type APR/FR without harmonic measures)

MEASUREMENTS - Measurements with automatic or manual scanning of:
W, Waverage, VAr, VA, VAaverage, **cosø** , **cosø** average, V, I, I average, H_Z, THD (min and max for all the measurements), KWh, KVArh on 4 quadrants. TRMS measurements in twisted wave form (voltage and currents)

- RANGE max : 430V / 5A direct (option: expansion with current clamps)
- DIGITAL DISPLAY
- RS-232 OUTPUT AND SOFTWARE
- Included software and study of the harmonicas

Microprocessor 32bit ; Class 0.5; back lighted display with 4 simultaneous measures
Harmonic analysis (FFT) up to 50° with graphic and digital indication (current and voltage); rising harmonic source. Autorange for voltage and current inputs
Equipped with software

APR/FR-ARM

B- Power analyzing and measurement

ITEM B2

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NETWORK AND ENERGY ANALYZER

POWER ANALYSER AND HARMONICS
TYPE APR/FR-ARM2 with interface – software - harmonic measures

Multifunction instruments with graphic display for local and telecontrol measurements type APR/FR-ARM2 with interface – software - harmonic measures. Single and three-phase at 3 and 4 wires power analyzer

MEASUREMENTS - Measurements with automatic or manual scanning of:
W, Waverage, VAr, VA, VAaverage, **cosø** , **cosø** average, V, I, I average, H_Z, THD (min and max for all the measurements), KWh, KVArh on 4 quadrants. TRMS measurements in twisted wave form (voltage and currents)

- RANGE max : 430V / 5A direct (option: expansion with current clamps) (on request: other ranges)
- DIGITAL DISPLAY
- RS-232 OUTPUT AND SOFTWARE
- Included software and study of the harmonicas

Microprocessor 32bit ; Class 0.5; back lighted display with 4 simultaneous measures
Harmonic analysis (FFT) up to 50° with graphic and digital indication (current and voltage); rising harmonic source. Autorange for voltage and current inputs
Power supply 230 V
Equipped with software


Type APR/FR-ARM2

OPTIONS: N. 3 current clamps 600/1 A (on request other ranges) / bag for clamps

POWER ANALYSER AND HARMONICS
TYPE APR/FR-ARM with harmonic measures

Multifunction instruments with graphic display for local measurements type APR/FR-ARM with harmonic measures. Single and three-phase at 3 and 4 wires power analyzer

MEASUREMENTS - Measurements with manual scanning of:
W, Waverage, VAr, VA, VAaverage, **cosø** , **cosø** average, V, I, I average, H_Z, THD (min and max for all the measurements), KWh, KVArh on 4 quadrants. TRMS measurements in twisted wave form (voltage and currents)

- RANGE max : 430V / 5A direct (option: expansion with current clamps) (on request: other ranges)
- DIGITAL DISPLAY

Microprocessor 32bit ; Class 0.5; back lighted display with 4 simultaneous measures
Harmonic analysis (FFT) up to 50° with graphic and digital indication (current and voltage); rising harmonic source. Autorange for voltage and current inputs
Power supply 230 V


Type APR/FR-ARM

OPTIONS: N. 3 current clamps 600/1 A (on request other ranges) / bag for clamps

POWER ANALYSER
TYPE APR/FR

Multifunction instruments for local measurements type APR/FR. Single and three-phase at 3 and 4 wires power analyzer

It makes possible the following measurements: voltages, currents, active power, reactive power, apparent power, power factor, energy.
Display with selection of measurement.
Range: 5 A/400 V direct (option: expansion with current clamps) (on request: other ranges)
constructed in a strong external box Plastic panel.
Power supply 230 V


Type APR/FR

Equipped with software
OPTIONS: N. 3 current clamps 600/1 A (on request other ranges) / bag for clamps

C- Panel trainers for different type of relays and protective devices (protection lab)

ITEMS

C-3,4,5,6,7,8,9

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Design & Project & Production & Trading of Industrial and Educational Instruments and Equipments

TRAINER FOR STUDYING THE ELECTRICAL PROTECTIONS

The protections in the electricity transmission systems and distribution of electricity shall perform the important task of intervening in the event of failure or abnormal situations by turning off one or more parts of the plant in order to prevent further damage and to ensure continuity of operation in parts ' functioning properly' of the plant.

Size: 36x25x40 (h) cm approx

The very important characteristics of a protection system are:

- sensibility
- selectivity
- reliability
- redundancy

In order to design and calibrate an appropriate protection system it is necessary to build a power plant model and calculate parameters such as impedance, symmetrical and asymmetrical short circuit currents, ground current and so on.
The kit of electrical protections proposed in the trainer uses the latest generation of fully digital relays, each of which is able to implement different functions.
With a small number of relays you can then cover all types of fault either to the lines to electric machines
The trip curves and all the functions of relays are easily programmable from PC.
The software provided is able not only to set the parameters of the relay but also to acquire real-time voltage, current and power of the circuit in which it is inserted.
The handbook covers the implementation of the protections of the line and electrical machines from the mathematical model of the plant.
The relays are in education execution, with synoptic, provided housing and bushing diameter 4 mm for the connection to our central simulator type CE / PE, transmission line type SLE / 2 and the distribution line type IDLE / 3

RE1 Protection of machinery and power lines from overload, short circuit, earth fault
This module implements the protection relay overcurrent and residual current.
It requires 3 inputs for the phase currents and an input for residual current.
The front panel operator has backlit alphanumeric LCD display and eight LEDs.
Different curves and delays are programmable in order to ensure the selectivity in current and in time.
All programming operations, modification, displaying measurements, are possible directly from the front panel or also using a personal computer with the included software.
Final Relay. There are four individually programmable relays. Each relay can be associated with a timer.
The relay also stores the faults occurred and the curve of the currents in the moments before the break.
For the latter function is however needed additional software license (on request)(used on all the relays)

RE2 Protection of lines and power transformers in radial and ring systems.
This relay implements the following protections:

- Undervoltage
- Picture thermal for lines and transformers
- Overcurrent
- Residual overcurrent
- Overvoltage
- Residual overvoltage
- Maximum directional current
- Directional of earth
- Failure Breaker

The relay is equipped with 3 phase current inputs and an input of leakage current and 3 input of voltages of phase and of an input of residual voltage.
The trainer also includes an input circuit and an output circuit block, used to implement the selectivity with relay upstream or downstream.
The circuit block functions as a contact of a relay whose state is captured by the upstream protection.
The operator panel front presents alphanumeric LCD display and eight LEDs.
All programming operations, modification, displaying measurements, are possible directly from the front panel or also using a personal computer with the included software.
Final Relay. There are six individually programmable relays. Each relay can be associated with a timer.
It 's a very versatile relay that can implement advanced features such as the function' cold start 'and' second harmonic restraint 'particularly useful to avoid the untimely intervention due to the high inrush current of transformers.

Measures
The measurements of phase and residual currents, the measurements of phase and residual voltage and the logical state of the inputs are available on the display on the communication interfaces.
The relay also stores the faults occurred and the curve of the currents in the moments before the break.
For the latter function is however needed additional software license (on request)(used on all the relays)

Suggested configuration
In order to implement the study of selectivity it is suggested to buy two relays type RE1 and two relays type RE2.

ON REQUEST: SOFTWARE AND INTERFACE

Protective Relay Trainers

Additional items:
- Differential Relay trainer type RE/3
- Distance protection Relay Trainer type RE/4
(including Siemens relay type 7SA6101-2AC02-6FAO)
- Frequency Relay Trainer type RE/5

Optional items:
- Training panels/ simulators type CE-PE for generation, SLE/2 for transmission and type IDLE/3 for distribution
- Earth/ safety and differential circuit breaker trainer type SELDIF
- Digital protection trainer with PLC/ Fieldbus study model (Siemens)type MAQ-NET with software type LOG-STEP
- Power Analyzer and measuring unit type APR-FR/ARM-2 with USB interface and software (minimum 2 required)
- Digital rms multimeter bench version type 1604
- RLC Loads (Resistive/ RHP05, Inductive/ LH10 and capacitive CHO5
- Single and three phase power supply with built in digital instrument type 180
- Multi-function installation tester type MFT1720
- Relay Test Set type Sverker780 with Win software

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RE/3 TRAINER FOR STUDYING THE ELECTRICAL DIFFERENTIAL PROTECTIONS

The protections in the electricity transmission systems and distribution of electricity shall perform the important task of intervening in the event of failure or abnormal situations by turning off one or more parts of the plant in order to prevent further damage and to ensure continuity of operation in parts ' functioning properly' of the plant.

The very important characteristics of a protection system are:

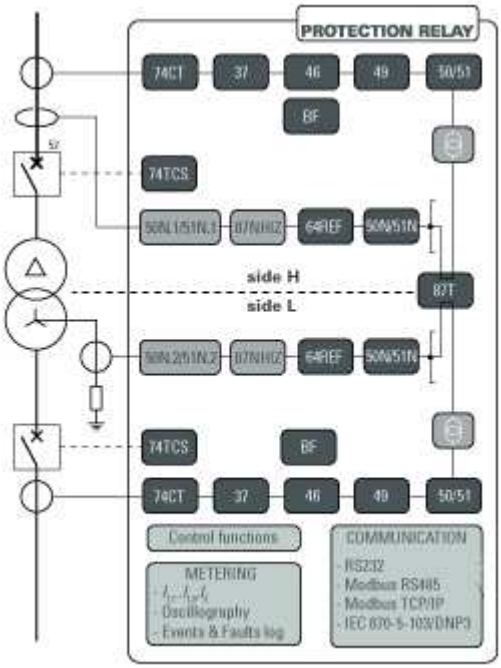
- sensibility
- selectivity
- reliability
- redundancy

In order to design and calibrate an appropriate protection system it is necessary to build a power plant model and calculate parameters such as impedance, symmetrical and asymmetrical short circuit currents, ground current and so on.
The kit of electrical protections proposed in the trainer uses the latest generation of fully digital relays, each of which is able to implement different functions.
With a small number of relays you can then cover all types of fault either to the lines to electric machines
The trip curves and all the functions of relays are easily programmable from PC.
The software provided is able not only to set the parameters of the relay but also to acquire real-time voltage, current and power of the circuit in which it is inserted.
The handbook covers the implementation of the protections of the line and electrical machines from the mathematical model of the plant.

Rev 1 – October 2012

The relays are in education execution, with synoptic, provided housing and bushing diameter 4 mm for the connection to our central simulator type CE / PE, transmission line type SLE / 2 and the distribution line type IDLE / 3

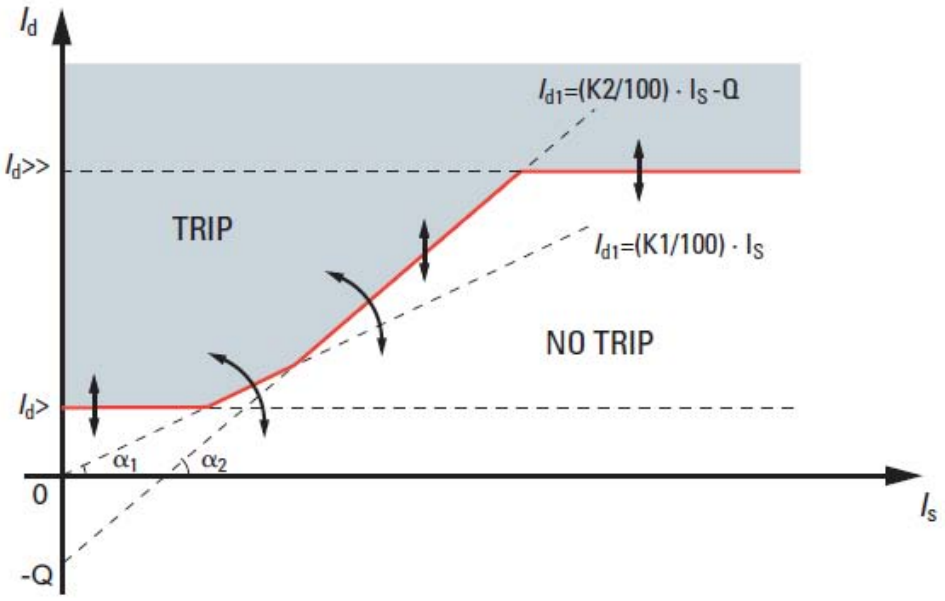
RE/3 Differential Protection for generator and trasformers.



This module implements the differenctial protection relay and overcurrent and residual current.
It requires 3 or 4 inputs for H SIDE and 3 or 4 inputs foir L SIDE. The front panel operator has backlit alphanumeric LCD display and eight LEDs.
Protection functions:
Phase undercurrent (37)
Negative sequence overcurrent (46)
Thermal image (49)
Phase overcurrent (50/51)
Low impedance restricted ground fault (64REF)
Biased differential for transformer (87T)

No matching CTs are required, you can set differential protection alsi in Delta/Star and Star/Delta transformer connection.

Different curves and delays are programmable in order to ensure the selectivity in current and in time.
All programming operations, modification, displaying measurements, are possible directly from the front panel or also using a personal computer with the included software.



Final Relay. There are four individually programmable relays. Each relay can be associated with a timer.

The relay also stores the faults occurred and the curve of the currents in the moments before the break.
For the latter function is however needed additional software license (on request)(used on all the relays)

Measures
The measurements of phase and residual currents, and the logical state of the inputs are available on the display on the communication interfaces.
The relay also stores the faults occurred and the curve of the currents in the moments before the break.
For the latter function is however needed additional software license (on request)(used on all the relays)

Multi-Tek International
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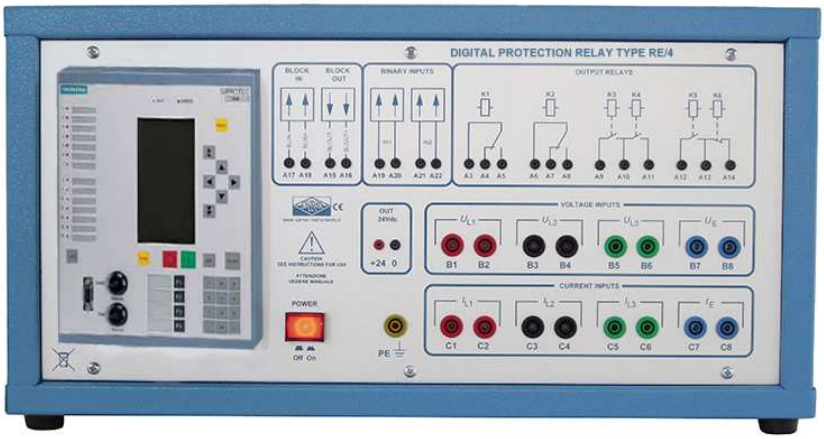
RE/4 TRAINER FOR STUDYING THE DISTANCE PROTECTION RELAY



The protections in the electricity transmission systems and distribution of electricity shall perform the important task of intervening in the event of failure or abnormal situations by turning off one or more parts of the plant in order to prevent further damage and to ensure continuity of operation in parts ' functioning properly' of the plant.

The very important characteristics of a protection system are:

- sensibility
- selectivity
- reliability
- redundancy

In order to design and calibrate an appropriate protection system it is necessary to build a power plant model and calculate parameters such as impedance, symmetrical and asymmetrical short circuit currents, ground current and so on.
The kit of electrical protections proposed in the trainer uses the latest generation of fully digital relays, each of which is able to implement different functions.
With a small number of relays you can then cover all types of fault either to the lines to electric machines
The trip curves and all the functions of relays are easily programmable from PC.
The software provided is able not only to set the parameters of the relay but also to acquire real-time voltage, current and power of the circuit in which it is inserted.
The handbook covers the implementation of the protections of the line and electrical machines from the mathematical model of the plant.
The relays are in education execution, with synoptic, provided housing and bushing diameter 4 mm for the connection to our central simulator type CE / PE, transmission line type SLE / 2 and the distribution line type IDLE / 3

The RE/4 distance protection relay is a universal device for protection of HV and MV lines. Its high level of flexibility makes it suitable to be implemented at all voltage levels.With this relay you are ideally equipped for the future: it offers security of investment and also saves on operating costs.

- High-speed tripping time
- Impedance setting range allows very small settings for the protection of very short lines
- Self-setting detection for power swing frequencies up to 7 Hz
- Current transformer saturation detector prevents non-selective tripping by distance protection in the event of CT saturation.
- Phase-segregated teleprotection for improved selectivity and availability
- Digital relay-to-relay communication by means of an integrated serial protection data interface

Protection functions

Non-switched distance protection with 6 measuring systems (21/21N)
• High resistance earth-fault protection for single and three-pole tripping (50N, 51N, 67N)
• Earth-fault detection in isolated and resonant-earthed networks
• Fault locator (FL)
• Power-swing detection/tripping (68/68T)
• Phase overcurrent protection (50/51/67)
• Switch-onto-fault protection (50HS)
• STUB bus overcurrent protection
(50STUB)
• Overvoltage/undervoltage protection
(59/27)
• Over/underfrequency protection (81O/U)
• Auto-reclosure (79)
• Synchro-check (25)
• Breaker failure protection (50BF)
• Thermal overload protection (49)

Distance protection (ANSI 21, 21N)

The main function of the 7SA6 is a nonswitched distance protection. By parallel calculation and monitoring of all six impedance loops, a high degree of sensitivity and selectivity is achieved for all types of fault.
The shortest tripping time is less than one cycle. All methods of neutral-point connection (resonant earthing, isolated, solid or low-resistance earthing) are reliably dealt with. Single-pole and three-pole tripping is possible. Overhead lines can be equipped with or without series capacitor compensation
This module implements the differenctial protection relay and overcurrent and residual current.
It requires 3 or 4 inputs for H SIDE and 3 or 4 inputs foir L SIDE. The front panel operator has backlit alphanumeric LCD display and eight LEDs.

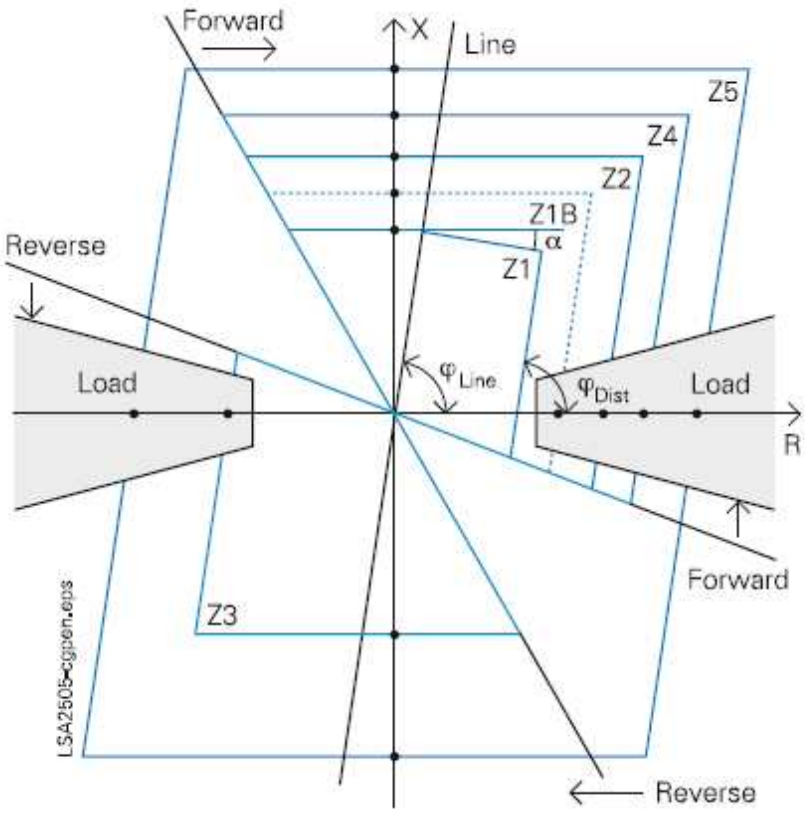
Seven distance zones

Six independant distance zones and one separate overreach zone are available. Each distance zone has dedicated time stages, partially separate for single-phase and three-phase faults. Earth faults are detected by monitoring the earth current 3I0 and the zero-sequence voltage 3V0. The quadrilateral tripping characteristic allows use of separate settings for the X and the R directions. Different R settings can be employed for earth and phase faults. This characteristic offers advantages in the case of faults with fault resistance. For applications to medium-voltage cables with low line angles, itmay be advantageous to select the distance zones with the optional circle characteristic.
All the distance protection zones can be set to forward, reverse or non-directional.

Different curves and delays are programmable in order to ensure the selectivity in current and in time.
All programming operations, modification, displaying measurements, are possible directly from the front panel or also using a personal computer with the included software.

Fault locator

The integrated fault locator calculates the fault impedance and the distance-to-fault.
The results are displayed in ohms, kilometers (miles) and in percent of the line length.
Parallel line compensation and load current compensation for high-resistance faults is also available.



Impedance fault detection Z<
with quadrilateral characteristic

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RE/5 TRAINER FOR STUDYING THE FREQUENCY PROTECTION RELAY

The protections in the electricity transmission systems and distribution of electricity shall perform the important task of intervening in the event of failure or abnormal situations by turning off one or more parts of the plant in order to prevent further damage and to ensure continuity of operation in parts ' functioning properly' of the plant.

The very important characteristics of a protection system are:

- sensibility
- selectivity
- reliability
- redundancy

In order to design and calibrate an appropriate protection system it is necessary to build a power plant model and calculate parameters such as impedance, symmetrical and asymmetrical short circuit currents, ground current and so on.
With a small number of relays you can then cover all types of fault either to the lines to electric machines.
The handbook covers the implementation of the protections of the line and electrical machines from the mathematical model of the plant.
The relays are in education execution, with synoptic, provided housing and bushing diameter 4 mm for the connection to our central simulator type CE / PE, transmission line type SLE / 2 and the distribution line type IDLE / 3

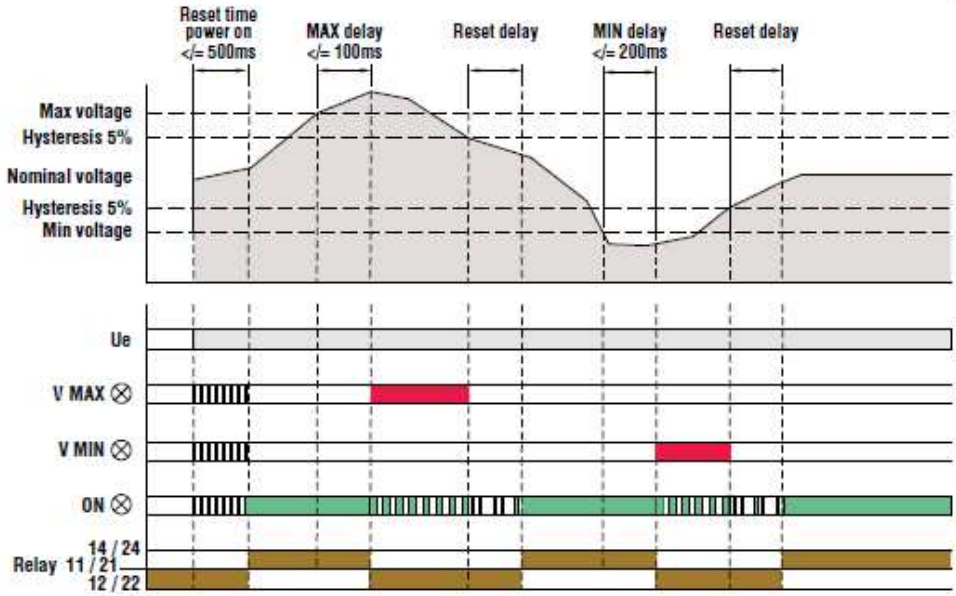
The RE5 frequency protection relay is a very simple relay for protection of small power generators and small island electrical network.

Rev 1 – October 2012

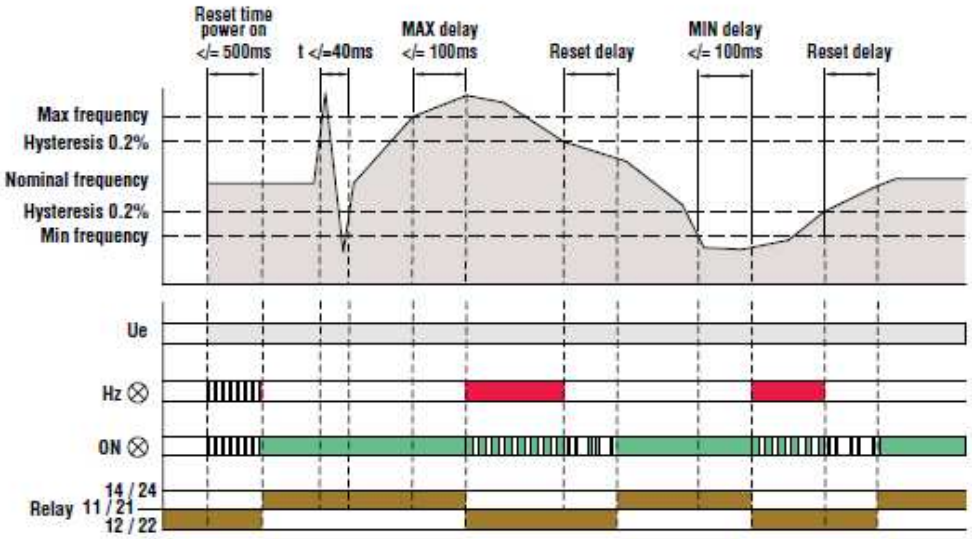
Protection functions

- Maximum voltage
- Minimum voltage
- Maximum cy
- Minimum frequency

Function diagram of voltage tripping



Function diagram of frequency tripping



Study of the role of the earth & a differential circuit-breaker

NEW

ref. SELDIF

SELDIF is a model intended to make students aware of the hazards of electrocution in the event of indirect contact, and those related to the quality of the earth. This model also explains the role of the residual current circuit-breaker 30mA in a domestic installation.

The front synoptic shows
- the public network, with its medium voltage/low voltage transformer substation, and the neutral to earth connection, in this substation.
- the transmission line from the transformer substation to the dwelling
- the domestic installation, with the residual current circuit-breaker 30mA, the local earth, and a washing machine. The TT neutral system is the same as that of a domestic installation
- A person in the right-hand part has an LED for a heart. If a dangerous leakage current flows here, the LED comes on
- A two-pole industrial residual current circuit-breaker 30mA is located in the centre of the synoptic.
- Two jumpers enable the washing machine to be fully isolated, and current measurements to be taken.
- An ON pushbutton starts the washing machine, and a green LED comes on, symbolizing rotation of the machine.

Safety terminals 4mm, located on the front, let the student measure the fault currents, and insert different resistive modules. These modules simulate two earth resistance values, and two leakage current values. One module with variable resistance enables the differential's tripping current to be measured.

To prevent any risk of electrocution to the student, the model operates at extra low voltage using an isolating transformer to standard NFEN60-742.

THEORETICAL SUMMARIES: DOCUMENTATION SUPPLIED
Operation of a magneto-thermal circuit-breaker
rating, breaking capacity, tripping curve, symbols
Operation of a residual current circuit-breaker
rating, tripping time, symbols
Physiological effects of the current
hazard zones: current function times, dangerous voltages
Maximum resistance of the earth

LIST OF PRACTICAL ASSIGNMENTS
Earth < 100Ω and fault resistance with poor isolation
- with person in contact with the metal enclosure of the machine
- with no contact

Appearance of a fault current greater than 30mA, tripping of the differential.
Demonstration of the short circuit

Earth < 100Ω and fault resistance with good isolation
Appearance of a fault current less than 30mA, no tripping of the differential.
Measurement of the fault current in the person in contact with the machine

Earth > 100Ω and fault resistance with good isolation
Appearance of a fault current less than 30mA, no tripping of the differential.
Measurement of the fault current in the person in contact with the machine

Earth > 100Ω and fault resistance with poor isolation
- with person not in contact with the metal enclosure of the machine measurement of the fault current
- with person in contact with the enclosure: measurement of the fault current greater than 30mA, no tripping of the differential. LED symbolizing the heart, coming on.

OTHER TECHNICAL CHARACTERISTICS
Power supply: 230VAC 50Hz - Dimensions/Weight: 390x270x100mm / 2.3kg
Supplied with 5 resistive modules, coupling jumpers and leads

Fieldbus study models **(Profinet et Profibus)**

MAQ-NET is a model for studying fieldbus communication between different automation components. Students will learn about the cabling (cable assembly), configuration (software setting) and parameter programming of the different buses required for proper operation. The wire frame for components is attached to a wheeled frame for passing the doors. Other components can be added on request: Please contact us.
Wheeled frame dimensions: 750 x 670mm Height 1950mm

STUDY MODEL FOR PROFINET AND PROFIBUS BUSES - SIEMENS® COMPONENTS

ref. MAQ-NET

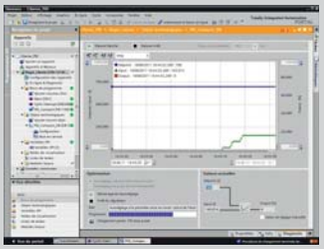
SIEMENS

MAQ-NET includes SIEMENS® components and enables study of the Profinet and Profibus buses. Power supply from three-phase mains 3 x 400V + N + E.

- 1 power supply unit with user and appliance protection (30mA) distributes voltage 24VAC to the speed controller (for the PLC, HMI, offset I/O interfaces and 400VAC-3p+E) .
- 1 "machine" box with 3 PB, 3 switches, 7 indicator lamps and 3 PB and 3 switches for simulating sensors.
- 2 "machine" boxes each with 4 indicator lamps and 2 PB and 2 switches for simulating sensors.
- 1 PLC SIMATIC S7-1200. 14I / 10O. Integral Ethernet port.
- 1 Profibus interface
- 1 ETHERNET switch 4 ports RJ45
- 1 HMI colour touchscreen 5.7" with Profinet RJ45 port
- 1 interface ET200S 4I/4O offset with Profinet coupler
- 1 interface ET200S 4I/4O offset with Profibus coupler
- 1 speed controller SINAMICS G120C 0.55kW with integral graphic terminal.
- 1 Asynchronous motor 230/400V- 0.12kW with fan for viewing rotation.
- 1 set of Profinet, Profibus leads.
- 1 set of Profinet, Profibus connectors for mounting.
- 20 metres of Profinet, Profibus cable.
- 1 Starter software for programming the speed controller.
- 1 CD includes the instructions for the different components and the practical assignments and programming examples for the PLC, the speed controller and the HMI.

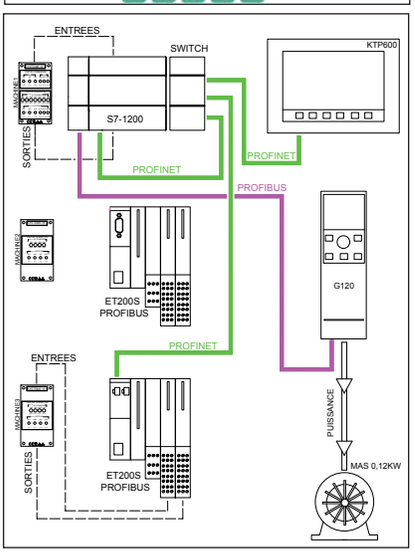
SOFTWARE OPTION

LOG-STEP is highly intuitive. On-line help and the practical assignments let students learn quickly with the different programming screens. Single workstation licence. Compatible with Windows XP Home/Pro, 7 Home/Pro 32bits. Recommended PC configuration: Dual Core Processor 2Ghz or equivalent, RAM 2GB and screen resolution 1280x1024.
For programming the PLC and the touchscreen HMI.

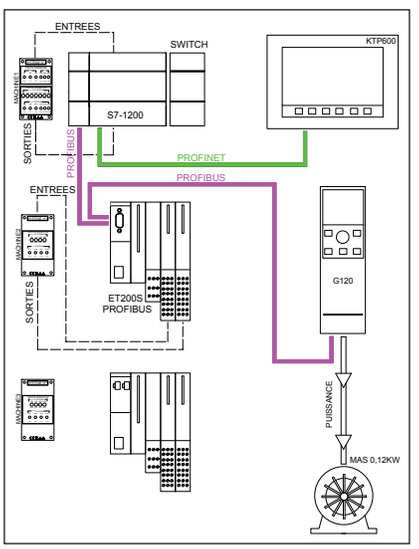


ref. LOG-STEP

PROFI INDUSTRIAL ETHERNET NET



PROFI BUS



C- Optional accessories and test equipment

ITEMS 10,11,12,13,14,15,16,17

1604

40,000 count auto/manual ranging bench multimeter

- *Accuracy 0.08%; resolution 10µV, 10mΩ and 0.1µA*
- *Large and bright LED display; ac line operation*
- *True RMS ac functions; wide ac bandwidth*
- *Frequency measurement; audible continuity; diode test*
- *Relative, T-Hold and Min-Max functions included*
- *Isolated RS-232 interface as standard*

Model 1604 - 40,000 count bench multimeter

A value-for-money DMM

The 1604 is a low-cost auto/manual ranging bench-top DMM with a large and bright LED display.

It offers 4¾ digit (40,000 count) scale length, true RMS ac measurements, a basic accuracy of 0.08% and a resolution of 10µV, 10mΩ and 0.1µA.

A substantial bench-top instrument

The 1604 is a robust mains-powered bench-top instrument. Unlike a hand-held multimeter it stays where you put it even with heavy test leads connected. The multi-position tilt stand ensures that the large display is always readable.

Smart functions

The 1604 incorporates several "smart" functions such as Relative measurement and Minimum-Maximum storage.

The T-Hold function enables readings to be held on the display automatically each time a new test point is probed.

DC VOLTAGE

Range	Accuracy	Resolution	Notes
400mV	0.08% 4 dig.	10 V	Max. Input 265V DC/AC rms
4V	0.08% 4 dig.	100 V	Input impedance 10MΩ nominal Max. input 1kV DC or AC pk NMR: >60dB @ 50/60Hz CMR: >90dB @ DC/50Hz/60Hz
40V	0.08% 4 dig.	1mV	
400V	0.08% 4 dig.	10mV	
1000V	0.09% 4 dig.	100mV	

AC VOLTAGE (True RMS, 4000 count scale length)

Range	Accuracy			Resolution
	45Hz - 400Hz	400Hz - 5kHz	5kHz - 20kHz	
400mV	0.5% 4 dig.	1% 4 dig.	3% 4 dig.	100 V
4V		2% 4 dig.	5% 4 dig.	1mV
40V				10mV
400V		3% 4 dig.		100mV
750V	1% 4dig.			1V

Accuracies apply for readings between 10% and 100% of full scale. Additional error at crest factor = 3 is typically 1%. Input impedance = 10MΩ nominal. Max. input = 750V rms, 1kV pk. (265V rms on 400mV range). 1kΩ unbalanced CMR = >60dB at DC or 50Hz (60Hz rejection available as factory option).

RESISTANCE

Range	Accuracy	Resolution	Notes
400Ω	0.15% 6 dig.*	10mΩ	* 400Ω specification applies after null Max. input 265V DC or AC rms on any range. Max. open circuit voltage 4V 40MΩ accuracy applies up to 20MΩ thereafter add 1%
4kΩ	0.1% 4 dig.	100mΩ	
40kΩ	0.1% 4 dig.	1Ω	
400kΩ	0.15% 4 dig.	10Ω	
4MΩ	0.3% 6 dig.	100Ω	
40MΩ	1.0% 10 dig.	1kΩ	

DC CURRENT

Range	Accuracy	Resolution	Notes
4mA	0.1% 4 dig.	0.1 A	Max. input 1A (Fused) Voltage burden <500mV
400mA	0.1% 4 dig.	10 A	
10A (up to 1A)	0.3% 4 dig.	1mA	Max. input 10A (Fused) Voltage burden <500mV
10A (up to 5A)	1.0% 4 dig.	1mA	
10A (up to 10A)	3.0% 10 dig.	1mA	

AC CURRENT (True RMS, 4000 count scale length)

Range	Accuracy	Resolution	Notes
1mA	0.5% 4 dig.	1 A	Max. input 1A (Fused) Voltage burden <500mV
100mA	0.5% 4 dig.	100 A	
10A (up to 1A)	0.8% 4 dig.	10mA	Max. input 10A (Fused) Voltage burden <500mV
10A (up to 5A)	1.5% 4 dig.	10mA	
10A (up to 10A)	3.0% 4 dig.	10mA	

Accuracies apply over 45Hz to 10kHz for readings between 10% and 100% of range. Additional error at crest factor = 3 is typically 1%.

True RMS ac ranges

All AC measurements on the 1604 are True RMS. This avoids the errors on non-sinusoidal waveforms associated with other multimeters.

Good ac bandwidth enables measurement within the audio band and ensures that higher frequency components of switching waveforms are included within the measurement result.

Frequency measurement

The 1604 has a frequency function which can be selected on any ac range in order to measure the frequency of the signal. Frequencies up to 40kHz can be measured and the maximum resolution is 0.1Hz.

Isolated RS-232 interface

The 1604 is fitted with an isolated RS-232 interface. This permits remote control and data-logging to disk using optional Windows based software.

FREQUENCY

Range	Accuracy	Resolution	Notes
4kHz	0.01% 1 dig.	0.1Hz	Sensitivity selected by AC range setting
40kHz	0.01% 1 dig.	1Hz	

Sensitivity better than 40mV (400mV range), better than 10% of range (other Vac & Iac ranges).

All accuracies apply for 1 year, 19°C to 25°C. Temperature coefficient outside these limits is <0.1 x quoted range accuracy per °C.

FURTHER FUNCTIONS

Continuity

Selects 4kΩ range and sounds audible tone for impedance <10Ω. Max. input 265V DC or AC rms.

Diode Test

Displays junction voltages up to 3V at a test current of 1mA at 1V. Max. open circuit voltage approximately 4V. Max. input 265V DC or AC rms.

Null (Relative): Stores current reading and subtracts it from future readings.
Hold: Reading is frozen until released.
T-Hold: Reading is frozen when it becomes stable.
Min/Max: Minimum and maximum readings are stored.

DISPLAY and RANGE CONTROL

0.56" (14mm) LED display. Annunciators for all ranges, functions and 'smart' modes. Scale Length 4¾ digits (± 40,000 counts) except ac ranges (4,000 counts). Reading rate 2.5 per second. Overrange shows OFL on display. Each measurement function can use automatic or up/down manual ranging.

RS-232 INTERFACE

Opto-isolated bi-directional RS-232 interface. 9600 baud.

GENERAL

Power:	230V or 115V AC nominal 50/60Hz, adjustable internally; operating range ±14% of nominal; 3VA max.; Installation category II
Size:	260(W) x 88(H) x 235(D)mm, excl. handle/feet.
Weight:	2.0kg (4.4lb)
Operating Range:	+ 5°C to 40°C, 20-80% RH.
Storage Range:	- 40°C to 70°C
Safety:	Complies with EN61010-1.
EMC:	Complies with EN61326.

Thurlby Thandar Instruments Ltd. operates a policy of continuous development and reserves the right to alter specifications without prior notice.

MFT1700 Series
Multifunction Tester

- **Simple colour-coded test selection with large clear backlit display for ease of use**
- **Two wire non trip loop testing for fast repeatable results**
- **3-phase RCD testing for industrial applications with no earth**
- **3-terminal earth test for electrode resistance measurement**
- **On-board data storage and Bluetooth® download**
- **EN61010 CATIV safety rating and tough IP54 case**

DESCRIPTION

The MFT1700 series is a range of 3 instruments for testing low voltage electrical installations to BS7671. They provide all the tests required to complete the necessary electrical certification for industrial, commercial and domestic fixed wiring installations, including:

- System voltage and frequency measurement (TRMS)*
- Insulation test at 100 V*, 250 V, 500 V and 1000 V*
  Including input protection against live circuits up to 600 V even when insulation test is locked-on
- Continuity resistance at 200 mA or 15 mA*
  Automatic start – no need to press TEST so leaving both hands free to hold probes
- Resistance range up to 100 kΩ
  With fast continuity buzzer at selectable thresholds
- 2-wire loop test
  Non-trip (RCD) and high-current testing
  Including Phase-to-Phase
- Prospective fault current measurement
  Up to 20 kA
- RCD testing including:
  Type AC, A, S, B* and programmable RCDs
  3-phase RCDs*
  Auto-test routine
  Fault (Touch) voltage display
- 3-pole earth testing

All instruments are IEC 61010 CAT IV 300 V rated for connection to low voltage systems with no protective device, so safe for connection anywhere on the system right up to the source transformer without risk of damage from large transient spikes.

The unique modern styling allows it to be operated while stood on the floor, a ladder-shelf or platform, hung around the neck or handheld. Dual TEST and LOCK buttons – one pair at each end – makes the testers easy to operate left or right handed.

Quick to pick up and use, the controls are colour coded to make range selection easy and fast. They also reduce the chance of using the wrong function or range. The large crystal clear backlit display uses the patented Megger digital/analogue arc, providing indication of fluctuating readings while the dual digital readout shows precise values of key measurements simultaneously with the test parameters, such as the output voltage on insulation testing as well as the resistance value in MΩ.

Visible and audible safety warnings are paramount when testing high-energy systems and the MFT1700 series includes full input protection and safety warnings when a hazardous voltage is present. If live voltages exist on a circuit during insulation or continuity testing, the voltage is displayed on the screen. If this voltage exceeds a safe level, further testing is inhibited and a warning beep sounds.

The MFT1730 features internally rechargeable batteries and charger with a charge time of less than 4 hrs, so reducing the cost of ownership.

Fully compliant with all requirements of IEC 60364 derived standards including VDE 0100 and BS 7671, the new MFT includes all the latest measurement technology in a light-weight compact design, fully protected and usable on single phase and 3 phase installations.

New measurement functions include two wire non-trip loop test technology for fast repeatable results, comprehensive testing of RCDs including type B, and integrated 3-terminal techniques for earth electrode testing.

The MFT1730 includes built in memory and Bluetooth communications for downloading test results using Megger Download Manager (supplied). As an option, the MFT1730 is available complete with PowerSuite® Lite combined with Ultra Mobile software as the MFT1730 On-Site. PowerSuite provides a professional solution to certification with electronic form completion from stored data within the MFT, either downloaded to a mobile device such as a Smartphone, or direct to a PC. See the separate datasheet on Megger PowerSuite software for further details.

The new MFT1700 series has been designed for tough environments and ultimate reliability. Features include a rubber over mould for extra protection and grip, IP54 protection against dust and water and an EN61010 Cat IV safety rating. Its class leading input protection ensures the new MFT can withstand accidental misuse and voltage transients when other testers can't.

All this in an intuitive and easy to use instrument with no hidden menus or complicated screens. Tests are easily selected using the colour coded rotary switches with results clearly displayed on the high contrast, dual measurement, backlit display.

Included with the instrument are standard 3-wire leadset and a mains test lead, a switched probe for fast and easy testing*, a full 12-month calibration certificate and warranty upgradeable to 3 years. The MFT is supplied in a robust moulded case with plenty of additional space for optional extras like a few tools and the earth electrode test kit, comprising 2 spikes and 3 long test leads.

* model dependant

** requires optional accessory

Product selection chart

	MFT1710	MFT1720	MFT1730
Insulation ranges			
100 V			■
250 V, 500 V	■	■	■
1000 V		■	■
Test voltage display	■	■	■
Adjustable buzzer threshold		■	■
Continuity and resistance ranges			
200 mA test	■	■	■
15 mA test		■	■
Adjustable buzzer threshold	■	■	■
RCD tests			
1/2, 1, 5 x I & ramp RCD test	■	■	■
Auto RCD test		■	■
Type AC, A & S RCDs	■	■	■
Type B (pure DC) RCDs			■
Programmable RCD		■	■
3-phase RCD (no earth)		■	■
30, 100, 300 & 500 mA RCD	■	■	■
10 mA & 1000 mA RCD		■	■
Loop testing			
2-wire non-tripping L~PE	■	■	■
2-wire high current L~L & L~N	■	■	■
50 V to 480 V (L~N) 50 V to 280 V (L~PE)	■	■	■
Phase to phase tests (L~L)		■	■
PSCC & PFC (20 kA max.)	■	■	■
Max. Zs display		■	■
R1 + R2 value		■	■
Touch voltage display on faulty earth	■	■	■
Earth electrode test			
2 & 3 pole **			■
Other features			
Supply measurement	■	■	■
True RMS			■
Leakage current measurement**		■	■
Phase rotation		■	■
Calibration certificate	■	■	■
Rechargeable batteries (charger included)			■
SP5 Switched probe included		■	■
Warranty upgradeable to 3 years FREE	■	■	■
On board memory with Bluetooth download			■
CAT IV 300 V	■	■	■

SPECIFICATION

Insulation test

Output voltage	-0% +20% at rated load or less
Voltage display	±3% ±3 digits ±0.5% of rated voltage
Short circuit current	1.5 mA nominal test current
Test current on load	1 mA at min pass values of insulation

Measurement accuracy

1000 Volts	10 kΩ ~ 999 MΩ	±3% ±2 digits
500 Volts	10 kΩ ~ 500 MΩ	±3% ±2 digits
	>500 MΩ	±10% ±4 digits
250 Volts	10 kΩ ~ 250 MΩ	±3% ±2 digits
	>250 MΩ	±10% ±4 digits
100 Volts	10 kΩ ~ 100 MΩ	±3% ±2 digits
	>100 MΩ	±10% ±4 digits

Continuity / resistance

0.01 Ω ~ 99.9 Ω	±2% ±2 digits
100 Ω ~ 99.9 kΩ	±5% ±2 digits
Open circuit voltage	5 V ±1 V
Test current (0 Ω ~ 2 Ω)	205 mA ± 5 mA 15 mA ±5 mA (user selectable)

Loop test

Live to earth supply	48 V ~ 280 V (45 Hz ~ 65 Hz)
Live to live supply	48 V ~ 480 V (45 Hz ~ 65 Hz)
L-N/L-L tests	±5% ±5 digits
L-E* tests	
0.1 Ω ~ 39.9 Ω	±5% ±5 digits ± noise margin
40.0 Ω ~ 1000 Ω	±10% ±5 digits
Display range	0.01 Ω ~ 1000 Ω
Live to earth PFC range	20 kA
Live to live PSCC range	20 kA

RCD tests

Supply up to 100 mA	48 V ~ 480 V	(45 Hz ~ 65 Hz)
Supply up to 1 A	48 V ~ 280 V	
RCD type	Type AC, A, S	
	Type B (pure dc)	
No trip test (1/2xI)	–10% ~ –0%	
Trip test (1xI, 2xI & 5xI)	+0% ~ +10%	
Ramp test		
Touch voltage (0 ~ 253 V)	+5% +15% ±0.5 V	
Trip time	±1% ±1 ms	
Trip current	±5%	
Step increments		
VAR (variable RCD selection)	10 mA ~ 50 mA	1 mA steps.
	50 mA ~ 500 mA	5 mA steps
	500 mA ~ 1000 mA	10 mA steps

Supply measurement

Voltage	10 V ~ 600 V (15 ~ 400 Hz) True RMS	
	±3% ± 1 V ±2 digits	
Phase rotation indication	L1–L2–L3 & L1–L3–L2	
Frequency	15 Hz ~ 99 Hz	±0.5% ±1 digit
	100 Hz ~ 400 Hz	±2.0% ±2 digit
Frequency resolution	0.1 Hz	

***** Reference conditions apply.
For test environments see service data.

Power

MFT1710 & MFT1720:	IEC LR6 type AA alkaline (6 cells - supplied)
MFT1730:	1.2 V NiMH (rechargeable pack of 6 – supplied) Mains charger for on-board re-charging (4 hours typical) 12 V car charger (cigar lighter lead - optional)

Earth test

Resolution	0.01 Ω
Current	0.45 mA or 4.5 mA
Noise rejection	20 V pk/pk (7 V rms).
Max probe resistances Rp & Rc	
	100 kΩ @ 50 V
	5 kΩ @ 25 V
2 & 3 pole method (0.01 Ω ~ 1.999 kΩ)	
	±2.0% ±3 digits

Current (via optional clamp meter)

	±5.0% ±3 digits.
Range	0.1 mA to 200 A ac
Resolution	0.1 mA

mV Sensor input

including temperature (third party module)	
	±1.0% ±2 digits
Range	0.0 mV to ±199.9 mV dc
Resolution	0.1 mV

Internal memory (MFT1730)

Capacity	1000 results
Bluetooth communication	

Design standards

Safety

IEC 61010-1:2010
IEC 61010-30:2010
IEC 61010-031:2008
600 V Cat III / 300 V Cat IV (Max Phase to Phase 600 V)
IEC 61557:2007 parts 1 to 10

EMC

IEC61326 edition 2 location class B

Environmental

Temperature (operational)	-10 °C ~ +55 °C
Temperature (storage)	-25 °C ~ +70 °C
Operating humidity	90% R.H. at +40 °C max
Max altitude	2000 m
Weight	1 kg (with batteries, excluding case)
Moisture/dust ingress protection	IP54
Calibration Temperature:	+20 °C

Temperature effects

Temperature coefficient:	<0,1% per °C

ORDERING INFORMATION

Item (Qty)	Cat. No.
MFT1710-BS	1001-063
MFT1720-BS	1001-064
MFT1730-BS	1001-066
Included accessories	
Printed quick start guide	
Full user guide on CD	
Calibration certificate	
Switched probe SP5 (not MFT1710)	1001-878
Neck strap - Megger embroidered	2001-509
3 Wire lead set with prods and clips	1001-860
SIA10 Socket Interface adaptor UK to 3 x 4 mm	6220-810
Plug-in battery charger	2001-697

Item (Qty)	Cat. No.
Optional accessories	
PowerSuite Lite	1000-631
PowerSuite Lite On-Site (mobile)	1000-632
Euro mains test lead SIA45	2000-674
Fused 10 A test lead set (red/green) with prods and clips	1001-977
ETL30, 30 m extension test lead	1000-215
ETL50, 50 m extension test lead	1000-217
12 V charger lead	6280-332
Earth electrode kit	1001-810
Switched Probe SP5 (silicone)	1001-687
Current clamp	ICLAMP

Multi-Tek International
E-mail: mti@multitekintl.com
Fax: +442073133191

POWER SUPPLY TYPE A0240M

This unit has been designed to provide all fixed and variable, AC and DC supplies necessary in an Electrical Laboratory to perform the required experiments and work projects.
The unit is contained in a metal housing with clear front panel identifications and 4 mm. Safety sockets.
General and outputs protections guarantee the user and the unit against misuse and/or faulty operation. All protections are designed according to the European standards for safety.
Alla a.c. and d.c. outputs are variable with continuity and the values of current and voltage are suitable for machines under test 1000 W

Each output is equipped with digital instrument.
The input includes:
Three-phase adjustable output: 0-440 V/0-250 V a.c. 4 A/5 A max
Single-phase adjustable output: 0-220 V a.c./5 A
Adjustable d.c. ouptut: 0-220 V d.c./10 A
Three-phase fixed output 380 V 13 A with EEC plug
Single-phase fixed output 220 V 16 A with Shuko plug
Adjustable d.c. output 0÷220 V/1 A

Complete of mushroom emergency button, differential magnetothermic protection high sensitivity 4 x 16 A, start and stop button, starting button, terminals according to safety rules interconnected by means of a synoptic, No. 2 sockets 230 V universal (on request: British socket) + No. 1 five-poles 16 A socket, measuring instruments on the outputs and protection of max speed rotation of motors.
Power supply: 380 V + N.

Multi-Tek International
Email: mti@multitekintl.com
Fax: +442073133191

A4240 - DC COMPOUND EXCITATION MACHINES

This is a series of educational motors/generators that are basically industrial models especially equipped to be suitable for training. For this purpose the windings ends are connected to 4 mm safety sockets in a metal housing on top of which a clear electrical drawing shows the internal logic. The students can therefore easily understand operation and windings connections. The machine has two excitation windings: one for series and one for shunt excitations.

The units can be supplied with an experiment manual which explains typical exercises that can be executed on these machines. A comprehensive set of accessories and a joint allow easy and quick coupling with other machines or with a brake

TECHNICAL AND ORDERING INFORMATION				
Model N.	**Motor Input Voltage Generator Output Voltage Volts DC***	**Excitation Voltage Volts DC***	**Nominal Speed RPM****	**Nominal Motor Power Approx. KW**
A4240S	220	220	3.000	0,2***
A4240M	220	220	3.000	1,0
A4240L	220	220	3.000	3,0
Industrial version is available. Add **I** to Model Number				
Kit version is available. Add **K** to Model Number				
Cutaway models are available. Add **C** to Model Number				
* 230 or 240V or other voltages are available. Specify on Order.				
** 1.500 RPM are available and can be quoted on request. Add **4** to Model N.				
*** 0,1 - 0,3 and 0,5 KW are available and can be quoted on request. NOTE: Powers are indicative and reflect the ranges of the industry standards				

A42CO Coupling accessories, composed of a half coupling joint and all required hardware to secure the motor to the coupling base (or to the Universal coupling base, to be specified when ordering). They are required when the motor is to be coupled to a brake

A42DS Double shaft

Multi-Tek International
Email: mti@multitekintl.com
Fax: +442073133191

SINGLE AND THREE-PHASE INDUCTIVE LOAD TYPE IMT/1K

Single and three-phase inductive load
3-phase delta connection, 3-phase Y connection and single phase can be usable by changing terminal connection
Power: 1 KVAR total in three-phase, 50 Hz
Feeding voltage: 230(at Δ connection)/400V(at Y connection)
Adjustment by equal steps with separate power on each phase.
The panel is supplied with terminals according to safety rules and synoptic.
Parallel, star and triangle connection
Controlled by steps 7 positions at respective phase + OFF position.
Standard accessories: English operation manual 1 copy
CE marked
Dimensions: 500 x 350 x 400 (h) mm
Terminal φ4mm banana plug socket

SINGLE AND THREE-PHASE RESISTIVE LOAD TYPE RMT/1K

Single and three-phase resistive load
3-phase delta connection, 3-phase Y connection and single phase can be usable by changing terminal connection
Power: 1 KW total in three-phase, 50Hz and 60 Hz
Feeding voltage: 230 (at Δ connection)/400V(at Y connection)
Adjustment by equal steps with separate power on each phase.
The panel is supplied with terminals according to safety rules and synoptic.
Parallel, star and triangle connection
Controlled by steps 7 positions at respective phase + OFF position.
Standard accessories: English operation manual 1 copy
CE marked
Dimensions: 500 x 350 x 400 (h) mm
Terminal φ4mm banana plug socket

SINGLE AND THREE-PHASE CAPACITIVE LOAD TYPE CMT/1K

Single and three-phase capacitive load
3-phase delta connection, 3-phase Y connection and single phase can be usable by changing terminal connection
Power: 1 KVAR total in three-phase, 50 Hz
Type: Condenser type
Feeding voltage: 230(at Δ connection)/400V(at Y connection)
Adjustment by equal steps with separate power on each phase.
The panel is supplied with terminals according to safety rules and synoptic.
Parallel, star and triangle connection
Controlled by steps 7 positions at respective phase + OFF position.
Standard accessories: English operation manual 1 copy
CE marked
Dimensions: 500 x 350 x 400 (h) mm
Terminal φ4mm banana plug socket

SVERKER 750/780
Relay Test Sets

- **The engineer's toolbox for all single phase relay testing**
- **Stand-alone functionality**
- **Rugged and reliable for field use**

Description

The SVERKER 750/780 Relay Test Set is the engineer's toolbox. The control panel features a logical layout, still SVERKER 650 users will find it comfortably familiar and will be able to start work right away.

The SVERKER 750/780 features many functions that make relay testing more efficient. For example, its powerful measurement section can display (in addition to time, voltage and current) Z, R, X, S, P, Q, phase angle and cos φ. The voltmeter can also be used as a 2nd ammeter (when testing differential relays for example). All values are presented on a single easy-to-read display.

You can also test directional protective equipment efficiantly by means of the built-in variable voltage source. In SVERKER 780 this has a continuous phase shift function and adjustable frequency as well. Automatic reclosing devices can also be tested – just as easily.

Designed to comply with EU standards and other personal and operational safety standards, SVERKER 750/780 is also equipped with a serial port for communication with personal computers and the PC software SVERKER Win. Since the compact SVERKER weighs only 18 kg (39 lbs), it's easy to move from site to site.

Two or more SVERKER units can also be synchronized, which for example allows the user to connect three SVERKER into a basic 3-phase test set.

Application

Relay Testing

SVERKER 750/780 is intended primarily for secondary testing of protective relay equipment. Virtually all types of single-phase protection can be tested. You can also test three-phase protection that can be tested one phase at a time, and also a number of protective relay systems that require phase shifting. Moreover, automatic reclosing devices can be tested.

SVERKER 780 can test voltage relays with a frequency range from 15 Hz up tp 550 Hz, e.g. rail way applications (16 2/3 Hz).

Examples of what SVERKER 750/780 can test	ANSI® No.
Overcurrent relays	50/76
Inverse time overcurrent relays	51
Undercurrent relays	37
Ground fault relays	50
Directional overcurrent relays	67
Directional ground fault relays	67N
Overvoltage relays	59
Undervoltage relays	27
Directional voltage relays	91
Directional power relays	32
Power factor relays	55
Differential protection (differential circuits)	87
Distance protection equipment (phase by phase)	21
Negative sequence overcurrent relays	46N
Motor overload protection	51/86
Automatic reclosing devices	79
Tripping relays	94
Voltage regulating relays	
Underimpedance relays, Z<	21
Thermal relays	50
Time-delay relays	
Frequency relays (SVERKER 780)	82

Other fields of application

- Plotting excitation curves
- Current and voltage transformer ratio tests
- Burden measurement for protective relay test equipment
- Impedance measurement
- Efficiency tests
- Polarity (direction) tests
- Injection
  - Maintained
    - Injection continues without any time limitation.
  - Momentary
    - Injection continues only as long as the button is kept depressed.
  - Max. time
    - Injection stops automatically when the preset maximum time is reached.
- Filtering
  - When filtering is selected, five successive readings are averaged. The following can be filtered: Current, Voltage and Extra items that are measured.
- Off delay
  - The turning off of generation can be delayed after tripping throughout a specified time interval that is expressed in mains frequency cycles.

Application example

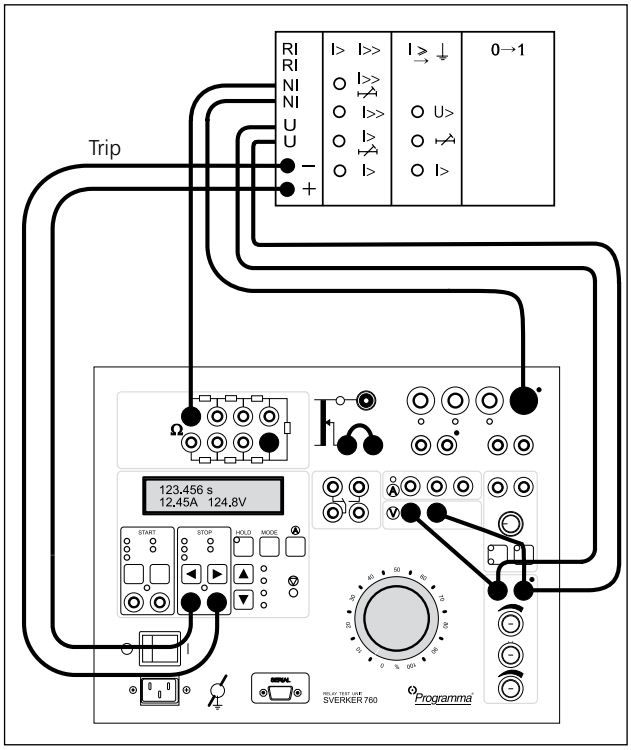
IMPORTANT!
Read the User's manual before using the instrument.

Testing the pick-up and drop-out using SVERKER 780

1. Connect as shown in the diagram.
2. Select stop conditions, dry or wet contact.
3. Select **HOLD** to freeze the current reading.
4. Press button **SEL/ A** until you get a red light at the built-in ammeter. **Note:** Maximum allowed current through the separate ammeter used in this connection example is 6 A. The other measurement points do not have this limitation.
5. Press the **MODE** button.
6. Use the key ▼ to select Ω, φ, **W, VA...**
7. Press **CHG** (Change)
8. Select φ (°, **Iref**) or (°, **Uref**) by using the key ▼.
9. Press **SEL** (Select)
10. Press **ESC**
11. Set the voltage amplitude with the upper small knob.
12. Make sure the main knob is set to **0**.
13. Turn on the SVERKER output by activating **ON** using the start switch ▼.
14. Set the phase-angle. Use the lower knob for fine adjustment, and the middle knob for step of 90°. **Note:** A small current flowing in the circuit is required to measure the phase angle.

Testing the operation time

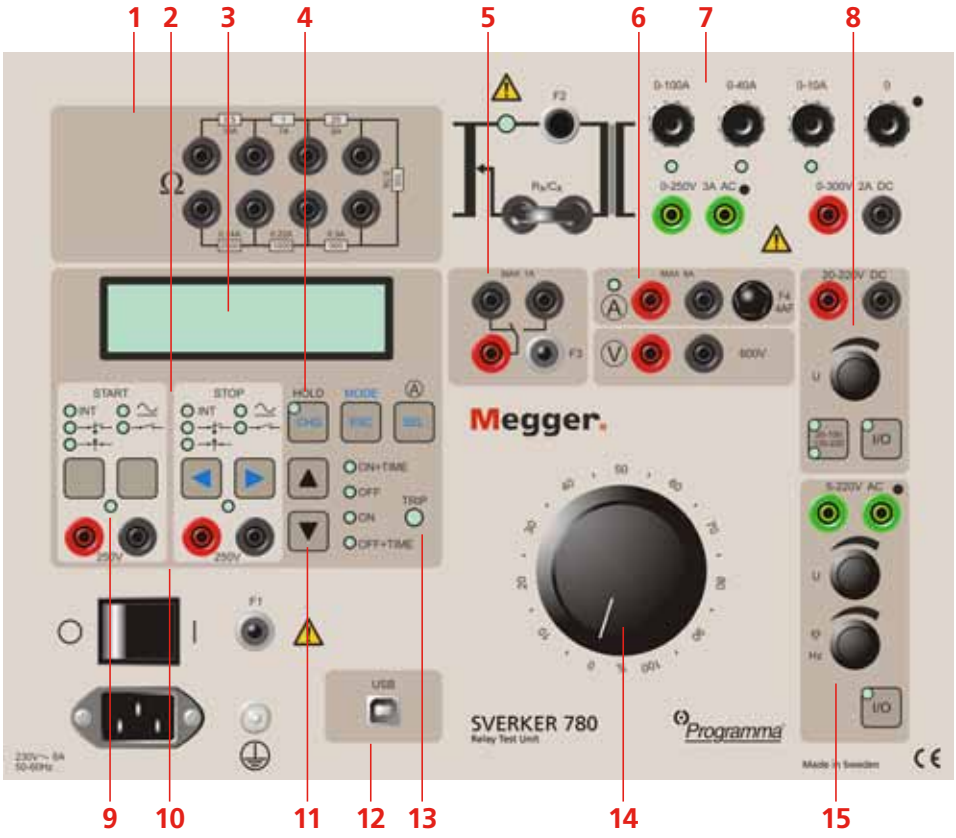
15. Increase the current to 1.5 times the pick-up value.
16. Invoke the ON+TIME state by means of the start switch. The outputs will now remain turned on until the protective relay equipment operates.
17. Read the time from the display. Check also the high current setting using the same procedure.



Testing the pick-up and drop-out using SVERKER 780

Features and benefits

1. **Set of resistors**
   Fine regulation of current and voltage thanks to the built-in set of resistors.
2. **Start and stop conditions**
   The timer's start and stop inputs respond to changes, voltage or contact closing/openings. The timer's start input is also used when testing auto-reclosing relays, to synchronize two or more SVERKER units and to start generation with an external signal.
3. **Display**
   Presents time, current, voltage and other entities. Also used to make settings, after you enter the setting mode by pressing button marked MODE.
4. **Freeze function (HOLD)**
   This makes it possible to measure voltages and current as short as a quarter of a mains-voltage period by immobilizing the reading on the display. Voltage and current readings are frozen when the timer stops. If the timer does not stop, the reading present when the current was interrupted is frozen on the display.
5. **Make/break contact**
   Changes state automatically when a test is started. Can be used (for example) to synchronize two or more SVERKER units, other external equipment or to switch the voltage applied to the protective relay equipment back and forth between non-faulty and faulty.
6. **Ammeter and voltmeter**
   Current and voltage are measured by the built-in ammeter and voltmeter. Resistance, impedance, phase angle, power and power factor can also be measured. Readings appear on the display. These instruments can also be used to take measurements in external circuits. The voltmeter can also be used as a 2nd ammeter (when testing differential relays for example, using CSU20A). Current and voltage can be displayed either as amperes and volts or as percentages of a given current or voltage (the present settings of the protective relay equipment for example).
7. **Current source**
   Provides 0-250 A AC, 0-250 V AC or 0-300 V DC, depending on the output that is being used. Settings are made using the main knob. The readings of current, voltage and other entities appear on the display. The start switch is used to turn the current source on and off. When time is being measured, this is done in synchronization with the timer.
8. **Auxiliary voltage source**
   Provides 20-220 V DC in two ranges. Equipped with overload protection and separated from the other outputs. Used frequently to supply the object being tested.
9. **Status indicator**
   The timer's start and stop inputs are each equipped with indicator lamps which, when lighted, indicate a closed circuit (useful for detecting contact closings/openings) or the presence of voltage. These indicator lamps make it possible (for example) to check circuits before starting a measurement cycle.
10. **Timer inputs**
    The timer has separate start and stop inputs, and it can be used to measure both external cycles and sequences initiated by SVERKER. The measured time appears on the display. Each input can be set to respond to the presence or absence of voltage (AC or DC) at a contact.
11. **Start switch**
    Controls the turning on and off of the current source and timer. Can be set to one of four states. ON+TIME. Starts generation and timing simultaneously. Used to test over... relays (...means current, voltage or some other entity). Generation continues a) until the protective relay equipment operates and stops the timer or b) until the maximum time expires or the start switch is released if time-limited generation has been selected. OFF. Turns off the current source, whereupon generation is interrupted. ON. Turns on the current source in the generating state. OFF+TIME. Interrupts generation and starts the timer simultaneously. Used when testing under ...relays (...means current, voltage or some other entity). The timer is stopped when the protective relay equipment operates. When automatic reclosing is to be tested, SVERKER can be set so that new generation will start when the timer's start input is activated by the closing command.
12. **Computer communication interface USB**
    SVERKER is equipped with a serial port for communication with personal computers and the PC software SVERKER Win.
13. **Tripping indicator**
    Lights when a stop condition is fulfilled to indicate operation of the protective relay equipment. If the test being conducted incorporates timing, this indicator starts to blink when relay operation occurs.
14. **Main knob**
    Used to set current output from the current source.
15. **AC voltage source**
    The AC voltage source provides 0-230 V AC with adjustable phase-angle and frequency. Since the AC voltage source is separated from other outputs, it is set independently of the current source. The AC voltage source is intended primarily for the relay protection equipment's voltage input..



SVERKER Win

PC software for SVERKER 750/780

The SVERKER Win software makes fieldwork easier while providing neater reports. The SVERKER Win software enables you to control the SVERKER from a PC. The SVERKER is connected to the PC's serial port. Test results can be reported either directly with table and graph, or from an external program, e.g. Microsoft® EXCEL.

SVERKER Win enables customised reports in an easy way. Very useful are the reference graphs, together with the current/voltage graph presentation for each test point during the test. The graph can of course be printed out on the test report if you like.

A usable feature is the ready-made current curves available for many relay types.

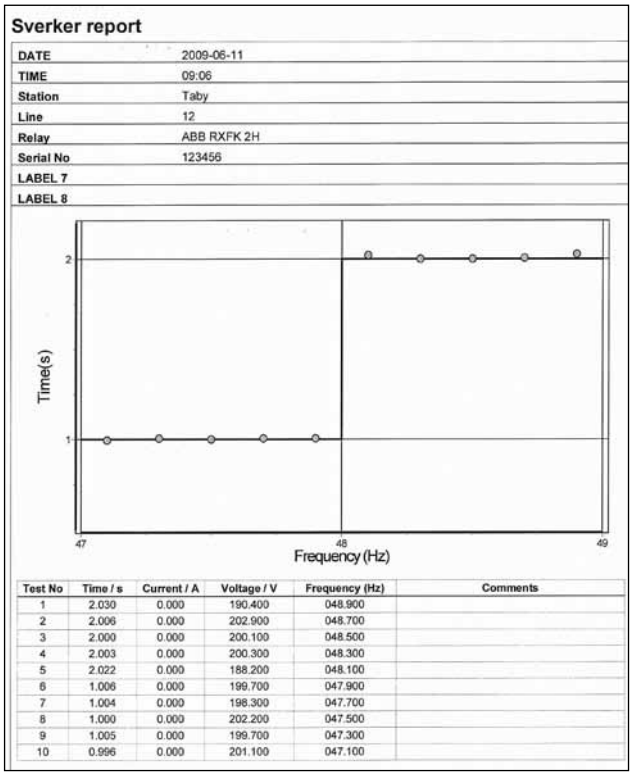
During relay testing, each measured value is stored in a log list. In this list you can add comments to each test point. When the entire test is finished, you can save everything as a data file. Later, you can print out the test results. You save time by not having to write your report in the field. All report writing can be done conveniently back at the office.

The SVERKER Win software provides easy access to connection instructions, test instructions and the like, which you prepare in advance. These instructions, which can contain both text and graphics, can be prepared using standard word processing packages.

The settings you make on SVERKER are also saved in a file, so that the next time you want to test the same or similar protective relay equipment, all you have to do in order to set-up the SVERKER, is to open the file.

Specifications SVERKER Win

The SVERKER Win software comprises a 32-bit program written to run under Windows® 95/98/2000/NT/XP. The amount of space needed to save reports and settings will depend on how many protective systems that are to be tested. Roughly estimated, you will thus need a total of about 20-100 MB of free space on the hard disk. Languages in SVERKER Win are: Czech, English, French, German, Spanish and Swedish.

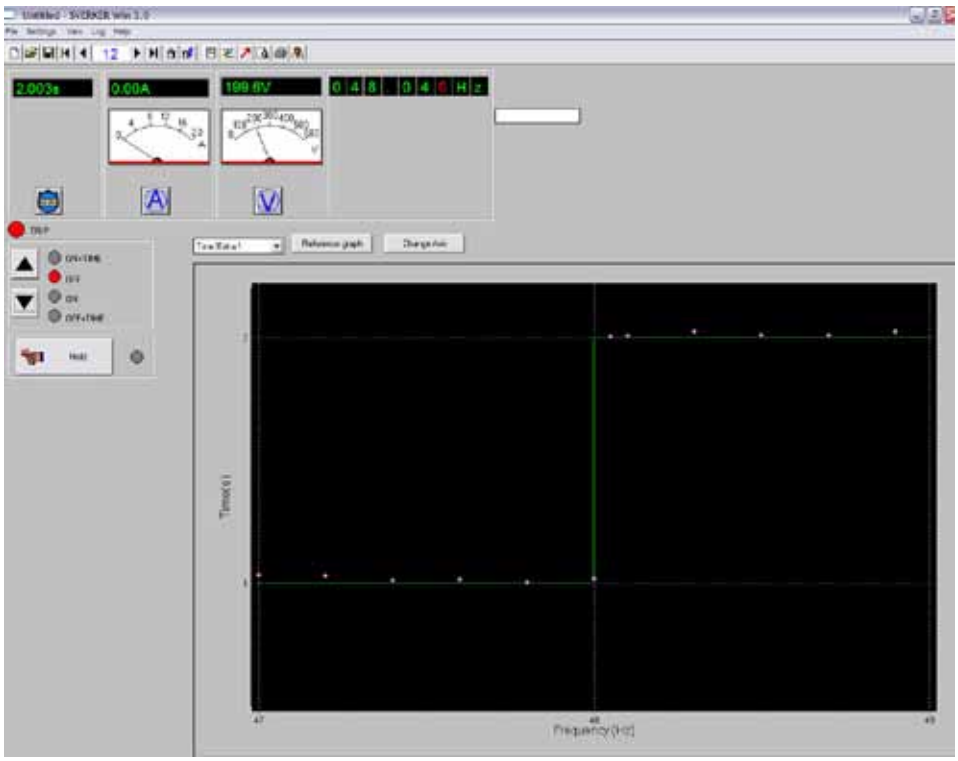


Sverker report

DATE	2009-06-11
TIME	09:06
Station	Taby
Line	12
Relay	ABB RXFK 2H
Serial No	123456
LABEL 7	
LABEL 8	

Test No	Time / s	Current / A	Voltage / V	Frequency (Hz)	Comments
1	2.030	0.000	190.400	048.900	
2	2.006	0.000	202.900	048.700	
3	2.000	0.000	200.100	048.500	
4	2.003	0.000	200.300	048.300	
5	2.022	0.000	188.200	048.100	
6	1.006	0.000	199.700	047.900	
7	1.004	0.000	198.300	047.700	
8	1.000	0.000	202.200	047.500	
9	1.005	0.000	199.700	047.300	
10	0.996	0.000	201.100	047.100	

Frequency relay test report



Testing frequency relay with SVERKER 780

Specifications SVERKER 750/780

Specifications are valid at nominal input voltage and an ambient temperature of +25°C, (77°F). Specifications are subject to change without notice.

Environment

Application field	The instrument is intended for use in high-voltage substations and industrial environments.
Temperature	
Operating	0°C to +50°C (32°F to +122°F)
Storage & transport	-40°C to +70°C (-40°F to +158°F)
Humidity	5% – 95% RH, non-condensing

CE-marking

LVD	Low Voltage Directive 73/23/ EEC am. by 93/68/EEC
EMC	EMC Directive 89/336/EEC am. by 91/263/EEC, 92/31/EEC and 93/68/ EEC

General

Mains voltage	115/230 V AC, 50/60 Hz
Power consumption (max)	1380 W
Protection	Thermal cut-outs, automatic overload protection
Dimensions	
Instrument	350 x 270 x 220 mm (13.8" x 10.6" x 8.7")
Transport case	610 x 350 x 275 mm (24.0" x 13.8" x 10.8")
Weight	
SVERKER 750	17.3 kg (38.1 lbs) 26.3 kg (58 lbs) with accessories and transport case
SVERKER 780	18.1 kg (39.9 lbs) 27.1 kg (59.7 lbs) with accessories and transport case
Test lead set, with 4 mm stackable safety plugs	2 x 0.25 m (0.8 ft), 2.5 mm^2 2 x 0.5 m (1.6 ft), 2.5 mm^2 8 x 2.0 m (6.6 ft), 2.5 mm^2
Test leads with spade tongue connectors	2 x 3.0 m (9.8 ft), 10 mm^2
Display	LCD
Available languages	
SVERKER 750	English, French, German, Spanish, Swedish
SVERKER 780	Bulgarian, Czech, English, French, German, Russian, Spanish, Swedish, Turkish

Measurement section

Timer

Time can be displayed in seconds or in mains-frequency cycles.

Range	Resolution	Inaccuracy
000-9.999 s	1 ms	±(1 ms + 0.01%)*
10.00-99.99 s	10 ms	±(10 ms + 0.01 %)*
100.0-999.9 s	100 ms	±(100 ms + 0.01 %)*

* For the OFF+TIME start condition in INT mode, 1 ms shall be added to the above measurement error.

Range	Resolution	Inaccuracy
0.0-999.9 cycles	0.1 cycles	±(0.1 cycles + 0.01%)
1000-49999 cycles at 50 Hz 1000-59999 cycles at 60 Hz	1 cycle	±(1 cycle + 0.01 %)

Ammeter

Measurement method	AC, true RMS DC, mean value

Ranges

Internal	0.00 – 250.0 A
External	0.000 – 6.000 A

Inaccuracy

Internal range [1]	
0–10 A AC	±(1% + 20 mA)
0–40 A AC	±(1% + 40 mA)
0–100 A AC	±(1% + 200 mA)
External range [1]	
0–0.6 A AC	±(1% + 20 mA)
0–6 A AC	±(1% + 20 mA)
0–0.6 A DC	±(0.5% + 2 mA)
0–6 A DC	±(0.5% + 20 mA)

Resolution

Internal range	10 mA (range <100 A) 100 mA (range >100 A)
External range	1 mA

Voltmeter

Measurement method	AC, true RMS DC, mean value
Range	0.00 – 600.0 V
Inaccuracy [1]	AC, ±(1% + 200 mV) Max. value DC, ±(0.5% + 200 mV) Max. value Values are range depending

Extra measurements

Power factor and phase angle measurements

	Range	Resolution	Inaccuracy
Power factor cos φ	-0.99 (cap) to +0.99 (ind)	0.01	±0.04
Phase angle φ (°)	000 – 359°	1°	±2°

Impedance and power measurements

AC	Z (Ω and °), Z (Ω), R and X (Ω and Ω), P (W), S (VA), Q (VAR)
DC	R (Ω), P (W)
Range	Up to 999 kX (X= unit)

Make / Break contact

Max. current	1 A
Max. voltage	250 V AC or 120 V DC

Reclosing test

Items measured	Tripping and reclosing times
Display	After test is finished a list of all times appears in display
Breaker state feedback	The Make/Break contact can be used to feed back the breaker state
Max. number of reclosings	49
Max. testing time	999 s

Sets of resistors and a capacitor

Resistors	0.5 Ω to 2.5 kΩ
Capacitor [2]	10 µF, max voltage 450 V AC

1) Measurement intervals longer than 100 ms
2) SVERKER 750

Outputs

Current outputs – AC

Range	No-load voltage (min)	Full-load voltage (min)	Full-load current (max)	Load / unload times On (max) / Off (min)
0 – 10 A	90 V	75 V	10 A	2 / 15 minutes
0 – 40 A	25 V	20 V	40 A	1 / 15 minutes
0 – 100 A	10 V	8 V	100 A	1 / 15 minutes
0 – 100 A	10 V	-	250 A	1 sec/5 minutes

Voltage outputs – AC / DC

Range	No-load voltage (min)	Full-load voltage (min)	Full-load current (max)	Load / unload times On (max) / Off (min)
0 – 250 V AC	290 V AC	250 V AC	3 A	10 min/45 min
0 – 300 V DC	320 V DC	250 V DC	2 A	10 min/45 min

Separate AC voltage source

SVERKER 750

Range	No-load voltage (min)	Full-load voltage (min)	Full-load current (max)
0 – 60 V AC	70 V	60 V	0.25 A
60 – 120 V AC	130 V	120 V	0.25 A

Both ranges are divided into voltage steps of 10 V that are steplessly variable.

SVERKER 780

Range	No-load voltage (min)	Full-load voltage (min)	Full-load power (max)
5 – 220 V AC minimum step 0.1 V	240 V AC	220 V AC at 33 W 200 V AC at 46 W	33 W continuously. 46 W 1 minute
Phase angle	**Resolution**	**Inaccuracy**	
0 – 359°	1°	±2°	
Frequency	**Resolution**	**Inaccuracy**	
15 – 550 Hz	1 mHz	±0.1%	

Auxiliary DC output

Range	Voltage	Max. current
20 – 130 V DC	20 V DC 130 V DC	300 mA 375mA
130 – 220 DC	130 V DC 220 V DC	325 mA 400 mA

Optional accessories

Power source CSU20A

CSU20A is a small light-weight current and voltage source primarily intended to work together with the SVERKER 750/780 Relay Testing Unit when testing differential relays. Using the CSU20A together with SVERKER 750/780 gives the user two independent current sources, and the timer/measurement section in SVERKER 750/780 is used both for measuring the two outputs as well as measuring the trip time of the relay.

Besides testing differential relays the unit can be used as a multi-purpose AC/DC source. The CSU20A features one AC current/voltage output, one fully rectified DC output and one half-wave rectified DC output for harmonic restraint testing.

Other features are a current measurement shunt, selectable current/voltage ranges and an AC mains input/output. Connecting the SVERKER 750/780 mains to the mains output of the CSU20A gives an in-phase synchronization of the two units.

Specifications CSU20A

Specifications are valid at nominal input voltage and an ambient temperature of +25°C, (77°F). Specifications are subject to change without notice.

Operating temperature	-20°C to +50°C (-4°F to +122°F)
Mains voltage	115/230 V AC, 50/60 Hz
Thermal protection	Built-in
Dimensions	280 x 178 x 246 mm (11" x 7" x 9.7")
Weight	5.9 kg (13 lbs) excl. transport case
Current measurements	Current shunt 0.1 A / 1 V, ± 2%

Output, AC

20 A setting	**Output voltage (min)**	**Load time**
Idle/non-load	26 V	Continuous
5 A	25 V	Continuous
10 A	22 V	Continuous
20 A	18 V	2 min
10 A setting		
Idle/non-load	52 V	Continuous
3 A	50 V	Continuous
5 A	47 V	Continuous
10 A	41 V	10 min

Output, DC

DC current	As above, less the voltage drop over the rectifying diodes

Phase selector switch PSS750

The Phase Selector Switch PSS750 is specifically designed to work with SVERKER 750/780 when testing three-phase relays. It is connected between SVERKER 750/780 and the relay inputs and allows the user to easily select which phase to test.

The PSS750 handles both the current and voltage sources and single-phase or phase-phase testing can be selected. Together with the output-input switching the unit also contains a variable resistor that can be used together with the built-in capacitor in SVERKER 750/780. This feature gives the user the possibility to create a variable phase shift at a decreased amplitude of the test voltage.

The design is passive which makes it very general. You may for example use any of the inputs for current or voltage as long as you do not exceed the specification. It is also possible to connect the measuring inputs of the SVERKER 750/780 to the PSS750 and use the switch for selecting measurement signals.

The PSS750 simplifies phase switching, selecting type of fault, phase reversing and gives a possibility to create a variable phase shift..

Specifications PSS750

Specifications are valid at nominal input voltage and an ambient temperature of +25°C, (77°F). Specifications are subject to change without notice.

Max input voltage	250 V AC / 3 A
Max input current	6 A / 250 V AC
Max resistor loading	200 V AC / 200 mA (0.5 A during 5 seconds)
Dimensions	200 x 120 x 85 mm (7.9" x 4.7" x 3.3")
Weight	1.3 kg (2.9 lbs)

CSU20A

PSS750

Connect the current and voltage outputs of SVERKER 750/780 to the PSS750 inputs.

2. Connect the current and voltage inputs of the relay to the PSS750 outputs.
3. Select which phase to test and type of test (phase-to-ground or phase-phase) with the selector switch.
4. Proceed with the test for each phase and fault type.
5. To create a phase shift, connect the 10 µF capacitor in SVERKER 750/780 in series between the voltage output and the PSS750 input, and connect the variable resistor in parallel with the PSS750 input.
6. Set the SVERKER 750/780 for phase (and impedance) measurement. Connect the voltage measurement input to the PSS750 input.
7. Start the test with the resistor in maximum position. Gradually decreasing the resistor gives increasing phase shift in the voltage signal. The test voltage/impedance will decrease at the same time so an adjustment of the test current might be necessary to get the correct impedance. Please observe that the phase shift depends on the input resistance and may vary between different relays. Some relays may also have a low voltage limit where the relay will not operate. For additional 180 degrees phase shift use the phase reversal switch.

Test lead set

Ordering information

Item	Art. No.
SVERKER 750 Complete with Test lead set GA-00030 and Transport case GD-00182, language: English, French, German, Spanish, Swedish	
115 V Mains voltage	CD-11190
230 V Mains voltage	CD-12390
SVERKER 780 Complete with Test lead set GA-00030 and Transport case GD-00182, language: Eng, Spa, Fre	
115 V Mains voltage	CD-31190
230 V Mains voltage	CD-32390
SVERKER 780 Complete with Test lead set GA-00030 and Transport case GD-00182, language: Eng, Ger, Swe	
230 V Mains voltage	CD-32392
SVERKER 780 Complete with Test lead set GA-00030 and Transport case GD-00182, language: Eng, Turk, Bulg	
230 V Mains voltage	CD-32394
SVERKER 780 Complete with Test lead set GA-00030 and Transport case GD-00182, language: Eng, Rus, Cze	
230 V Mains voltage	CD-32396

Item	Art. No.
Optional	
SVERKER Win PC Software Please specify the SVERKER serial number when ordering. SVERKER Win contains software, a copy-protection key and cables (RS232 and USB) for connecting the PC to SVERKER. Note that the software key can be installed on a single SVERKER. The software itself, however, can be installed on an unlimited number of PCs.	CD-8102X
SVERKER Win Upgrade	CD-8101X
PROM* update, done by Megger Sweden	CD-89010
PROM* update, done by customer	CD-89011
* SVERKER Win requires PROM-version R04A or higher	
Optional accessories	
CSU20A Complete with cables and transport case	
115 V Mains voltage	BF-41190
230 V Mains voltage	BF-42390
PSS750	CD-90020
Cable organizer Velcro straps, 10 pcs.	

MULTI-TEK INTERNATIONAL
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London W10 6TR, England
Tel: +44 20-73133190
Fax: +44 20-73133191
E-Mail: mti@multitekintl.com

D- Power quality and power factor correction training systems

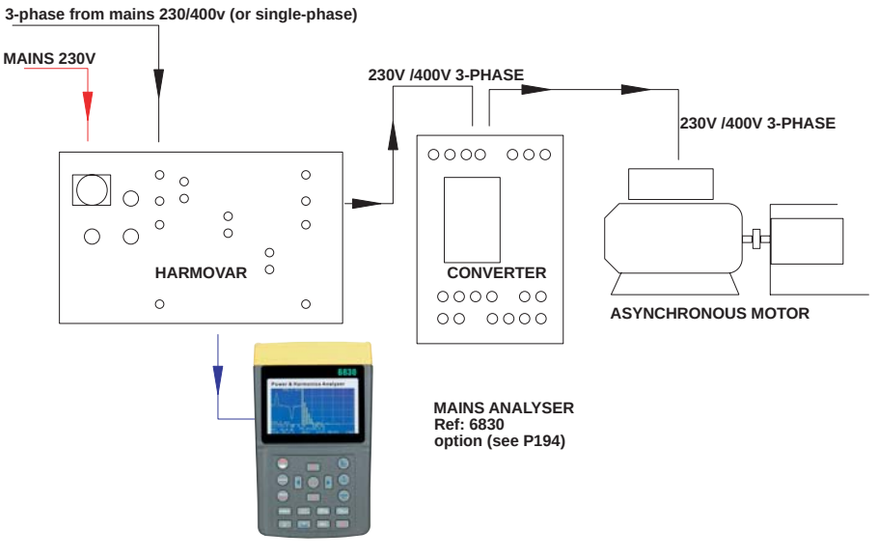
ITEMS D-1,2

Study of the third & fifth order harmonics

NEW

Unit on wheels consisting of passive filters used for studying the filtering of the third and fifth order harmonics (and, as a result, the increase in the power factor) during the use of a speed controller for an AC motor or apparatus with a diode-thyristor bridge with a capacitor filter (VOIR PAGE 74)

ref. HARMOVAR



Mains analyser V A W VAR VA COSφ THD HARMONICS

ref. 6830

The 6830 analyser is well suited to taking measurements in both living and educational spaces due to low current ratings (999.9mA) and low power ratings (999.9 W – 999.9VAR – 999.9VA). It is also suitable for industry due to its high ratings, the analysis of 3-wire and 4-wire unbalanced three-phase and single phase networks, the detection of transience, a comprehensive current and voltage analysis, and harmonic distortion. 4 display modes: electrical quantities (35 simultaneous parameters), dual-trace oscilloscope, harmonic analysis and Fresnel diagram.

FUNCTIONS	RANGES	BANDWIDTH	ACCURACY
ACTIVE POWER	999.9 W - 9.999 - 99.99 - 999.9 - 9999 kW	6kHz	1% + 8dgt
REACTIVE POWER	999.9 VAR - 9.999 - 99.99 - 999.9 - 9999 KVAR	6kHz	1% + 8dgt
APPARENT POWER	999.9 VA - 9.999 - 99.99 - 999.9 - 9999 kVA	6kHz	1% + 8dgt
INTENSITY TRMS	999.9 mA - 9.999 - 99.99 A	12kHz	0.5% + 5 dgt
VOLTAGE TRMS	600.0 V	12kHz	0.5% + 5 dgt
POWER FACTOR	0.00 ~ 1.00		0.04
PHASE ANGLE	-180° ~ 180°		1°
Capture of peaks V	600.0 V		5%
Capture of peaks A	999.9 mA - 9.999 - 99.99 A		5%
Crest factor	1.00 à 99.99		5%
THD-F	0.0 ~ 20.0 %		1%
	20.0 ~ 100.0 %		3%
	100.0 ~ 999.9 %		10%

HARMONICS order 1 ~ 100 Measured in / expressed in	RANGES	ACCURACY as per order
VOLTAGE / In VOLT	600.0 V	2 ~ 6%
VOLTAGE / % of the fundamental	0.0 ~ 100.0%	2 ~ 6%
CURRENT / In mA or A	999.9 mA - 9.999 - 99.99 A	0.2 ~ 35%
CURRENT / % of the fundamental	0.0 ~ 100.0%	0.2 ~ 35%

Supplied accessories
- 3 multiple-rating hook-on ammeters: 1 - 10 - 100A
- 4 measurement leads + crocodile clips
- 1 RS232/USB cable + software + handbook
- 1 mains adapter
- 1 carry case

Networks
- 2- and 3-wire single-phase
- 3- and 4-wire three-phase Balanced or otherwise.

Displayed measurements
- phase-to-ground and composite RMS voltages
- RMS voltage of the neutral/earth
- RMS currents in phases and neutral
- RMS voltages and current peaks
- average current, average voltage
- Power, W, VAR and VA in each phase
- total power W, VAR and VA in the charge
- average power W, VAR and VA
- power peaks W, VAR and VA
- cosφ and average cosφ
- phase shift of the phase-to-ground and composite voltages
- phase shift of currents in the phases
- consumption WH, VARH and VAH

Harmonics 1 to 99
- RMS currents and voltages of harmonics
- harmonic currents and voltages as a % of the fundamental component
- frequency and distortion of harmonics
- THD-F (total harmonic distortion)
- Imbalance ratio between voltages
- Fluctuation ratio between voltages
- Imbalance ratio between currents
- Fluctuation ratio of currents

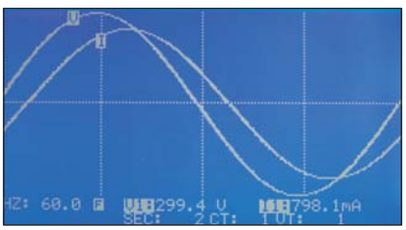
Capture of transients
- overvoltages – undervoltages – lack of a phase

Memory capacity
- up to 28 files of transients (from all of the measurements)
- 2.4 MB

Data transfer
- screen files (measurements, harmonics, Fresnel diagrams and transients)
- RS232 – USB optical link.
- Supplied software.

Screen hard copy
- table of measurements, oscillograms, harmonics and Fresnel diagrams

Miscellaneous
- Internal calendar: year-month-day-hour-min-sec
- 106 x 60mm backlit LCD screen
- Dimensions: 25 x 155 x 57mm
- Weight: 1.2kg



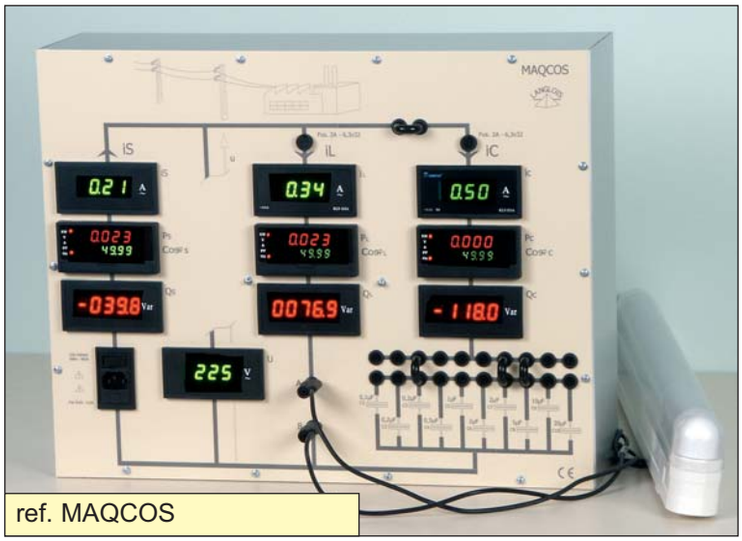
OPTION THERMAL PRINTER

- With opto isolated lead to the analyser
- Thermal paper roll : width 57mm - length 8m

ref. XP300

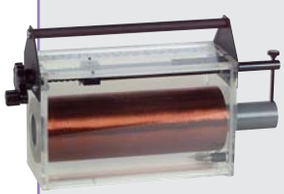
ref. XPP
Thermal paper roll more

Power factor correction system



ref. MAQCOS

VARIABLE INDUCTANCE OPTION



Students have to find out the pure resistances and inductions of an installation, without interrupting its operation and with a view to deciding on the compensation condenser battery to activate, via a power factor regulator.

ref. PSYJR

DESCRIPTION

The MAQCOS model is designed for studying and rectifying power factors. It consists of three branches:

- source branch, S, representing the energy supplied by the electricity mains (Network)
- plant branch, L , symbolizing a plant's energy consumption
- plant branch, C, including the padding condensers (integrated in the model and connected using jumper wires)

Each branch is equipped with the same measuring instruments:

- ammeter
- wattmeter, measuring active energy
- Power factor meter, measuring the power factor
- varmeter, measuring reactive energy

Students are thus able to compare four electrical variables in the three branches at the same time. They will observe (surprisingly?) that the source current value in the mains network branch may be much lower than the value in the plant branches. That source reactive energy is close to zero when power factor is around 1, whereas plant reactive energy is at maximum value. The model shows the impact of a power factor regulator on the cost per kWh transmitted and the resulting electricity bill.

MAQCOS is supplied with a fluorescent tube and IPXX connection.

PROPOSED EXERCISES AND CORRECTIONS:

- Study an industrial lighting installation using the fluorescent tube Current in the branches - power in the mains with and without power factor compensation - active and reactive energy in the branches – Fresnel patterns.
- Study power factor for a single-phase motor idling and loaded, with and without compensation – power in the transmission line in different cases – Fresnel pattern
- Study of pure inductance in an operating plant to determine the capacitor bank required.
- Role of automatic compensation.
- Study resonance, max/min current

TECHNICAL SPECIFICATIONS

13 displays: 3 x A , 3 x W , 3 x power factor , 3 x VAR , 1 x V
10 condensers: 0.1µF - 41µF
Fuse protection
Dimensions: 510 x 400 x 150 mm Weight 6.5kg

E – ALTERNATIVE/ RENEWABLE ENERGY TRAINING SYSTEM

ITEMS 1,2,3,4,5,6,7,8

Solar central unit with network injection and isolated site

ref. SOL-1 electrical cabinet + 2 photovoltaic solar panels + 1 link cable

SOL-1 is a standard compliant solar central unit, comprising an electrical cabinet (with its protection and metering components), 2 photovoltaic solar panels with power 2 x 200Wc on tilting frame and 30-m link cable.

PARTIAL OR TOTAL RESALE OPERATION

In the cabinet a DC/AC inverter converts the DC from the photovoltaic panels to AC 220VAC 50Hz, and injects its power in synchronism into the network through an isolation transformer. This inverter is protected against any polarity reversal and any overload on the DC or AC side. When the panels are not lit, the inverter consumes no current.

INVERTER	VOLTAGE	Max current	Power
INPUT	65~125VDC	8A	
OUTPUT	230VAC-50Hz	2,25A	525VA

OPERATION IN ISOLATED SITE WITH NO RESALE

The photovoltaic current charges two 12V sealed batteries cabled in series through a charging controller. This DC voltage is used directly by low energy consumption lamps 24VDC, and/or converted to 250VAC 50Hz by a 200W voltage converter.

Technical characteristics for the isolated site converter

VOLTAGE CONVERTER	Voltage	Max Current	Power
INPUT	20~32 VDC	11A	210W
OUTPUT	230VAC 50Hz	1A	200VA

1. ELECTRICAL CABINET

Technical cabinet of standardized solar central unit on wheeled frame.
Dimensions: 810 x 600 x 1890mm

COMPRISES

- 2 disconnectors
- 1 500mA -30A differential
- 1 30mA differential
- 1 lightning arrester + fuses
- 3 100 Wh resolution meters
- 1 Mushroom head emergency stop
- 1 source inverter
- 1 charging controller 12/24VDC-20A
- 1 4-20mA interface for the wind speed/Solar irradiation/Temperature sensors
- 2 batteries 12V-12Ah
- 1 set of photovoltaic connectors
- 1 500W inverter for network synchronisation
- 1 Voltage converter 24VDC/230VAC-200W

2. LINK CABLE

30-m cable for connecting the solar panels to any type of solar system.

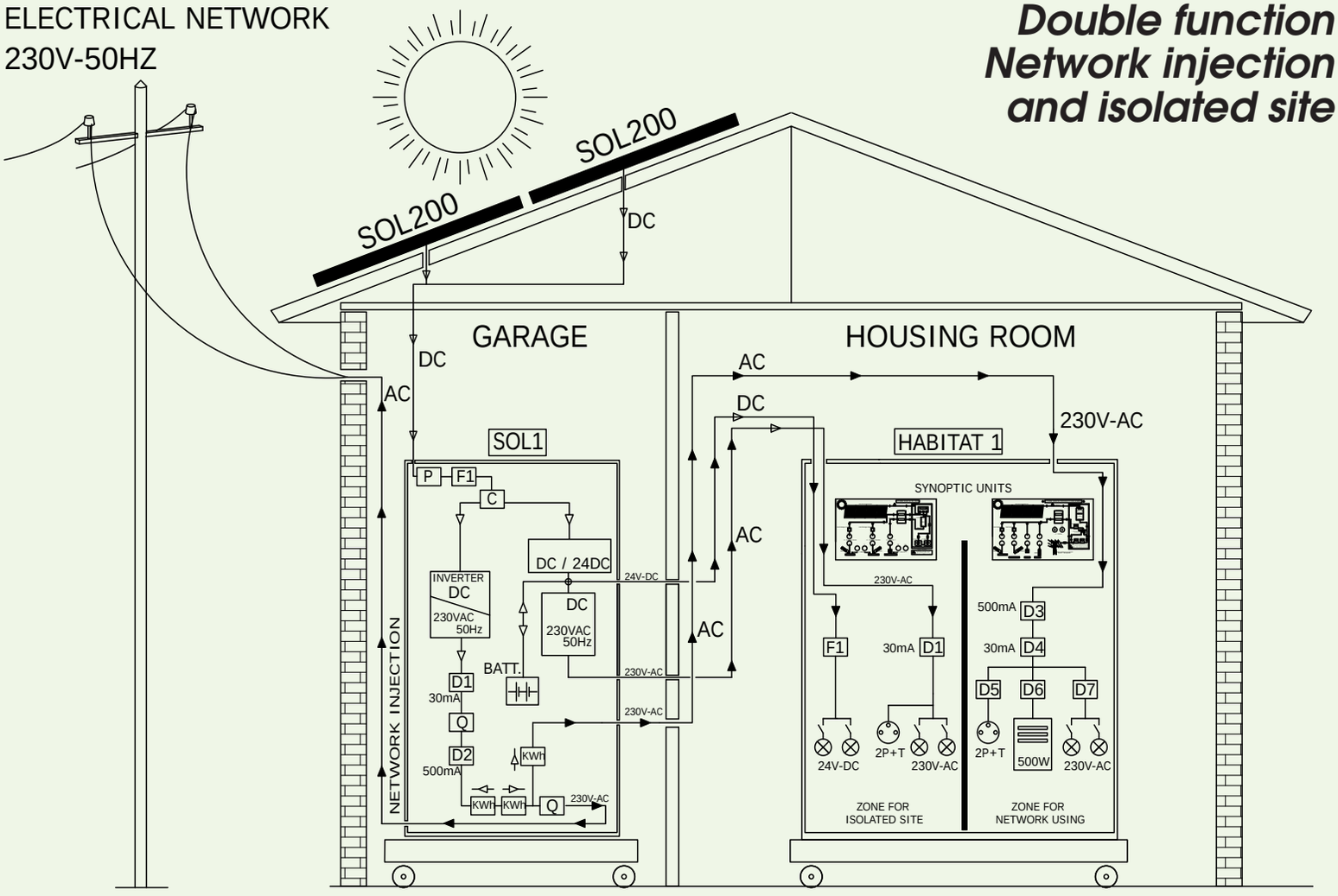
3. PHOTOVOLTAIC SOLAR PANEL 200WC ON TILTING FRAME

- Open circuit voltage: 57V DC
- Short-circuit current: 4.8A
- Optimum operating voltage: 46V DC
- Optimum operating current: 4.3A
- Maximum power: 200Wc (variation of ± 10% depending on the series)
- Sealed connections IP65 – 1000V on the rear of the panel.
- Type of cells: Monocrystalline silicon
- Robust aluminium frame.
- Useful surface area of the cells 1.5m².
- Output 47VDC – 4.2A – 200Wc per panel on 2 photovoltaic terminals.
- Device for measuring the tilt angle
- Tilt adjustable from 5° to 70°
- Two ball joints with clamping levers for positioning the panel to the required tilt angle.
- Light and easy to move.

Dimensions:
Folded position: 1620 x 1060 x 100mm
Unfolded to 70° position: 2100 x 1060 x 700mm

ELECTRICAL NETWORK
230V-50HZ

Double function Network injection and isolated site



USING SOLAR ENERGY WITH PUBLIC NETWORK INJECTION AND/OR ISOLATED SITE WITHOUT NETWORK ACCESS - CHOOSE SOL-1 + HABITAT-1

RECOMMENDED OPTION LOADING PANEL FOR ISOLATED SITE USE

SEE REF. HABITAT-1

RECOMMENDED OPTION INDOOR ARTIFICIAL SOLAR SOURCE QTE 2.

SEE REF. SOL-ARTI

Renewable energy

Acquisition for central unit

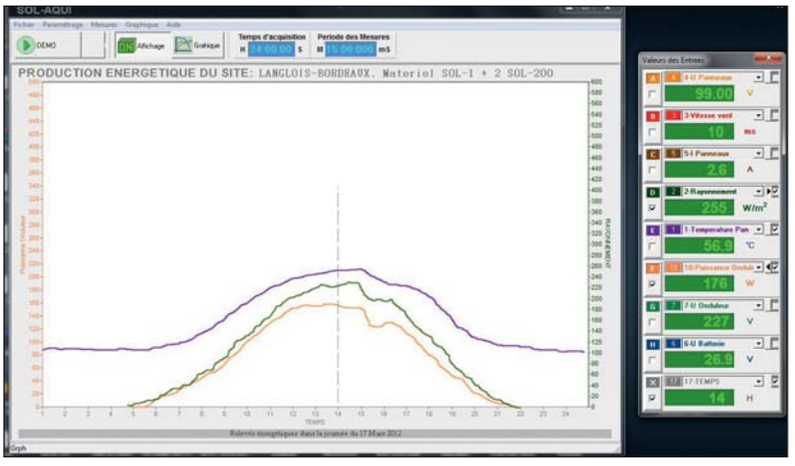
NEW

Set of sensors, interfaces and software for the real time data monitoring of a photovoltaic installation.

COMPOSITION

- Three 4-20mA sensors for reading wind speed (ms), solar irradiation (W/m2) and the temperature of the solar panel (°C).
- 1 sealed "solar panel power interface" box for reading the voltage and current supplied by the photovoltaic panels. This interface transmits information (U / I / Wind speed /temperature / irradiance) to the data interface as 4-20mA signals. Voltage 250VDC Max./Current 25A Max.
- 1 "inverter power interface" box to be installed near the inverter reads the voltage and current supplied to the installation. U/I information is transmitted to the data interface as 4-20mA signals. Voltage 250VDC Max./Current 20A Max
- 1 "battery power interface" box to be installed near the batteries reads the voltage supplied to the installation. U information is transmitted to the data interface as 4-20mA signals. Voltage 250VDC.
- 1 "data interface" box collects the 4-20mA signals from the different power interfaces to transmit them to your PC. Mains power supply 230VAC - PC link by USB lead supplied.
- 1 Software for monitoring photovoltaic settings and data
  Allows:
  - you to create your photovoltaic installation.
  - real time display as curves and numeric blocks of the different data of: wind speed, solar irradiation, panel temperature; U / I supplied by the solar panel; U / I supplied by the inverter; U supplied by the battery
  - the display, after acquisition, of the curves of electrical power supplied by the solar panels, electrical power supplied by the inverter, installation efficiency
  - selection of the sampling frequency for data acquisition (1 to 60 minutes), the acquisition period (1 minute to 24H), the display scales of the curves and their colours, data export to a spreadsheet like Excel®.

The Software is compatible with Windows XP, W7. Supplied on CD.
All the connection cables and mounting accessories are supplied.



ref. ACQUI-SOL

Simulation of solar panel

Given that photovoltaic panels do not produce significant power in cloudy conditions, it is not possible to complete the related tutorials. DC10 is a source which, by replacing the solar panels, overcomes unpredictable sunshine

• Mains input	230V single-phase
• Stop/start switching	Push-button + LED indicator lights
• Emergency stop	Key operated
• DC output	Adjustable from 0 to 230V DC
• Maximum current	10A
• Filtering	5% of residual ripple at 10A.
• Adjustment method	Button on the top
• Display of outputs	1 voltmeter and 1 ammeter
• Output terminals in parallel	2 photovoltaic type connectors 2 4mm safety terminals
• Upstream protection	By fuse
• Output protection	By circuit breaker
• Protection of individuals	By safety isolation transformer
• Dimensions/Weight	330 x 280mm height 510mm/40kg
• Castors	4 including 2 with brakes

Supplied with cable (1m) for connection to the management system of photovoltaic panels.

ref. DC10

Solar analyser

- Current/voltage graph drawing (characteristics of the solar panel)
- Autoscan search of the solar panel maximum power – Pmax (60V – 6A)
- Maximal voltage Vmaxp at Pmax power
- Maximal voltage Imaxp at Pmax power
- Opened circuit voltage Vopen
- Short-circuit opened Ishort
- I = f(V) graph with a cursor
- Efficiency calculation in %
- Power by area unit (in W/m2)
- Manual test for a particular point
- Range 10V / accuracy 0.001V
  Range 60V / accuracy 0.01V
  Range 1A / accuracy 0.1mA
  Range 6A / accuracy 1mA
  Accuracy 1% + 18dgt

ref. VA200

Delivered with
- carrying case, power supply
- batteries (8x LR6 / AA), connection
- cables for solar panel
- USB cable and software.

Solar pumping station

NEW

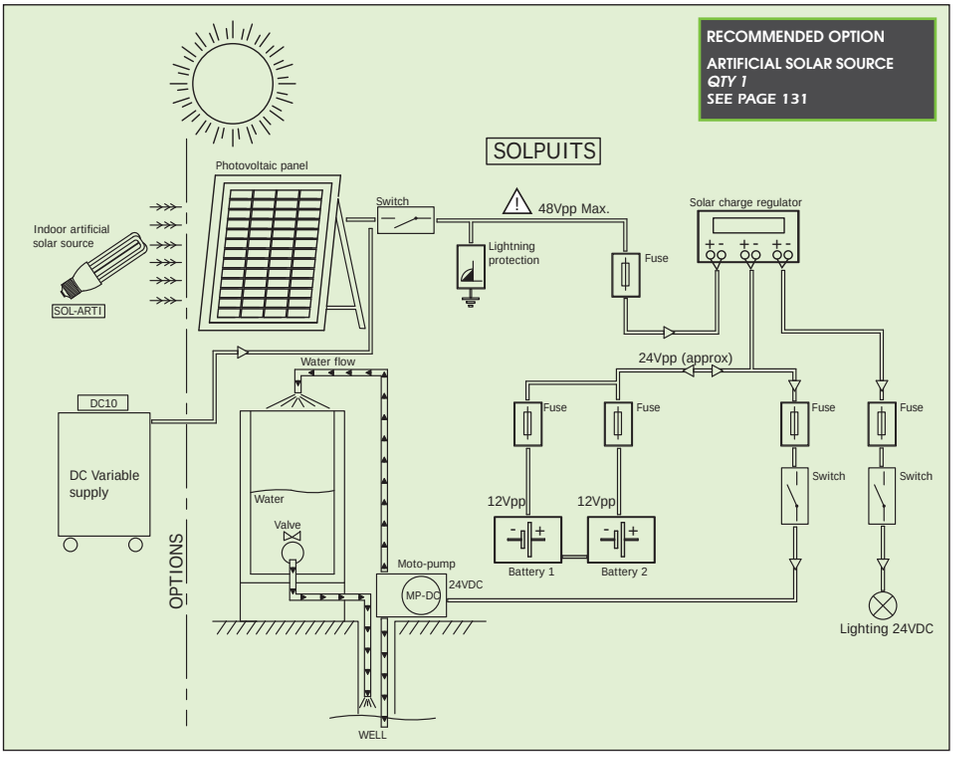
SOLPUITS is a fully self-contained solar pumping station with electrical energy. This system lets students understand and analyse its operation and cable solar electrical components.

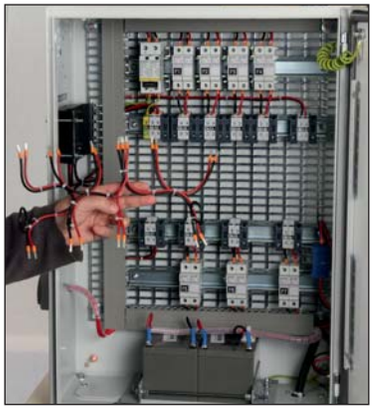
COMPRISES

- 1 photovoltaic solar panel 200Wc mounted on a robust frame that tilts from 5° to 70°. Output 47VDC-4.2A on 2 photovoltaic terminals. 1 30-m link cable.
- 1 100-l tank simulates the underground water source.
- 1 60-l transparent container acts as water reserve. A tap simulates user consumption and returns water to the tank.
- 1 sealed motor pump 140W- 24DVC-6A. 13l/min capable of pumping dry. It takes water from the tank and fills the reserve water container.
- 2 12V/6Ah batteries supply the pumping station when sunlight is absent.
- 1 24VDC-20A regulator controls battery charging. One 2-button display accessible outside the cabinet enables configuration and viewing of the currents of the solar panel, the battery charge and the lamp and the battery voltage.
- 1 electrical cabinet includes the cabling of all the solar components on connection terminals. A lightning arrester protects the installation and each component is protected by fused circuit-breaker type gPV. The cabling is fully marked and students can easily remove the original strand to do their cabling. Students can also take voltage and current readings. A main switch isolates the solar panel from the electrical cabinet.
- A switched 24VDC lamp lights the area.

A wheeled frame for passing under doors.
SOLPUITS requires no direct water connection. Once the 80-l tank is filled with water, the system is totally self-contained.
Supplied cabled with detailed instructions and complete practical assignments.
Dimensions: 750 x 670 x 1980mm

ref. SOLPUITS

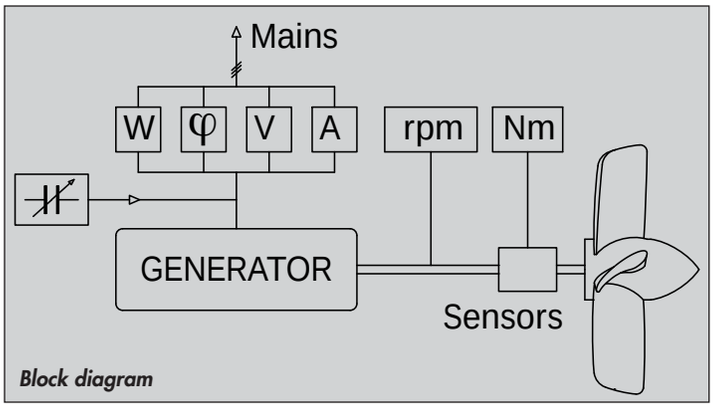




Simply remove the strand before asking students to do the cabling.

Wind turbine simulator – Network injection

EOLYP is a test bench dealing with the study of the hyper synchronous activity of a wind turbine for its electricity production aspects, excluding the mechanical aspects.
Due to noise pollution and draughts, which are incompatible with a classroom environment, the propeller has been replaced by a variable speed drive motor.



Block diagram

The functional diagram presents the operating principle. The safety components placed in the electrical cabinet are not represented to simplify reading. The propeller, for which the operator adjusts the speed, drives the generator from 0 to 1800 rpm. Two sensors placed on the shaft, returns rotation speed and torque information to the console which displays this information. The generator is coupled to the public three-phase network, through an electrical measurement bench indicating the:

- active power injected into the network.
- voltage between phases
- current
- power factor.

The central-zero wattmeter shows that depending on the drive speed, the generator consumes or produces energy highlighting the hypersynchronous and hyposynchronous operations. The voltage/current distortion also changes with the rotation speed as indicated by the central-zero cosφmeter. The adjustable capacitors battery is used to adjust the cosφ to around 1 depending on the speed and power produced.

COMPRISES

- 1 frame on casters, dim. 1200x750mm height : 1820mm
- 1 asynchronous motor 1.5 kVA
- 1 generator
- 1 DC tachogenerator / 1 torque sensor
- 1 command console
- 1 electrical cabinet
- 1 network coupling unit

GENERATOR FEATURES

- Generator: 3x400VAC Asynchronous motor.
- Active power injected into the network: 0 to 1.2kVA
- Generator efficiency: 78%
- Speed variation: 0 to 1800 rpm

ref. EOLYP

ref. EOLYP-ECO sans capteur ni afficheur de couple

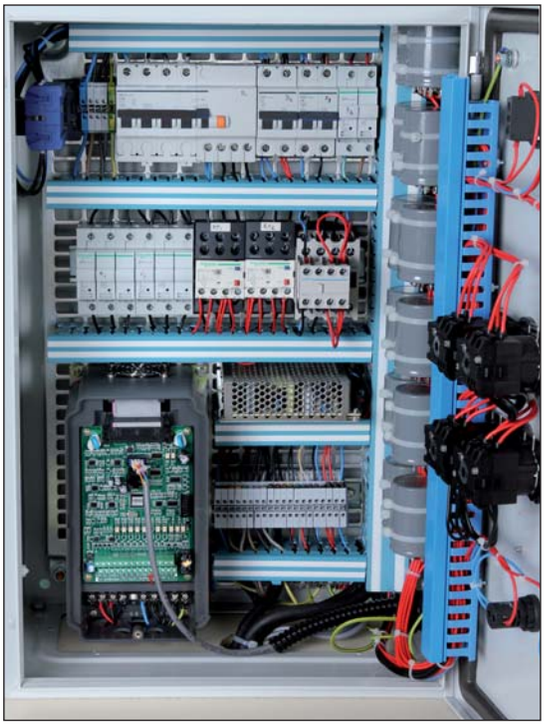
ELECTRICAL CABINET

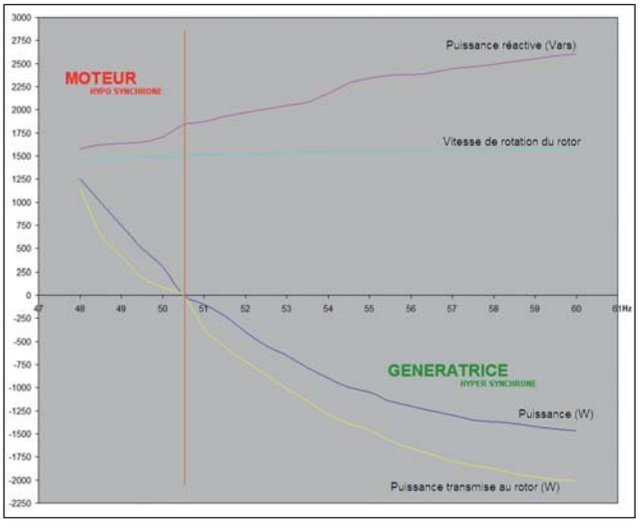
Interior:

- 30 mA circuit breakers and magnetothermal and thermal circuit breakers.
- 2.2kVA speed controller with control unit on the console.
- stepped capacitors battery

On the front:

- 1 emergency stop circuit breaker
- 1 switch disconnector
- 1 stop/Start button with push button
- 4 switches triggering the capacitors to rectify the cosϕ
- 2 indicator lights show a thermal fault on the motor and generator





Several tutorials are delivered with the teacher and student folders:

- Plot of the active power curve as a function of the rotation speed.
- Demonstration of the reactive power injected into the network at synchronism speed.
- Compensation by the capacitors battery in hypersynchronous operation.
- Demonstration of the reactive current at maximum active power and compensation.
- Impact of the speed on the cosϕ and solutions to automate the regulation.
- Efficiency calculation: Electrical power injected into the network/mechanical drive power
- Checks before coupling with the network. Limit speed, electricity production peak.

SECTION 2:

INSTALATION TRAINING LAB

INSTALATION TRAINING LAB

Section 2

ITEMS

1 to 20

Source switching kit

Despite the 125A current supported by the reversing switch, and in order to prevent damage to the attached components (terminals and fuse holders, etc), the charging current must not exceed 16A.

A pedagogical manual comprising diagrams, properties and instructions relating to each component is supplied with the kit.

COMPONENTS COULD BE SOLD SEPARATELY ON REQUEST

This industrial kit comprises a motorised source switch and control accessories used for switching from one power source to another. One of them is deemed «NORMAL» and the other "EMERGENCY». The latter is used if the former experiences an outage. The main application is to provide an uninterrupted power supply in case of mains network fail. This switch (or reverser) is often built into the low-voltage master distribution board cabinets.
Switching from the normal source to the emergency source is performed either manually (using the palm switch) or automatically (using a control module). The control module detects the absence of the normal source and controls the switch which activates the emergency source. Lamps show the status of the switch.

COMPRISES

- 1 motorised reversing switch with three stable positions (I-0-II), in charge switching.
  Sectioning by means of fully visible power cut-off
  Electrical control of position by means of potential-free dry contacts
  - emergency manual control
  - with padlock
  - 4-pole, 125A, 400V network, 3P+N+E
- 1 automatic control module for source switch
  - DIN modular case
  - relay output for control of the reversing switch
  - display + keys on the front for programming
- 1 600 x 500mm detachable wiring grid
- 5 4-pole fuse holders
- 1 auto/manual switch
- 1 3-position switch (source1-0-emergency source)
- 3 220V lamps
- 2 plastic cases for the switches and lamps
- 1 set of connection terminals
- 1 set of HARTING® industrial connectors for connection to the control components, lamps and charge.

CE

Asynchronous motor start-up kit

Male and female HARTING industrial rapid connectors, with mobile covers and fixed bases, are supplied with the KIT. They are used for connections between the following: wiring grid - push-buttons - switches - lamps - motor.

The KIT is supplied with detailed instructions, wiring diagrams, manufacturer's instructions and a parts list.

This industrial kit comprises actuators and control components which are used to study and create the main schematics for the start-up of asynchronous motors:

- direct start-up, with or without reversal of the direction of rotation
- star/delta start-up
- start-up by means of a STARTER/DECELERATOR Telemecanique® module
- start-up by means of speed converter.

COMPRISES

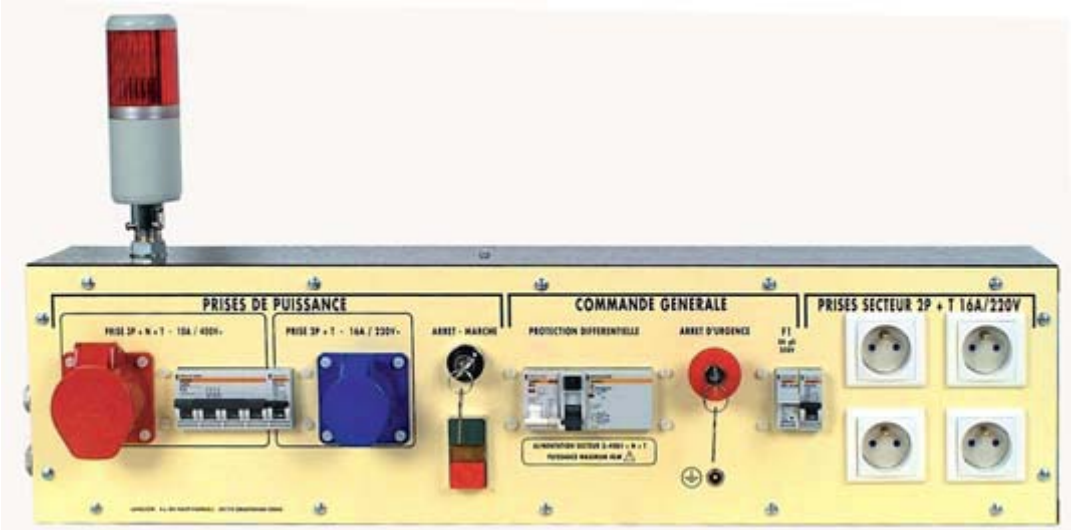
- 1 25A-400V 4-pole circuit breaker
- 1 double-pole fuse holder
- 2 4-pole fuse holders
- 3 25A power contactors with 24V coil
- 2 auxiliary contactors with 24V coil
- 1 block of auxiliary contacts with time-delayed «work» from 1 to 30s
- 3 auxiliary contact blocks, 1 «NO» + 1 «NC»
- 1 0.63 to 1A thermal relay with its support
- 1 Telemecanique® Altivar-type 1.5kW speed controller
- 1 Telemecanique® Altistart-type starter/decelerator
- 1 220V/24V-100VA single-phase transformer for the control circuit
- 1 grid measuring 600 x 500mm
- 1 set of 4mm connection terminals
- 1 set comprising push-buttons, emergency stop and lamps for controlling and viewing all features of the wired grid
- 1 set of HARTING® industrial connectors for connecting the control components and motor to the grid

COMPONENTS COULD BE SOLD SEPARATELY ON REQUEST

CE

SYSTEM CONSOLE type PUP695

Fully-wired horizontal console, ready to be connected to the mains three-phase, designed to supply a maximum total power of 4kW with:
• emergency stop + On/Off button with lamp, plus memory function.
• 1 30mA residual current circuit breaker
• 1 three-phase industrial socket +N+E with its circuit breaker.
• 1 single-phase industrial socket + E with its circuit breaker.
• 1 key-operated switch + 1 double push-button which prevents the use of industrial sockets
• 4 2P+E+circuit breaker protection sockets
• 1 single-colour remote signal tower, total length: 800mm
• single colour: brown (beige front panel)

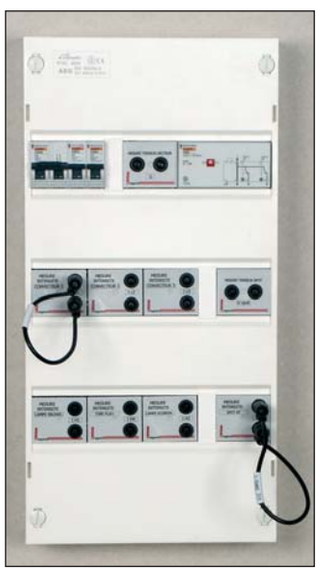


Ref.PUP695

Home energy use panel

ref. ECODOM-C Wired Version

ref. ECODOM-A Not Wired Version



ICO cables (placed between the 2 melamine plates that the panel comprises) connect the components together

With ECODOM, students tackle measuring power, currents, load shedding and the ideal settings for domestic lighting and heating circuits

Features of the base

- *Base on large wheels*
- *easy to move.*
- *Dim. L x W x H: 1500 x 690 x 1980mm*
- *Melamine surface: 1200 x 1700mm*

Components located on the panel

- 1 watt-hour meter displaying:
  - The total power consumed for tariff 1 and 2.
  - The partial power consumed for tariff 1 and 2.
  - The instantaneous active power consumed.
  - The max. active power for tariff 1 and 2.
- 1 500mA mains installation residual current circuit breaker at the front of the unit, after the meter.
- 1 modular table consisting of:
  - 1 circuit breaker protection set, including 1 30mA residual current type.
  - 1 adjustable cut-off device with 2 secondary circuits
  - 9 modules with 4mm safety terminals, including:
    - 7 for measuring currents
    - 2 for measuring voltages (mains and low-voltage).
- 4 lighting circuits with fitted circuit breaker
  - for an 18W fluorescent tube
  - for a wall light with a 100W incandescence light bulb
  - for a wall light with a 20W energy-efficient light bulb
  - for a 50W low-voltage spotlight
- 3 heating circuits with
  - two 1000W convectors.
  - a 600W radiant.

- Panel supplied with a full wiring diagram and all of the detailed instructions for each component.
- The items on the panel may be different from one series to another depending on manufacturer alterations.

PRACTICAL APPLICATIONS INCLUDE

- Measuring instantaneous consumption and consumption over time using the watt-hour meter.
- Varying consumption according to usage between two periods
- Distributing power consumption between two tariffs
- Managing overconsumption (watt-hour meter and load shedding)
- Measuring the two voltages available on the panel
- Measuring the current using modules fitted with safety terminals (Without modification, currents are measured using a standard ammeter or a hook-on ammeter).

Jumper wires panel

PRACTICAL APPLICATIONS INCLUDE:

- A simple introduction to circuit protection.
- Simple switching on and dubbing of phases and neutrals.
- Two-way switch fitting.
- Fitting a light with a timer.
- Fitting a light with a dusk-to-dawn switch
- Fitting a light with a remote control switch.
- Circuits controlled by the timer switch (clock).
- Creating a sockets circuit.
- Supplying power to a radiator with a built-in thermostat.
- Controlling a roller-blind

FEATURES OF THE BASE

- *Base on large wheels*
- *easy to move.*
- *Dim. L x W x H: 1500 x 690 x 1980mm*
- *Melamine surface: 1200 x 1700mm*

- Panel supplied with a full wiring diagram and all of the detailed instructions for each component.
- The items on the panel may be different from one series to another depending on manufacturer alterations.

Standard home components are interconnected on this panel using safety terminals. All of the double insulation components are fitted with safety terminals.

ref. BASIFIL-1

COMPONENTS LOCATED ON THE PANEL

- 1 single-phase 30mA residual current circuit breaker (1)
- 2 10A circuit breakers (1)
- 1 16A circuit breaker (1)
- 1 dusk-to-dawn switch with cell (1)
- 1 timer (1)
- 1 remote control switch (1)
- 1 clock (1)
- 2 40W light bulkhead luminaires
- 2 simple lighting circuit breakers
- 2 two-way switches
- 2 simple push-buttons
- 2 16A 2P+E sockets
- 1 roller-blind control
- 2 connection terminal blocks
- 1 heating indicator light
- 1 500W convector
- 1 roller-blind

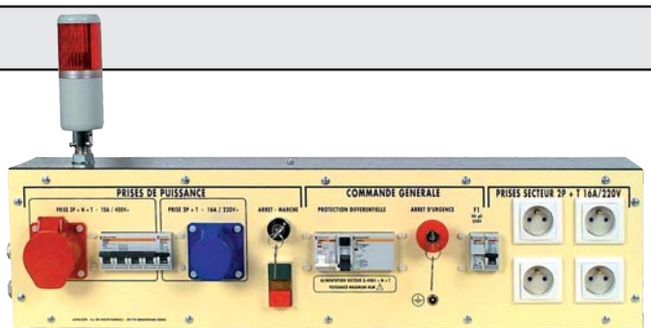
Other components: upon request

(1) items in a transparent case.
High-visibility components.

System console

Fully-wired horizontal console, ready to be connected to the mains three-phase, designed to supply a maximum total power of 4kW with:

- emergency stop + On/Off button with lamp, plus memory function.
- 1 30mA residual current circuit breaker
- 1 three-phase industrial socket +N+E with its circuit breaker.
- 1 single-phase industrial socket + E with its circuit breaker.
- 1 key-operated switch + 1 double push-button which prevents the use of industrial sockets
- 4 2P+E+circuit breaker protection sockets
- 1 single-colour remote signal tower, total length: 800mm
- single colour: brown (beige front panel)



ref. PUP695

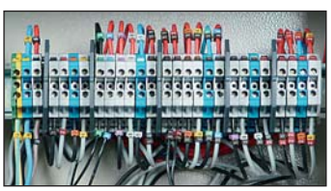
CE

Access control system (by swipe cards & entry system)

Profile view

Front view

Electrical cabinet



Terminal block built into the cabinet

Electric door opener

Control swipe cards

Closing system

Swipe card reader

GES-2 is a panel used for studying, wiring and programming access control in three simulated "rooms". These "rooms" are closed off by swinging doors that are locked using an electric door opener system. Two of the doors open by passing a swipe card in front of the local readers that are fitted on the doors, whereas the third door opens with an entry system.
Three push-buttons placed nearby also control the opening of the doors.
In addition to the features on the basic model, the **GES-2-COM** version also has a PLC to connect to the Ethernet network and a PC monitoring software program.
The student is required to interconnect the control module, the local readers, the entry system, the electric door openers, the push-buttons and their power supplies. All of the marked connections are wired to a terminal block. The student also programs the swipe cards and the digicode.

TECHNICAL CHARACTERISTICS

- 1 access control module, 6 swipe cards and 1 entry system.
- Viewing cover electrical cabinet and modular equipment.
- 220V AC power supply. Protected by a 30mA residual current circuit breaker.
- Base on wheels, dimensions: 1000 x 750 Height: 2000mm
- Dimensions of front and rear panels: 1000 x 750mm
- The unit is supplied fully wired, in working order, with wiring diagram, operating principle and detailed instructions for each component.

ref. GES-2

Model with PLC and software

Identical to **GES-2**, this **GES-2-COM** model also has a PLC to connect to the Ethernet network via an RJ45 connector and a highly intuitive monitoring software program, which, via the PLC, controls the door opener and receives information from the sensors on the panel.

TECHNICAL FEATURES OF THE PLC

- 9 24VDC inputs / 7 binary outputs
- Programming: sequential function chart or ladder language
- Ethernet connection to the IP computer network
- Software supplied with ladder language programme
- Fully functioning program: Supplied

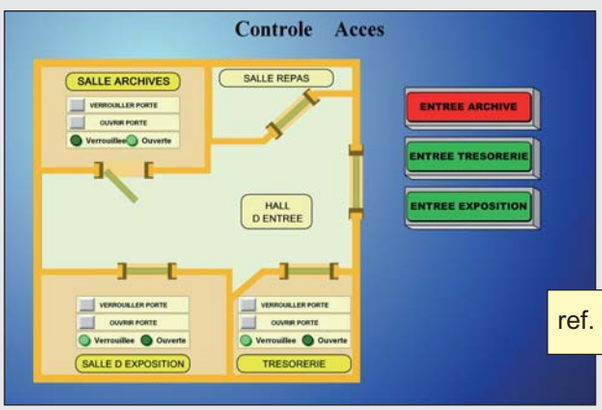
FEATURES OF THE MONITORING SOFTWARE

- Offers the basic functions of a graphical monitoring tool.
- Compatible with Windows® 2000 and XP:

Allows you to:
- acquire and display PLC variables
- Monitor and control of process

Displays:
- access to each room
- door locking
- the mains power

controls:
- access to rooms granted or denied



ref. GES-2-COM

The **GES-2-COM** model is supplied with:
- 1 software licence for the programming software
- 1 program for the PLC
- 1 monitoring software and 1 application software

COMPATIBLE V.D.I.

SEE PAGES 119-121

CE

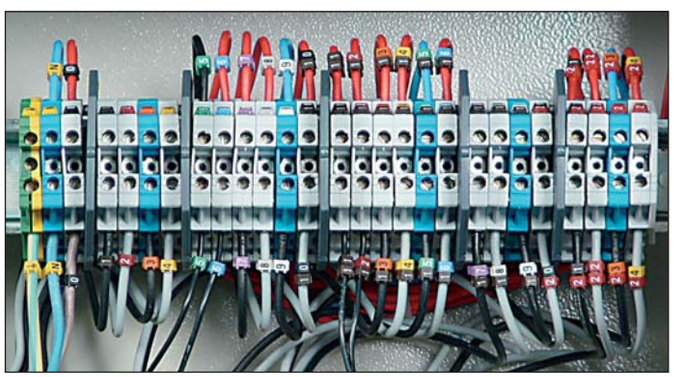
Intruder alarm control system

Front view

Profile view

Electrical cabinet

ref. GES-3



Terminal block built into the cabinet

Kit intruder alarm control see Page 47

GES-3 is a panel used for studying, wiring and programming an alarm unit that monitors three areas in the business premises, via two infra-red detectors and a magnetic detector triggered when the window is opened. In addition to the features on the basic model, the **GES-3-COM** version also has a PLC to connect to the Ethernet network and a PC monitoring software program. The student is required to interconnect the unit, the infrared detectors, the magnetic contact, the keypad, the siren and the flashing light. All of the marked connections are wired to a terminal block. The student is also required to programme the access code.

TECHNICAL FEATURES AND EQUIPMENT

- 1 stand-alone alarm unit (powered by mains and battery)
- 1 power supply for the sensors
- 2 infrared detectors
- 1 keypad for code entry (4 numbers)
- 1 siren
- 1 flashing light
- 1 magnetic door-opening detector fitted on the window
- 1 viewing cover electrical cabinet and modular equipment.
- 220V AC power supply. Protected by a 30mA residual current and circuit breakers.
- Base on wheels, dimensions: 2000x750mm Height: 2000mm
- Dimensions of front and rear panels: 1000 x 750mm
- The unit is supplied fully wired, in working order, with wiring diagram, operating principle and detailed instructions for each component.

Model with PLC and software

Identical to the **GES-3**, but this **GES-3-COM** model has a PLC to connect to the Ethernet network using an RJ45 connector and a highly intuitive software program, which, via the PLC, controls the monitoring and shutdown of the unit, the shutdown of the siren and receives information about the status of the detectors and the warning system.

TECHNICAL FEATURES OF THE PLC

- Please refer to the features described on page 110.

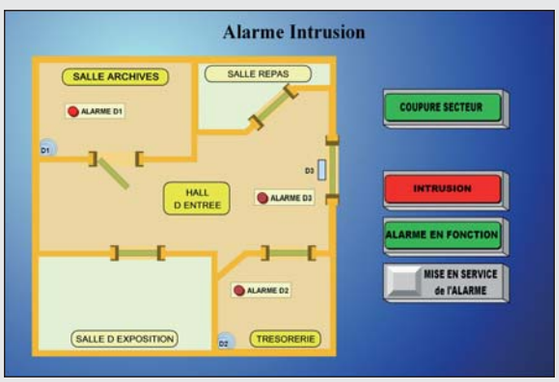
FEATURES OF THE MONITORING SOFTWARE

- Offers the basic functions of a graphical monitoring tool.
- Compatible with Windows® 2000 and XP:

Allows you to:
- acquire and display PLC variables
- Monitor and control of process

Displays:
- the status of the infrared and magnetic detectors
- the ON/OFF status of the alarm
- the room where the intrusion took place
- the mains power
- the status of the siren

controls:
- the monitoring and shutdown
- the siren



COMPATIBLE V.D.I.

SEE PAGES 119-121

The **GES-3-COM** model is supplied with:

- 1 software licence for the programming software
- 1 program for the PLC
- 1 monitoring software & 1 application software

ref. GES-3-COM

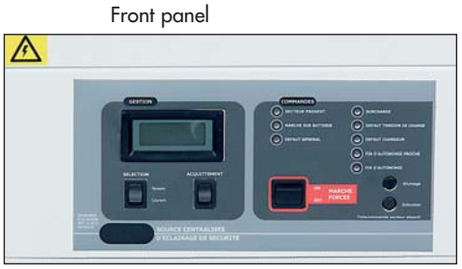
CE

Security lighting control system

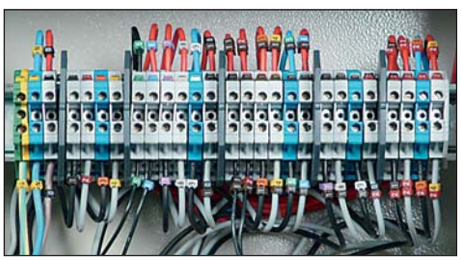
Rear panel

Front panel

Profile view



24V unit safety power source



Terminal block built into the cabinet

GES-4 is a panel used for studying and wiring security lighting. It operates in two independent modes.

- Permanent mode, wired onto the front panel: security lighting is always switched on. Power is supplied to it via a central battery
- Intermittent mode, wired to the back of the panel: security lighting is switched on if the mains power fails. They are stand-alone units and each has its own battery.

In addition to the features on the basic model, the **GES-4-COM** version also has a PLC to connect to the Ethernet network and a PC monitoring software program.
The student has to interconnect the lighting units, the anti-panic unit, the central battery and the "mains power fault" detector. All of the marked connections are wired to a terminal block.

TECHNICAL FEATURES AND EQUIPMENT

Front panel

- 2 security lighting units
- 1 forced operation switch for the security lighting
- 1 anti-panic lighting unit
- 1 communication unit which controls the anti-panic lighting
- 1 manual unit shutdown control
- 1 maintenance-free central battery for permanent lighting, with digital voltage and drain current display, indicator lamps: mains power on, battery operation, battery discharge, fault.
- 1 spotlight connected to the mains showing the mains voltage.

Back panel

- 2 stand-alone security lighting units, with maintenance-free internal battery
- 1 stand-alone anti-panic lighting unit with maintenance-free internal battery
- 1 manual unit shutdown control
- 1 spotlight connected to the mains showing the mains voltage.

- 1 viewing cover electrical cabinet, shared by both panels, modular equipment.1 reinforced electrical cabinet, common to both panels, modular equipment. 220V AC Power supply. Protected by circuit breakers inculding a 30mA residual current type.
- If a general shutdown occurs, the remote control cuts off the battery power to prevent discharge.
- Base on wheels, dimensions: 2000x750mm Height: 2000mm
- Dimensions of front and rear panels: 1000 x 750mm
- The unit is supplied fully wired, in working order, with wiring diagram, operating principle and detailed instructions for each component.

ref. GES-4

Model with PLC and software

The **GES-4-COM** is identical to the basic **GES-4** model, except that it also has a PLC for linking to the Ethernet network using an RJ45 connector. A highly intuitive PC monitoring software program is used to control the lighting units via the PLC.

TECHNICAL FEATURES OF THE PLC

- Please refer to the features described on page 110.

FEATURES OF THE MONITORING SOFTWARE

- Offers the basic functions of a graphical monitoring tool.
- Compatible with Windows® 2000 and XP:

Allows you to:

- acquire and display PLC variables
- Monitor and control of process

Displays:

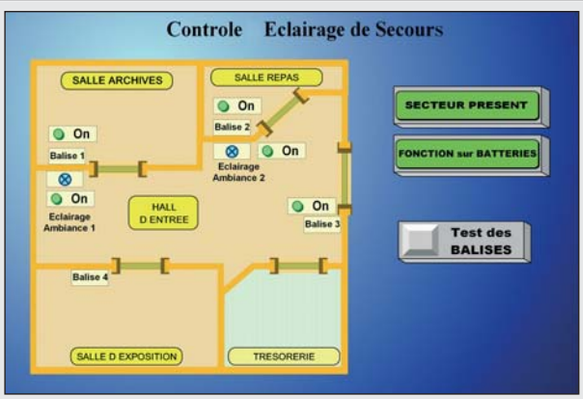
- battery-operated
- a voltage on the lighting unit terminals

controls :

- the activation of the anti-panic unit
- the activation of the security lighting units

COMPATIBLE V.D.I.

SEE PAGES 119-121



The **GES-4-COM** model is supplied with:

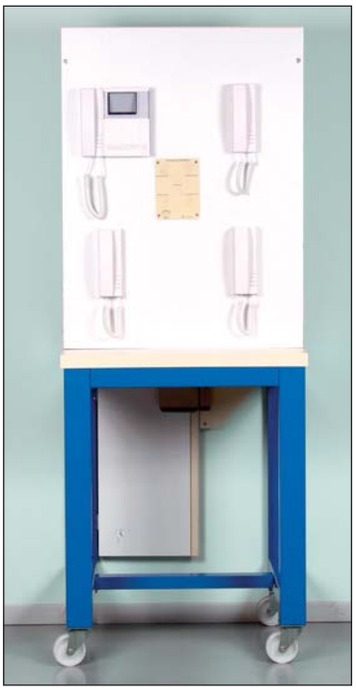
- 1 software licence for the programming software
- 1 program for the PLC
- 1 monitoring software & 1 application software

ref. GES-4-COM

CE

Entry access and video access control system

Rear panel



Front panel

ref. GES-5

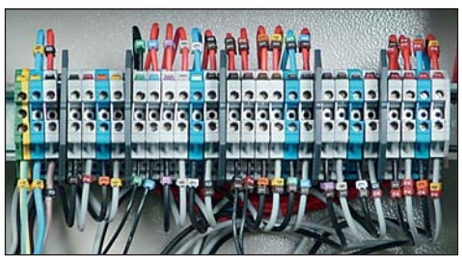
GES-5 is a panel used for studying and wiring a building access system, with video monitoring and communication via the entry phone. In addition to the features on the basic model, the **GES-5-COM** version also has a PLC to connect to the Ethernet network and a PC monitoring software program.

The student is required to interconnect the "street" end video unit, the videophone and the entry phones, the control buttons and the electric door opener. All of the marked connections are wired to a distributor and a terminal block.

TECHNICAL FEATURES AND EQUIPMENT

- 1 door, opening onto the "street", with electric door opener
- 1 "street" video unit comprising:
  a camera / a loudspeaker / a 4-button caller keypad (one for each area)
- 1 "building" videophone with a screen that is linked to the camera
- 3 "building" entry phones
  The videophone and entry phones have a button which controls the electric door opener
- 1 4-channel distributor for interconnecting the videophone and entry phone
- 1 viewing cover electrical cabinet, modular equipment.
- 220V AC power supply. Protected by a 30mA residual current circuit breaker.
- Base on wheels, dimensions: 2000x750mm Height: 2000mm
- Dimensions of front and rear panels 1000x750mm
- The unit is supplied fully wired, in working order, with wiring diagram, operating principle and detailed instructions for each component.

Electric door opener



Terminal block built into the cabinet

Profile view

Model with PLC and software

The GES-5-COM is identical to the basic GES-5 model, except that it also has a PLC for linking to the Ethernet network using an RJ45 connector. A highly intuitive PC monitoring software program is used to control the electric door opener via the PLC.

TECHNICAL FEATURES OF THE PLC

- Please refer to the features described on page 110.

FEATURES OF THE MONITORING SOFTWARE

- Offers the basic functions of a graphical monitoring tool.
- Compatible with Windows® 2000 and XP:

Allows you to:

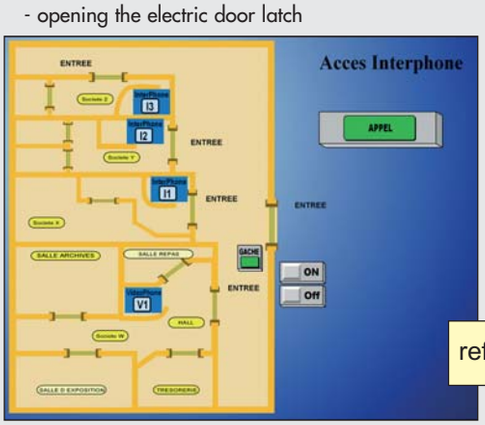
- acquire and display PLC variables
- Monitor and control of process

Displays:

- a call
- power to the electric door opener
- the mains power

controls:

- opening the electric door latch



ref. GES-5-COM

The **GES-5-COM** model is supplied with:

- 1 software licence for the programming software
- 1 program for the PLC
- 1 monitoring software & 1 application software

COMPATIBLE V.D.I.

SEE PAGES 119-121

Kit access control
see Page 46

CE

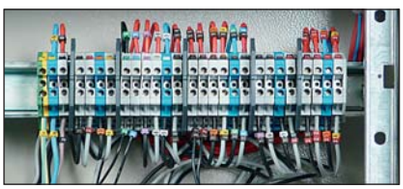
Fire alarm control system

front view

Profile view

Electrical cabinet

ref. GES-6



Terminal block built into the cabinet

Optical detector

Closing system

Optical smoke detector

Kit fire warning control voir Page 47

GES-6 is a wiring and study panel for an independent initiating detector. The independent initiating detector detects a fire using 2 optical smoke detectors and 2 manual triggers. If a warning occurs, a magnetic bolt allows an emergency exit door to open.
The student is required to interconnect the optical smoke detectors, the manual triggers, the independent initiating detector and the electric bolt. All of the marked connections are wired to a terminal block.

TECHNICAL FEATURES AND EQUIPMENT

- 2 resettable manual triggers with diaphragms
- 2 optical smoke detectors They can be activated using an aerosol that is supplied with the panel
- 1 independent initiating detector fitted with a maintenance-free battery (3 hours autonomy)
  - with reset push-button
  - with operating test push-button
- 1 door with electric bolt
- 1 viewing cover electrical cabinet, modular equipment.
- 220V AC power supply. Protected by a 30mA residual current and circuit breakers.
- Base on wheels, dimensions: 2000 x 750mm Height: 2000 mm.
- Dimensions of front and rear panels 1000 x 750mm
- Unit supplied fully wired, in working order, with wiring diagram, operating principle and detailed instructions for each component.

Model with a PLC software

Identical to the **GES-6**, but this **GES-6-COM** model also has a PLC to connect to the Ethernet network, using an RJ45 connector, and a highly intuitive software program that controls door opening via the PLC.

TECHNICAL FEATURES OF THE PLC

- Please refer to the features described on page 110.

FEATURES OF THE MONITORING SOFTWARE

- Offers the basic functions of a graphical monitoring tool.
- Compatible with Windows ® 2000 and XP:

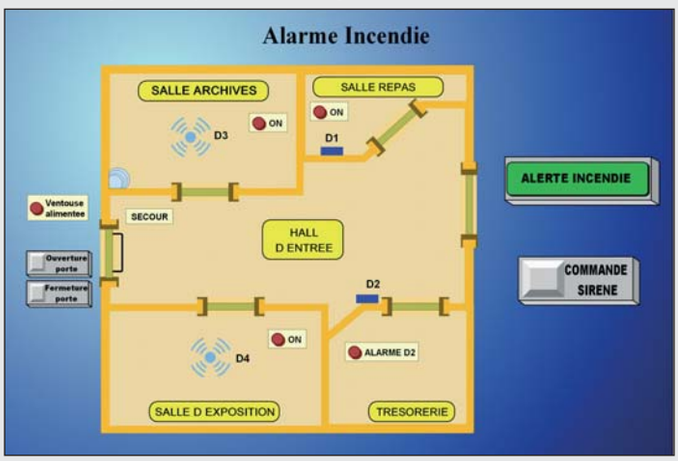
Allows you to:
- acquire and display PLC variables
- Monitor and control of process

Displays:
- opening of the emergency exit
- power supply to the electric bolt
- mains power on

controls:
- opening the electric door latch
- powering the siren
- Resetting the independent initiating detector

COMPATIBLE V.D.I.

SEE PAGES 119-121



The **GES-6-COM** model is supplied with:
- 1 software licence for the programming software
- 1 program for the PLC
- 1 monitoring software & 1 application software

ref. GES-6-COM

CE

Anti-intrusion unit on BUS wire

ref. GES-7

GES-7 is a programming and wiring panel for a BUS wired (two wires) anti-intrusion alarm unit. This unit monitors two areas in the business premises by means of a passive infrared sensor, a dual-technology intrusion sensor (infrared + microwave frequency) and two magnetic sensors which are triggered if the windows are opened. A keypad for entry code, which is built into the unit, activates or deactivates monitoring of the area. A second remote keypad performs the same operation remotely. A contacts/BUS wiring interface makes it possible to connect any type of sensor with a contact opening onto the BUS network.
A stand-alone fire sensor is supplied with the GES-7.

Supplied with 2 detectors and 1 fire detector

Students build the interconnections and carry out the programming between the unit on the one hand and the various sensors, keypads for code entry and siren on the other hand. All of the outputs are marked and attributed to a terminal where the wiring takes place.

TECHNICAL FEATURES AND EQUIPMENT

- 1 BUS unit monitors two areas and displays the events log. The built-in keypad activates and deactivates monitoring. 10 different codes: 1 master, 1 installer, 8 users.
- 1 radio keypad (information + controls) fitted with an LCD display.
- displays the system status
- controls the activation and deactivation of monitoring
- customises the installation by clearly naming the system elements on an alphanumeric keypad.
- 1 siren with four different tones (intrusion – fire – technical – emergency)
- 1 dual technology intrusion sensor (infrared + microwave frequency). 12m range (90°)
- 2 break contacts for protecting access points (doors and windows, etc.)
- 1 8 contacts/BUS interface for connecting contact sensors to the network.
- 1 optical smoke detector, with its own aerosol for testing purposes.
- 1 viewing cover electrical cabinet and modular equipment.
- 220V AC power supply. Protected by circuit breakers, including one 30mA residual current circuit breaker.
- Base on wheels, dimensions: 750 x 670mm Height: 950mm
- White melamine panel. Dimensions: 1000 x 750mm.
- The unit is supplied fully wired, in working order, with a wiring diagram, operating principle and detailed instructions for each component.

BUS unit monitor

Keypad

Siren

Detector

CE

Anti-intrusion unit on telephone line

Front panel

Rear panel

ref. GES-8

GES-8 is a programming and wiring panel for an anti-intrusion alarm unit. This unit monitors three areas in the business premises by means of a passive infrared sensor, a dual technology intrusion sensor (infrared + microwave frequency) and a magnetic sensor triggered if the window is opened.
A keypad for entry code, which is built into the unit, activates or deactivates monitoring of the area. A second remote keypad performs the same operation remotely.
A transmitter associated with a telephone interface reports triggering of the alarm via the remote telephone. The transmitter is easy to program, thanks to its built-in keypad.

Supplied with 2 detectors and 1 fire detector

IMPORTANT: *The panel is fitted with a stand-alone telephone line. Commands sent from the telephone set that is supplied with the system are not routed via the school's telephone network or via the public telephone network.*

Students build the interconnections and carry out the programming between the unit on the one hand and the various sensors, keypads for code entry, automatic switchboard, transmitter and siren on the other hand. All of the outputs are marked and attributed to a terminal where the wiring takes place.

TECHNICAL FEATURES AND EQUIPMENT

- 1 wired unit with 3 areas. Controlled from the unit, locked by a key or by the remote keypad for code entry.
- 1 2-output keypad for code entry with inverter, 2 free lamps, 1 master code, 1 duress code and 45 user codes.
- 1 internal siren
- 1 passive infrared sensor with a 12m range.
- 1 dual-technology intrusion sensor (infrared + microwave frequency), with a 10m range
- 1 break contact
- 1 telephone
- 1 telephone interface
- 1 telephone transmitter which carries out all the transmission and reception functions of the alarm, voice assistance and interphone dialogue.

- 4 programmable telephone numbers
- message which can be personalised
- built-in keypad for activating and deactivating monitoring and for programming telephone numbers.

- 1 optical smoke detector with its own aerosol.
- 1 viewing cover electrical cabinet and modular equipment.
- 220V AC Power supply. Protected by circuit breakers, including one 30mA residual current circuit breaker.
- Base on wheels, dimensions: 750 x 670mm Height: 950mm
- White melamine panel. Dim. 1000 x 750mm.
- The unit is supplied fully wired, in working order, with wiring diagram, operating principle and detailed instructions for each component.

Electrical cabinet

Wired unit with 3 areas

Remode keypad

Telephone transmitter

CE

Wireless anti-intrusion unit

ref. GES-9

GES-9 is a panel used for studying and programming a wireless anti-intrusion alarm unit with a built-in siren. The unit is fitted with a passive infrared sensor, a dual intrusion sensor (infrared + microwave frequency) and a magnetic sensor which is triggered if the window is opened. The keypad for code entry enables or disables the alarm remotely. A transmitter associated with an automatic switchboard reports any triggering of the alarm via a remote telephone. The transmitter is easy to program, thanks to its built-in keypad.
A stand-alone fire sensor is supplied with the GES-9.

Supplied with 2 detectors and 1 fire detector

IMPORTANT: *The panel is fitted with a stand-alone telephone line. Commands sent from the telephone set that is supplied with the system are not routed via the school's telephone network or via the public telephone network.*

Students program the unit, the various sensors, the keypad for code entry, the siren, the automatic switchboard and the transmitter.

TECHNICAL FEATURES AND EQUIPMENT

- 1 radio unit fitted with a siren which can be disabled. 4 programmable tones (intrusion, fire, technical and emergency).
- 1 radio keypad for receiving information and remote control, with LCD display: activation and deactivation. Fully on and partially on. 3 access codes: 1 master, 2 users. Log of the last 200 events. Information about the system status: activated and deactivated, open doors, etc. Siren test. System configuration. Allocation of sensors to partially on.
- 1 infrared sensor. 12m range
- 1 dual technology intrusion sensor: (infrared + microwave frequency)
- 2 break contacts for protecting access points (doors and windows, etc.)
- 1 optical smoke detector with its own aerosol.
- 1 telephone interface
- 1 telephone
- 1 telephone transmitter carries out all the alarm transmission and reception functions. Voice assistance and interphone dialogue. 4 programmable telephone numbers. Message which can be personalised. Built-in keypad for activating and deactivating monitoring and for programming telephone numbers.
- Base on wheels, dimensions: 750 x 670mm Height: 950mm
- White melamine panel. Dim. 1000 x 750mm.
- The unit is supplied fully programmed, in working order, with a wiring diagram, operating principle and detailed instructions for each component.

Radio unit

Keypad

Telephone transmitter

Detector

CE

Didactic lift

The ASC89 lift is a model which may be connected to a PLC or some microprocessors.
It comprises 24 outputs and 21 inputs.
You can only use a part of input/outputs if you want to do easy programmes

MAIN FEATURES :

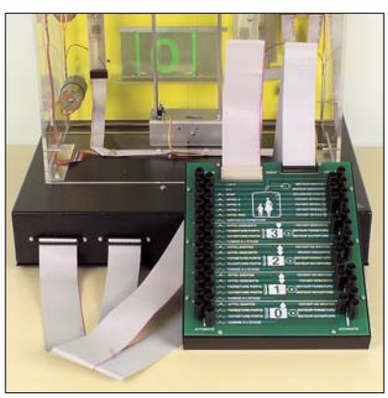
- Opening and closing of the doors on each floor is done by electric servo motors.
- The rear of the lift is visible through the sides and the bottom which are transparent
- The route of the lift is sensed at each floor by a photo-detectors.
- Two limit switches, high & low, (without program control) stop the lift if there is an error in the program.
- All of the buttons and switches are fitted with de-bounce circuits.
- The outputs are protected against the possibility of a short-circuit.
- The rear sliding door is of a transparent Plexiglass design and there is no manual access possible, as there is risk of damaging the servomotor.
- The mechanical controls are sturdy and can withstand any likely faults.

ref. ASC89-24 LOGIC ON 24V

ref. ASC89-05 LOGIC ON 5V

4 LEVELS EACH LEVEL HAS	1 electrically opening door - 1 photo-detector for 'door closed' - 1 photo-detector for 'door-open' 2 safety limit switches for door open/close (No control from the program possible) 1 button to call the lift 'up' (except the 3rd floor) with indicator lamp. 1 button to call the lift 'down' (except the ground floor) with indicator lamp 1 lamp to indicate the presence of the lift - 1 photodetector to indicate the presence of the lift
CONTROLS INSIDE THE LIFT	4 buttons for each floor - 1 stop button 1 switch to simulate a blocked door 4 lights for each floor - 1 light inside the lift (simulating the lighting)
UNIT SUPPLIES POWER TO	the motors - the LED - internal logic to the unit.
OTHERS SPECIFICATIONS	Dims 780 x 480 x 440mm Weight 15kg Supply 220V The unit is available in two driving logic values, 24V or 5V.

OPTION INTERFACE FOR DIDACTIC LIFT

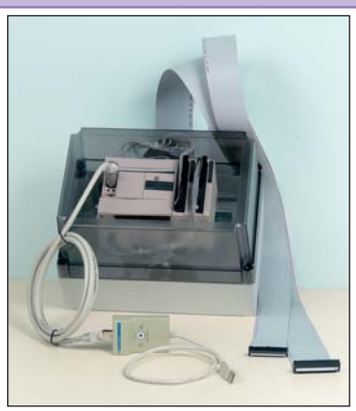


ASMAT is an interface allowing a quick connection to the ASC89 lift from a PLC. To help in quickly identifying the functions of the connectors, small symbol and piece of text next to each connector, allowing immediate understanding of its function. The operating sense: Lift - PLC or PLC - Lift. It is clearly indicated by vertical arrows.
Metal box: 22x272x32mm. Weight: 250g.

CONNECTION ASMAT - LIFT	CONNECTION ASMAT - PLC
Two flat cables are fitted. One connector for the inputs and the other for the outputs.	The front face of the board has two columns of 4mm plugs, which are used to connect to the PLC with normal leads. The plugs on the left are for the inputs to the PLC, on the right for the outputs.

ref. ASMAT

OPTION PLC FOR DIDACTIC LIFT



AUTOMASC is delivered in a plastic box including:

- a 30 inputs / 26 outputs PLC (dry contacts)
- an interface for the lift
- supplies for the PLC outputs
- All cables to the lift, mains cord.

AUTOMASC is connected to the lift rear connectors with 2 flat cables, one for inputs, the other one for outputs.

PROGRAMMING
User can program AUTOMASC with 2 languages: Instructions list or contact language. You can program it from PC, using the Télémécanique® TWIDO suite software (included)

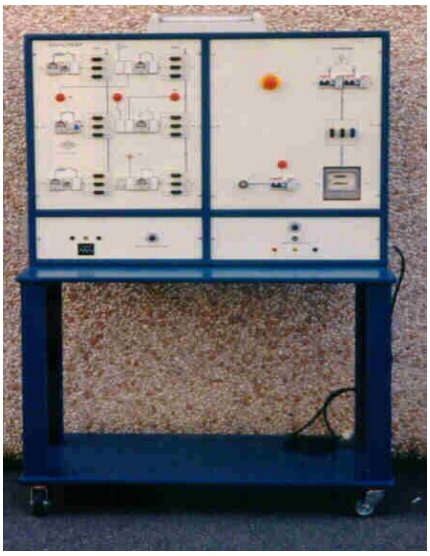
OTHER FEATURES
The front panel is transparent to see many LED, showing the PLC state. AUTOMASC is supplied with a demo program, which can be modified or completed. The technical leaflet indicates the corresponding between the lift inputs and outputs and the ones of the PLC, allowing the development of a complete program.
Mains: 220/240V - 50Hz - 50VA
Dimensions: 350 x 190 x 170 mm
Weight: 2.7kg

ref. AUTOMASC

CE

RESIDENTIAL INSTALLATION TRAINER TYPE PANN-RESID

The trainer of residential installation type PANN-RESID allows studying the electrical installation as wiring, measurements and certification. It was realized with the purpose to train the students to the installation, the test and the certification of residential electrical installation. The equipment allows to create a residential electrical installation, which simulates the real electrical installation of a house, makes the controls and the measurements regarding the performance and the electrical security according to the standards law and issues the relative certification. The trainer is divided into 2 sections.



POWER SUPPLY SECTION

Power supply cable, Differential thermo magnetic general switch with high sensitivity, indication red lamp voltage. Single-phase electronic energy meter 16 A / 250 V, Thermo magnetic switch range 10 A complete of differential high sensitivity 30 mA, Line simulator equivalent about 20 m of cable having section 2.5 mm^2, thermo magnetic switch range 16 A complete of differential with high sensitivity 30 mA. Connection box to separate the electrical plant. Earth resistance simulator equipped with switches 1-2-3-4 for earth resistance value setting.

ELECTRICAL INSTALLATION SECTION

- No. 6 connection boxes to separate the different sections of electrical plants and measurement instruments insertion.
- No. 6 plugs for connection to external loads
- Internal load power 500W to simulate the household appliance loads etc. ... ...
- Cooling fan placed on the back.
- Differential high sensitivity (10 mA) for bathroom protection
- N. 3 internal incandescence lamps.
- Halogen lamp 12 V 50 W equipped with transformer and electronic brightness regulator.
- Fluorescence lamp
- Simulator of insulation resistance with 4 switch positions to set the values of insulation resistance.

On the 2 sections it is possible to create a residential electrical plant, inserting the household appliances, the light points etc.. .
The teacher, through the suitable switches, can set up some values of unknown earth and insulation values

- **Verify of the continuity of the protection conductor**
- **Earth resistance measure**
- **Loop ring resistance measure**
- **Insulation resistance measure**
- **Verify of the drop of voltage in a plant**
- **Power factor correction**
- **Verify of the functionality of the differentials**
- **etc.. . etc.. . depending on the teaching methodology .**

User manual included.

SUGGESTED ACCESSORIES:

- Step single-three phase RLC load of 1 KW to be added to the load already included in PANN-RESID to increase the loads that simulate household appliances etc.
- Multifunction instruments for measurements and tests (earth, insulation and differentials)

Dimensions of panel complete of basement to be placed vertically on the bench: 850x450x700 (h) mm
The trainer is supplied with set of necessary cables for tests and jumpers.

Power supply: 230 V – 1000 VA

STUDY AND TESTING ON DISTRIBUTION SYSTEMS (position of neutral conductor) TYPE PANN/DISTRIB

Demonstration panel with electric components.
The panel is made of insulating material and it represents the support for the necessary devices for carrying out the testing program. The apparatuses are represented on the panel with their standardized international symbols. The field of application of these devices includes both civil installations and those of business and/or production (craftindustrial) sectors.

This panel is designed to study the distribution systems of electric power with reference to the main topics indicated here below:
• TT, TN and IT systems
• Protection against direct contacts by earthing, electric separation, differential circuit breaker
• Protection against overcurrents, selectivity in protection devices
• Earthing system and conductors
• Natural and artificial earth plates
• Supervision of insulation resistance in systems isolated from earth (IT)
• Suitability of materials and equipment
• Protection and breaking devices

This panel enables to carry out the following testing and measurements with instruments:
• Identification of neutral and earth conductors
• Measurement of insulation resistance
• Measurement of earth resistance
• Continuity tests of protection conductors
• Analyzing the functionality of differential breakers
• Measurement of resistance/impedance of fault loop
• Measurement of first earth fault current in isolated systems

TECHNICAL SPECIFICATIONS:

Framework is made of sheet steel chemically treated and painted with several coats of epoxy varnish; its base is provided with rubber feet and it can be positioned on a working top. All the necessary electric components for the correct power supply of circuits are included in the panel.
Here are the main components installed and accessible, electrically, via safety terminals for plugs with diameter of 4 mm:
• 1 three-phase insulation transformer
– 230-400 V / 230-400 V; 1500 VA
• 1 differential circuit breaker – 4 x 6 A; curve C with minimum voltage releasing coil, stop/emergency button with mechanic holding and signalling LED on operation panel
• 1 power line of 230 Vac -1 A for powering auxiliary devices
• 1 three-pole lever selector for inserting two different values of capacitance to earth in IT line

• 1 simulation of substation earthing with resistances of 0.3 Ω, 1 Ω
• 1 simulation of earth plate with resistances of 2 Ω, 20 Ω, 200 Ω, 2 kΩ
• 2 simulators of power consuming devices with sinusoidal or unidirectional earth fault current; fault resistance of 50 kΩ, 15 kΩ, 5 kΩ, 1.5 kΩ, 500 Ω, bolted fault
• 1 monitor for checking the isolation in IT systems with adjustment of the value of tripping sensitivity, and scale for monitoring the instantaneous value of insulation resistance of the installation
• 1 differential circuit breaker 4 x 2 A, curve C, provided with remote opening current start-up coil
• 1 four-pole differential circuit breaker of 25 A / 0.3 A, class A, "S" selective
• 1 set of three fuse holders, with breakable neutral conductor and fuses 10.2 x 38 of 1 A and 2 A
• 1 automatic magnetothermal differential switch 2 x 1 A, curve C, class AC, with possibility of using the only magnetothermal switch without the differential part
• 1 automatic magnetothermal differential switch 2 x 1 A, curve C, class A, with possibility of using the only magnetothermal switch without the differential part
• 1 differential relay coupled to a toroidal transformer with adjustable current Idn and tripping time

Dimensions of panel complete of basement to be placed vertically on the bench: 850x450x700 (h) mm
The trainer is supplied with set of necessary cables for tests and jumpers.

SUGGESTED ACCESSORIES:

- Multifunction microprocessor instrument for electric testing
- Digital current probe for measuring currents.
- Portable digital autorange multimeter

Power supply: 3x400 V + neutral (50-60 Hz)
Max absorption: 1500 VA

DCM340
Digital clampmeter

- **DC and AC current and voltage**
- **600 A and 600 V**
- **Resistance and continuity**
- **3½ digit, 4000 count display with backlight**
- **High resolution digital bargraph**
- **Peak, min/max and data-hold functions**

DESCRIPTION

The DCM340 is a highly versatile instrument and ideal for use in the installation, maintenance, monitoring or checking of a.c. or d.c. electrical systems and equipment.

There are four instruments in the DCM series of clampmeters, including the 400 A a.c. current-only DCM310; the DCM320 which includes voltage and resistance measurement; the DCM330 Fork-Multimeter, which is an open fixed jaw design; and this, the DCM340. Capable of measuring a.c. and d.c. current up to 600 A; a.c. and d.c. voltage up to 600 V; resistance up to 400 Ω; and frequency up to 400 Hz, the DCM340 is the most versatile in the range.

Current measurement combined with the comprehensive and accurate multimeter functions of the DCM340 eliminate the need to carry around both a clampmeter and multimeter – this instrument does it all.

The large clear digits of the numeric display are complemented by the high-resolution digital bar graph, useful for indicating trending and fluctuation of measurement. The backlight assists use in poorly lit areas such as distribution cupboards and corners of switchrooms; and the data-hold feature enables use on difficult access cables where otherwise the display may be impossible to see.

Min/Max hold provides the ability to store the maximum and minimum d.c. or rms values over a period of time. While storage is taking place, either the present, maximum or minimum value can be displayed. Peak hold stores the maximum and minimum peak value of an a.c. signal at a 10 ms sample rate. The auto-off feature automatically places the meter in power-save mode after 30 minutes from power-on, but this can be disabled if required for min/max measurements.

Using the Relative mode (REL), a stable value can be stored, the instrument zeroed at that point, and then any variation from that value is displayed as a direct measurement relative to it.

The DCM340 is safety rated to IEC 61010-1 Cat III 600 V, and is drop-tested to 1.2 m onto a hard floor. It is supplied with test leads and a carry case, and a full 1-year manufacturer's warranty.

APPLICATIONS

The DCM340 is designed to be used on electrical systems and equipment where there is a need to measure current, volts, resistance and frequency. It is therefore intended for use while installing, maintaining, fault-finding or monitoring those systems.

The min/max and peak-hold enable maximum load currents from equipment to be identified such as start-up currents to motors and heaters.

With the added benefit of d.c. current measurement, it can also be used in applications including domestic power generation from solar panels and wind-turbines; battery monitoring; automotive uses for charging and load circuits; electric vehicle servicing such as fork-lift trucks; lift maintenance; UPS commissioning, servicing and maintenance; electro-plating plants and welding equipment servicing.

SPECIFICATION

Base specifications only. For detailed specification, refer to User Guide

All accuracies specified at 23°C ±5° <80%Rh

AC Current

Range	Accuracy 50 - 60Hz	Accuracy 61 - 400Hz
0-60.0 A	±1.9% ±7 digits	±2.5% ±7 digits
60.0 - 400.0 A	±1.9% ±5 digits	±2.5% ±5 digits
400 - 600 A	±2.5% ±5 digits	±2.9% ±5 digits

DC Current

Range	Accuracy
0 - 60.0A	±1.5% ±10 digits
60.0 - 400.0A	±1.9% ±5 digits
400 - 600 A	±1.9% ±10 digits

Voltage

Range	50 - 500Hz Accuracy	DC Accuracy
0 - 400.0 V	±1.0% ±5 digits	±0.7% ±2 digits
400 - 600 V	±1.0% ±5 digits	±0.7% ±2 digits

Input impedance: 1 MΩ // < 100pF

Resistance and Continuity

Range	Accuracy
0 - 400.0 Ω	±1% ±3 digits

Open circuit voltage: 3 V

Continuity Check: beeper sounds @ < 30 Ω

Frequency

Range	Resolution	Accuracy
20 - 400 Hz	1 Hz	±0.1 % ±2 digtits

Sensitivity: 3 A

Peak Hold: ±3% ±15 digits

Sample time: 10 ms

MIN/MAX Hold: add 15 digits to accuracy for a.c. & d.c. A

Positional error: ±1% of reading

Overload protection: 600 V & 600 A rms

AC conversion: Average sensing rms indication calibrated to the rms value of a sine wave input

Auto power-off: 30 minutes after power-on

LCD

Display: 3½ digit large-scale readout

Count: 40,000

Sample Rate: 1.5 per second

Overrange: "OL"

Power Requirement

1 x 9V PP3 MN1604 6LR61 alkaline cell

Battery life: 200 hours (alkaline)

Operating Temperature

0°C - 30°C <80% Rh

30°C - 40°C <75% Rh

400°C - 50°C <45% Rh

Storage Temperature

-20°C - +60°C (<81% Rh)

(batteries removed)

Safety

Overvoltage safety category: IEC 61010-1 600V CAT III

Operating Altitude: 2000 m

Drop-protection: 1.2 m onto a hardwood surface

Jaw size/maximum conductor: 35 mm diameter

Calibration period: 12 month recommended

Dimensions 68 mm (W) x 237 mm (H) x 42 mm (D)

Weight 225 g including batteries

ORDERING INFORMATION

Item (Qty)	Order Code
DCM340 Digital clampmeter; 600 A ac & dc; 600 V a.c. & d.c.; 400 Ω; 400Hz	1000-305
Included accessories	
Batteries	
Pouch	
Test leads	
User guide	
Replacement test leads	
Red/black test leads with croc clips	6220-779
Red/black fused test leads (500 mA) with croc clips	6220-789

DET14C and DET24C
Digital Earth Clamps

- **Elliptical clamp shape improves access to earth cables and straps up to 50 mm**
- **Low maintenance flat jaw interface**
- **Measures ground resistance from 0.05 Ω to 1500 Ω**
- **Measures true RMS ground leakage current from 0.5 mA rms to 35 A rms**
- **CAT IV 600 V safety rating**
- **Backlit LCD display**

DESCRIPTION

The DET14C and DET24C represent a new generation of earth/ground clamp-on resistance testers. These instruments induce a test current into earth systems and measure ground resistance in multi ground installations without needing to disconnect the ground. They offer market leading access, advanced features, simple operation and CAT IV 600 V safety protection.

Designed with flat core ends they prevent dirt build up, ensuring measurement integrity and improved reliability over products with interlocking teeth. Other enhancements over current generation products include improved accuracy and up to 300% increase in battery life. In electrically noisy environments the built-in filter function offers increased noise immunity.

DET14C and DET24C also offer a true RMS AC current measurement facility up to 35 Amps. The instrument's ability to measure current flowing in an earth cable is a useful safety feature, especially if the earth cable has to be disconnected. A high current flow to earth could draw an arc on disconnection with potentially severe consequences.

The elliptical shaped head design offers improved access to cables and earth straps in space constrained locations. The clamp head accommodates up to 37 mm diameter cable and 50 mm earth tapes making them suitable for use in power stations, substations, towers and many more facilities. Operation in dark and restricted areas is facilitated by a display with backlight and an audible tone associated with the hold key. Optimised jaw opening mechanism ensures proper jaw closure without excessive use of force when opening the jaws.

The DET14C offers storage of results for later on-screen recall and the DET24C supports a download of results via IrDA-to-USB link into PowerDB and Power DB Lite, Megger's acceptance and maintenance test data management software. Stored data is indexed using a sequential serial number together with a time and date stamp for each record.

FEATURES AND BENEFITS

- Auto-current measurement safety feature
- Memory to record and view results
- Automatic self calibration
- Auto ranging
- High and low alarms
- Real time clock for date and time stamping of results

DET24C ADDITIONAL FEATURES

- IrDA USB interface to PC
- Advanced memory functionality with download
- Megger PowerDB/PowerDB Lite™ compatible

APPLICATION

The earth resistance clamp meters are particularly suitable for measuring earth resistance in various installations such as buildings, pylons and RF transmitter sites without system disconnection. In addition, they can be used for the inspection and verification of lightening protection systems and virtually any installation where a current loop can be generated.

SPECIFICATIONS

Resistance measurements

Ground resistance range	Resolution	Intrinsic certainty
0.05 Ω to 0.99 Ω	0.01 Ω	±1.5% ±0.05 Ω
1.00 Ω to 9.99 Ω	0.01 Ω	±1.5% ± 0.1Ω
10.0 Ω to 99.9 Ω	0.1 Ω	±2% ± 0.5 Ω
100.0 Ω to 199.9 Ω	0.1 Ω	±5% ± 1 Ω
200 Ω to 400 Ω	1 Ω	±6% ± 5 Ω
400 Ω to 600 Ω	1 Ω	±10% ± 10 Ω
600 Ω to 1200 Ω	10 Ω	±20%
1200 Ω to 1500 Ω	10 Ω	±35%

- Frequency of measurement 1390 Hz.

Alarm settings

Alarm type	Range	Resolution
Threshold 1	1 Ω to 1500 Ω	1 Ω
Threshold 2	1 Ω to 1500 Ω	1 Ω

Current measurements (RMS)

Current range	Resolution	Intrinsic Certainty
0.5 mA to 0.99 mA	0.01 mA	±2% ±0.05 mA
1.00 mA to 9.99 mA	0.01 mA	±2% ±0.05 mA
10.0 mA to 99.9 mA	0.1 mA	±2% ±0.1 mA
100 mA to 999 mA	1 mA	±2% ±1 mA
1.00 A to 9.99 A	0.01 A	±2% ±0.01 A
10.0 A to 35.0 A	0.1 A	±2% ±0.1 A

- True RMS readings up to a crest factor of 5.0 (peak current 40 A).
- Accuracy guaranteed for 50 Hz and 60 Hz.
- Measurement over the range 16 Hz to 400 Hz.
- Maximum current is 100 A rms continuous and 200 A rms for 60 s max at 50 Hz and 60 Hz

Maximum jaw opening	39 mm
Maximum jaw inner dimensions	39 mm x 55 mm
Display type	4 + 6 digit with backlight
Battery type	4 x 1.5 V IEC LR6/AA alkaline
Battery life	24 hours continuous testing – see Note 1
Auto power down	300 s (reset by jaw action or button press)
Data logging	DET14C 256 records DET24C 2 k records
Data download (DET24C only)	Opto-coupled IrDA-USB interface
Range selection	Automatic within each mode
Sample time	< 1 s
Hold function	Yes with visual indicator
Alarm function	Yes with visual indicator
Warning buzzer	Yes
Operating temperature and humidity	-20 °C to +50 °C, <85% RH
Storage temperature and humidity	-40 °C to +60 °C, <75% RH
Weight	985 g
Instrument dimensions	248 mm (l) x 114 mm (w) x 49 mm (h)
IP rating	IP30 with jaws closed

Note 1: Whilst measuring a 25 Ω resistance without backlight

Performance
IEC 61557-5
IEC 61557-13 Class 1

Safety

EN 61010-2-032

CATIV 600 V
Pollution degree 2

EMC

Class B Compliant, IEC 61326, BSEN 61326

ORDERING INFORMATION

Product	Order Code
DET14C Digital earth test clamp-on meter	1000-761
DET24C Digital earth test clamp-on meter	1000-762
Included accessories for DET14C and DET24C	
Carrying case	1001-715
Carrying strap (wrist loop)	1001-716
User guide CD-ROM	1001-198
Calibration check	1001-498
Battery AA (Alkaline) (4 required)	25511-841
Included accessories for DET24C	
USB IrDA dongle	90001-434
PowerDB Lite software	1000-576

N ISO
Registered to ISO 9001:2008 Cert. no. Q 09250
Registered to ISO 14001-2004 Cert. no. EMS 61597

DET14C_DET24C_DS_EN

AVO410
Digital Multimeter

- **6000 count backlit digital display**
- **True RMS reading on AC mode**
- **1000 V DC / 750 V AC ranges**
- **10 A AC / DC ranges**
- **Resistance, frequency and capacitance ranges**
- **CAT IV 600 V**

DESCRIPTION

The Megger AVO410 digital multimeter has been designed for the contracting electrician and has the additional features that also make the instrument suitable for wide range of applications and users.

The instrument offers AC and DC voltage and current measurements as well as resistance, frequency and capacitance ranges. True RMS readings on the AC functions are standard on the AVO410 and the instrument features a CATIV 600 V safety rating meaning the instrument is suitable for industrial applications.

The slim, compact case has a tough rubberised holster that provides that extra degree of protection from the extreme conditions found in industrial environments. The style of the case and positioning of the function switch and buttons means the unit sits comfortably in the palm for single handed use.

Continuous references to the user guide have been avoided by the AVO410 utilising simplified functions.

The display features a back light that allows measurements to be made in poorly lit areas.

The AVO410 test leads are supplied with silicon cable and have GS38 compliant shrouded tips on the prods.

Auto-ranging

When first selected, all functions are auto-ranging. A range button on the AVO410 allows multiple manual range selection on each function; a feature that is generally welcomed by many users.

Minimum / Maximum measurements

The instrument has a MIN MAX function that allows the user to switch between minimum and maximum measurements. The display does not have to be continually monitored to capture a momentary increase or fall in readings.

Data hold

This function allows a displayed result to be frozen on the display which avoids having to remember a measurement value. The hold function can be nested within the MIN MAX feature which stops the AVO410 continuously updating the minimum and maximum measurement values.

Voltage measurements

Both AC and DC voltage measurements up to 750 V and 1000 V respectively are possible with the AVO410, the AC reading being a true RMS value.

Current measurements

For current measurements up to 10 A, a separate fused terminal is provided to protect both user and instrument from excess current.

RS232

The AVO410 has optically isolated RS232 interface that allows the user to connect to a PC via a USB port for data acquisition and analysis. (Optional software is required for this function).

Continuity / diode testing

The continuity function features a buzzer and provides the user both optical and audio indication of identifying and confirming continuity between two points. This function also allows forward and reverse bias testing of diode and semiconductor junctions.

Resistance, capacitance and frequency

Resistance can measured directly on the ohms range from 0 to 60 MΩ with capacitance measurements from 0 to 6.000 mF. In addition, frequency measurements from 0 to 60 MHz are possible.

SPECIFICATIONS

Display 6000 counts updates 1.5/sec.

Polarity indication Automatic, positive implied, negative indicated

Over-range indication "OL" or "-OL"

Low battery indication Displayed when the battery voltage drops below operating voltage

Auto power off Approx 10 minutes

Operating ambient Non-condensing ≤10 °C, 11 °C ~ 30 °C (≤80% R.H)
31 °C ~ 40 °C (≤75% R.H), 41 °C ~ 50 °C (≤45% R.H)

Storage temperature -20 °C to 60 °C, 0 to 80% R.H. when battery removed from meter

Temperature coefficient 0.15 x (Spec.Acc'y) / °C, <18 °C or >28 °C

Safety

The instrument complies with IEC61010 CATIV 600 V

Power requirements

Standard 9 V battery PP3, NEDA 1604, IEC6F22, JIS006P

Battery life Alkaline 300 hours

Dimensions (W x H x D)

76 mm x 158 mm x 38 mm without holster
82 mm x 164 mm x 44 mm with holster

Weight

522 g

ELECTRICAL SPECIFICATIONS

Accuracy is ± (% reading + number of digits) at 23 °C ±5 °C, less than 80% R.H.

DC / AC Volts

Range	DC accuracy	AC accuracy
600.0 mV	± (0.5% + 2 digits)	50 Hz/60 Hz sine wave only for 600.0 mV range, ± (0.9% +5 digits) 50 Hz ~ 500 Hz *1
6.000		
60.00 V		
600.0 mV		
DC 1000 V/AC 750 V		

Over voltage protection DC 1000 V or AC

Input impedance 10 MΩ // less than 100 pF

CMRR/NMRR

(Common mode rejection ration/normal mode rejection ratio)
VAC: CMRR >60 dB at DC, 50 Hz/60 Hz
VDC: CMRR >100 dB at DC, 50 Hz/60 Hz
NMRR: >50 dB at DC, 50 Hz/60 Hz

AC conversion type

AC conversions are AC coupled True RMS responding, calibrated to the sine wave input.

*1) The basic accuracy is specified for a sine wave below 4000 counts. Over 4000 counts, add 0.6% to the accuracy. For non-sine waves below 2000 counts, refer to the following for accuracy:

±1.5% addition error for C.F from 1.4 to 3

Crest factor

C.F. = Peak/rms

DC/AC current

Range	DC accuracy	AC accuracy	Voltage burden
600.0 µA	± (1.0% + 2 digits)	N/A	<4 mV/µA
6000 µA			
6.000 A		±(1.5% +6 dgt) 50 Hz ~ 500 Hz *1	2 V max
10.00 A			

Overload protection

A input 10 A (500 V) fast blow fuse
µA input 600 V rms

*1) AC conversion type

Conversion type and additional specification are the same as DC/AC voltage.

Resistance

Range	Accuracy	Overload protection
600.0 Ω *2	± (0.7% + 2 digits)	600 V rms
6.000 KΩ		
60.00 KΩ		
600.0 KΩ		
6.000 MΩ ±(1.0% +2 digits)	± (1.0% + 2 digits)	
60.00 MΩ *1	± (1.5% + 2 digits)	

Open circuit voltage -1.3 V approx.
*1 <100 digit rolling
*2 <10 digit rolling

Diode check and continuity

Range	Resolution	Accuracy
Diode	10 mV	± (1.5% + digits*

* For 0.4 V ~ 0.8 V

Max. test current 1.5 mA
Max. open circuit voltage 3 V
Overload protection 600 V rms
Continuity
Built-in buzzer will sound when the resistance is less than 500 Ω approx. Response time is 100 ms approx.

Frequency

Range	**Sensitivity	Overload protection
6000 Hz	100 mV rms *	Frequency: 0.1% ±1 digit
60.00 KHz		
600.0 KHz		
6.000 MHz	250 mV rms	
60.0 MHz	1 V rms	

Overload protection 600 V rms
* Less than 20 Hz, the sensitivity is 1.5 V rms
** Max. sensitivity <5 V ac rms

Capacitance

Range	Accuracy
6.000 nF	± (1.9%) +8 digits)
60.00 nF	
600.0 nF	
6.000 µF	
60.00 µF	
600.0 µF	
6.00 mF*	

Overload protection 600 V rms
* <100 digit of reading rolling

Auto power OFF (APO)
If idle for more than 10 minutes

ORDERING INFORMATION

Item (Qty)	Cat. No.
AVO410 digital multimeter CAT IV 600 V	1001-613
Included accessories	
Test leads and probes	

CERTIFICATION ISO
Registered to ISO 9001:2008 Cert. no. Q 09250
Registered to ISO 14001-2004 Cert. no. EMS 61597

MFT1800
Multifuction Tester

- **Simple colour-coded test selection and large clear backlit display for ease of use**
- **Two wire non trip loop testing for fast repeatable results**
- **Phase rotation indication for verification of rotating machinery**
- **Type-B RCD and 3-phase RCD testing for industrial applications with no Earth**
- **3-terminal Earth test and Stakeless testing for spike resistance measurement**
- **EN61010 CATIV safety ratings and tough IP54 case**

DESCRIPTION

The MFT1800 range consists of 3 instruments designed for testing low voltage electrical installations. They provide all the tests required to complete the necessary electrical certification for industrial, commercial and domestic fixed wiring installations, including:

- System voltage and frequency measurement (TRMS AC + DC)
- Insulation test at 100 V, 250 V, 500 V and 1000 V
  - Including input protection against live circuits up to 600 V even when Insulation Test is locked-on
- Continuity resistance at 200 mA or 15 mA
  - Automatic – no need to press TEST so leaving both hands free
- Resistance range 0.01 Ω to 100 kΩ
  - With fast continuity buzzer and selectable thresholds
- 2-wire Loop test
  - Non-trip (RCD) and high-current testing
  - Including Phase-to-Phase
- Prospective fault current measurement
  - Up to 40kA Phase-to-Phase
  - Increased resolution
- RCD testing including:
  - Type AC, A, S, B and programmable RCDs
  - 1/2 x I, 1 x I, 2 x I and 5 x I
  - 3-phase RCDs
  - Fast ramp test
  - Auto-test routine
  - Fault (Touch) voltage display
- Earth testing
  - 2-pole,
  - 3-pole
  - ART
  - Stakeless techniques

All instruments are IEC 61010 CAT IV 300 V rated for connection to low voltage systems with no protective device, so safe for connection anywhere on the system up to the source transformer without risk of damage from the large transient spikes which are possible up to the limit of IEC 61010 CAT IV definitions.

The unique modern styling allows it to be operated while stood on the floor, a ladder-shelf or platform, hung around the neck or held in the hand. Dual TEST and LOCK buttons – one pair at each end – make the testers easy to operate left or right handed.

Quick to pick up and use, the rotary controls are colour coded to make range selection easy and fast. They also reduce the chance of using the wrong function or range. The large crystal clear backlit display uses the patented Megger digital/analogue arc, providing indication of fluctuating readings while the dual digital display shows precise values of key measurements. The dual display shows test para-meters simultaneously with the measured value, such as the output voltage on insulation testing as well as the resistance value in MΩ.

Visible and audible safety warnings are paramount when testing high-energy systems, and the MFT1800 range includes full input protection and safety warnings when a hazardous voltage is encountered. If live voltages exist on a circuit during insulation or continuity testing, the voltage is displayed on the screen. If this voltage exceeds a safe level, further testing is inhibited and a warning beep sounds for extra safety.

Megger

MFT1800
Multifunction Tester

For intensive users the MFT1830 features internally rechargeable batteries and charger with a charge time of less than 4 hrs.

Future proof and fully compliant with all requirements of Harmonised Document 60364 derived standards including VDE 0100 and BS 7671, the new MFT includes all the latest measurement technology in a lightweight compact design and fully protected and usable on single phase and 3 phase installations.

New measurement functions include two wire non-trip loop test technology for fast repeatable results, comprehensive testing of RCDs including type B and the latest clamp-on techniques for Earth testing.

The MFT1835 includes built in memory and Bluetooth communications for downloading of memory using Megger Download Manager (supplied) for simple form filling of test results using the optional Megger PowerSuite software.

The new MFT1800 series has been designed for tough environments and ultimate reliability. Features include a rubber over mould for extra protection and grip, IP54 protection against dust and water and an EN61010 Cat IV safety rating.

Its class leading input protection ensures the new MFT can withstand accidental misuse and voltage transients when other testers can't.

All this in an intuitive and easy to use instrument with no hidden menus or complicated screens. Tests are easily selected using the colour coded rotary switches with results clearly displayed on the high contrast dual backlit display.

Included with the instrument are standard 3-wire leadset and a mains connection lead, a switched probe for fast and easy testing, a full 12-month calibration certificate and 3-year warranty for extra peace-of-mind. All this is housed in a robust moulded case with additional space for optional extras like the earth test kit, comprising 2 spikes and 3 long test leads.

SELECTION CHART

INSULATION RANGES	MFT1815	MFT1825	MFT1835
100 V			■
250 V	■	■	■
500 V	■	■	■
1000 V		■	■
Test voltage display	■	■	■
Adjustable buzzer threshold		■	■
Test lock	■	■	■
25 V or 50 V test inhibit setup option	■	■	■
CONTINUITY AND RESISTANCE RANGES			
200 mA test	■	■	■
15 mA test		■	■
Lead null	■	■	■
Adjustable buzzer threshold	■	■	■
Auto-start test	■	■	■
Auto-reverse continuity test option	■	■	■
RCD TESTS			
1/2 x I RCD test		■	■
1 x I RCD test	■	■	■
2 x I RCD test		■	■
5 x I RCD test		■	■
Auto RCD test		■	■
Fast ramp test (setup option)	■	■	■
Type AC (General purpose AC) RCDs	■	■	■
Type A (AC + pulsed-DC) RCDs	■	■	■
Type S (time-delayed) RCDs		■	■
Type B (pure DC) RCDs			■
Programmable RCD		■	■
3-phase RCD (no Earth)		■	■
10 mA RCD		■	■
30 mA RCD	■	■	■
100 mA RCD	■	■	■
300 mA RCD	■	■	■
500 mA RCD	■	■	■
1000 mA RCD		■	■
LOOP TESTING			
2-wire non-tripping L~PE	■	■	■
2-wire high current L~L & L~N	■	■	■
50 V to 480 V (L~N) 5 0V to 280 V (L~PE)	■	■	■
Phase to Phase tests (L~L)		■	■
20 kA Fault current	■	■	■
40 kA Fault current		■	■
Auto-start loop test	■	■	■
Touch-voltage inhibit (25/50/60 V)	■	■	■
Touch-voltage display (0 V~253 V)	■	■	■

	MFT1815	MFT1825	MFT1835
EARTH TEST			
2-pole*		■	■
3-pole*		■	■
3-pole + clamp (ART)*			■
Stakeless*			■
25 V and 50 V output voltage		■	■
Ground-noise voltage check		■	■
OTHER FEATURES			
AC voltage measurement	■	■	■
True RMS			■
Frequency measurement	■	■	■
Current measurement*		■	■
Phase rotation	■	■	■
Temperature measurement		■	■
Backlight	■	■	■
Auto power-down	■	■	■
Calibration certificate supplied	■	■	■
Batteries included	■	■	■
Rechargeable batteries/Chrgr included			■
Progressive battery monitor	■	■	■
SP5 Switched probe included	■	■	■
3-year warranty	■	■	■
Onboard memory with Bluetooth® download			■
CAT IV 300 V	■	■	■
IP 54	■	■	■

* additional accessories required

SPECIFICATIONS

insualtion test

Output voltage -0% +20% at rated load or less
Voltage display ±3% ±3 digits ±0.5% of rated voltage
Short circuit current 1.5 mA nominal test current
Test current on load 1 mA at min pass values of insulation

Measurement Accuracy

1000 V	10 kΩ ~ 999 MΩ	±3% ±2 digits
500 V	10 kΩ ~ 500 MΩ	±3% ±2 digits
	>500 MΩ	±10% ±4 digits
250 V	10 kΩ ~ 250 MΩ	±3% ±2 digits
	>250 MΩ	±10% ±4 digits
100 V	10 kΩ ~ 100 MΩ	±3% ±2 digits
	>100 MΩ	±10% ±4 digits

Continuity/resistance

	0.01 Ω ~ 99.9 Ω	±2% ±2 digits
	100 Ω ~ 99.9 kΩ	±5% ±2 digits

Open circuit voltage 5V ±1V
Test current (0 Ω ~ 9.99 Ω) 205 mA or 1 5mA (user selectable) ± 5 mA

Loop test

Live to earth supply 48 V ~ 280 V (45 Hz ~ 65 Hz)
Live to live supply 48 V ~ 480 V (45 Hz ~ 65 Hz)
Trip and non-trip tests ±5% ±0.03 Ω
Display range 0.01 Ω ~ 1000 Ω
Live to earth PFC range 20 kA
Live to live PSCC range 0 kA

RCD TESTS

Supply 48 V ~ 280 V (45 Hz ~ 65 Hz)
RCD type Type AC, A, S
Type B - pure dc
No trip test (1/2xI) –8% ~ –2%
Trip test (1xI, 2xI & 5xI) +2% ~ +8%

Ramp Test

Auto RCD test
Trip time ±1% ±1 ms
Trip current ±3%
Programmable step increments

10 mA ~ 50 mA	1 mA steps.
50 mA ~ 500 mA	5 mA steps
500 mA ~ 1000 mA	10 mA steps

Supply measurement

Voltage 10 V ~ 600 V (50 ~ 60 Hz) True RMS
±3% ± 1 V ±2 digits
Phase rotation indication L1–L2–L3 & L1–L3–L2
Touch voltage (0 ~ 253 V) +5% +15% ±0.5V
Frequency

15 Hz ~ 99 Hz	±0.5% ±1 digit
100 Hz ~ 400 Hz	±2.0% ±2 digit

Frequency resolution 0.1 Hz

Earth test

Resolution 0.01 Ω
Current 0.45 mA or 4.5 mA
Noise rejection 20 V pk/pk (7 V rms).
Max Probe Resistances Rp & Rc

@50 V	100 kΩ
@25 V	5 kΩ

2 & 3 pole method (0.01 Ω ~ 1.999 kΩ)
±2.0% ±3 digits
ART method (1.00 Ω ~ 1.999 kΩ)
±5.0% ±3 digits
Stakeless method (1.00 Ω ~ 199 Ω)
±7.0% ± 3 digits

Temperature (via optional probe)

Range -20 °C ~ +100 °C
Accuracy ±1.0% ± 2 digits.
Resolution 1 °C

Current (via optional clamp meter)

0.5 mA ~ 199.9 A ±5.0% ±3 digits.
Resolution 0.1 mA

ENVIRONMENTAL

Temperature (operational)	-10 °C ~ +55 °C
Temperature (storage)	-25 °C ~ +70 °C
Operating humidity	93% R.H. at +40 °C max
Max altitude	2000 m

Weight

1 kg (with batteries, excluding case)

Moisture/Dust ingress protection

IP54

Power

Primary dry cells (6 cells)	IEC LR6 type AA alkaline (supplied)
Rechargeable (6 cells)	1.2 V NiMH (optional)
On-board re-charging	Mains power or car-battery (4 hours typical)

DESIGN STANDARDS

Safety	BS EN 61010 -1:2001 600 V Cat III / 300 V Cat IV (Max Phase to Phase 600 V)
EMC	IEC61326 edition 2 location class B
Design	EN61557

ORDERING INFORMATION

Item (Qty)	Cat. No.
MFT1815-SC	1001-081
MFT1825-SC	1001-088
MFT1835-SC	1001-093
Included Accessories	
Printed Quickstart Guide	
Full User Guide on CD	
Calibration Certificate	
Switched Probe SP5	6220-812
Neck strap - Megger embroidered	2001-509
3 Wire lead set with prods and clips	6220-796
Euro Mains Test Lead SIA45	2000-674
Battery charger	2001-697

Item (Qty)	Cat. No.
Optional accessories	
Soft Carry case with lead/document pouch	6420-143
Switched Probe SP5	6220-812
Euro Mains Test Lead SIA40	6220-832
Fused 10A test lead set (Red/Green) with Prods and clips (NEW) right angle plugs	6220-827
Earth bond test lead set (high current loop test only)	6231-586
Fused prod and clip set, use with 6220-770	6180-405
3 Wire lead set with separate prods and clips (MFT1500 mk1) 6220-770	
ETL30, 30 m extension test lead	1000-215
ETL50, 50 m extension test lead	1000-217
12V charger lead	6280-332

CERTIFICATION ISO
Registered to ISO 9001:2000 Cert. no. Q 09290
Registered to ISO 14001-1996 Cert. no. EMS 61597

MFT1800_DS_eu_V01

SECTION 3:

ELECTRICAL MACHINES LAB

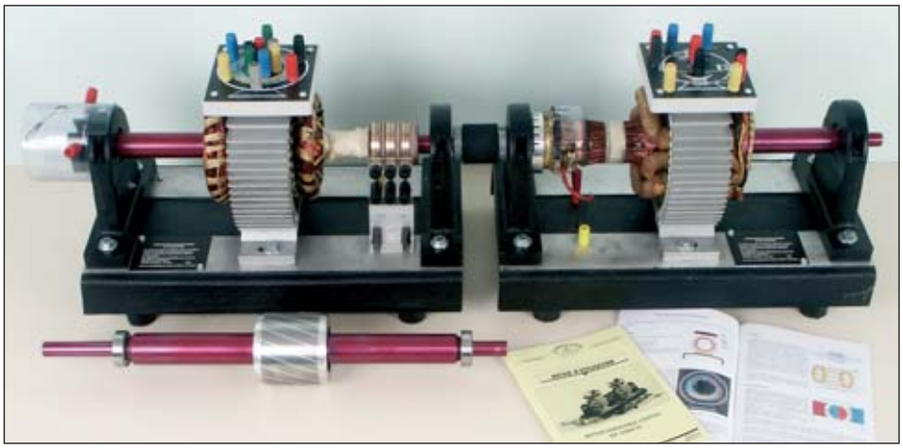
ELECTRICAL MACHINE LAB

Section 3

ITEMS

1,2,3,4

Demo plug & play multimotor



The dismantleable motors are electric motors with open housing that can be mechanically and electrically configured for creating various electrical motors and generators, without the use of specific tools.

The various functions can be obtained by simple coupling, perfectly explained in the instructions.

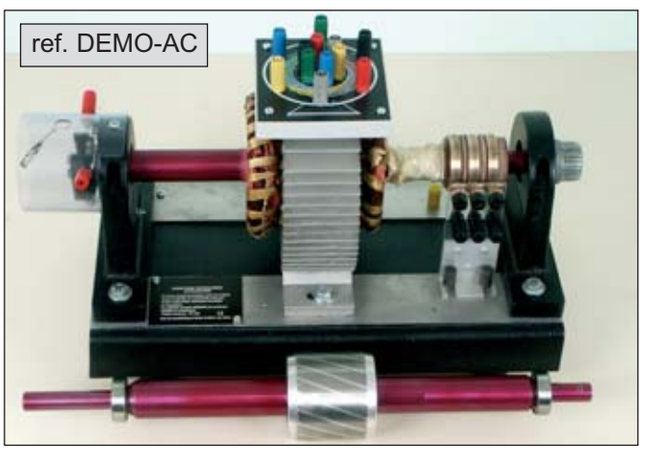
Although powered by non-hazardous voltages (< 50VAC < 100VDC), the powering up of these products is restricted to authorised staff due to the lack of protective housing.

48V ALTERNATING CURRENT UNIT

Presentation: The interconnection of the widings on to a didactic terminal box provides a visual understanding of the coil of the various electrical machines and their functions. Users are able to see the position of the brushes and their movement. It is powered by 48 volt ELV. A full user manual is provided with the motor/alternator.

TECHNICAL DESCRIPTION

- Open frame.
- An alternating current stator.
- An aluminium base.
- Two aluminium bearings for supporting the motor shaft.
- Possibility for studying 8 different motors, with safety terminal connections
  Single-phase motor with capacitors
  2-pole star connection three-phase motor
  4-pole delta connection three-phase motor
  Star-delta three-phase asynchronous motor
  Dahlander connection asynchronous squirrel cage motor
  Three-phase slip-ring motor
  Synchronous three-phase motor
  Three-phase alternator
- Extension shafts.
- One squirrel cage rotor.
- One slip ring rotor. Enables the functioning of the motor and the alternator.
- One rotating brush holder.
- One brush holder mount.
- Three brushes for the slip-ring motor.
- Coupling half.
- A rotating centrifugal contact.
- A user manual.



DEVELOPED PRACTICAL WORK

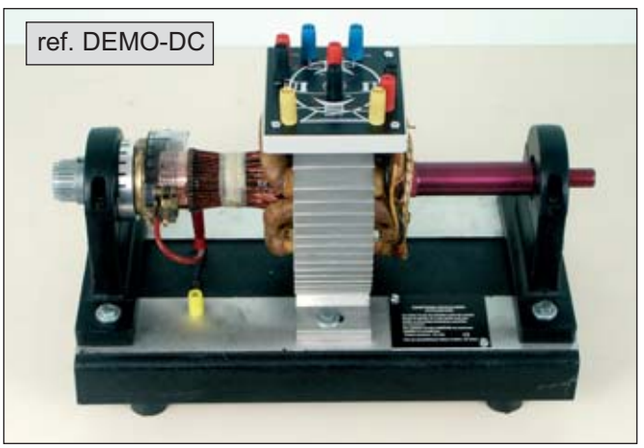
- Single-phase alternating motor.
- Alternating motor theory.
- Repulsion-induction motor with auxiliary wiring.
- Capacitor motor.
- Capacitor start and run motor.
- Three-phase alternating motor theory.
- 2-pole star motor.
- 4-pole delta motor.
- Slip-ring motor.
- Alternator theory.
- Three-phase alternator functions.
- Synchronous motor.

48V DIRECT CURRENT UNIT

Presentation: The interconnection of the windings on to a didactic terminal box provides a visual understanding of the coil of the various electrical machines and their functions. Series poles can be added or removed to/from the shunt poles to create a compound machine. Users are able to see the position of the brushes and their movement. It is powered by 48 volt ELV. A full user manual is provided with the motor/alternator.

TECHNICAL DESCRIPTION

- Open frame.
- A direct current stator.
- An aluminium base.
- Two aluminium bearings for supporting the motor shaft.
- Possibility for studying 14 different motors, with safety terminal connections
  DC shunt motor/DC shunt motor with commutating poles
  DC series motor/DC series motor with commutating poles
  Long shunt compound generator
  Long shunt compound generator with commutating poles
  Short shunt compound motor
  Short shunt compound motor with commutating poles.
  Separately excited shunt motor
  Universal motor without commutating poles/Universal motor with commutating poles
  Repulsion motor
  Series generator with commutating poles.
  Separately excited series source rotor generator
  Separately excited series source stator generator
  Self-excited long shunt compound generator
  Self-excited short shunt compound generator
- An armature
- Coupling half.
- A user manual.

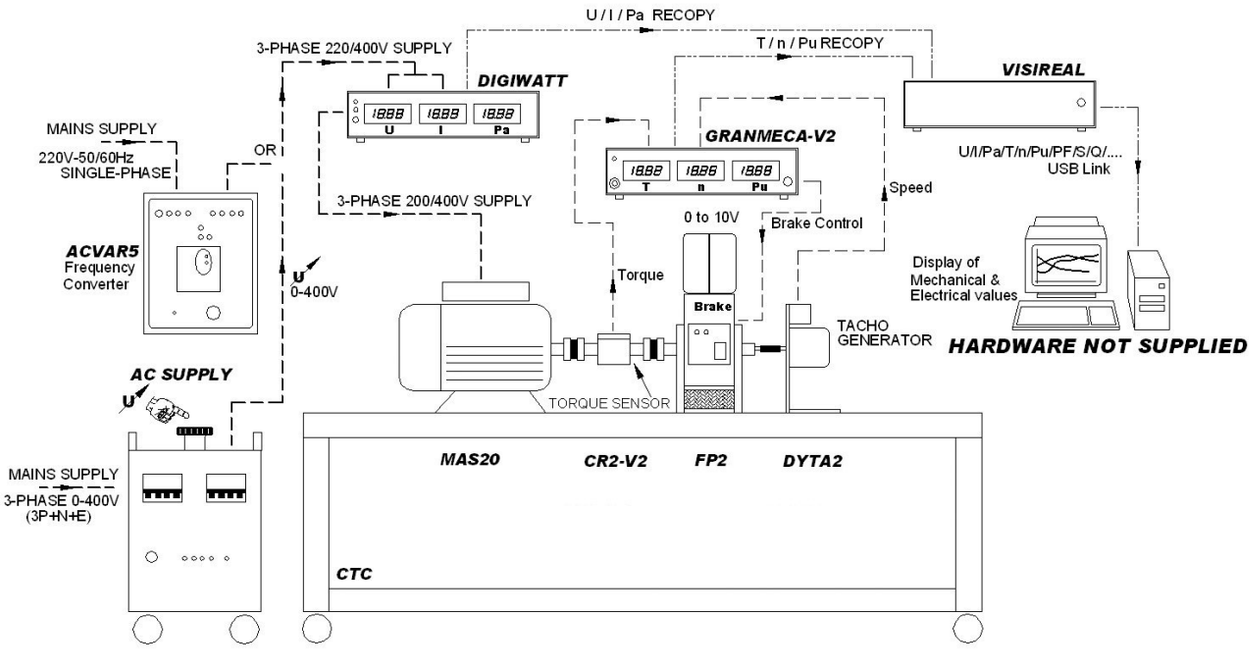


DEVELOPED PRACTICAL WORK

- Direct current motor theory.
- Armature reaction.
- Winding polarities.
- DC shunt motor
- DC shunt motor with commutating poles.
- Speed control.
- Long shunt compound DC motor.
- Long shunt compound DC motor with commutating poles.
- Short shunt compound DC motor.
- Short shunt compound DC motor with commutating poles.
- DC shunt motor, separately excited.
- DC generator theory.
- DC shunt generator.
- Separately excited generator.
- Series DC generator with commutating poles.
- Series-excitation generator.
- Compound generator.
- Long shunt compound DC generator.
- Short shunt compound DC motor.

PACK-AC1: Complete kit for studying the 1.5kW

The PACK-AC1 power unit kit (power unit + accessories) can be used for studying the short-circuited 220/400V 1500W, three-phase, asynchronous induction motor with rotor in short-circuit. Several measurements can be taken and the motor load properties can be monitored on a PC.



TUTORIALS DESCRIBED IN THE INSTRUCTIONS SUPPLIED WITH MOTOR PACK REF. PACK-AC1

- **Study of the star/triangle coupling of the asynchronous motor.**
  - Understanding and undertaking motor wiring.
  - Measurements and comparison of the various voltage and current values according to the coupling type selected.
  - Measurement of properties on a PC.

- **Study of the operation of the motor controlled by the speed controller (frequency converter)**
  - Understanding and undertaking the wiring of the speed controller to the motor.
  - Adjustment of speed controller settings.
  - Adjustment of motor acceleration and deceleration rotation speed settings.
  - Measurement on a PC of the rotation speed properties as a function of time.

- **Study of motor operation with no load, with a load and with an overload, using the 230/400V three-phase power supply.**
  - Theoretical reminders of the mathematical formulae concerning an asynchronous induction motor.
  - Understanding and undertaking motor wiring with measuring and monitoring devices.
  - Calculation of the electrical and mechanical quantities of the motor based on its identification plate, such as:
    - ✔ *Synchronism speed*
    - ✔ *Number of pairs of motor poles*
    - ✔ *Slip*
    - ✔ *Power consumption*
    - ✔ *Power consumption*
    - ✔ *Efficiency*
    - ✔ *Reactive power*
    - ✔ *Apparent power*
  - Creation of a table containing calculations and measurements of electrical and mechanical quantities at various points of the motor load:
    - ✔ *Current consumption*
    - ✔ *Power consumption*
    - ✔ *Rotation speed*
    - ✔ *Useful power*
    - ✔ *Motor torque*
    - ✔ *Power factor*
    - ✔ *Apparent power*
    - ✔ *Reactive power*
    - ✔ *Slip*
    - ✔ *Efficiency*
  - Monitoring on the PC and comments about the various motor load curves
  - Comparison of the theoretical calculation of values with those values measured during the motor tests
  - Plotting of properties based on motor measurements such as:
    - ✔ *Torque as a function of the speed**
    - ✔ *Torque as a function of useful power**
    - ✔ *Efficiency as a function of useful power**
    - ✔ *Reactive power as a function of useful power**
    - ✔ *Current as a function of useful power**
    - ✔ *Power factor as a function of useful power**
    - ✔ *Rotation speed as a function of useful power**
    - ✔ *Slip as a function of useful power**

** or other variable*

asynchronous motor with PC monitoring

OPERATING PRINCIPLE

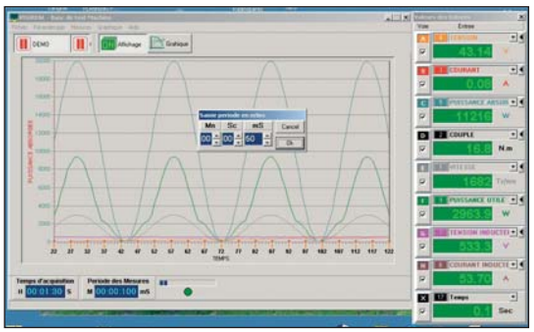
A speed controller, constant V/F frequency converter, controls the motor's rotation speed according to the various acceleration or deceleration ramps. A three-phase power supply on casters is also used to supply power to the motor, replacing the speed controller.

A 1500W ventilated powder brake loads the motor with values of between 0 and 125% inclusive of the rated load.

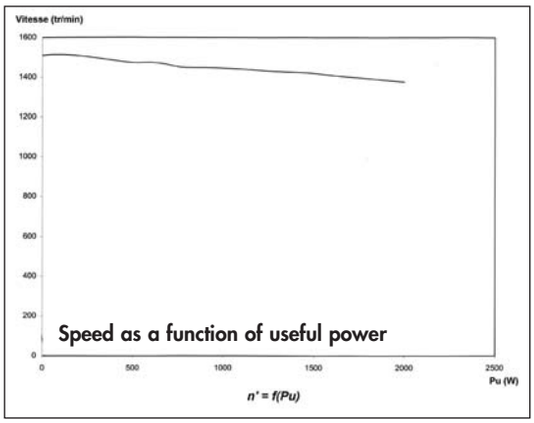
A brushless torque sensor (requiring no maintenance) measures the various torque values, whereas a DC tachogenerator provides an image signal of the motor's rotation speed.

A first unit, with three digital displays, shows the electrical quantities such as voltage, current and power used by the motor. The second unit, which also has three displays, shows the mechanical quantities such as torque, rotation speed and useful power.

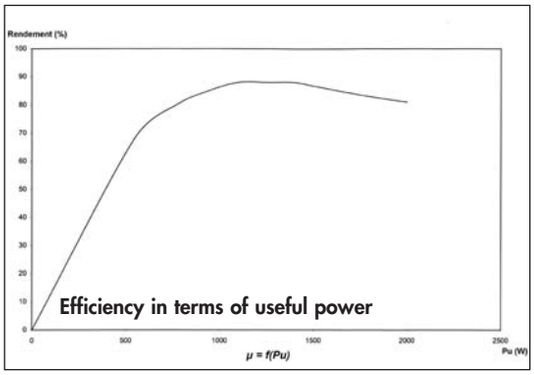
All of these quantities, as well as the motor load curves, can be displayed in real time on a PC, before being printed out.



Example of monitoring with a display of curves and values

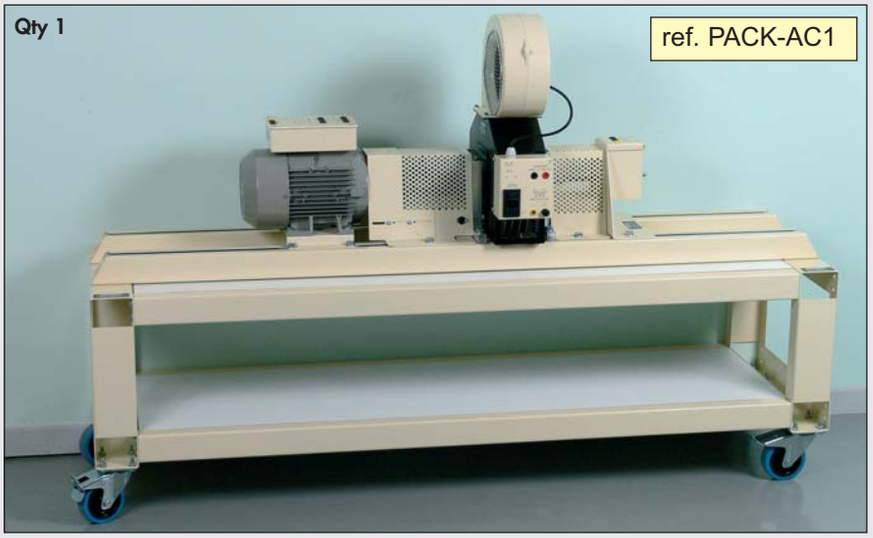


Speed as a function of useful power



Efficiency in terms of useful power

DESCRIPTION OF THE 11 ITEMS INCLUDED IN PACK-AC1 REFERENCE



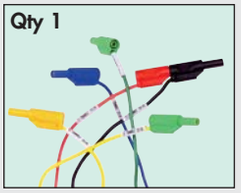
3-phase asynchronous motor
Ref. MAS20 - Qty 1
(features P. 62)
Rotary torque sensor
Ref.CR2-V2 - Qty 1
(features P. 63)

Powder brake
Ref. FP2 - Qty 1
(features P. 63)
DC tachogenerator
Ref. DYTA2 - Qty 1
(features P. 63)

Transport carriage
Ref. CTC - Qty 1
(features P. 72)

3-phase supply on wheels
Ref. TRT8PE
(features P. 84)

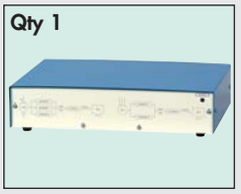
Frequency converter
Ref. ACVAR5
(features P. 74)



Set of safety leads
Ref. 300S
(features P. 227)

Digital wattmeter
Ref. DIGIWAT
(features P. 68)

Measurement of mechanical quantities
Ref. GRANMECA-V2
(features P. 67)



Real time and monitoring system
Ref. VISIREAL
(features P. 69)

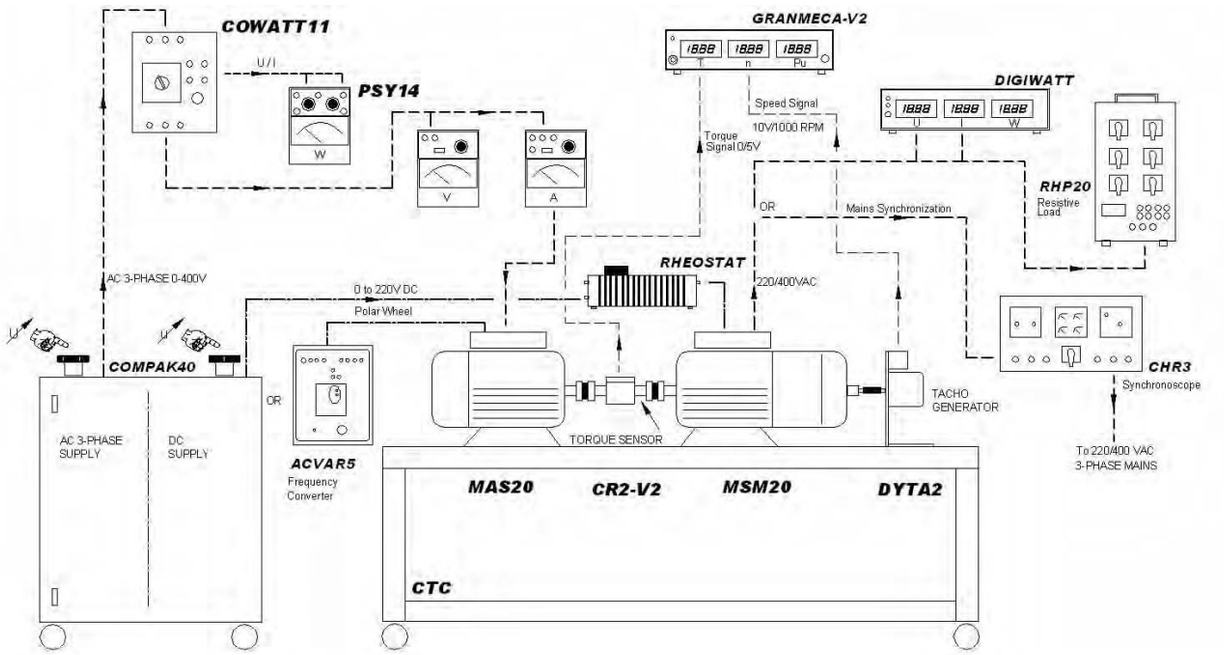
Instructions are supplied with the motor kit, including measurements, curves and theoretical reminders.

ALSO AVAILABLE IN 300W. CONTACT US.

CE

Complete kit for studying the 1.5kW asynchronous motor

The PACK-AC2 power unit kit (power unit + accessories) can be used for studying a 1500W asynchronous motor.
Charged by a 1500W three-phase alternator, the charge properties are plotted based on measurements taken by various analogue or digital devices.



TUTORIALS DESCRIBED IN THE INSTRUCTIONS SUPPLIED WITH PACK-AC2

STUDY OF THE ASYNCHRONOUS INDUCTION MOTOR

- **Study of the star/delta coupling of the asynchronous motor.**
  - Understanding and undertaking motor wiring.
  - Measurements and comparison of the various voltage and current values according to the coupling type selected.

- **Study of the "two powers" method.**
  - Understanding and undertaking of wiring.
  - Power measurements P1/P2.
  - Calculation of the total power and total speed consumed by the motor.

- **Study of motor operation with no load, with a load and with an overload, using the 1500W alternator.**
  - Theoretical reminders of the mathematical formulae concerning an asynchronous motor.
  - Understanding and undertaking motor wiring with measuring devices.
  - Calculations of the electrical and mechanical quantities of the motor using its identification plate, such as:
    - ✓ *Synchronism speed*
    - ✓ *Number of pairs of motor poles*
    - ✓ *Slip*
    - ✓ *Torque*
    - ✓ *Power consumption*
    - ✓ *Efficiency*
    - ✓ *Reactive power*
    - ✓ *Apparent power*
  - Creation of a table containing calculations and measurements of electrical and mechanical quantities at various points of the motor load:
    - ✓ *Current consumption*
    - ✓ *Power consumption*
    - ✓ *Rotation speed*
    - ✓ *Useful power*
    - ✓ *Motor torque*
    - ✓ *Power factor*
    - ✓ *Apparent power*
    - ✓ *Reactive power*
    - ✓ *Slip*
    - ✓ *Efficiency*
  - Comparison of the theoretical calculation of values with those values measured during the motor tests
  - Plotting of properties based on motor measurements such as:
    - ✓ *Torque as a function of useful power**
    - ✓ *Efficiency as a function of useful power**
    - ✓ *Current as a function of useful power**
    - ✓ *Rotation speed as a function of useful power**
    - ✓ *Slip as a function of useful power**

    ** or other variable*

STUDY OF THE ALTERNATOR

- **Study of the star/delta coupling of the asynchronous motor.**
  - Understanding and undertaking alternator wiring.
  - Measurements and comparison of the various voltage and current values according to the coupling type selected.

- **Study of alternator operation with no load, with a load and with an overload, using a resistive load:**
  - Theoretical reminders of the mathematical formulae which apply to the alternator.
  - Understanding and undertaking alternator wiring with measuring devices.
  - Measurement and plotting of the properties of the magnetic circuit's hysteresis cycle.
  - Calculations of the electrical quantities of the alternator based on its identification plate, such as:
    - ✓ *Number of pairs of poles*
    - ✓ *Power supplied*
    - ✓ *Power consumed by the rotary field*
    - ✓ *Joule loss*
  - Creation of a table containing calculations and measurements of electrical and mechanical quantities at various points of the motor load
  - Comparison of the theoretical calculation of values with those values measured during the practical tests
  - Plotting the properties of the alternator's load: voltage as a function of the supplied current
  - Calculation of the voltage decrease as a function of the load
  - Theoretical plotting of the shapes of the capacitive and inductive loads, compared with a resistive load
  - Analysis of results and conclusion

- **Study of the operation of the synchronised alternator on the public network**
  - Understanding and undertaking alternator wiring on the network.
  - Use of the speed controller
  - Use of the synchroscope with its various displays
  - Synchronisation on the mains network

- **Study of the operation of a short-circuited alternator:**
  - Measurement of the short-circuit current and the current in the rotary field
  - Plotting of properties

DELIVERED COMPLETE WITH TEACHING RESOURCES
STUDENT BOOKLET :
THEORETICAL STUDIES AND PRACTICAL WORK
TEACHER BOOKLET :
WITH CORRECT VERSIONS OF THE PRACTICAL WORKS

ref. PACK-AC2
ALSO AVAILABLE IN 300W. CONTACT US.

CE

and three-phase alternator

OPERATING PRINCIPLE

A 1500W asynchronous motor, powered by a 3 X 400V source, is charged by means of an alternator. The electrical power generated by the alternator is drained either in the form of an adjustable resistive charge or throughout the public network.

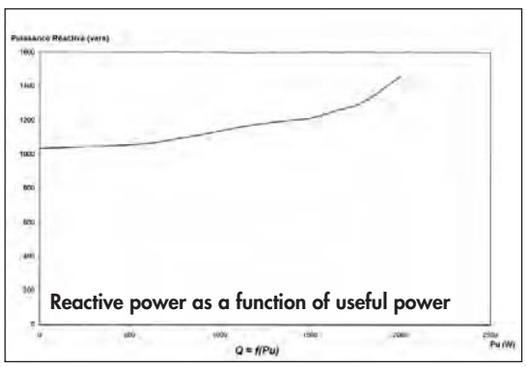
The power consumed by the motor is measured using the "two powers" method by using a wattmeter switch and an analogue wattmeter.

The voltage and current consumed by the motor are measured using an analogue voltmeter and ammeter.

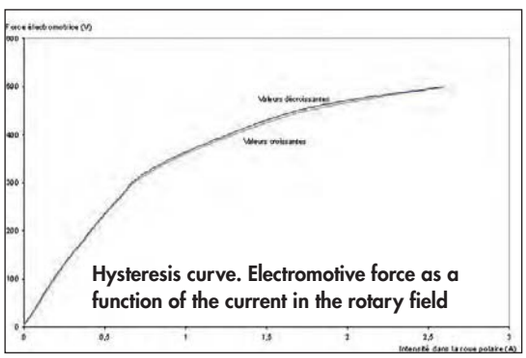
On the alternator, the electrical quantities such as power, voltage and current supply are measured using a digital wattmeter with three displays.

A brushless torque sensor (requiring no maintenance) measures the motor torque, whereas the tachometer generator measures the rotation speed. An analogue unit with three displays shows the torque, speed and useful power values.

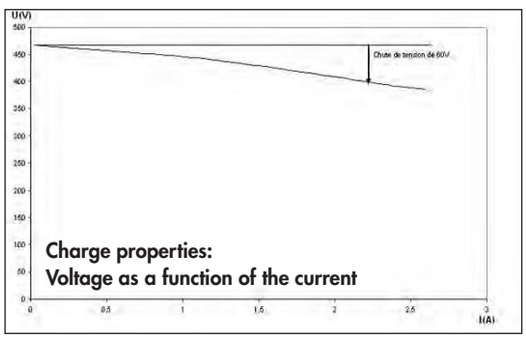
COMPLETE RANGE ROTARY MACHINES



Reactive power as a function of useful power

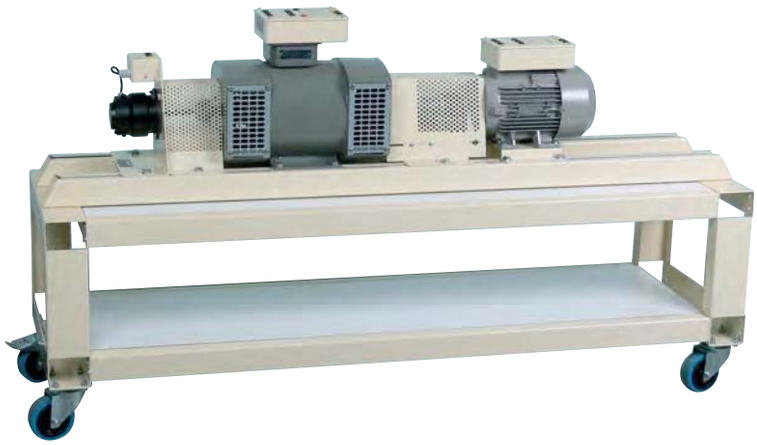


Hysteresis curve. Electromotive force as a function of the current in the rotary field



Charge properties:
Voltage as a function of the current

DESCRIPTION OF THE 18 ITEMS INCLUDED IN PACK-AC2 REFERENCE



3-phase asynchronous motor
Ref. MAS20 - Qty 1
(features P. 58)
Rotary torque sensor
Ref.CR2-V2 - Qty 1
(features P. 60

3-phase alternator
Ref. MSM20 - Qty 1
(features P. 58)
DC tachogenerator
Ref. DYTA2 - Qty 1
(features P. 60

Stand on wheels
Ref. CTC - Qty 1
(features P. 60)
Guide rails
Ref. RGC - Qty 1
(features P. 59)

DC single-phase & 3-phase variable supply
Ref. COMPAK40
(features P. 88)

Resistive load 2000W
Ref. RHP20
(features P. 83)

3-phase wattmeter
Ref. PSY14 - Qty 1
(features P. 196)

Synchronoscope
Ref.CHR3 - Qty 1
(features P. 58)

Safety wattmeter switch
Ref. COWATT11 - Qty 1
(features P. 195)

Magnetoelectric voltmeter
Ref. V1001 - Qty 1
(features P. 199)

Digital wattmeter
Ref. DIGIWAT - Qty 1
(features P. 68)

Measurement of mechanical quantities
Ref. GRANMECA-V2 - Qty 1
(features P. 68)

Rheostat
Ref. ECO2-106 - Qty 1
(features P. 94)

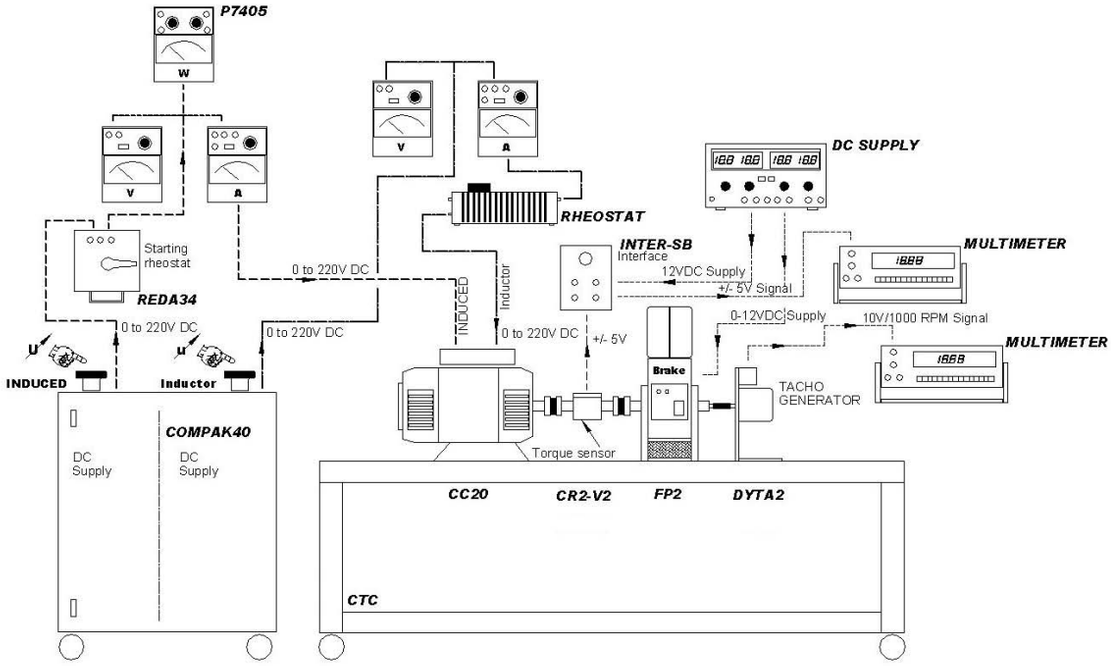
Set of 67 safety leads
Ref. 300S - Qty 1 set
(features P. 211)

20A magnetoelectric ammeter
Ref. A11 - Qty 1
(features P. 199)

Frequency converter
Ref. ACVAR5 - Qty 1
(features P. 84)

PACK-DC1: Complete kit for studying the 1.5kW

The PACK-DC1 power unit kit can be used for studying a 1500W DC motor.
The load properties are plotted based on measurements taken by various analogue or digital devices.



TUTORIALS DESCRIBED IN THE INSTRUCTIONS SUPPLIED WITH MOTOR PACK REF. PACK-AC1

- **Study of connection schematics with shunt excitation and separate excitation (independent).**
  - Understanding and undertaking motor wiring depending on the selected excitation type.
  - Measurements and comparisons of the various consumed power, voltage and current values depending on the selected excitation type.

- **Calculation method used for determining the resistance value:**
  - of the start-up rheostat
  - of the excitation rheostat

- **Study of the motor's operation when unloaded, when loaded and when overloaded with separate excitation (independent) and with shunt excitation:**
  - Theoretical reminders of the mathematical formulae applying to a DC motor.
  - Understanding and undertaking motor wiring with measuring devices.
  - Creation of a table containing calculations and measurements of electrical and mechanical quantities at various points of the motor load:
    - ✔ Current consumption of field system/in the rotor
    - ✔ Power consumption of field system/in the rotor
    - ✔ Rotation speed
    - ✔ Useful power
    - ✔ Motor torque
    - ✔ Counter-electromotive force
    - ✔ Rotor Joule decrease
    - ✔ Efficiency

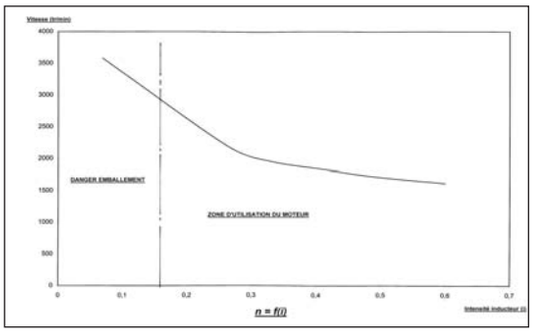
- **Plotting of properties based on motor measurements such as:**
  - Rotation speed as a function of the field system current
  - Rotation speed as a function of the rotor current
  - Efficiency as a function of the rotor current
  - Torque as a function of the rotor current
  - Power consumption as a function of the rotor current

- **Analysis of results and conclusion**

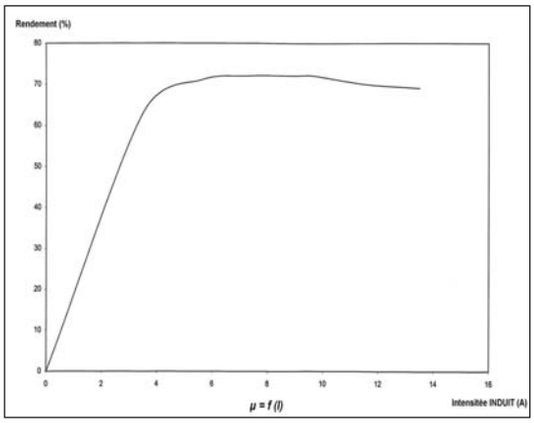
DC motor

OPERATING PRINCIPLE

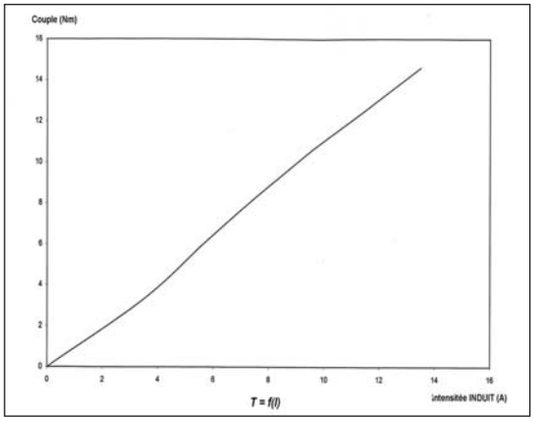
A power supply with two independent outputs varying from 0 to 220V DC powers the armature and field system of the motor.
A starting rheostat is used for starting the motor without any surges and with overspeed protection.
A powder brake loads the motor with values of between 0 and 125% of the rated load. The torque sensor (brushless, no maintenance required) provides an image signal of the dynamic torque. The DC tachogenerator generates an image signal (10V/1000 rev/min) of the speed.
Various measuring devices can be used to plot the motor's load properties.



Speed as a function of the inductor current with separate excitation



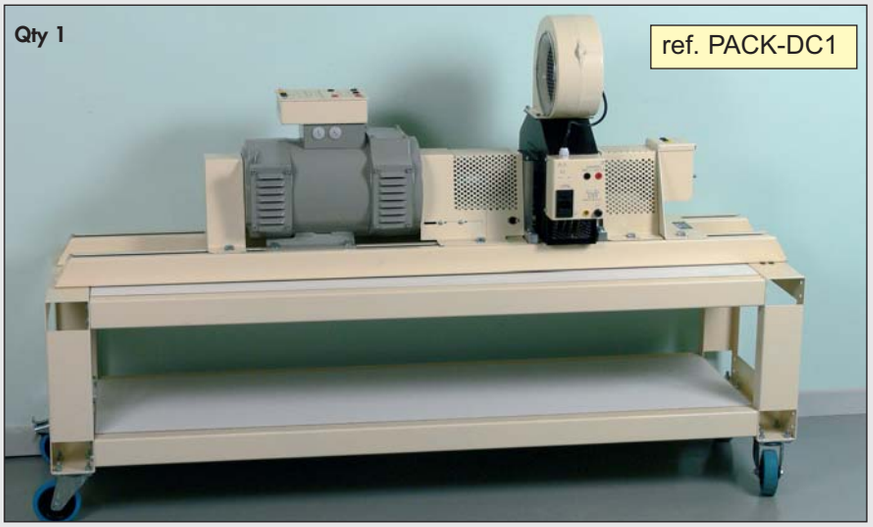
Efficiency as a function of the armature current with shunt excitation



Torque as a function of the armature current

DESCRIPTION OF THE 18 ELEMENTS INCLUDED PACK-DC1 REFERENCE

Qty 1



DC motor
Ref. CC20 - Qty 1
(features P. 62)
Capteur de couple rotatif
Ref.CR2-V2 - Qty 1
(features P. 63)

Powder brake
Ref. FP2 - Qty 1
(features P. 63)
DC tachogenerator
Ref. DYTA2 - Qty 1
(features P. 63)

Transport carriage
Ref. CTC - Qty 1
(features P. 72)

Qty 1

DC single-phase & 3-phase variable supply
Ref. COMPAK40
(features P. 84)

Qty 1

Wattmeter
Ref. P7405
(features P. 200)

Qty 2

Magnetoelectric voltmeter
Ref. V1000
(features P. 202)

Qty 2

20A magnetoelectric Ammeter
Ref. PSY30UA
(features P. 203)

Qty 1

Master/slave power supply
Ref. GPS3303
(features P. 177)

Qty 1

Torque measuring interface without display
Ref. INTER-SB
(features P. 66)

Qty 2

Multimeter
Ref. GDM8135
(features P. 185)

Qty 1

Safety starter Rheostat
Ref. REDA34
(features P. 62

Qty 1

Rheostat
Ref. ECO1-470
(features P. 227)

Qty 1

Set of safety leads
Ref. 300S
(features P. 227)

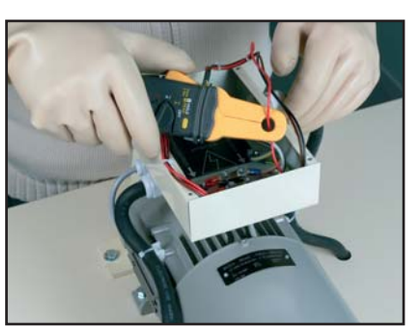
Instructions are supplied with the motor kit, including measurements, curves and theoretical reminders.

ALSO AVAILABLE IN 300W. CONTACT US.

Fault finding in motor

View of the teacher side unit, door closed and open.

View of the student side unit, door closed



Faults can be looked for inside the student unit and in the motor terminal.

This complete kit on casters, comprising two back-to-back units and an asynchronous squirrel cage motor and a parking brake, can be used to simulate the faults which occur most frequently.
The principle and the instructions have been devised by teachers who want to propose a method for diagnosing faults.

PRINCIPLE

Faults are recreated when the teacher rotates a single switch. Students can take measurements or perform tests in complete safety, regardless of the fault type. Faults can be looked for inside the student unit and in the motor terminal. The unit is isolated from the mains by means of an insulation transformer. In addition, a TT earthing system is recreated on the secondary for safety reasons. Therefore, even isolation faults are detected by a 30mA differential mechanism. All safety measures are implemented in order to protect individuals and equipment. (See the faults in the description of the teacher unit)

ref. MOTODIAG

- Overall dimensions: 670 x 750 x 1180 mm
- Laminated bench-top: 670 x 750 mm
- 4 casters Ø 80 mm
- 3-phase Hypra socket on 5m mains cable
- Weight: 80 kg

TEACHER SIDE UNIT

The teacher uses this lockable area to manage faults activated by key swiches he/she knows, and to view all of the simulator's workings. Thanks to indicator light. The position of the switches and indicator lights remain invisible to students.
The following faults are possible:

- 3 faults involving «damaged coil». A resistor is connected in series with a coil to change its impedance.
  One switch per phase, or three switches.
- 3 faults involving «power being cut in a coil». The power is cut in a coil. One switch per phase, or three switches.
- 3 faults involving a «short-circuit in a coil». The coils are short-circuited two at a time. One switch per possibility or three switches.
- 3 faults involving «coil earthing». A coil is earthed. One switch per phase, or three switches.
- 1 fault on the brake.
  The power in the parking brake is cut.

STUDENT SIDE UNIT

This lockable area is used for starting up the simulator (if authorised by the teacher). The transparent door gives the unit a highly didactic appearance.
The student control panel is simpler than the teacher control panel, offering standard normal operation indications. This means that fault finding, testing and measurement are identical to reality in the field.

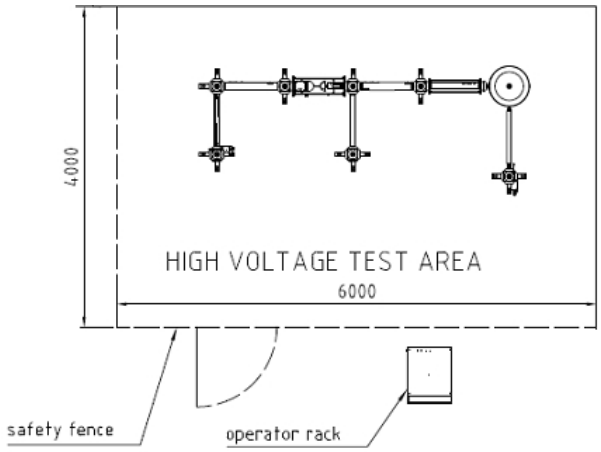
Instructions devised by teachers to enable rapid product implementation and the creation of tutorials in the spirit of industrial fault finding.

MULTI-TEK INTERNATIONAL
140 – 144 Freston Road (Industrial Area), London W10 6TR, England
Tel.: +44-(0)20-73133190 ϖ Fax.:+44-(0)20-73133191
E-Mail: mti@multitekintl.com :: Website: www.multitekintl.com

HIGH VOLTAGE LAB

(For training as well as industrial application)

Computerised HV lab for AC, DC and impulse measurement and analysis based on advanced design with the usage of the Siemens components



Recommended lab dimensions: 4m x 8m x 3m
HV test field (fences): 4m x 6m x 2m

MULTI-TEK INTERNATIONAL
140 – 144 Freston Road (Industrial Area), London W10 6TR, England
Tel.: +44-(0)20-73133190 ϖ Fax.:+44-(0)20-73133191
E-Mail: mti@multitekintl.com :: Website: www.multitekintl.com

System description (HV AC, DC and Impulse) :

The test system is designed to produce an AC, DC and impulse test voltage. The AC/DC test system has a modular design for easy operation, flexible configuration and expandability. It can be used in laboratories as well as in industrial applications. It has a maximum AC voltage of 100 kV, DC voltage of 135 kV and an impulse voltage of 135 kV.
The test system can later be expanded.

NOTE: IEC standard requires an transient measuring system (MIAS) for impulse voltage evaluation instead of impulse peak voltmeter (MU 28).

Advanced version: In this version laptop will be replaced by industrial PC and operator rack, software, etc. (CMS 23).
This allows fully automatic computer aided testing and measuring.
Technical offer No:A-108935-00 (MTI 2012).

Economic version: The basic control BC 8M contains a laptop which is used for measurement/ evaluation of MIAS. The test system control itself has to be done by operator device BG 8M G.
Technical offer No: A-109996-00 (MTI 2012). (On request).

Options (if required):
PD surveyor for partial detection, mobile fences,
Test objects (DG100, oil testing vessel/ cap, spark gap unit VF2)

Technical Specification

System: AC/DC and impulse voltage module system
Type: WGSBS 5.8/100-135-135

Offer No.: A-108935-00

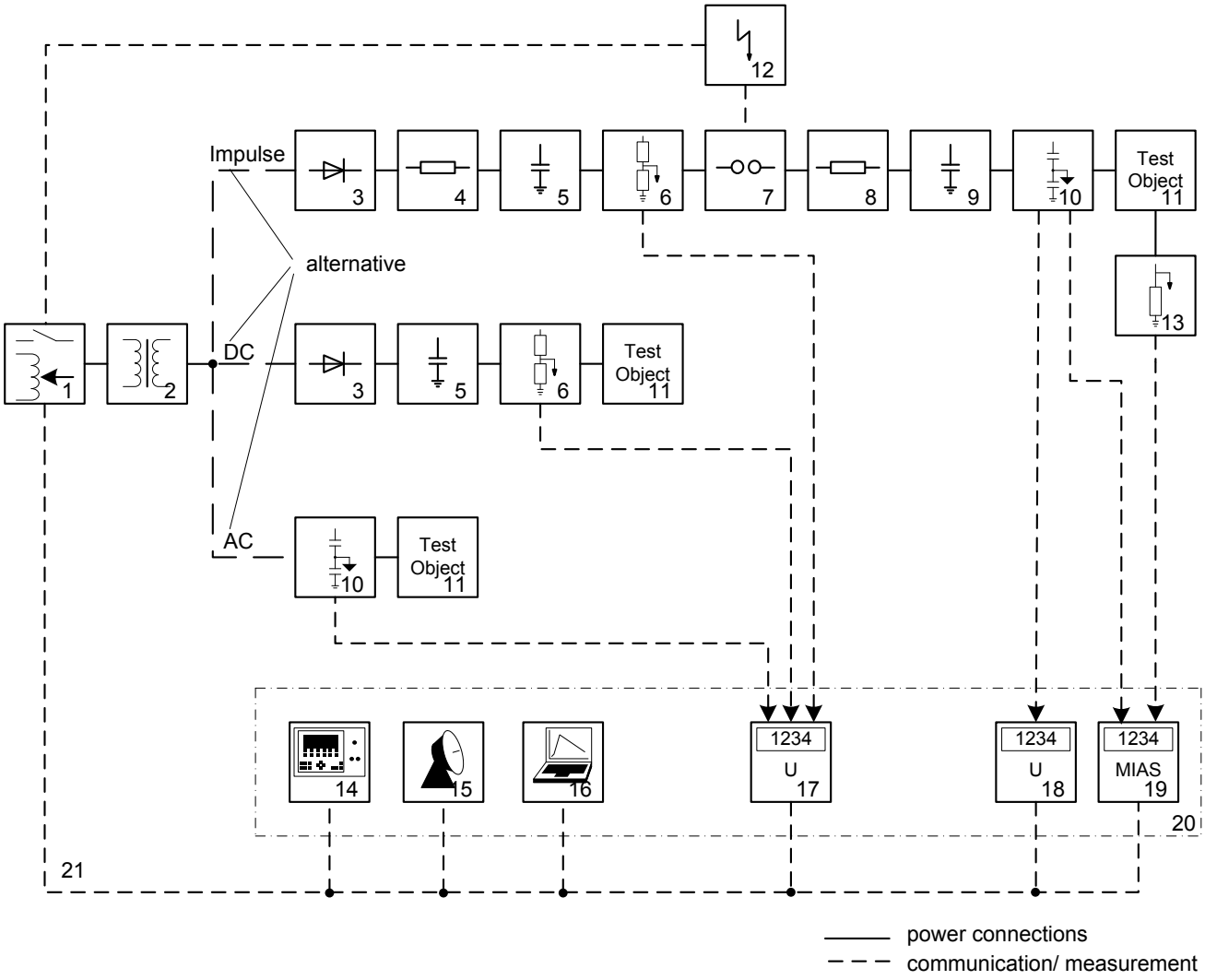
System description

The test system is designed to produce an AC, DC and impulse test voltage. The AC/DC test system has a modular design for easy operation, flexible configuration and expandability. It can be used in laboratories as well as in industrial applications. It has a maximum AC voltage of 100 kV , DC voltage of 135 kV and an impulse voltage of 135 kV.

The test system can later be expanded.

- Complete AC, DC and impulse HV lab with industrial PC and software.
Options: fences, test objects (Test vessel type DG100,oil testing vessel/ cap, spark gap unit), partial discharge surveyor.

Multi-Tek International
140-144 Freston Road
London
Tel:(0)2073133190
www.multitekintl.com



1 Power module
2 Transformer
3 Rectifier
4 Charging resistor
5 Charging capacitor
6 Resistive voltage divider
7 Trigger spark gap
8 Damping resistor
9 Impulse capacitance
10 Capacitive voltage divider
11 Test object *)
12 Trigger device (Impulse detection included)
13 Impulse current shunt
14 Operator device
15 Remote access module *)
16 Industrial computer
17 AC/DC Peak voltmeter
18 Impulse peak voltmeter *)
19 Impulse transient measuring system
20 Control and measuring system
21 Bus system/Control cables

*) Not included
This block diagram is preliminary and only demonstrates the basic principle of the technical solution.
All components listed in the scope of supply of this technical specification are binding.

Fig. 1 Block diagram of test system

Main parameters:

Rated AC voltage	kV	100
Rated AC current	mA	54
Rated AC power	kVA	5.4
Frequency	Hz	50
Rated DC voltage	kV	135
Rated DC current	mA	26
Duty cycle at rated AC current		Continuous operation
Duty cycle at rated DC current		Continuous operation
Rated charging voltage	kV	135
Impulse capacitance	nF	10
Rated impulse energy	kJ	0.1
Minimum time difference between impulses at rated voltage	s	10
Standard impulse shape:		
Lightning impulse voltage 1.2/50	kV	110
at max. capacity of test object	nF	0.9
Delay time 1.2/50	µs	1
Switching impulse voltage 250/2500	kV	100
at max. capacity of test object	nF	0.7
Delay time 250/2500	µs	100
Mains supply[1)]		
Power circuit		1NPE
	V	230
	Hz	50
	kVA	5.8
Operating conditions:		
Ambient temperature	°C	5 … 40
Daily mean temperature	°C	≤ 25
Max. relative humidity	%	90 (no condensation)
Height above sea level	m	≤ 1000 (at higher altitude with reduced voltage)
Ambient temperature for storage and transportation	°C	-30 … 60
Installation		Indoor, stationary

1) No current-operated earth-leakage protection

The dielectric strength of the external insulation of the test system applies to the following climatic conditions:

Atmospheric pressure	MPa	0.1
Temperature	°C	20
Atmospheric humidity	g/m³	11

We reserve the right to introduce minor modification in order to further improve and develop the test system.

Scope of supply

Item	Pieces	Description	Sheet[1)]
1	**1**	**HVAC/HVDC and Impulse generator**	
1.1	1	Test transformer T 100	4.5
1.2	1	HV capacitor C 1	4.6
1.3	1	HV capacitor C 10	4.6
1.4	1	HV rectifier G 270	4.7
1.5	1	HV resistor R 025	4.8
1.6	1	HV resistor R 08	4.8
1.7	1	HV resistor R 5000	4.8
1.8	1	Trigger spark gap TF 3	4.13
1.9	1	Impulse registration module EI 1	4.27
2	**1**	**Set of resistors for LI 1.2/50**	
2.1	1	HV resistor R 03	4.8
2.2	1	HV resistor R 6	4.8
3	**1**	**Set of resistors for SI 250/2500**	
3.1	1	HV resistor R 45	4.8
3.2	1	HV resistor R 280	4.8
4	**1**	**Power supply and regulation**	
4.1	1	Power module LM 25	4.26
4.2	2	Harmonic filter WSK 6/0.4	1.16
5	**1**	**HV voltage measuring divider**	
5.1	1	HV capacitor C 01	4.6
5.2	1	LV measuring branch MC 20	5.20
5.3	1	HV resistive divider MRT 250	4.8
6	**1**	**Impulse voltage measuring divider**	
6.1	1	HV capacitor C 03	4.6
6.2	1	LV measuring branch MCS	4.27
7	**1**	**Modules for mechanical constructions**	
7.1	1	Insulating element IE 1	4.9
7.2	2	Connecting element VE 1	4.9
7.3	7	Junction element KE 1	4.10
7.4	7	Base element FE 1	4.10
7.5	4	Base connection element FV 1	4.10

8	**1**	**Digital impulse analyzer MIAS 50-12/1 BS**	
8.1	1	Digital impulse analyzer - base device MIA BS	5.60-2
8.2	1	Basic software for digital impulse analyzer IAS	5.61
8.3	2	MIA measuring channels 50 MS/s, 12 Bit	5.60-2
8.4	1	MIA input divider 1000 V with Ratio 100:1	5.60
9	**1**	**Control and measuring system CMS 23M**	
9.1	1	Industrial PC (English)	
9.2	1	Operator rack OR 130	7.31
9.3	1	Operator device BG 8M E	4.23
9.4	1	Module extension for impulse voltage	4.26
9.5	1	AC/DC peak voltmeter MU 18	5.56
9.6	1	AC secondary current measurement MI 11 W	1.58
9.7	1	DC secondary current measurement MI 11 G	2.58
9.8	1	Software for computer-aided testing WGMS 23 M	1.55
9.9	1	Software for computer-aided testing IMS 23	3.52
10	**1**	**Special accessories**	
10.1	1	Rod for earthing ES 1	4.11
10.2	1	Rod for discharge and earthing ERS 1	4.11
10.3	1	Module for discharge and earthing ERE 150	4.11
11	**1**	**Miscellaneous**	
11.1	1	DKD-Calibration of alternating voltage measuring system	10.31
11.2	1	DKD-Calibration of direct voltage measuring system	10.31
11.3	1	DKD-Calibration of impulse voltage measuring system	10.31
11.4	1	DKD calibration certificate	
11.5	1	DKD calibration certificate	
11.6	1	DKD calibration certificate	
11.7	1	Documentation	
11.8	1	Transportation packing (sea freight)	
11.9	1	Factory acceptance test	

Description of items

Item	Pieces	Description
1	**1**	**HVAC/HVDC and Impulse generator**
1.1	1	Test transformer T 100

The test-transformer is an insulating case design with oil insulation. The oil-filled case is a fiberglass reinforced plastic (FRP) tube with steel covers. The lower cover is connected to the grounded base frame, the upper cover carries the HV potential and is connected to the top electrode. The exciting winding is divided into two parts. For the rated voltage the two parts are switched in parallel, for voltages up to 50 % they might be switched in series to improve the voltage adjustment.

It is equipped with a transfer winding which allows to form HV transformer cascades for hi gher v oltages. The i nternal pa rtial di scharge (PD) l evel o f i nsulating c ase transformers is very low. Therefore they are well suited for PD measuring circuits.

Contrary to other HV modules, the transformer does not need to be complemented by junction- or base-elements.

Main parameters:

Rated voltage	kV	100
Primary voltage	V	230
Rated power at		
Continuous operation	kVA	6.6
1h ON - 23h OFF	kVA	11
Frequency	Hz	50/60
Dimensions (approx.)		
Diameter (D)	mm	500
Height (H)	mm	980
Total weight (approx.)	kg	270

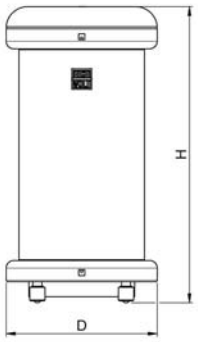


Fig. 2 Schematic sketch of T 100

1.2 1 HV capacitor C 1

The HV capacitor is used as:

- coupling capacitor for PD measurement
- basic load for impulse voltage measurement system

Main parameters:

Rated AC voltage	kV	100
Rated DC voltage	kV	135
Capacity	nF	1
Frequency	Hz	50/60
Dielectric		Oil impregnated paper
Dimensions (approx.)		
Length (L)	mm	720
Diameter (D)	mm	98.5
Weight (approx.)	kg	11

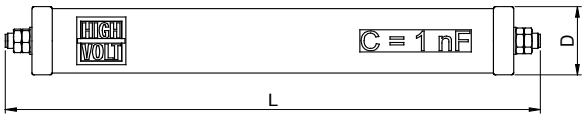


Fig. 3 Schematic sketch of HV capacitor

1.3 1 HV capacitor C 10

The HV capacitor can be used as:

- doubling capacitor
- smoothing capacitor
- impulse voltage measurement capacitor

Main parameters:

Rated AC voltage	kV	100
Rated DC voltage	kV	135
Capacity	nF	10
Frequency	Hz	50/60
Dielectric		Oil impregnated paper
Dimensions (approx.)		
Length (L)	mm	720
Diameter (D)	mm	140
Weight (approx.)	kg	17

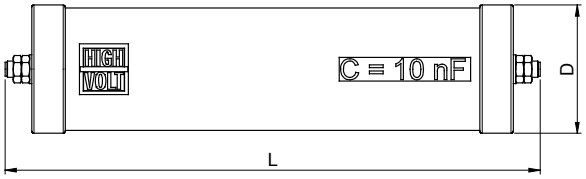


Fig. 4 Schematic sketch of HV capacitor

1.4 1 HV rectifier G 270

This rectifier can be used for impulse and DC voltage test systems. The rectifier consists of the rectifier element and an insulating cage. For quick and convenient polarity reversal of the system the rectifier element can be turned within the casing.

Main parameters:

Reverse voltage	kV	270
Rated current	mA	26
Duty cycle		Continuous operation
Insulation		Polyurethane resin, porcelain, insulating oil
Dimensions (approx.)		
Length (L)	mm	720
Diameter (D)	mm	185
Total weight (approx.)	kg	6.6

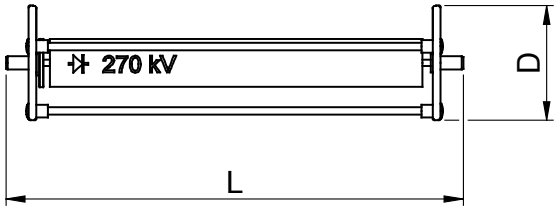


Fig. 5 Schematic sketch of HV rectifier G 270

1.5 1 HV resistor R 025

The HV resistor is designed as damping resistor.

Main parameters:

Rated voltage	kV	140
Resistance	kΩ	0.25
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	40
Total weight (approx.)	kg	5

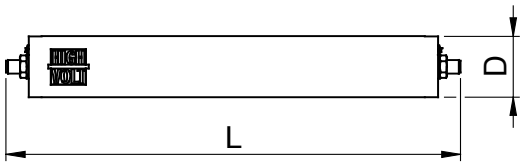


Fig. 6 Schematic sketch of HV resistor

1.6 1 HV resistor R 08

The HV resistor is designed as damping resistor.

Main parameters:

Rated voltage	kV	140
Resistance	kΩ	0.8
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	100
Total weight (approx.)	kg	5

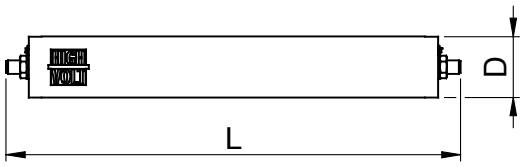


Fig. 7 Schematic sketch of HV resistor

1.7 1 HV resistor R 5000

The HV resistor is designed as charging resistor for impulse voltage configurations.

Main parameters:

Rated voltage	kV	140
Resistance	kΩ	5000
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	170
Total weight (approx.)	kg	10

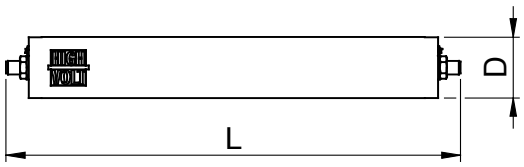


Fig. 8 Schematic sketch of HV resistor

1.8 1 Trigger spark gap TF 3

The trigger spark gap is used for impulse module systems.

Two spheres, a trigger generator and a spindle gear for the adjustments of the gap spacing are located in an insulating frame. The sphere with the trigger gap is fixed at the trigger generator, the non-triggered sphere is adjustable.

The drive is located below the spark gap between two base elements and contains the motor drive including the motor control for the gap spacing and the power supply unit. An insulating shaft forms the mechanical connection between the spark gap and the drive.

The battery-operated trigger generator and the drive are controlled by the control and measuring system and receive the signals by fiber optic links to avoid electro-magnetic interferences completely.

Main parameters:

Rated AC voltage	kV	100
Rated DC and impulse voltage	kV	135
Dimensions (approx.)		
Length (L)	mm	770
Height (H)	mm	983
Diameter (D)	mm	235
Total weight (approx.)	kg	20

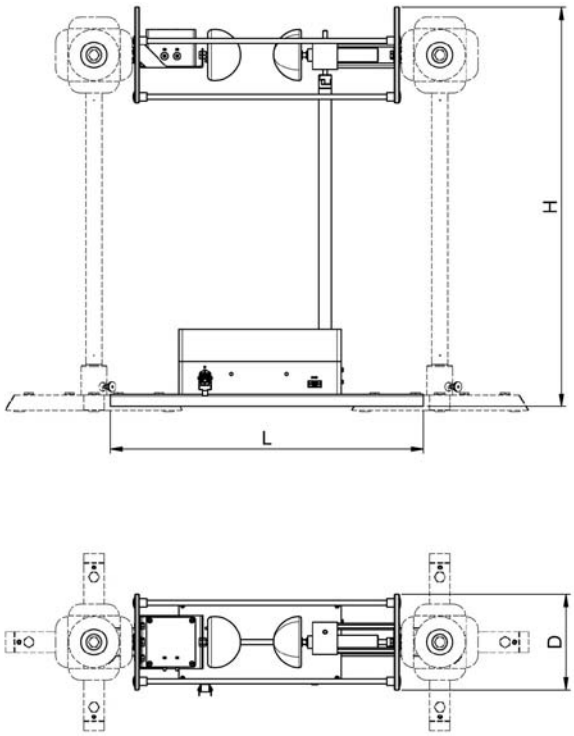


Fig. 9 Schematic sketch of TF 3 assembled between KE1, IE1, FE1

1.9 1 Impulse registration module EI 1

The impulse registration module EI 1 is used for impulse voltage module systems. It comprises the impulse registration and a fiber optic transmitter to transmit the signal to the control module. The impulse registration module EI 1 is mounted on the base element of the discharging resistor. A high voltage capacitor connects the module to the high voltage.

Main parameters:

Dimensions (approx.)		
Length (L)	mm	233
Width (W)	mm	75
Height (H)	mm	693
Total weight (approx.)	kg	3

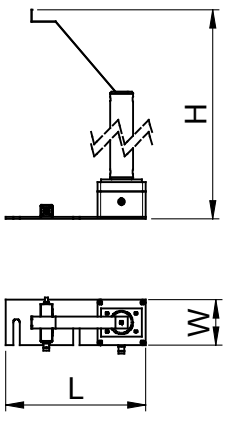


Fig. 10 Schematic sketch of EI 1

2 1 Set of resistors for LI 1.2/50

2.1 1 HV resistor R 03

The HV resistor is designed for impulse voltage generation and is determining the wave front.

Main parameters:

Rated voltage	kV	140
Resistance	kΩ	0.3
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	40
Total weight (approx.)	kg	5

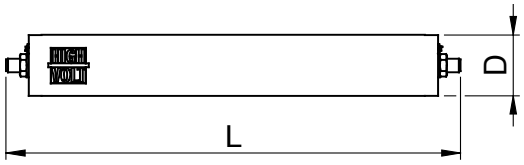


Fig. 11 Schematic sketch of HV resistor

2.2 1 HV resistor R 6

The HV resistor is designed for impulse voltage generation and is determining the wave tail.

Main parameters:

Rated voltage	kV	140
Resistance	kΩ	6.2
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	40
Total weight (approx.)	kg	5

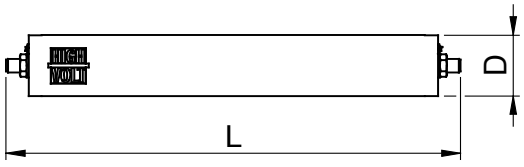


Fig. 12 Schematic sketch of HV resistor

3 1 Set of resistors for SI 250/2500

3.1 1 HV resistor R 45

The HV resistor is designed for impulse voltage generation and is determining the wave front.

Main parameters:

Rated voltage	kV	140
Resistance	kΩ	45

Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	100
Total weight (approx.)	kg	5

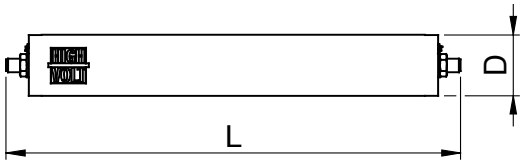


Fig. 13 Schematic sketch of HV resistor

3.2 1 HV resistor R 280

The HV resistor is designed for impulse voltage generation and is determining the wave tail.

Main parameters:

Rated voltage	kV	140
Resistance	kΩ	280
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	105
Total weight (approx.)	kg	5

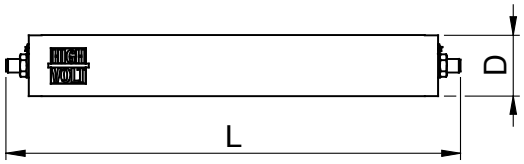


Fig. 14 Schematic sketch of HV resistor

4 1 Power supply and regulation

4.1 1 Power module LM 25

The power module comprises a regulating transformer which is controlled by programmable logic controllers (PLC). The interaction with the control component takes place by a PROFIBUS-interface realized by a fiber-optic link. Connectors for output, door safety circuit and external signal lamps are located at the back-side. The power module is equipped with a 5 m supply cable. Integral part of the power modules is the AC/DC Peak Voltmeter MU 18 (see separate position in the offer).

Main parameters:

Input voltage	V	230 ± 10 %
Output voltage	V	0 … 230
Frequency	Hz	50/60
Power	kVA	6
Output current	A	25
Rate of rise (with motor)	V/s	1 … 25

Dimensions (approx.)

Width (W)	mm	505
Depth (L)	mm	870
Height (H)	mm	690
Total weight (approx.)	kg	95

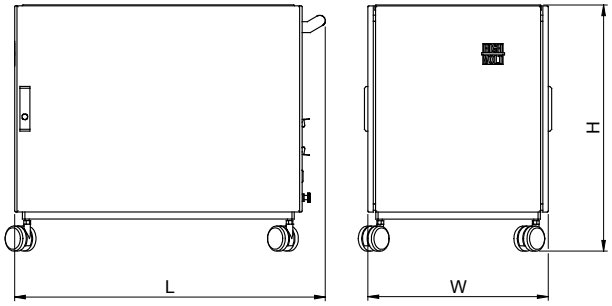


Fig. 15 Schematic sketch of LM 25

4.2 2 Harmonic filter WSK 6/0.4

The harmonic filter is used for improving the sinusoidal waveform of the output voltage of AC test systems. The harmonic filter is a series resonant circuit, which is tuned to one harmonic wave of the operating frequency.

The harmonic filter is protected against overloading by fuses.
It is built into the regulating transformer / HV transformer.

Main parameters:

Rated voltage	V	400
Rated current	A	6
Rated frequency	Hz	50/60
One tunable frequency at		3^{rd} or 5^{th} or 7^{th} harmonic

5 1 HV voltage measuring divider

5.1 1 HV capacitor C 01

The HV capacitor is designed for AC voltage and PD measurement.

Main parameters:

Rated AC voltage	kV	100
Capacity	nF	0.1
Frequency	Hz	50/60
Dielectric		Oil impregnated paper
Dimensions (approx.)		
Length (L)	mm	720
Diameter (D)	mm	98.5
Weight (approx.)	kg	8.5

Fig. 16 Schematic sketch of HV capacitor

5.2 1 LV measuring branch MC 20

The l ow v oltage measuring br anch i s adap ted t o t he H V capacitor to form a HV divider. The output voltage fits to the input of the AC/DC peak voltmeter. The LV arms are fitted out with connectors type “N”, 50 Ohm.

5.3 1 HV resistive divider MRT 250

The HV measuring divider is designed for DC measurement. It is resin insulated and PD-free. The HV resistor includes:

- high-voltage measuring branch
- low-voltage measuring branch

Main parameters:

Rated DC voltage	kV	135
Divider ratio		167.67
Resistance	MΩ	251.5
Measuring uncertainty	%	< 2
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	170
Total weight (approx.)	kg	10

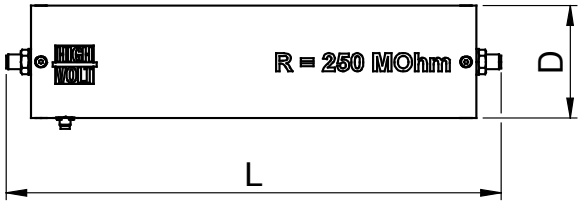


Fig. 17 Schematic sketch of MRT 250

6 1 Impulse voltage measuring divider

6.1 1 HV capacitor C 03

The HV capacitor is designed for:

- AC voltage and PD measurement
- impulse voltage measurement

Main parameters:

Rated AC voltage	kV	100
Capacity	nF	0.3
Frequency	Hz	50/60
Dielectric		Oil impregnated paper
Dimensions (approx.)		
Length (L)	mm	720
Diameter (D)	mm	98.5
Weight (approx.)	kg	10

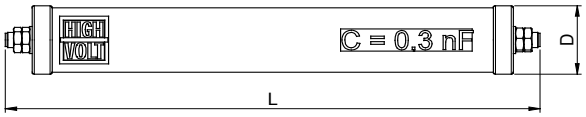


Fig. 18 Schematic sketch of HV capacitor

6.2 1 LV measuring branch MCS

The LV measuring branch MCS is designed for impulse voltage measurement and is arranged directly at the base element of the measuring capacitor and directly connected by a 10 m coaxial measuring cable to the peak voltmeter MU.

Main parameters:

Voltage range of divider	kV	≤ 135
Dimensions (approx.)		
Length (L)	mm	136
Width (W)	mm	110
Height (H)	mm	133
Total weight (approx.)	kg	1.5

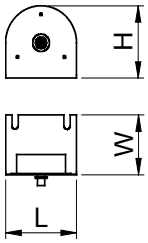


Fig. 19 Schematic sketch of MCS

7 1 Modules for mechanical constructions

7.1 1 Insulating element IE 1

The insulating element IE serves as a PD-free HV supporting insulator (vertical use) or spacer (horizontal use).

Main parameters:

Rated voltage	kV	140
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	40
Total weight (approx.)	kg	1.1

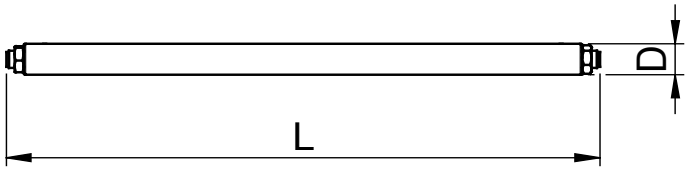


Fig. 20 Schematic sketch of IE 1

7.2 2 Connecting element VE 1

The connecting element VE is used as a PD-free electrical connection.

Main parameters:

Rated voltage	kV	140
Dimensions (approx.)		
Length (L)	mm	722
Diameter (D)	mm	60.3
Total weight (approx.)	kg	3.2

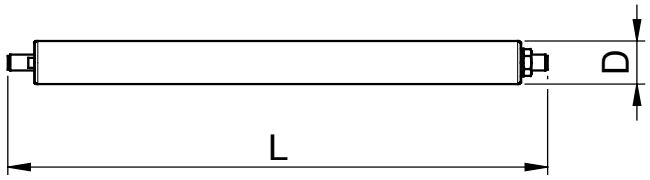


Fig. 21 Schematic sketch of VE 1

7.3 7 Junction element KE 1

As junction element a six-segment PD-free electrode is used for electrical and mechanical connection. The components are connected to the junction elements with a cap screw.

Main parameters:

Rated voltage	kV	240
Dimensions (approx.)		
Width (W)	mm	188
Diameter of segment (D)	mm	125
Total weight (approx.)	kg	1.3

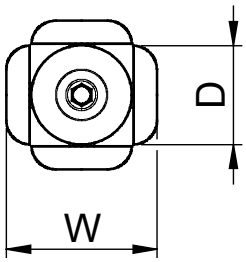


Fig. 22 Schematic sketch of KE 1

7.4 7 Base element FE 1

Base element ensures the stable assembly of the modules, the reliable earthing of the HV circuit and the safe operation of power, control and measuring cables.

Main parameters:

Dimensions (approx.)		
Length	mm	436
Width (W)	mm	436
Height (H)	mm	114
Total weight (approx.)	kg	6.3

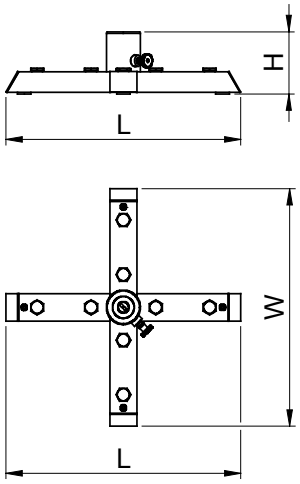


Fig. 23 Schematic sketch of FE 1

7.5 4 Base connection element FV 1

Base connection element ensures the stable assembly of the modules, the reliable earthing of the HV circuit and the safe operation of power, control and measuring cables.

Main parameters:

Dimensions (approx.)		
Length	mm	770
Width (W)	mm	70
Height (H)	mm	30
Total weight (approx.)	kg	2

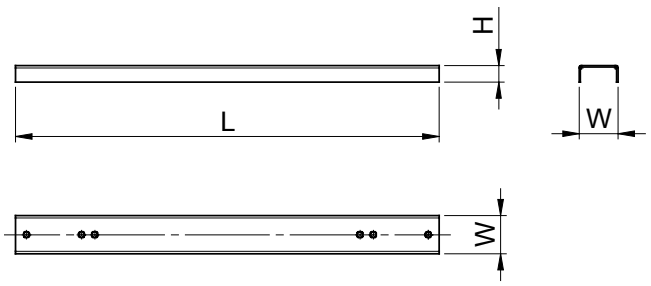


Fig. 24 Schematic sketch of FV 1

8 1 Digital impulse analyzer MIAS 50-12/1 BS

8.1 1 Digital impulse analyzer - base device MIA BS

The digital impulse analyzers of the type MIAS can be adapted to very different measurements, but both, hardware and software, are especially designed for measurements in high-voltage, high-current and high-power technology. This includes the application for impulse voltage and impulse current testing with complete parameter evaluation, for testing with combined and composite voltages, for transient processes in special tests with alternating and direct voltage and for synthetic high-power tests. The digital impulse analyzer, type MIAS, can also be applied for the adjustment of circuit breakers, tap changers and similar electrical-mechanical processes. Advantage of MIAS and related standards:

- MIAS is well adapted for any research work and students training.
- MIAS has been EMP/EMC as well as mechanical tested successfully according to relevant standards.

Operation

In connection with high-voltage and/or high-current converting devices (voltage dividers, voltage or current transformers, sensors, shunts, etc.) the digital impulse analyzer forms a measuring system. The voltage and current waveform is represented graphically. The digital recorder directly displays the measured value under consideration of the scale factor of the converting devices. The voltage and current waveforms are represented graphically. The digital recorder directly displays the actual measured value under consideration of the scale factor of the converting devices. An internal testing procedure enables a rapid check of the device.

MIA design type BS

Types MIAS BS are built into a desktop case that is also suitable to be mounted into a 19" rack. For operation it has to be connected to a control computer (not included in this position) by a fiber optic USB link. The PC (with the necessary software package, type IAS) is not only utilized for the processing and the evaluation of the recorder raw data, but it can also be used for the control of a HIGHVOLT high voltage or current generation circuit (see our data sheets). The digital impulse analyzer can be connected (via the control computer) to a local computer network (LAN) or even with the HIGHVOLT Service Center for software updates or trouble shooting.

Main parameters:

Dimensions (approx.)		
Width	mm	450
Depth	mm	375
Height	mm	95
Weight (approx.)	kg	5

Fig. 25 Schematic sketch of MIA plug-in unit type BS

8.2 1 Basic software for digital impulse analyzer IAS

All wave shapes are evaluated, displayed and stored. Further data comparison and the processing of all measured data are done by the impulse analyzer software package, type IAS.

The basic software, type IAS, is delivered to all MIAS types. It contains the graphical user interface, the data recording, the automatic evaluation of all impulse parameters for lightning and switching impulse voltages according to IEC 60060-1 and the maximum value of the current, the manual parameter measurement by cursors, zooming, viewing channels, the data storage and the preparation of test reports. For further software packages please see data sheets 5.62-1, 5.62-3 and 5.62-4.

IAS is the result of a longstanding know-how of software development for the use of digital recorder measuring systems and the possibilities, provided by a modern operating system like Windows XP ®.

IAS is able to acquire, evaluate and process measured data within a standardized user-friendly user interface. All saved data managed with integrated modules. Because of this, the user has multiple opportunities of further data processing (e.g. with EXCEL®).

The integrated report generator creates automatically a WORD® format test report. The corresponding templates can be easily adapted to the requirements of customers. The MIAS measuring results will be automatically integrated in that generated test report.

Features of IAS

- impulse evaluation acc. to IEC 60060 and 61083 and evaluation of mathematical operation results of different channels
- easy to handle
- integrated data handling module
- import of NICOLET-ASCII, DIAS-ASCII, WinTRAS-RealASCII and IEC-TDG-ASCII raw data for evaluation
- integrated hardware-diagnostics
- automatic test-sequences (configurable)
- WORD® test report generator
- remote control with COM software interface

8.3 2 MIA measuring channels 50 MS/s, 12 Bit

The MIA measuring channel is built in the digital impulse analyzer for measuring wave shapes according to the IEC standards.

Each measuring channel of the digital impulse analyzer is separately calibrated with voltage shapes LI (lightning impulse voltage), LIC (lightning impulse voltage chopped and SI (switching impulse voltage) according to IEC 60600-2.

It is verified whether the expanded measurement uncertainty is within the limits defined in standard IEC 610083.

The calibration is performed by the HIGHVOLT Calibration Laboratory DKD-K-24501, accredited by the German Calibration Service DKD. One DKD calibration certificate, which contains all calibrated measuring channels, is issued.

The certificate documents the traceability to national standards, which realize the units of measurements according to the International System of Units (SI).

Main parameters:

Rated resolution of output data	Bit	12
Sampling rate	MS/s	0.01 … 50
Max. number of samples	kS	128
Input[1)]		
Voltage (peak value)	V	0.2 … 80
Impedance	MΩ||pF	1||30
Analogue bandwidth (-3dB)	MHz	> 50
Connector type		BNC
Measuring uncertainty		
Peak value LI, SI	%	≤ ± 2
Peak value LIC	%	≤ ± 3
Time parameters LI, SI	%	≤ ± 4
Time parameters LIC	%	≤ ± 4

1) Parameters are related to the input without divider.
Divider parameters see "MIA input divider"!

8.4 1 MIA input divider 1000 V with Ratio 100:1

Built-in input divider for measuring voltages with peak values up to 1000 V.

Main parameters:

Input		
Voltage (peak value)	V	10 … 1000
Impedance	MΩ||pF	1||45
Analogue bandwidth (-3dB)	MHz	> 150
Connector type		N

9 1 Control and measuring system CMS 23M

9.1 1 Industrial PC (English)

The industrial computer is characterized by:

- central processing unit with up-to-date clock frequency
- min. 1024 MB RAM
- hard disk with up-to-date capacity
- DVD-R/W drive
- network adapter: 10/100 Mbit, optical
- plug-in 19"-unit with a height of 4 HU
- keyboard (English) / 2-key optical mouse, designed as plug-in 19"-unit (1 HU) to pull out and down foldable
- display: TFT, 17"-diagonal, 19"-built-in
- MS operating system (English)
- MS Office Basic ® (English)

9.2 1 Operator rack OR 130

The rack is provided for all equipment for control and measurement. The rack has a base with lockable rollers which allow an easy transportation.

Main parameters:

Material	aluminium / steel sheet
Color	light and dark grey

Dimensions (approx.)		
Width	mm	553
Depth	mm	690
Height	mm	1275
Total weight (approx.)	kg	45

9.3 1 Operator device BG 8M E

The operator device is used to operate HV modular test systems. This device is a plug-in 19"-unit. It contains a SIEMENS branded operator panel which acts as a Human Machine Interface (HMI) between the operator and the test system. Manual and simple automatic test procedures can be carried out. An LCD-backlight-touch-screen ensures an easy handling of the operator device.
The communication between the operator device and the test system is realized via a fiber optic link (ETHERNET) to eliminate electromagnetic interferences.

Main functions of the operator device are:

- emergency stop
- control on/off
- operating switch on/off
- voltage increases/decreases
- status indication of main and operating switch
- state messages of the test system
- pre-selection of test voltage and test time
- two pre-selectable regulating speeds
- limits for voltage and current for system protection
- password protection of essential system settings

Main parameters:

Supply voltage	V	230
Frequency	Hz	50/60
Operating temperature	°C	5 ... 35
Operating humidity (rel.)	%	≤ 95, no condensation
Dimensions (approx.)		
Width	mm	462
Height	mm	293 (6 HU)
Depth	mm	440
Weight	kg	9
Interface		ETHERNET, fiber optic

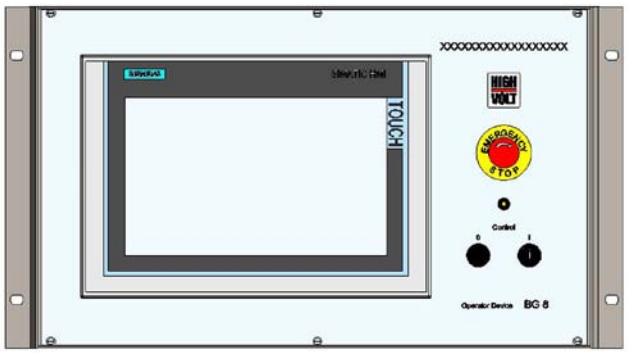


Fig. 26 Schematic sketch of operator device as plug-in 19"-unit

9.4 1 Module extension for impulse voltage

This module is an extension to the control for impulse voltage configurations of module systems.

9.5 1 AC/DC peak voltmeter MU 18

The peak voltmeter MU 18 is designed as built-in unit. It is used for all measurements of AC and DC voltages especially in HVAC and HVDC test systems in connection with HV dividers.

The measured voltage is displayed on the operator device and/or control computer of the system control. All pre-selection as well as handling the measured data and the display is also done via the operator device or control computer.

Advantageous for practical measurements is the immediate storage of the latest value in case of a disruptive discharge at the test object.

The unit MU 18 is always built into another device of the HIGHVOLT control system.

The AC/DC peak voltmeter is in accordance with the related international standard IEC 60060-2.

The peak voltmeter is calibrated according to IEC 60060-2 by the HIGHVOLT Calibration Laboratory DKD-K-24501, accredited by the German Calibration Service DKD. A respective DKD calibration certificate is issued. The certificate documents the traceability to national standards, which realize the units of measurements according to the International System of Units (SI).

Main parameters:

Input voltage	V	0 … ±1000
Input impedance	MΩ||pF	10||50
Frequency range	Hz	10 … 500 and DC
Measuring uncertainty	%	≤ 0.5
Temperature range	°C	5 … 40
Relative humidity	%	10 … 80
Input connector		coaxial, type N
Divider ratio		typical 1...20000; possible 1...9.999E09

9.6 1 AC secondary current measurement MI 11 W

The AC secondary current measurement will be carried out on the HV side of the HV test system.

The MI 11 W is always built into another device of the HIGHVOLT test system.

It consists of a current measuring transformer (selected according to the rated current of the AC test system) and a measuring transducer. The current transformer is placed close to the grounded end of the HV winding of the test or exciter transformer whereas the transducer is placed in the switchgear cubicle / power module. Both are connected by a two-wire cable. The output of the transducer is processed by a programmable logic controller (PLC). The current is displayed on the operator device or IPC.

9.7 1 DC secondary current measurement MI 11 G

The DC secondary current measurement will be carried out on the HV side of the HV test system.

The MI 11 G is always built into another device of the HIGHVOLT test system.

It consists of a current measuring shunt arranged in the ground connection of the rectifier column. It is selected according to the test equipment data. The shunt resistor is completed by related over voltage and over current protections. The output shunt is connected to a buffer amplifier that supplies an output voltage (0 … 10 V DC) to the PLC. The current is displayed on the operator device or IPC.

9.8 1 Software for computer-aided testing WGMS 23 M

The software for computer-aided testing WGMS 23 M is designed for HV testing using the HV module system. It can control different components/sub-systems of the test system via one IPC. Supported features are:

- operation of the HV module test system
- voltage measurement
- check of the safety circuits; information about feedings and test circuit
- recording of data and printing of the protocol
- help functions

The advanced software WGMS 23 M enhances the performance of the test system significantly. Advanced features in this version are:

- software interface for hardware extensions, e.g. PD measurement
- full automation of test procedures
- template PSM 11(breakdown test according to the progressive stress method - IEC 60060-1)
- template LTC 11(life-time characteristic)
- template WDT 11(withstand and assured discharge test according to IEC 60060-1)
- open interface for customer developed templates
- data transmitting to customer LAN via Ethernet

Remark: A proper operation of the software can only be guaranteed if the IPC/Laptop is delivered by HIGHVOLT. Otherwise Windows and MS Office are necessary requirements.

9.9 1 Software for computer-aided testing IMS 23

The software for computer-aided testing IMS 23 is designed for impulse testing. It can control different components/sub-systems of the test system via one IPC. Supported features are:

- operation of the HV impulse test system
- charging measurement
- controlling of switching gap
- controlling of chopping gap (as far as included)
- check of the safety circuits; information about feedings and test circuit
- recording of data and printing of the protocol
- help functions

The advanced software IMS 23 enhances the performance of the test system significantly. Advanced features in this version are:

- software interface for hardware extensions, e.g. transient measuring system and impulse voltage measurement
- full automation of test procedures
- template MLM 21 (multiple level method)
- template PSM 21 (progressive stress method)
- template UDM 21 (up-and-down method)
- template WDT 21 (withstand voltage test, discharge voltage test)
- open interface for customer developed templates
- data transmitting to customer LAN via Ethernet

Remark: A proper operation of the software can only be guaranteed if the IPC/Laptop is delivered by HIGHVOLT. Otherwise Windows and MS Office are necessary requirements.

10 1 Special accessories

10.1 1 Rod for earthing ES 1

The ES 1 is designed for earthing and short-circuiting of AC test systems. The test system has to be switched off before the rod for earthing can be used. It is designed for indoor operation.

Main parameters:

Dimensions (approx.)		
Length total (l_g)	mm	1125
Length handle (l_h)	mm	300
Length isolation (l_i)	mm	700
Weight (approx.)	kg	4

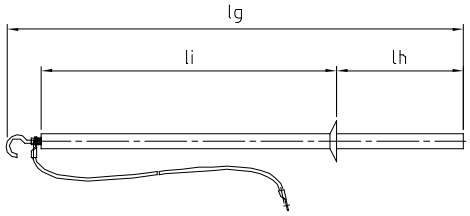


Fig. 27 Schematic sketch of ES 1

10.2 1 Rod for discharge and earthing ERS 1

The ERS 1 is designed for earthing, discharging and short-circuiting of ≤ 135 kV DC test systems. The test system has to be switched off before the rod for discharge and earthing can be used. It is designed for indoor operation.

Main parameters:

Maximum energy	kJ	2
Discharging resistor	Ω	500
Dischargeable capacitance	nF	175
Maximum discharge	mC	24

Dimensions (approx.)

Length total (l_g)	mm	1740
Length handle (l_h)	mm	300
Length isolation (l_i)	mm	700
Weight (approx.)	kg	5

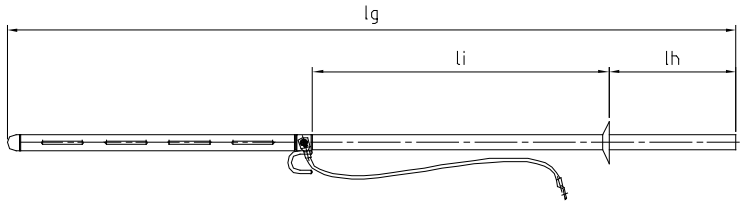


Fig. 28 Schematic sketch of ERS 1

10.3 1 Module for discharge and earthing ERE 150

The ERE 150 is designed for earthing, discharging and short-circuiting of ≤ 150 kV DC test systems. It is driven by a magnet and works in conjunction with a HIGHVOLT control module. The test system has to be switched off before the module for discharge and earthing can be used. It is designed for indoor operation.

Main parameters:

Max. rated voltage DC	kV	150
Maximum energy	kJ	0.2
Discharging resistor	Ω	1000
Dischargeable capacitance	nF	20
Maximum discharge	mC	3
Dimensions (approx.)		
Height (H)	mm	840
Width (W)	mm	300
Weight (approx.)	kg	5

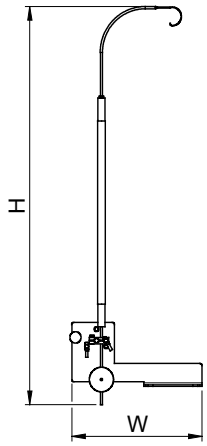


Fig. 29 Schematic sketch of ERE 150

11 1 Miscellaneous

11.1 1 DKD-Calibration of alternating voltage measuring system

The HIGHVOLT calibration laboratory DKD-K-24501 is accredited by the German Calibration Service DKD according to DIN EN ISO/IEC 17025:2005. The DKD is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.

The laboratory performs the calibration according to IEC 60060-2 by comparison measurement against reference standards.

The assigned scale factor of the measuring system is determined and it is verified if the measurement uncertainty is within the limits of ± 3 % defined in IEC 60060-2.

The measurement uncertainty is estimated according to the ISO/BIMP guide GUM ("Guide to the Expression of Uncertainty in Measurement").

11.2 1 DKD-Calibration of direct voltage measuring system

The HIGHVOLT calibration laboratory DKD-K-24501 is accredited by the German Calibration Service DKD according to DIN EN ISO/IEC 17025:2005. The DKD is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.

The laboratory performs the calibration according to IEC 60060-2 by comparison measurement against reference standards.

The assigned scale factor of the measuring system is determined and it is verified if the measurement uncertainty is within the limits of ± 3 % defined in IEC 60060-2.

The measurement uncertainty is estimated according to the ISO/BIMP guide GUM ("Guide to the Expression of Uncertainty in Measurement").

11.3 1 DKD-Calibration of impulse voltage measuring system

The HIGHVOLT calibration laboratory DKD-K-24501 is accredited by the German Calibration Service DKD according to DIN EN ISO/IEC 17025:2005. The DKD is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.

The laboratory performs the calibration according to IEC 60060-2 by comparison measurement against reference standards.

The assigned scale factor of the measuring system is determined and it is verified if the measurement uncertainty for the voltage measurement is within the limits of ± 3 % and for the time parameters within ± 10 % defined in IEC 60060-2.

The measurement uncertainty is estimated according to the ISO/BIMP guide GUM ("Guide to the Expression of Uncertainty in Measurement").

11.4 1 DKD calibration certificate

About the calibration a DKD-calibration certificate in English language is issued. The certificate documents the traceability to national standards, which realize the units of measurements according to the International System of Units (SI).

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About the calibration a DKD-calibration certificate in English language is issued. The certificate documents the traceability to national standards, which realize the units of measurements according to the International System of Units (SI).

11.7 1 Documentation

Technical documentation of test system will be provided in English as paper copy. The documentation will be handed over to customer's use together with handover of testing equipment.

11.8 1 Transportation packing (sea freight)

The packed good is shrink-wrapped in waterproof cover with preservation for 6 months and stackable under deck.

11.9 1 Factory acceptance test

The aim of the factory acceptance test is to demonstrate that the HV Module System under test was correctly produced and fulfils its technical specification including the relevant standards, especially IEC 60060.

The factory acceptance test is performed under the conditions of the HIGHVOLT production and test hall and is limited according to its environmental conditions (atmospheric conditions, electric and acoustic noise level, clearances, available load, cleanness, etc.).

The factory acceptance test is used to demonstrate the operation and the handling of the HV Module System and could be considered as a first training of customer's engineers.

The test is considered to be successful if the following procedures show the proper operation:

(1) Check of the content of delivery for completeness and explanation of the test records of the main components.
(2) Explanation of the HV Module System.
(3) Check of the safety functions (earthing devices, emergency-off, safety circuit, overcurrent protection, etc.).
(4) Demonstration and explanation of the specified voltage measuring systems (and current measuring systems - if any) and of all other specified measuring devices, including explanation of the calibration of the voltage measuring system(s).
(5) Check and demonstration of the control functions, including manual and automatic operation (if any) as well as explanation of the operator screen of the computer control and / or of the operator device.

(6) Voltage test without external load for
- AC voltage at V_{rated} / 15 min.
- DC voltage at V_{rated} / 15 min for both polarities.
- lightning impulse (LI) voltage at rated charging voltage (135 kV), 5 impulses for each polarity.
- switching impulse (SI) voltage at rated charging voltage (135 kV), 5 impulses for each polarity.

(7) External breakdown test at all specified rated voltages and polarities with an external rod gap in air and 5 breakdowns each.

The HV Module System has passed the factory acceptance test if the system operates precisely.

GROUP EXPORTER:
MULTI-TEK INTERNATIONAL
email: mti@multitekintl.com

Data Sheet no. 4.13/7

Spark Gaps

GROUP EXPORTER:
MULTI-TEK INTERNATIONAL
email:mti@multitekintl.com

Description test spark gap VF 1:

The test spark gap VF 1 can be used for all module systems in the grid 850 mm.
Two spheres and a spindle gear with a hand wheel for the manual adjustments of the gap spacing are located in an insulating frame.
One of the electrodes is fixed and the other electrode is adjustable between 0 to 75 mm.
A motor driven test spark gap VF 2 is on request available.

Note that, for the standalone installation two base elements FE1, two insulating elements IE1 and two junction elements KE1 have to be ordered as well.
In the test spark gap a barrier frame can be included to demonstrate the effect of barriers. The barrier frame can hold an insulating screen, for example a sheet of paper.

Technical data:

Environmental conditions: temperature 5 to 40° C
relative humidity ≤ 90 %
indoor operation
(different parameters on request)

type code	rated voltage AC kV	rated voltage DC and Impulse voltage kV	dimensions (l x ød) mm	total weight kg
VF 1	100	135	722 x 235	5

Dimensional drawing

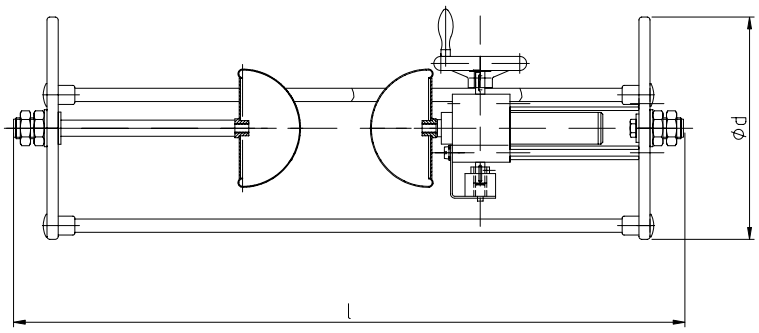


Fig. 1: VF 1

TF 3	135	722 x 235	20

Environmental conditions: temperature 5 to 40° C
relative humidity ≤ 90 %
indoor operation
(different parameters on request)

Dimensional drawing

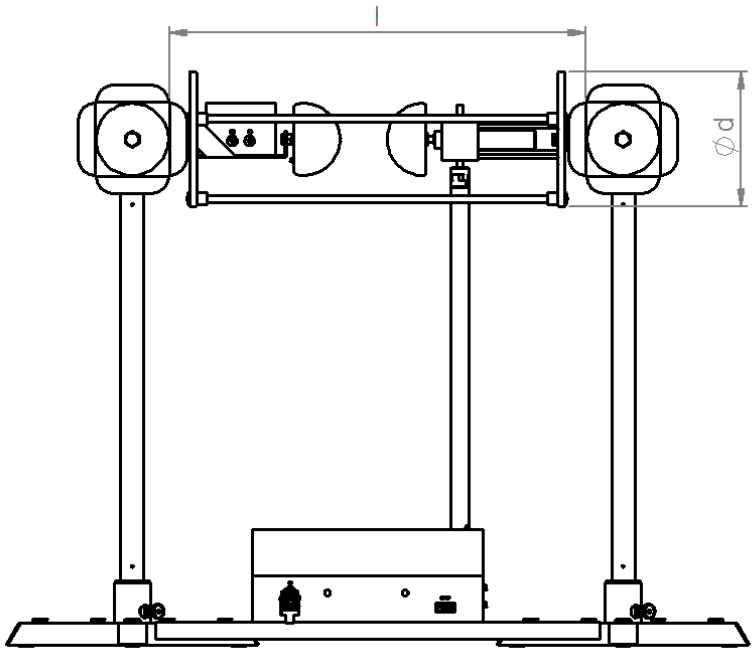


Fig. 2: TF 3

Data Sheet no. 4.14/3

Test vessel, Type DG 100

GROUP EXPORTER:
MULTI-TEK INTERNATIONAL
email:mti@multitekintl.com

Description test vessel DG 100
The pressure and vacuum test vessel serves to demonstrate the high-voltage performance in insulating gases depending on their pressure. Preferably, it is used in connection with the high-voltage module test system. Dimensions are in accordance with the reference grid 850, connection thread is M 22 x 1.5.
The vessel itself is made of transparent material to observe the tests. The distance between the electrodes is adjustable.

The scope of supply includes:
- one set of exchangeable electrodes, consisting of semi-spherical electrodes (diameter 20 mm), rod and two needle electrodes,
- filling adapter and
- manom eter.

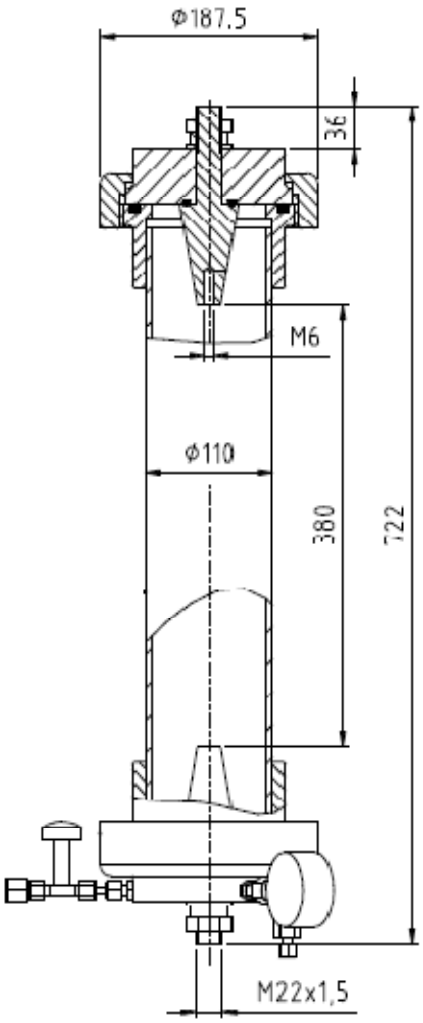
For the separate installation with PD free high-voltage connection:
- one base element FE1,
- one base connection element FV1,
- one junction element KE1 and
- one electrical connection, e.g. VE1

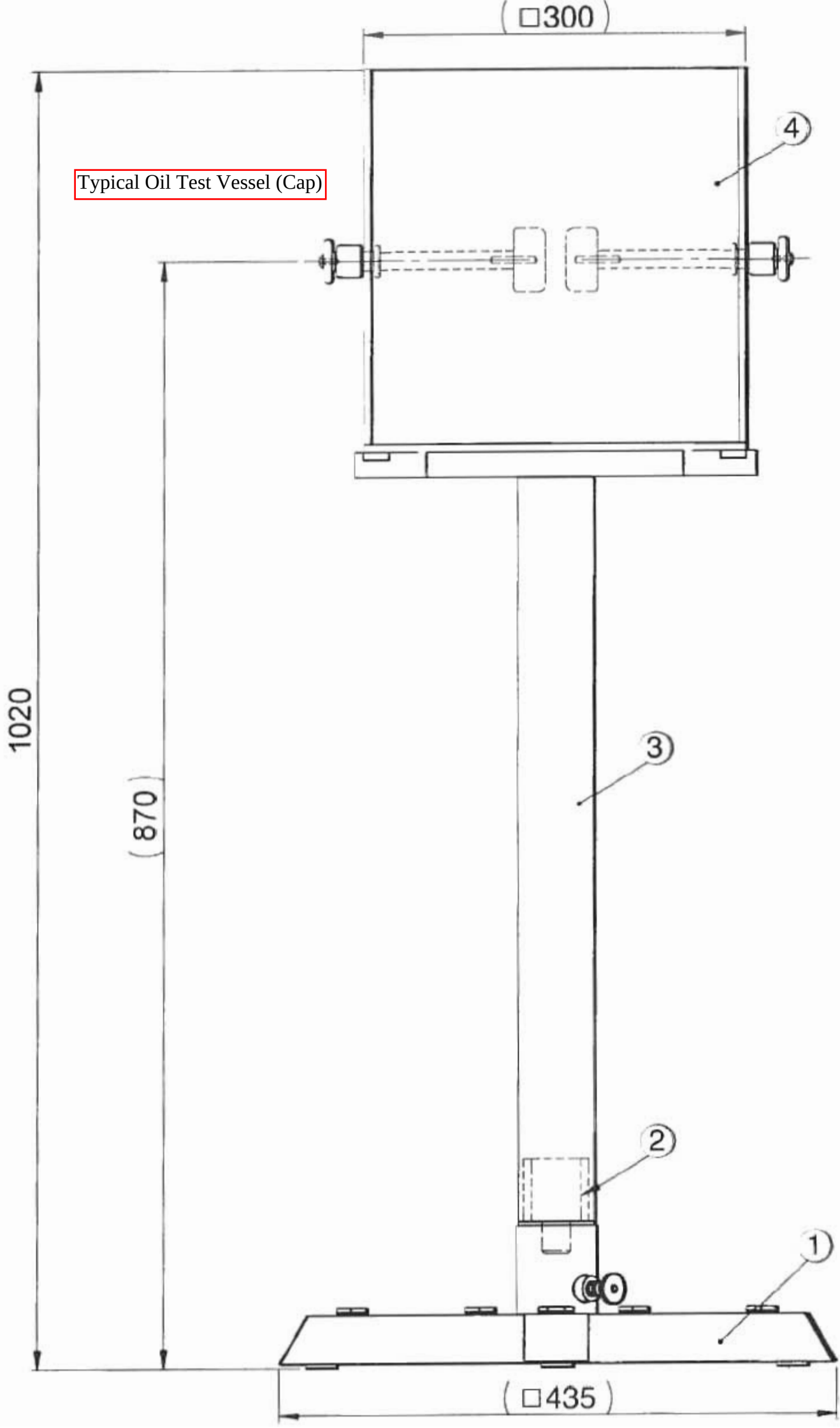
have to be ordered as well.

Technical Data

Type description:	DG 100
Max. test voltage:	100 kV AC; 140 kV DC and impulse voltages
Operating overpressure:	3 bar or 5 bar
Volume: 4	l
Temperature: 5...35°C	
Filling adapter:	DILO ½ Inch

Options
- vacuum pump
- SF_6-gas handling device
- different dimensions and electrodes upon customer's request


Φ187.5
36
M6
Φ110
380
722
M22x1,5


□300
4
Typical Oil Test Vessel (Cap)
1020
(870)
3
2
1
(□435)

The PDSurveyor™

"On-line PD Testing"

PDSurveyor™ testing AIS for Surface PD

HV Motor PD Testing – TEV & CT

TEV Testing of Solid Insulated Switchgear

Product Features

- The World's First, handheld, multi-purpose, Partial Discharge (PD) Test Technology.
- Lightweight & Portable device suitable for On-line insulation condition testing of in-service High Voltage (HV) plant.
- Enables first-line PD 'screening' of HV cables, switchgear, motors and transformers.
- Seven-Level PD Magnitude Detector to provide an immediate PD level measurement.
- Unique Technology incorporating 3x Partial Discharge Sensors (Ultrasonic, Acoustic, HFCT - Electromagnetic and TEV-Transient Earth Voltage) into one test unit.

Applications

- The *PDSurveyor*™ can be used to test HV Cables, CTs, VTs, Switchgear, Motors and Transformers in the following applications:
- As a Safety and Security Device - To provide an immediate indication to the user the HV Plant in the substation is safe to approach.
- As a First-Line Screening/Diagnostic Device to provide a quantified, colour-coded ' PD scan' of large numbers of HV plant items prior to higher level, PD diagnostic testing - Refer to *OSM-Longshot*™ On-line PD Test Technology from IPEC HV).

Background

The *PDSurveyor*™ was developed by IPEC HV further to requests from our customers for a simple, portable and easy-to-use partial discharge detector. The unit is intended to be used as a first-line PD ‘checker’ for HV plant, providing the user with the ability to test the condition of their HV plant in seconds.

The PDSurveyor™

"Science and Technology in Power Engineering"

On-Line Partial Discharge Surveying System

PD Level Guide:

	CT	TEV	AA	Condition / Action
●	300pC	15dB	12dB	Plant OK/ No Action
●	600pC	23dB	18dB	
●	1100pC	28dB	20dB	Moderate PD/ Monitor
●	3300pC	36dB	22dB	
●	7500pC	42dB	25dB	Moderate to High / Investigate
●	20000pC	44dB	28dB	High PD/ Test & Restrict Access
●	50000pC	48dB	33dB	

PD Level Guidelines

Testing the PD level of 33kV XLPE Cable with a High Frequency Current Transformer

The CT LEDs (top line) show an 'Orange 1' Cable PD Level which equates to 3300pC. The Action here would be to investigate this further by PD testing with the OSM-Longshot™ On-Line PD Spot Tester.

How it Works

The PDSurveyor™ units simple, 7-level, colour-coded PD level indications (displayed as a range of LEDs from green to red as shown opposite) allows very quick identification of potential insulation defects. Used in this way a large number of HV plant items can be scanned for PD activity in a fraction of the time required by other commercially available systems.

The *PDSurveyor*™ incorporates three individual partial discharge sensors and corresponding measurement circuits which are designed to pick up variations of PD activity in different types of HV plant, as follows:

AA – Airborne Acoustic Circuit – Acoustic PD signals are generated by partial discharges into air and are detected using the unit's 40kHz airborne acoustic sensor ('line-of-sight' to pd site required). This sensor is very useful when testing Air Insulated Switchgear.

CT - Cable PD Circuit – Cable PD is measured using an external, split-core, High Frequency Current Transformer (HFCT) sensor which is clipped around the earth strap of the cable. These pulses are generally in the frequency range of between 200kHz – 4MHz and are typically monopolar in shape. The unit measures the Cable PD pulses in picoCoulombs (pC's) by measuring the charge content (area under the monopolar pulse).

TEV Circuit – Transient Earth Voltage (TEV) PD signals are generated by internal partial discharges in switchgear, cable terminations, motors and transformers. TEV signals are in a higher frequency range of between 4MHz – 100MHz and are oscillating in general. The unit has a built-in TEV sensor which is placed against the equipment under test to measure these signals. The resultant PD signals are measured in dB (decibels), as is the convention for on-line switchgear testing.

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