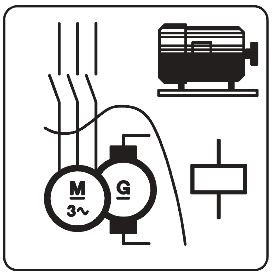
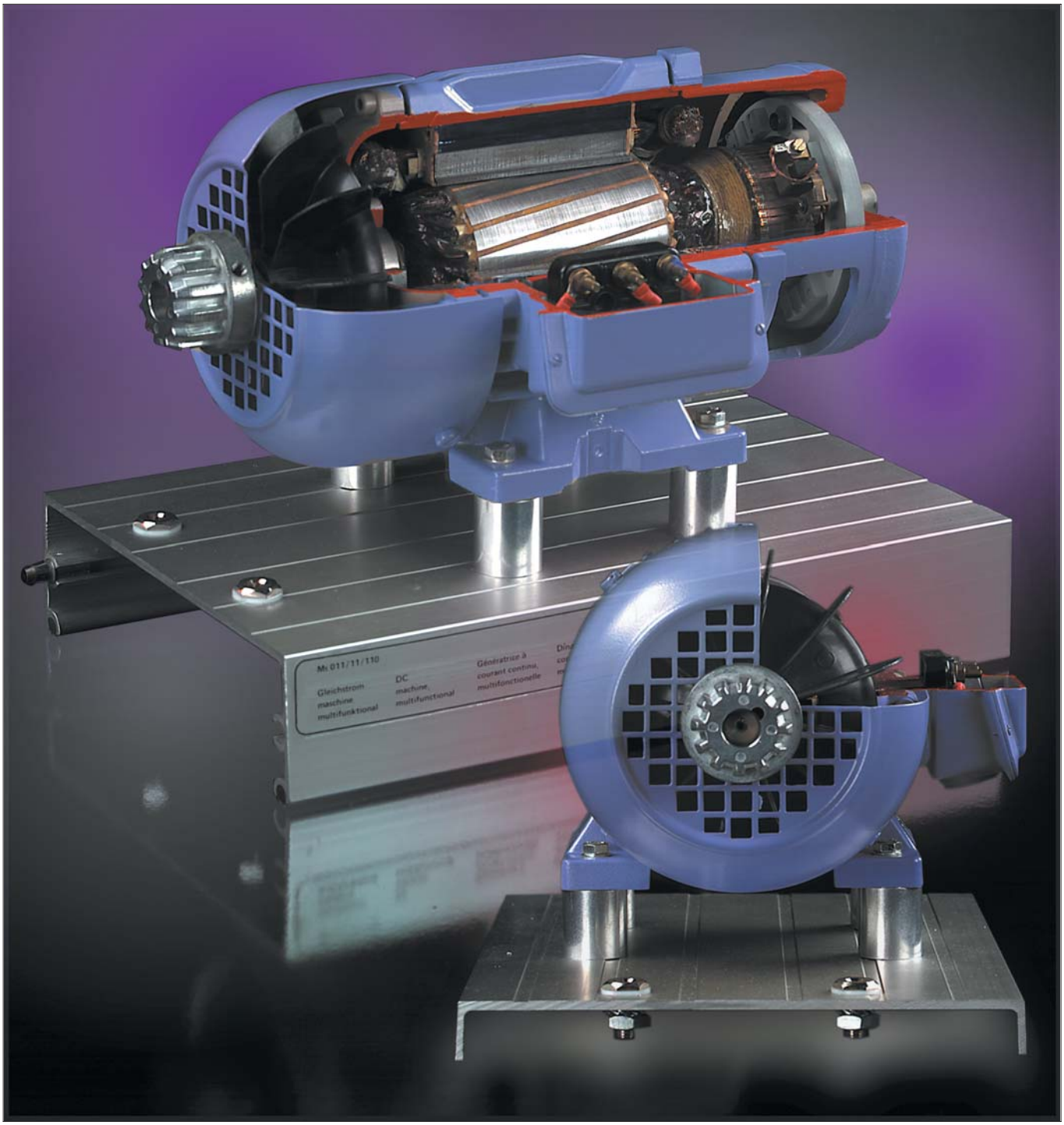
Training systems for basic and future oriented education in natural science and engineering

EN ISO 9001:2000
DNV Certified Company

Electrical Machines



Experimental – Panel and Module System



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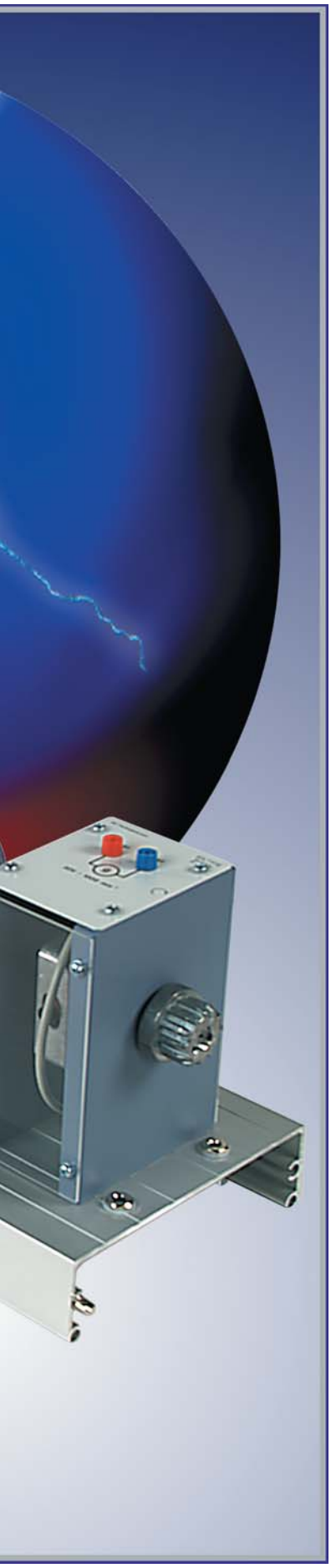
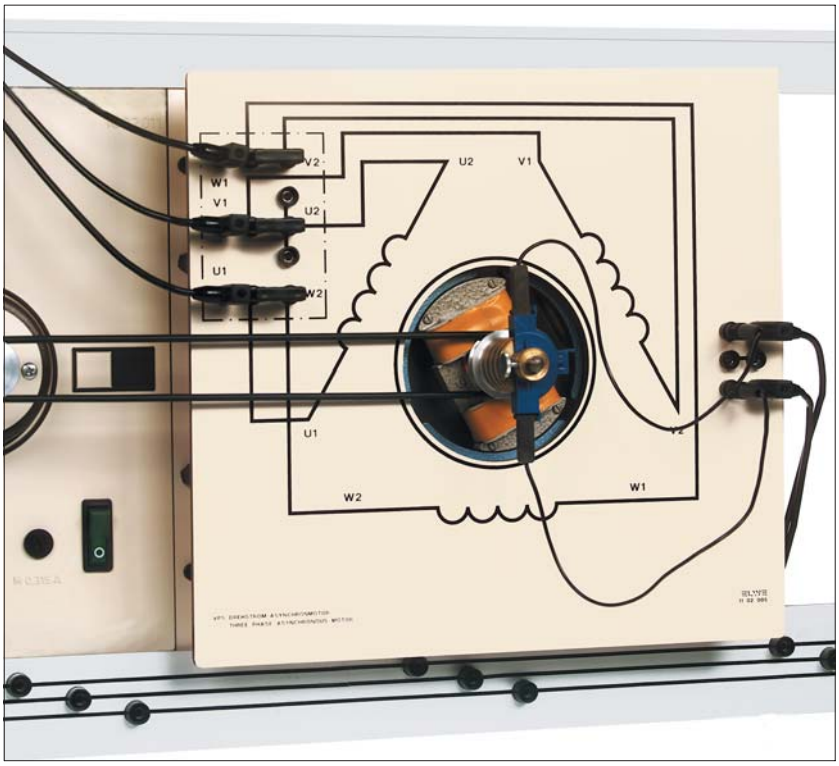


Table of Contents

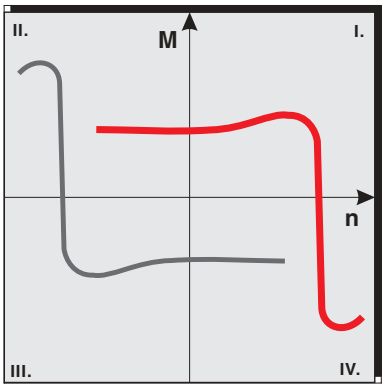
Already 30 years ago, ELWE in cooperation with the Bundesinstitut für Berufsbildung (BIBB) of Berlin (Federal Institute of Professional Education), set new accents for the application of electrical machines in experimental lessons, which have meanwhile become generally valid. Large machine sets which could only be applied for demonstrational purposes containing a certain amount of risk had been substituted by less powerful machines with characteristic curves that are also typical for powerful machines. Furthermore, ELWE replaced the eddy current brake, which was standard at that time, by the ELWE magnetic powder brake what allows the measurement of static and starting torques. Since the products have consistently advanced in the following years, ELWE can now offer an extensive tutorial system on the subject "Electrical Machines and Drive Engineering" including numerous innovations and equipments:



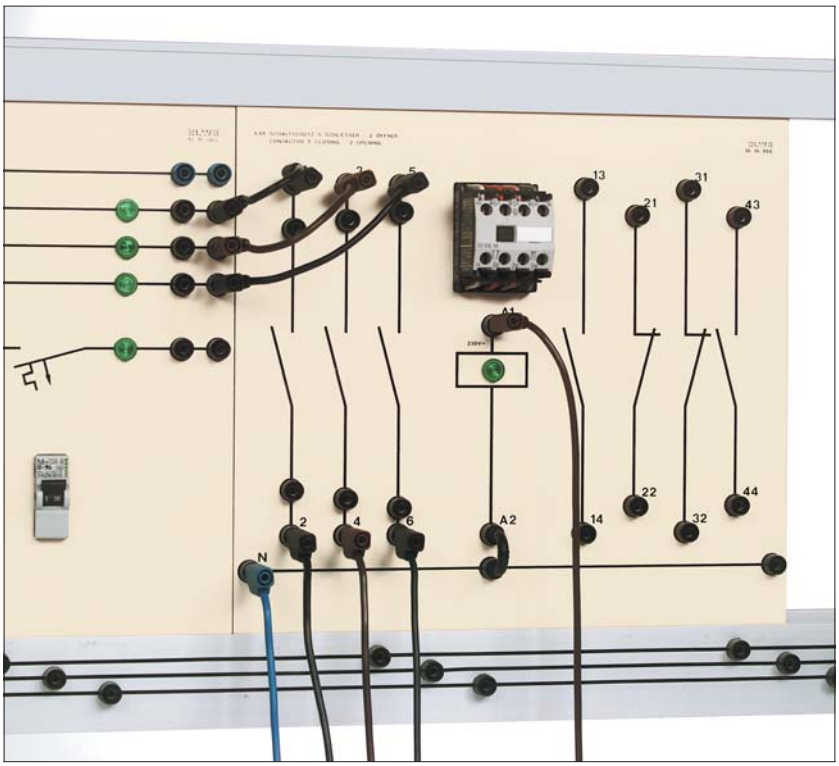
The **experimental panel system "Modular Electrical Machines"** (represented in a separate prospectus) is used to demonstrate the principal structure and action of electrical machines. The most important DC, AC and three-phase motors/generators can be constructed by using separate components.

The type series of **experimental electrical machines** contain almost all field-experienced, electrical machines used in industry and in home appliances. In order to meet all groups of addressees – ranging from the field of professional education to the courses of study at universities - and the requirements of demonstrations in classrooms or lecture-rooms and in students excercises and courses of practical work, ELWE provides machines of the power classes 100 W, 300 W and 1000 W. All machines can be used to record characteristics or to examine the operating performance and they can be applied in experimental set-ups on the subject of contactor circuits and closed loop control.

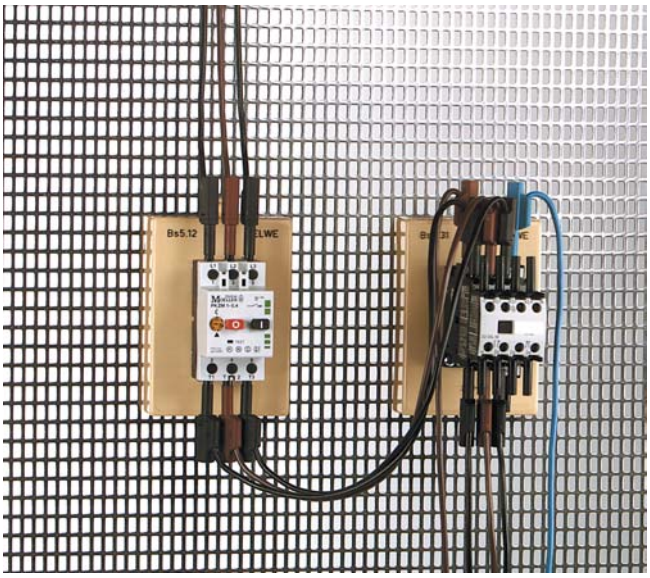
For loading the machines, ELWE provides **magnetic powder brakes** with appropriate control units, which have been proved for many years and are easy to handle. Thus it is possible to measure torque and speed in the 1st and 3rd quadrants of the examined machines (motor operation).

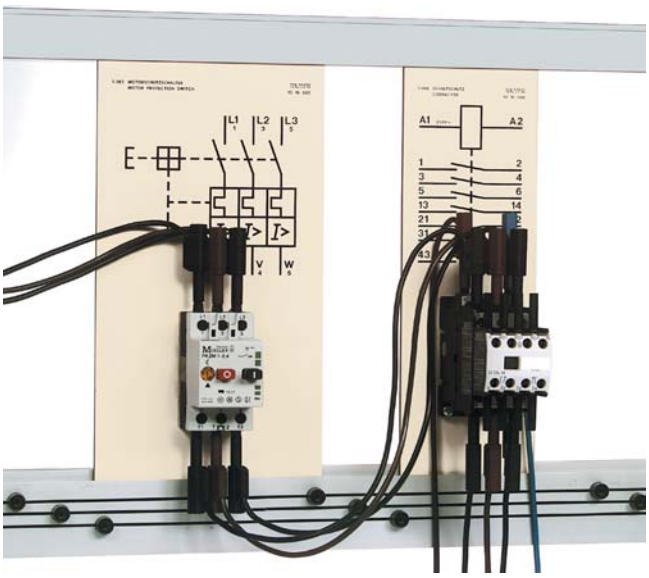


The new ELWE **servo drive and brake systems** in compact design allow you to operate the test machines with high precision in all four quadrants.



The **experimental panel system "Electrical Machines"** is mainly used for the application of experimental electrical machines for demonstration purposes in classrooms and lecture-rooms. The individual units of an experimental set-up are connected via 4-mm safety sockets which are arranged in large, synoptical graphical symbols or current flow diagrams. Due to the vertical arrangement of the experimental panels, the experimental set-up can be seen from a far distance and can be adapted step by step to the course of the lessons or lectures.



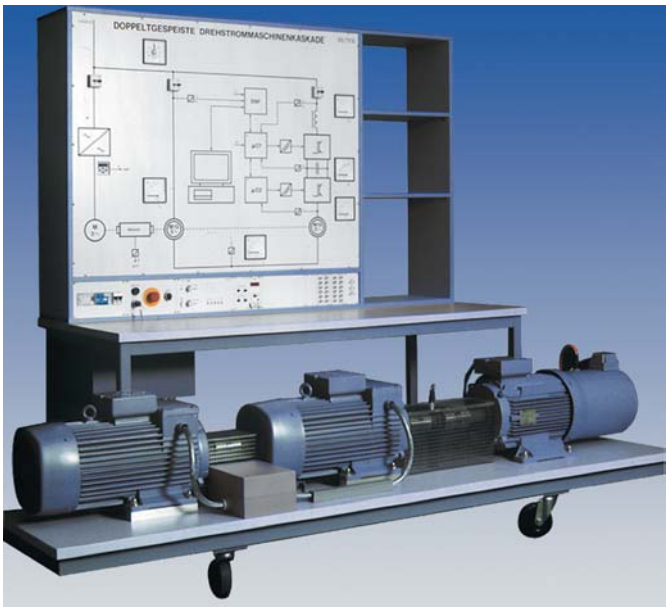


ELWE alternatively provides an **experimental module system and an experimental panel system PU** for the application of experimental electrical machines in students' exercises and courses of practical work. As far as possible, the individual units are connected directly to going switchgear via 4-mm safety sockets as in reality.

Extensive **experimental manuals** on all subject fields have been designed corresponding to the latest trends of research on professional education. They are divided into sections of information, working and exercise sheets as well as solution sheets thus facilitating the preparation of lessons or lectures and courses of practical work. Several forms of realizing lessons or training, such as the covering of other subjects, direct lecturing or action-oriented lessons, are possible depending on the way of applying the experimental manuals.

By means of the experimental panel systems PU and the experimental module system "Electrical Machines" it is possible to carry out experiments practically on the following subjects:

- Connection of electrical machines
- Operating performance of electrical machines
- Determining the characteristics of electrical machines
- Control circuits for electrical machines
- Servo-controlled drives



ELWE also develops experimental stands for electrical machines for universities and the industry meeting the specific demands of the customers. Modern development and manufacturing processes allow optimum overall solutions existing of machine sets and working stations with measuring instruments and interfaces for the connection of PCs. The appropriate power electronic unit is either integrated in the working station or housed in a rack depending on its scope.

Covering all branches of study, ELWE provides an extensive program of **power supply units and measuring instruments** which are mainly developed and produced by ELWE itself. An own **program of working stations and furniture** allows an optimum planning and creation of complete arrangements of laboratory equipment and furniture, e.g. on the subject field of electrical machines and drives.

Performance Features of Electrical Machines of the Power Classes 100 W, 300 W and 1000 W

- The machines are solid industrial-type units in compliance with the type of construction B3.
- All machines meet the recent state of international standards, e.g. DIN-VDE 0530.
- All machines guarantee a maximum safety, for example by having a design according to the protection system IP 54 and the insulation class F in most cases. Thermal sensors which are embedded in the stator windings allow to set up certain connection measures to protect against thermal overloading.
- All machines, speed sensors, brakes and gyrating masses are mounted on solid aluminium casting profiles. Thus they can be connected fast and safely without any effort and can be handled, transported and stored without any problems.
- All machines which can also be operated as generators are equipped with two shaft ends or couplings so that even extensive machine groups can be set up for individual purposes and without any problems. All connections and connecting leads are visible on the front.
- Elastic coupling collars and plastic profiles in the aluminium base plates guarantee an extremely noiseless and safe operation.
- Rotating shaft ends are covered by plugged-on guard bows. If the guard bow is not plugged on, the brake or servo machine cannot be put into operation.
- The winding terminations are accessible via 4-mm safety sockets in the lid of the terminal box. Even multifunctionally used machines are clearly designated according to the desired case of application by snap-on masks with printed name plates as well as graphical symbols and pin names.
- Since the machines have characteristic curves which are typical of their types, the knowledge obtained during the experiments can easily be conferred to machines of very high power.
- The DC machines (except the 100-W machines) are equipped with commutating and compensating-field windings.
- The series winding of the DC compound-wound machine has a tapping to allow the arrangement of different compoundings.
- Machines with brushes, slip-rings or special sensors are equipped with transparent covers so that components which are typical of the machine can be made visible.
- The modular design of the system allows a selection which easily meets the requirements in conformity with the respective educational object in view. The continious advancement of ELWE products guarantees that extentions corresponding to technological progresses can be made later on.
- Already existing machines of other systems, even of other manufacturers, can be equipped with new couplings and mounted to the modern ELWE aluminium casting profiles at low costs.

Performance Features of the new Servo Drive and Brake System

- The new servo drive and brake system, containing the servo machine and the control unit, has the following special features: compact design, few mechanical parts, high precision and simple operation.
- The connected test machine can be driven or braked by the servo machine in both directions (4-quadrant operation).
- The control unit is equipped with an isolating amplifier with electrical isolation to measure the voltage and the current of the tested machine.
- The control unit also has an integrated RS232 interface for the transfer of measured data to a PC.
- With the software "Servo Machine" running under Windows®, the measured data and resulting values of the tested machined, such as M, n, I, U, P_1, P_2, $\cos\varphi$ or η, can be illustrated graphically and printed out or put into the archives.
- It is possible to measure the stationary torque.
- The start and stop speed can be defined for an automatic characteristic curve measurement.
- Two large, circular-scale instruments on the control unit for the display of speed and torque allow you to observe trend changes of the measured values at the same time.

Experimental Manual "Three-phase AC Basic Circuits and Transformers" 53 05 012

The experimental manual contains the following experimental subjects:

Experimental group: Three-phase AC basic circuits

- Star connection with resistors without neutral conductor
- Star connection with resistors and neutral conductor
- Star connection of resistors in case of unbalanced load
- Delta connection of resistors

Experimental group: Transformers

- Single-phase transformer, no-load and load
- Single-phase transformer, short-circuit voltage and sustained short-circuit current
- Single-phase ring core transformer, no-load and load
- Single-phase ring core transformer, short-circuit voltage and sustained short-circuit current
- Single-phase auto-transformer, operating characteristics
- Three-phase transformer, Yy0-connection
- Three-phase transformer, Dy5-connection
- Three-phase transformer, Yd5-connection
- Three-phase transformer, Yz5-connection
- Single- and three-phase transformer (induction motor with slip-ring rotor)

Experimental Manual "DC Machines" 53 05 022

The experimental manual contains the following experimental subjects:

Experimental group: DC shunt-wound motor

- Connection, starting, change of rotation
- Rating plate data
- Load characteristics n, I_A, P_2, $\eta = f(M)$
- Speed and exciting current characteristic $n = f(I_E)$
- Speed and voltage characteristic $n = f(U)$
- Speed and torque characteristic $n = f(M)$ at different armature voltages
- Speed and torque characteristic $n = f(M)$ at different armature series resistance values

Experimental group: DC shunt-wound generator

- Separately-excited: connection, change of rotation
- Self-excited: connection, change of rotation
- Separately- and self-excited: load characteristics U_K, P_2, $\eta = f(I_A)$
- No-load characteristic $U_0 = f(I_E)$

Experimental group: DC series-wound motor

- Connection, starting, change of rotation
- Speed control
- Load characteristics n, I_A, P_2, $\eta = f(M)$

Experimental group: ***DC series-wound generator***

- Connection, change of rotation
- Load characteristics U_K, P_2 = f (I_A)

Experimental group: ***DC compound-wound motor***

- Connection, starting, change of rotation
- Load characteristics n, I_A, P_2, η = f (M)
- Compound characteristics n = f (M)

Experimental group: ***DC compound-wound generator***

- Connection, change of rotation
- Load characteristics U_K, P_2, η = f (I_A)
- Compound characteristics U = f (I_A)

Experimental Manual "AC Machines" — 53 05 032

The experimental manual contains the following experimental subjects:

Experimental group: ***Capacitor motor***

- Starting behaviour
- Connection, change of rotation
- Starting connection with centrifugal switch
- Starting connection with starting relay
- Rating plate data
- Load characteristics n, I, cos φ, I_{Hi}, P_2, s, η = f (M)
- Starting characteristics M, I = f (n)

Experimental group: ***Single-phase induction motor with auxiliary resistance winding***

- Starting behaviour
- Connection, change of rotation
- Load characteristics n, I, cos φ, P_2, s, η = f (M)
- Starting characteristics M, I = f (n)

Experimental group: ***Split-pole motor*** *(only in 100-W program)*

- Connection
- Load characteristics n, I, cos φ, P_2, s, η = f (M)
- Starting characteristics M, I = f (n)

Experimental group: ***Repulsion motor***

- Connection, brush shift, change of rotation
- Load characteristics n, I, cos φ, P_2, η = f (M)

Experimental group: ***Universal motor***

- Connection, change of rotation
- Load characteristics n, I, cos φ, P_2, η = f (M) at DC and AC voltage
- Speed and torque characteristic at DC and AC voltage

Experimental Manual "Three-phase Machines" — 53 05 042

The experimental manual contains the following experimental subjects:

Experimental group: Three-phase induction motor with squirrel-cage rotor

- Connection, change of rotation
- Star-delta connection
- Rating plate data
- Kusa connection
- Compensation of reactive power I, $\cos \varphi = f(M)$
- Steinmetz connection: Load characteristics n, I, I_U, I_V, I_W, $\cos \varphi$, P_2, η, $s = f(M)$ (motor: 230/400 V)
- Steinmetz connection: Starting characteristic $M = f(n)$ (motor: 230/400 V)
- Load characteristics n, I, $\cos \varphi$, P_2, s, $\eta = f(M)$
- Starting characteristics M, $I = f(n)$
- Subsynchronous and hypersynchronous operation, moving in opposite directions

Experimental group: Three-phase induction motor with slip-ring rotor

- Rotor voltage, rotor current, rotor frequency
- Starting, change of rotation
- Rating plate data
- Load characteristics n, I, $\cos \varphi$, P_2, η, $s = f(M)$
- Starting characteristics M, $I = f(n)$ at different resistance values of the rotor starter
- Speed characteristic $n = f(R_{\text{rotor starter}})$

Experimental group: Three-phase induction motor, pole-changeable, Dahlander circuit

- Connection, change of speed
- Load characteristics n, I, $\cos \varphi$, P_2, s, $\eta = f(M)$ at low speed
- Load characteristics n, I, $\cos \varphi$, P_2, s, $\eta = f(M)$ at high speed
- Starting characteristics M, $I = f(n)$ at low and high speed

Experimental group: Three-phase induction motor, pole-changeable, 2 separate windings

- Connection, change of speed
- Load characteristics n, I, $\cos \varphi$, P_2, η, $s = f(M)$ at low speed
- Load characteristics n, I, $\cos \varphi$, P_2, η, $s = f(M)$ at high speed
- Starting characteristics M, $I = f(n)$ at low and high speed

Experimental group: Three-phase synchronous motor with smooth-core rotor

- Connection, starting
- Load characteristics n, I, $\cos \varphi$, P_2, $\eta = f(M)$
- Load characteristics n, I, I_E, η , $P_2 = f(M)$ at $\cos \varphi = 1$ constant
- V-characteristic $I = f(I_E)$

Experimental group: Three-phase synchronous generator with smooth-core rotor

- Connection
- Synchronizing circuits (light-dark circuit)
- Synchronizing circuits with double frequency meter, double voltage meter and zero voltage meter
- Synchronizing circuits with double frequency meter, double voltage meter and synchronoscope
- No-load and short-circuit characteristic $U_0 = f(I_E)$; $I_K = f(I_E)$
- Load characteristics U, S, $\eta = f(I)$
- Exciter-regulator characteristic $I_E = f(I_1)$

Experimental group: Three-phase synchronous motor with salient-pole rotor

- Connection, starting
- Load characteristics n, I, $\cos \varphi$, P_2, $\eta = f(M)$
- Load characteristics n, I, I_E, η, $P_2 = f(M)$ at $\cos \varphi = 1$ constant
- V-characteristic $I = f(I_E)$

Experimental group: Three-phase synchronous generator with salient-pole rotor

- Connection
- Synchronizing circuits (light-dark circuit)
- Synchronizing circuits with double frequency meter, double voltage meter and zero voltage meter
- Synchronizing circuits with double frequency meter, double voltage meter and synchronoscope
- No-load and short-circuit characteristic $U_0 = f(I_E)$; $I_K = f(I_E)$
- Load characteristics U, S, $\eta = f(I)$
- Exciter-regulator characteristic $I_E = f(I_1)$

Experimental group: Reluctance motor

- Connection, change of rotation
- Load characteristics n, I, $\cos \varphi$, η, $P_2 = f(M)$
- Starting characteristics M, $I = f(n)$

Experimental group: Protection of electrical machines

- Motor protection with motor protection switch
- Motor protection with motor protection relay
- Machine protection with built-in temperature switch
- Machine protection with thermistor

Experimental Manual "Control of Electrical Machines" 53 05 052

The experimental manual contains the following experimental subjects:

Experimental group: Limit and proximity switches

- Mechanical limit switch: operating mode
- Inductive proximity switch: operating distance
- Capacitive proximity switch: operating distance as a function of different material
- Optical proximity switch (push-button system): operating distance as a function of different material
- Application of mechanical limit and proximity switches on the example of the reversing contactor connection

Experimental group: Contactor circuits

- Control of a motor (automatic control)
- Control of a motor from two actuators
- Contactor circuit with motor protective relay and fault signal
- Bridging of a motor protective relay during starting time at heavy starting duty of motors
- Automatic Kusa circuit
- Reversing contactor circuit
- Automatic reversing contactor control
- Positive sequence control for 3 belt conveyors
- Dahlander circuit
- Pendulum contactor circuit
- Automatic star-delta circuit
- Multifunctional relay
- Contactor circuit with multifunctional relay

Experimental group: Protective circuits

- Avoidance of unintentional operation
- Immobilisation of the start button
- Emergency tripping device in the control circuit for simple drives
- Emergency tripping device in the control circuit to interrupt several electric circuits
- Two-hand control type 1
- Two-hand control type 2

Experimental group: Electronic switching and motor control devices

- Electronic motor starter
- Electronic three-phase load disconnecting relay
- DC braking of a squirrel-cage motor

Experimental Manual "Fault Simulators" — 53 05 062

The experimental manual contains the following experimental subjects:

Experimental group: Fault simulator for contactor circuits

- On/off circuit
- Reversing contactor circuit
- Reversing contactor circuit with limit switches
- Automatic star-delta circuit
- Dahlander circuit
- Automatic Dahlander circuit
- Automatic Dahlander reversing circuit with limit switches

Experimental group: Motor fault simulator

- Fault finding at the three-phase induction motor with squirrel-cage rotor
  (Selectable faults: winding interruption, interturn short-circuit, body contact, winding short-circuit)

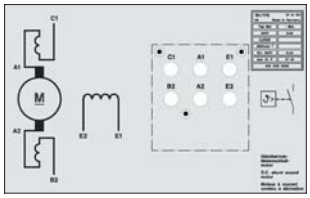
Experimental Manual "Automatic Compensation of Reactive Power" — 53 05 072

The experimental manual contains the following experimental subjects:

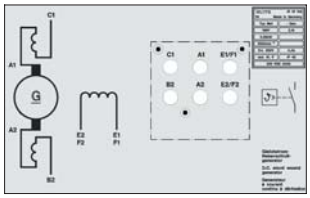
- Capacitors in star connection
- Capacitors in delta connection
- Currents in a compensated, electric plant
- Compensation of reactive power and power factor
- Overcompensated, electric plant
- Calculation of step power for compensation plants
- Automatic compensation of reactive power of a motor with resistive load and inductive load
- Causes of faults in a compensation plant with reactive power regulator
- Automatic compensation of reactive power of a system with resistive load and inductive load

Equipment "DC Machines"

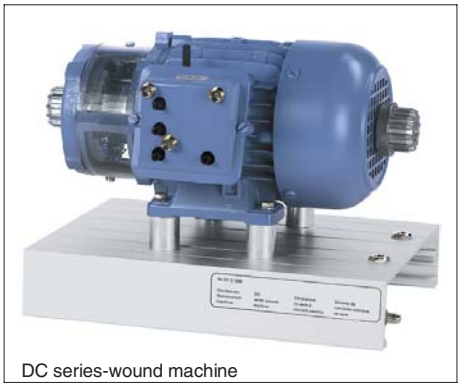
DC shunt-wound machine



Connection mask, motor 31 15 101.1



Connection mask, generator 31 15 102.1



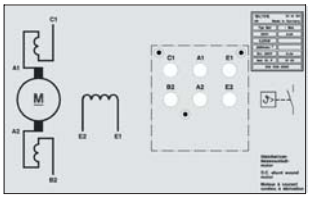
DC series-wound machine

DC compound-wound machine

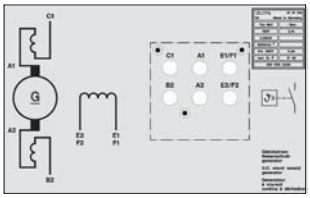
Power class	**100 W**	**300 W**	**1000 W**
Equipment Art. no.	**03 07 110 01**	**03 17 110 01**	**03 27 110 01**
consisting of:			
DC shunt-wound machine	**30 07 100 01**	**30 17 100 01**	**30 27 100 01**
for motor and generator operation; with commutating and compensating winding at 300 W and 1000 W			
Rated data during motor operation:			
Voltage	220 V	220 V	220 V
Current	0.53 A	2.15 A	5.7 A
Power	90 W	370 W	1000 W
Exciting voltage	220 V	220 V	220 V
Exciting current	0.14 A	0.5 A	0.5 A
Speed	1800 rpm	2390 rpm	2025 rpm
Dimensions in mm (l x w x h)	315x250x200	320x240x230	360x240x230
Mass	9.15 kg	10.7 kg	15.0 kg
Connection mask, motor	**31 05 101**	**31 15 101.1**	**31 25 101**
Connection mask, generator	**31 05 102**	**31 15 102.1**	**31 25 102**
DC series-wound machine	**30 07 200 01**	**30 17 200 01**	**30 27 200 01**
for motor and generator operation; with commutating and compensating winding at 300 W and 1000 W			
Rated data during motor operation:			
Voltage	220 V	220 V	220 V
Current	0.6 A	2.37 A	5.1 A
Power	90 W	370 W	800 W
Speed	1720 rpm	2880 rpm	2730 rpm
Dimensions in mm (l x w x h)	315x250x200	320x230x230	360x240x230
Mass	9.15 kg	10.6 kg	15.0 kg
Connection mask, motor	**31 05 201**	**31 15 201.1**	**31 25 201**
Connection mask, generator	**31 05 202**	**31 15 202.1**	**31 25 202**
DC compound-wound machine	**30 07 300 01**	**30 17 300 01**	**30 27 300 01**
for motor and generator operation; Series winding with tap for compounding; with commutating and compensating winding at 300 W and 1000 W			
Rated data during motor operation:			
Voltage	220 V	220 V	220 V
Current	0.55 A	2.7 A	4.8 A
Power	90 W	370 W	800 W
Exciting voltage	220 V	220 V	220 V
Exciting current	0.14 A	0.5 A	0.36 A
Speed	1590 rpm	2250 rpm	2400 rpm
Dimensions in mm (l x w x h)	315x250x200	320x230x230	350x250x220
Mass	9.15 kg	10.5 kg	15.5 kg
Connection mask, motor	**31 05 301**	**31 15 301.1**	**31 25 301**
Connection mask, generator	**31 05 302**	**31 15 302.1**	**31 25 302**

Alternative to Equipment "DC Machines":
Equipment "Multifunctional DC Machine"

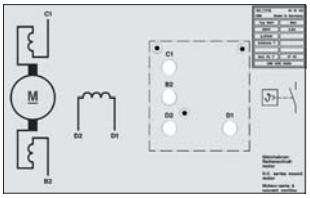
Multifunctional DC machine



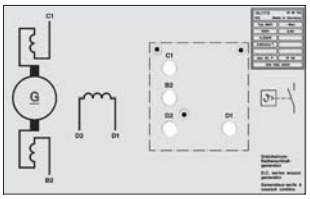
Connection mask, motor 31 15 101.1



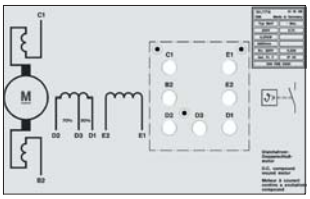
Connection mask, generator 31 15 102.1



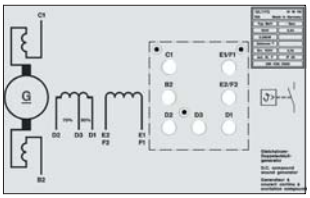
Connection mask, motor 31 15 201.1



Connection mask, generator 31 15 202.1



Connection mask, motor 31 15 301.1

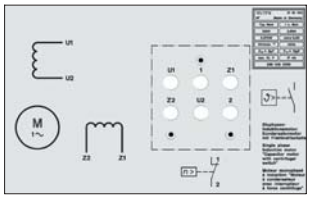


Connection mask, generator 31 15 302.1

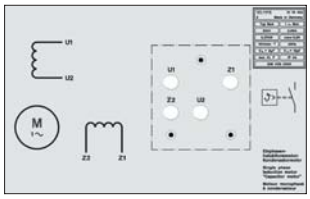
Power class	**100 W**	**300 W**	**1000 W**
Equipment Art. no.	**03 07 120 01**	**03 17 120 01**	**03 27 120 01**
consisting of:			
Multifunctional DC machine for motor and generator operation; usable as shunt-, series-, compound-wound machine; Series winding with tap for compounding; with commutating and compensating winding at 300 W and 1000 W	**30 07 110 01**	**30 17 110 01**	**30 27 110 01**
Rated data during motor operation as shunt-wound machine:			
Voltage	220 V	220 V	220 V
Current	0.53 A	2.15 A	7.3 A
Power	90 W	370 W	1000 W
Exciting voltage	220 V	220 V	220 V
Exciting current	0.14 A	0.5 A	0.34 A
Speed	1800 rpm	2390 rpm	2600 rpm
Rated data during motor operation as series-wound machine:			
Voltage	220 V	220 V	220 V
Current	0.6 A	2.37 A	5.0 A
Power	90 W	370 W	800 W
Speed	1720 rpm	2880 rpm	3100 rpm
Rated data during motor operation as compound-wound machine:			
Voltage	220 V	220 V	220 V
Current	0.55 A	2.7 A	4.8 A
Power	90 W	370 W	800 W
Exciting voltage	220 V	220 V	220 V
Exciting current	0.14 A	0.5 A	0.36 A
Speed	1590 rpm	2250 rpm	2400 rpm
Dimensions in mm (l x w x h)	315x250x200	300x230x230	360x240x230
Mass	9.15 kg	10.5 kg	15.0 kg
Connection mask, NS motor	**31 05 101**	**31 15 101.1**	**31 25 111**
Connection mask, NS generator	**31 05 102**	**31 15 102.1**	**31 25 112**
Connection mask, RS motor	**31 05 201**	**31 15 201.1**	**31 25 113**
Connection mask, RS generator	**31 05 202**	**31 15 202.1**	**31 25 114**
Connection mask, DS motor	**31 05 301**	**31 15 301.1**	**31 25 301**
Connection mask, DS generator	**31 05 302**	**31 15 302.1**	**31 25 302**

Equipment "AC Machines"

Capacitor motor with centrifugal switch



Connection mask 31 15 401



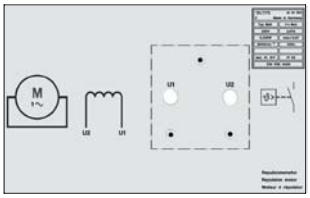
Connection mask 31 15 402

Single-phase induction motor

Split-pole motor

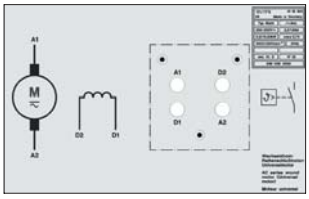
Power class	**100 W**	**300 W**	**1000 W**
Equipment Art. no.	**03 07 210 11**	**03 17 210 01**	**03 27 210 01**
consisting of:			
Capacitor motor with centrifugal switch for the operation with starting and operating capacitor	**30 07 400 01**	**30 17 400 01**	**30 27 400 01**
Rated data:			
Voltage	230 V	230 V	230 V
Current	1.29 A	2.66 A	4.75 A
Power	120 W	370 W	750 W
Power factor cos φ	0.84	0.95	0.93
Speed (at 50 Hz)	1250 rpm	1375 rpm	1430 rpm
Dimensions in mm (l x w x h)	240x210x200	210x240x230	310x250x230
Mass	5.6 kg	10.5 kg	14.7 kg
Connection mask for operation with centrifugal switch	**31 05 401**	**31 15 401**	**31 25 401**
Connection mask for operation without centrifugal switch	**31 05 402**	**31 15 402**	**31 25 402**
Single-phase induction motor with auxiliary resistance winding and centrifugal switch	**30 07 450 01**	**30 17 450 01**	**30 27 450 01**
Rated data:			
Voltage	230 V	230 V	230 V
Current	1.8 A	3.47 A	7.6 A
Power	120 W	260 W	750 W
Power factor cos φ	0.7	0.6	0.7
Speed (at 50 Hz)	1400 rpm	1410 rpm	1400 rpm
Dimensions in mm (l x w x h)	230x210x200	310x230x240	310x250x250
Mass	6.1 kg	10.6 kg	14.5 kg
Connection mask	**31 05 451.1**	**31 15 451**	**31 25 451**
Split-pole motor	**30 07 480 01**	—	—
Rated data:			
Voltage	230 V		
Current	1.2 A		
Power	55 W		
Power factor cos φ	0.67		
Speed	1300 rpm		
Dimensions in mm (l x w x h)	240x210x200		
Mass	5.5 kg		
Connection mask	**31 05 481**		

Repulsion motor



Connection mask 31 15 501

Universal motor



Connection mask 31 15 551

Power class	100 W	300 W	1000 W
Repulsion motor with adjustable brushes for changing the rotational frequency and direction of rotation	**30 07 500 01**	**30 17 500 01**	**30 27 500 01**
Rated data:			
Voltage	230 V	230 V	230 V
Current	0.76 A	2.67 A	11.0 A
Power	70 W	250 W	1000 W
Power factor cos φ	0.9	0.87	0.62
Speed	2800 rpm	2800 rpm	2900 rpm
Dimensions in mm (l x w x h)	240x210x180	320x240x250	360x240x240
Mass	4.7 kg	9.6 kg	22.6 kg
Connection mask	**31 05 501**	**31 15 501**	**31 25 501.1**
Universal motor for operation at 230 V AC or 220 V DC	**30 07 550 01**	**30 17 550 01**	**30 27 550 01**
Rated data (DC/AC):			
Voltage	220/230 V	220/230 V	220/230 V
Current	0.8/0.79 A	2.1/2.3 A	4.5/3.9 A
Power	90/60 W	370/280 W	800/650 W
Power factor cos φ	0.8	0.79	0.9
Speed	4900/2930 rpm	5000/4450 rpm	2685/3100 rpm
Dimensions in mm (l x w x h)	240x210x180	260x220x230	360x240x230
Mass	4.7 kg	8.8 kg	15.0 kg
Connection mask	**31 05 551**	**31 15 551**	**31 25 551.1**

Alternative to Equipment "AC Machines": Equipment "AC Machines without Centrifugal Switch"

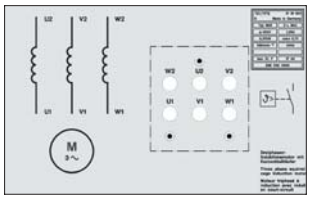
With this equipment the capacitor motor and the single-phase induction motor with auxiliary resistance winding are both supplied **without** centrifugal switches.

The technical data correspond to those of the machines with centrifugal switches on page 15.

Power class	100 W	300 W	1000 W
Equipment Art. no.	**03 07 220 01**	**03 17 220 01**	**03 27 220 01**
consisting of:			
Capacitor motor	**30 07 410 01**	**30 17 410 01**	**30 27 410 01**
Connection mask	**31 05 402**	**31 15 402**	**31 25 402**
Single-phase induction motor with auxiliary resistance winding	**30 07 460 01**	**30 17 460 01**	**30 27 460 01**
Connection mask	**31 05 461**	**31 15 461**	**31 25 461**
Split-pole motor	**30 07 480 01**	**–**	**–**
Connection mask	**31 05 481**	**–**	**–**
Repulsion motor	**30 07 500 01**	**30 17 500 01**	**30 27 500 01**
Connection mask	**31 05 501**	**31 15 501**	**31 25 501.1**
Universal motor	**30 07 550 01**	**30 17 550 01**	**30 27 550 01**
Connection mask	**31 05 551**	**31 15 551**	**31 25 551.1**

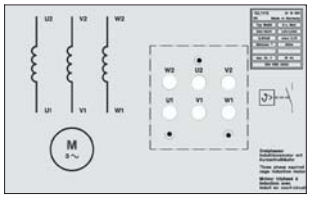
Equipment "Three-phase Machines for 400-V Three-phase Systems"

Three-phase induction motor with squirrel-cage rotor, 400/690 V



Connection mask 31 15 601.1

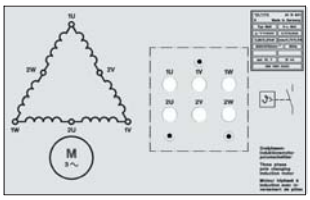
Three-phase induction motor with squirrel-cage rotor, 230/400 V



Connection mask 31 15 651.1

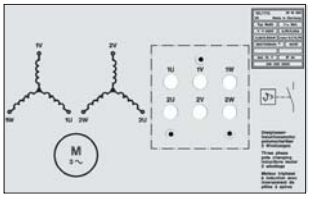
Power class	**100 W**	**300 W**	**1000 W**
Equipment Art. no.	**03 07 310 01**	**03 17 310 01**	**03 27 310 01**
consisting of:			
Three-phase induction motor with squirrel-cage rotor, 400/690 V	**30 07 600 01**	**30 17 600 01**	**30 27 600 01**
Rated data:			
Voltage (Δ/Y)	400/690 V	400/690 V	400/690 V
Current (Δ)	0.35 A	1.22 A	2.71 A
Power	120 W	370 W	1000 W
Power factor cos φ	0.78	0.64	0.73
Speed	1385 rpm	1400 rpm	1415 rpm
Dimensions in mm (l x w x h)	240x210x200	317x220x220	310x240x240
Mass	5.45 kg	8.4 kg	14.2 kg
Connection mask	**31 05 601**	**31 15 601.1**	**31 25 601**
Three-phase induction motor with squirrel-cage rotor 230/400 V	**30 07 650 01**	**30 17 650 01**	**30 27 650 01**
Rated data:			
Voltage (Δ/Y)	230/400 V	230/400 V	230/400 V
Current	0.57/0.33 A	2/1.17 A	4.44/2.57 A
Power	120 W	370 W	1000 W
Power factor cos φ	0.82	0.67	0.73
Speed	1320 rpm	1400 rpm	1415 rpm
Dimensions in mm (l x w x h)	240x210x190	317x220x220	320x250x240
Mass	5.65 kg	8.5 kg	14.6 kg
Connection mask	**31 05 651**	**31 15 651.1**	**31 25 651**

Three-phase induction motor, pole-changeable

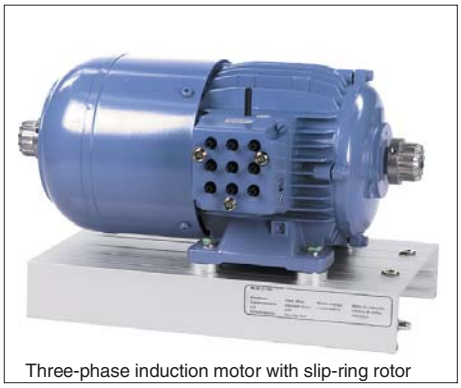


Connection mask 31 15 801.1

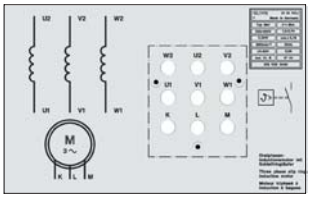
Three-phase induction motor, 2 separate windings



Connection mask 31 15 851.1



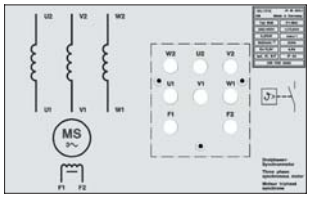
Three-phase induction motor with slip-ring rotor



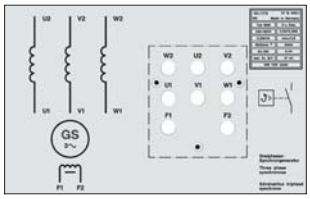
Connection mask 31 15 701.1

Power class	100 W	300 W	1000 W
Three-phase induction motor, pole-changeable, Dahlander circuit	**30 07 800 01**	**30 17 800 01**	**30 27 800 01**
Rated data:			
Voltage (Δ/YY)	400 V	400 V	400 V
Current	0.27/0.31 A	0.71/0.90 A	1.9/2.66 A
Power	80/120 W	260/370 W	700/950 W
Power factor cos φ	0.72/0.9	0.73/0.84	0.72/0.76
Speed	1390/2720 rpm	1395/2785 rpm	1415/2825 rpm
Dimensions in mm (l x w x h)	240x210x200	317x220x220	310x240x230
Mass	5.45 kg	7.8 kg	14.2 kg
Connection mask	**31 05 801**	**31 15 801.1**	**31 25 801**
Three-phase induction motor pole-changeable, 2 separate windings	**30 07 850 01**	**30 17 850 01**	**30 27 850 01**
Rated data:			
Voltage (YY)	400 V	400 V	400 V
Current	0.31/0.33 A	0.76/0.90 A	2.0/2.66 A
Power	80/120 W	220/330 W	650/1000 W
Power factor cos φ	0.64/0.78	0.70/0.75	0.70/0.82
Speed	960/1440 rpm	950/1435 rpm	945/1415 rpm
Dimensions in mm (l x w x h)	230x210x200	250x230x220	310x240x250
Mass	7.5 kg	10.5 kg	16.75 kg
Connection mask	**31 05 851**	**31 15 851.1**	**31 25 851**
Three-phase induction motor with slip-ring rotor	**30 07 700 01**	**30 17 700 01**	**30 27 700 01**
Rated data:			
Voltage (Δ/Y)	230/400 V	230/400 V	230/400 V
Current	0.41/0.25 A	1.2/0.7 A	4.22/2.44 A
Power	90 W	300 W	1000 W
Power factor cos φ	0.78	0.79	0.75
Speed	1430 rpm	1395 rpm	1385 rpm
Rotor voltage	100 V	95 V	130 V
Rotor current	0.7 A	2.2 A	5.7 A
Dimensions in mm (l x w x h)	300x210x200	400x250x240	460x250x250
Mass	12.2 kg	16 kg	22 kg
Connection mask	**31 05 701**	**31 15 701.1**	**31 25 701.1**

Three-phase synchronous machine with smooth-core rotor

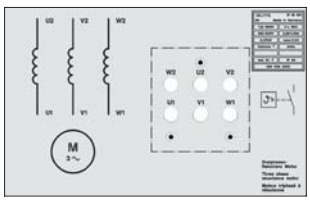


Connection mask, motor 31 15 901.1



Connection mask, generator 31 15 902.1

Three-phase reluctance motor



Connection mask 31 15 951

Power class	**100 W**	**300 W**	**1000 W**
Three-phase synchronous machine with smooth-core rotor for motor and generator operation	**30 07 900 01**	**30 17 900 01**	**30 27 900 01**
Rated data during motor operation:			
Voltage (Δ/Y):	230/400 V	230/400 V	230/400 V
Current	0.29/0.17 A	1.1/0.64 A	2.37/1.66 A
Power	90 W	370 W	1000 W
Power factor cos φ	1	1	1
Speed (at 50 Hz)	1500 rpm	1500 rpm	1500 rpm
Exciting voltage	8 V	11.3 V	14.8 V
Exciting current	1 A	4.6 A	9.8 A
Dimensions in mm (l x w x h)	300x210x200	400x220x240	400x240x240
Mass	12.2 kg	16.0 kg	19.8 kg
Connection mask, motor	**31 05 712**	**31 15 901.1**	**31 25 901.1**
Connection mask, generator	**31 05 713**	**31 15 902.1**	**31 25 902.1**
Three-phase reluctance motor	**30 07 950 01**	**30 17 950 01**	**30 27 950 01**
Rated data:			
Voltage (Δ/Y)	230/400 V	230/400 V	230/400 V
Current	0.99/0.57 A	2.28/1.33 A	4.42/2.57 A
Power	120 W	370 W	750 W
Power factor cos φ	0.55	0.54	0.5
Speed	1500 rpm	1500 rpm	1500 rpm
Dimensions in mm (l x w x h)	230x210x190	270x230x230	310x240x240
Mass	5.4 kg	9.9 kg	15.0 kg
Connection mask	**31 05 951**	**31 15 951**	**31 25 951**

Equipment "Three-phase Machines for 230-V Three-phase Systems"

For technical data of the machines, please see pages 17 to 19.

The voltage of the Dahlander three-phase pole-changable induction motor and the three-phase pole-changeable induction motor with 2 separate windings is 230 V. The current values have to be multiplied by $\sqrt{3}$.

Power class	100 W	300 W	1000 W
Equipment Art. no.	**03 07 311 01**	**03 17 311 01**	**03 27 311 01**
consisting of:			
Three-phase induction motor with squirrel-cage rotor, 230/400 V	**30 07 650 01**	**30 17 650 01**	**30 27 650 01**
Connection mask	**31 05 651**	**31 15 651.1**	**31 25 651**
Three-phase induction motor, pole-changeable, Dahlander circuit, 230 V	**30 07 800 01**	**30 17 800 01**	**30 27 800 01**
Connection mask	**31 05 802**	**31 15 802**	**31 25 802**
Three-phase induction motor, pole-changeable, 2 separate windings, 230 V	**30 07 850 01**	**30 17 850 01**	**30 27 850 01**
Connection mask	**31 05 852**	**31 15 852**	**31 25 852**
Three-phase induction motor with slip-ring rotor	**30 07 700 01**	**30 17 700 01**	**30 27 700 01**
Connection mask	**31 05 701**	**31 15 701.1**	**31 25 701.1**
Three-phase synchronous machine with smooth-core rotor	**30 07 900 01**	**30 17 900 01**	**30 27 900 01**
Connection mask, motor	**31 05 712**	**31 15 901.1**	**31 25 901.1**
Connection mask, generator	**31 05 713**	**31 15 902.1**	**31 25 902.1**
Three-phase reluctance motor	**30 07 950 01**	**30 17 950 01**	**30 27 950 01**
Connection mask	**31 05 951**	**31 15 951**	**31 25 951**

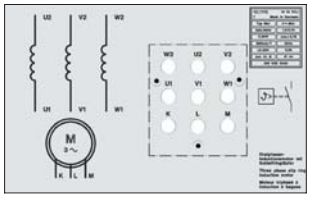
Equipment "Three-phase Machines with Multifunctional Asynchronous/Synchronous Machine for 400-V Three-phase Systems"

For technical data of the machines, please see pages 17 to 19.

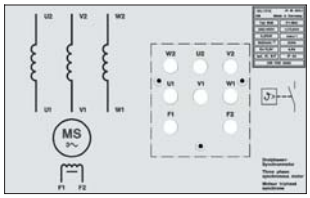
This equipment is almost adequate to the equipment "Three-phase Machines for 400 V Three-phase Systems" illustrated on pages 17 to 19.
It is equipped with a multifunctional three-phase asynchronous/synchronous machine instead of the three-phase induction motor with slip-ring rotor and the three-phase synchronous machine with smooth-core rotor.

Power class	100 W	300 W	1000 W
Equipment Art. no.	**03 07 320 01**	**03 17 320 01**	**03 27 320 01**
consisting of:			
Three-phase induction motor with squirrel-cage rotor, 400/690 V	**30 07 600 01**	**30 17 600 01**	**30 27 600 01**
Connection mask	**31 05 601**	**31 15 601.1**	**31 25 601**
Three-phase induction motor with squirrel-cage rotor, 230/400 V	**30 07 650 01**	**30 17 650 01**	**30 27 650 01**
Connection mask	**31 05 651**	**31 15 651.1**	**31 25 651**
Three-phase induction motor, pole-changeable, Dahlander circuit, 400 V	**30 07 800 01**	**30 17 800 01**	**30 27 800 01**
Connection mask	**31 05 801**	**31 15 801**	**31 25 801**
Three-phase induction motor, pole-changeable, 2 separate windings, 400 V	**30 07 850 01**	**30 17 850 01**	**30 27 850 01**
Connection mask	**31 05 851**	**31 15 851.1**	**31 25 851**
Three-phase reluctance motor	**30 07 950 01**	**30 17 950 01**	**30 27 950 01**
Connection mask	**31 05 951**	**31 15 951**	**31 25 951**

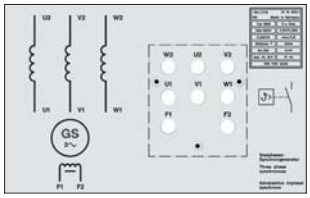
Multifunctional three-phase asynchronous/synchronous machine



Connection mask 31 15 701.1



Connection mask 31 15 901.1



Connection mask 31 15 902.1

Power class	100 W	300 W	1000 W
Multifunctional three-phase asynchronous/synchronous machine suitable as induction motor with slip-ring rotor, synchronous motor with smooth-core rotor or synchronous generator with smooth-core rotor	**30 07 710 01**	**30 17 710 01**	**30 27 710 01**
Rated data during operation as motor with slip-ring rotor:			
Voltage (Δ/Y):	230/400 V	230/400 V	230/400 V
Current	0.41/0.25 A	1.2/0.7 A	4.22/2.44 A
Power	90 W	300 W	1000 W
Power factor cos φ	0.78	0.79	0.75
Speed	1430 rpm	1395 rpm	1385 rpm
Rotor voltage	100 V	95 V	130 V
Rotor current	0.7 A	2.2 A	5.7 A
Connection mask	**31 05 701**	**31 15 701.1**	**31 25 701.1**
Rated data during operation as synchronous motor:			
Voltage (Δ/Y):	230/400 V	230/400 V	230/400 V
Current	0.29/0.17 A	1.1/0.64 A	2.37/1.66 A
Power	90 W	370 W	1000 W
Power factor cos φ	1	1	1
Speed	1500 rpm	1500 rpm	1500 rpm
Exciting voltage	8 V	11.3 V	14.8 V
Exciting current	1 A	4.6 A	9.8 A
Connection mask, motor	**31 05 712**	**31 15 901.1**	**31 25 901.1**
Connection mask, generator	**31 05 713**	**31 15 902.1**	**31 25 902.1**
Dimensions in mm (l x w x h)	300x210x200	400x250x240	460x250x250
Mass	12.2 kg	16.0 kg	22.0 kg

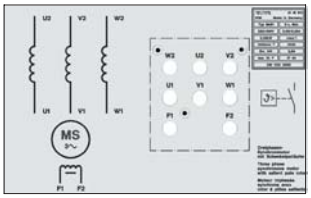
Equipment "Three-phase Machines with Multifunctional Asynchronous/Synchronous Machine for 230-V Three-phase Systems"

Power class		100 W	300 W	1000 W
Equipment	**Art. no.**	**03 07 321 01**	**03 17 321 01**	**03 27 321 01**

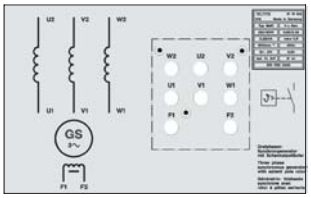
The equipment is almost adequate to the equipment "Three-phase Machines for 230-V Three-phase Systems" illustrated on page 20.
It is equipped with a multifunctional three-phase asynchronous/synchronous machine (see above) instead of the three-phase induction motor with slip-ring rotor and three-phase synchronous machine with smooth-core rotor.

Equipment "Three-phase Synchronous Machine with Salient-pole Rotor"

Three-phase synchronous machine
with salient-pole rotor



Connection mask 31 15 911

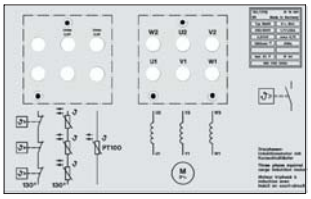


Connection mask 31 15 912

Power class	100 W	300 W	1000 W
Equipment Art. no.	**03 07 340 01**	**03 17 340 01**	**03 27 340 01**
consisting of:			
Three-phase synchronous machine with salient-pole rotor for motor and generator operation	**30 07 910 01**	**30 17 910 01**	**30 27 910 01**
Rated data during motor operation:			
Voltage (Δ/Y):	230/400 V	230/400 V	230/400 V
Current	0.4/0.33 A	0.95/0.55 A	2.8/1.63 A
Power	100 W	330 W	1000 W
Power factor cos φ	1	1	1
Speed	1500 rpm	1500 rpm	1500 rpm
Exciting voltage	24 V	14 V	13 V
Exciting current	1 A	2.6 A	3.9 A
Dimensions in mm (l x w x h)	320x230x230	320x230x230	400x240x240
Mass	7.5 kg	7.8 kg	19.8 kg
Connection mask, motor	**31 05 911**	**31 15 911**	**31 25 911**
Connection mask, generator	**31 05 912**	**31 15 912**	**31 25 912**

Equipment "Three-phase Induction Motor for Machine Protective Systems"

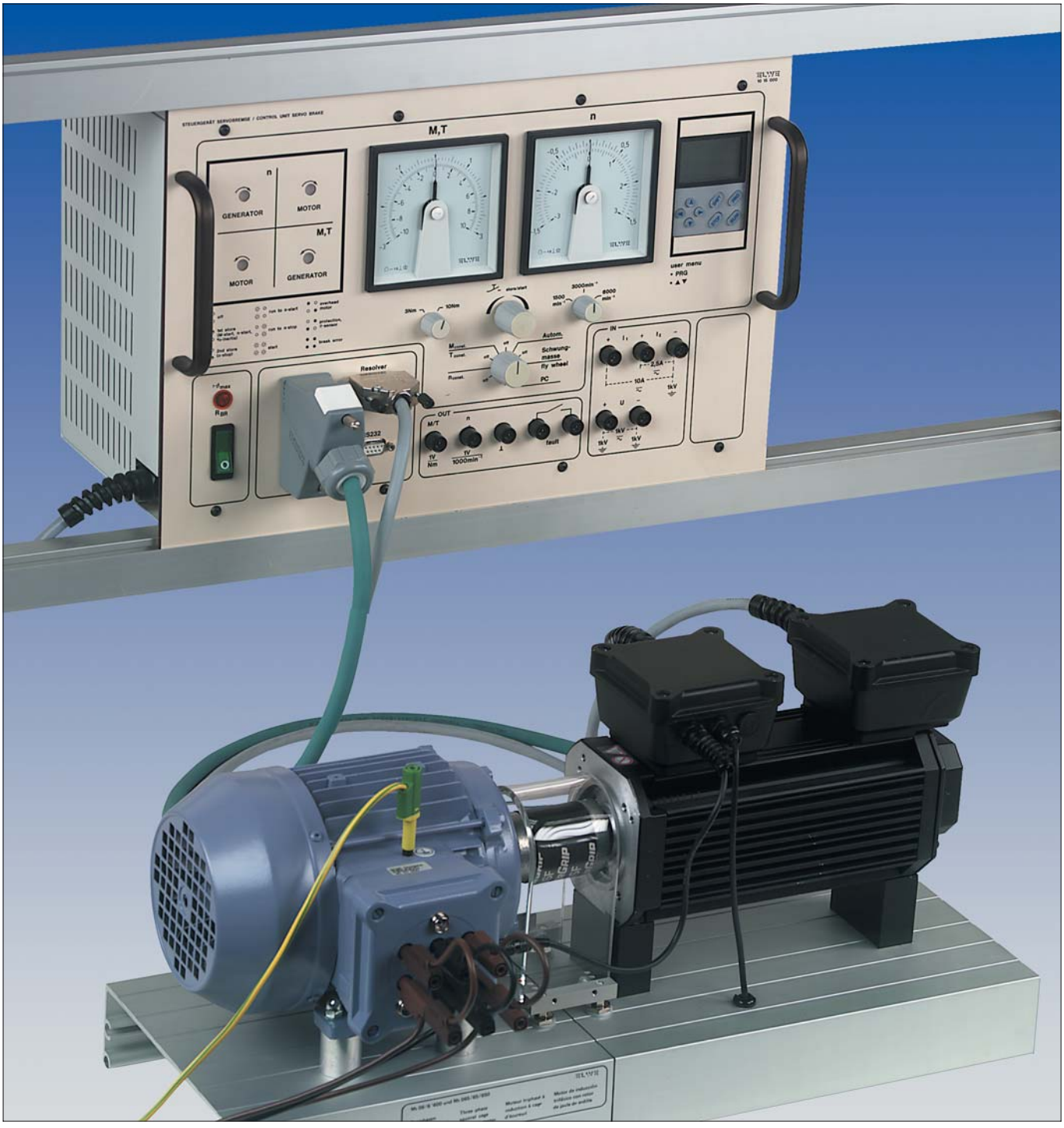
Three-phase induction motor
with built-in temperature sensors



Connection mask 31 15 661

Power class	100 W	300 W	1000 W
Equipment Art. no.	**03 07 390 01**	**03 17 390 01**	**03 27 390 01**
consisting of:			
Three-phase induction motor with built-in temperature sensors for testing of protection means against thermal overload. Sensors included into the windings: 1 Pt 100, 3 PTC, 3 temperature switches, additionally 1 temperature switch for protection of the motor	**30 07 660 01**	**30 17 660 01**	**30 27 660 01**
Rated data (Δ/Y):			
Voltage	230/400 V	230/400 V	230/400 V
Current	0.57/0.33 A	1.81/1.05 A	4.44/2.57 A
Power	120 W	370 W	1000 W
Power factor cos φ	0.82	0.72	0.73
Speed	1320 rpm	1390 rpm	1415 rpm
Dimensions in mm (l x w x h)	240x210x190	290x220x220	310x240x240
Mass	6.0 kg	8.5 kg	14.6 kg
Connection mask	**31 05 661**	**31 15 661**	**31 25 661**

The Servo Drive and Brake System



The illustration shows the control unit for the servo drive and brake system mounted to an experimental frame and the servo machine connected to a tested three-phase squirrel-cage induction machine.

After the classic magnetic powder brake and the innovative pendulum machine, ELWE Lehrsysteme has now developed a new generation of drive and brake systems to follow on from their successful series for the loading and examination of electrical machines:

The Servo Drive and Brake System.

Compared to the pendulum machine, which has already made a 4 quadrant function possible, the new Servo Drive and Brake System is distinguished by its more compact shape, less mechanical components, greater precision and even simpler operation.

The **decoupled isolating amplifier**, which is needed to measure the voltage and current of the test machine, **is now integrated** into the control unit of the servo machine. Thus considerably fewer components are needed to implement the test and the experimental set up is even clearer.

The already **integrated interface RS232**, together with the Windows® compatible **software "Servo Machines"**, allows for an easy operation, data recording and analysis of DC-, AC- and three-phase-machine parameters, as well as a standard characteristic display and archiving on the PC.

Besides the known operating functions of the Servo Drive and Brake System, such as speed control, engine torque control and automatic characteristic recording, the **simulation of the gyrating masses** is also possible. The moment of inertia can be set up within a large range.

At present, an optional software is being developed. With its aid the Servo Drive and Brake System can simulate the characteristic behaviour of different loads, such as working machines e.g. of centrifugal pumps, fans, cranes, compressors, winders, centrifuges etc.

Possible experimental set-up:

Three-phase squirrel-cage induction motor operated with a frequency inverter and loaded with the servo drive and brake system.

Note:
The frequency inverter has been described in full detail in the ELWE brochure "Power Electronics/Drive Engineering".

The Control Unit for the Servo Machine

The control unit is used to drive the synchronising servo machine and to measure the engine speed and torque, as well as the voltage and current of the electrical test machine. The speed and torque are indicated by two 270 degrees circular measuring dials with centre neutral positions. A four quadrant monitor with large LEDs is used as an operating status indicator, for operator guidance and to diagnose faults.

The clear design, a digital potentiometer with a push button switch, a tachometric switch and an integrated operational module guarantee simple, intuitive operation of the control unit. Alternatively the operation, measured value indicators and evaluation can be implemented by a PC and the optional software "Servo Machine" (for DC/AC and 3 phase machines, see page 28). The required interface RS232 is already integrated.

Control unit	100-W class	300-W class	1000-W class
Art. no.	**10 05 000**	**10 15 000**	**24 05 000**
Type of construction	Experimental panel	Experimental panel	Portable equipment *
Dimensions in mm (W x H x D)	440 x 297 x 190	440 x 297 x 190	480 x 310 x 315
Mass	11.3 kg	12.9 kg	15.0 kg
Experimental panel available in a table-top housing * (equipped at factory)	•	•	–
Colour of table unit	RAL 5014, pigeon blue	RAL 5014, pigeon blue	–

* see illustration on page 26 and equipment sets on page 27.

An Overview of the Performance Characteristics of the Control Unit:

– **Types of operation**:

Engine speed control n_{const}
Engine torque control M_{const}; the engine starting torque is adjustable.
Automatic characteristic recording; start and stop speeds as well as the ramp time are adjustable.
Simulation of a flywheel mass with adjustable moment of inertia

– **Automatic characteristic recording** with adjustable start and stop values: also over two quadrants.

– The **digital potentiometer** (with a push button switch for manual set point adjustment or parameter setting of the start and stop values with automatic mechanical operation) gives a familiar, analogue feeling of control and offers step by step digital precision in the set up.

– **Integrated decoupled isolating amplifier** to measure the voltage and current of the test machine (without additional shunts).

– An **integrated operational module**; so no wear with a multi-pin socket.

– An **integrated interface RS232**, so no retrofit required.

– **Analogue output voltages** to connect further measuring equipment for *n* and *M* or for the optimum display panel n, M (see page 28): 1 V / 1000 rpm.

100-W class	300-W class	1000-W class
2.0 V / Nm	1.0 V / Nm	0.2 V / Nm

– **Four quadrant monitor** with large LEDs for operating status indicators, operator guidance and for diagnosing.

– **270 degrees circular measuring dials** with centre neutral position:

Engine torque ranges in Nm		
100-W class	**300-W class**	**1000-W class**
–1 ... 0 ... +1	–3 ... 0 ... +3	–10 ... 0 ... +10
–3 ... 0 ... +3	–10 ... 0 ... +10	–30 ... 0 ... +30

Speed range in rpm		
100 / 300 / 1000-W class		
–1500 ... 0 ... +1500	–3000 ... 0 ... +3000	–6000 ... 0 ... +6000

– **Extensive protective functions** for the servo machine and the test machine; thermal monitoring, hoop guard monitor, integrated relay to set up safety switching on the test machine.

– Robust non-interchangeable **multi-pin plug-in connections** for quick use, such as when disconnecting the servo machine.

– **Voltage supply**: 3 x 230 V, 50(60) Hz, Cekon plug

The control equipment of the 100/300-W class can also be mounted to table units.

The control unit for the 1000-W class is only available as a table-top unit.

The Servo Machine

The small compact AC synchronised servo machine for driving, stopping and braking on the ELWE machines, is equipped with an integrated resolver which supplies the precise values of the speed and the rotor bearing. The self-cooling servo machine, which is mounted onto an aluminium profile, supplies the rated load torque over the whole speed range required for the test. It can be connected to the control unit using two multi-wire cables over robust plug-in connections, which are protected against polarity reversal.

Servo machine	100-W class	300-W class	1000-W class
Art. no.	**30 07 001 01**	**30 17 001 01**	**30 27 001 01**
Power output in kW	P_N = 0.54 kW	P_N = 1.8 kW	P_N = 2.6 kW
Speed in rpm	n_N = 4000, n_{max} = 5500	n_N = 4000, n_{max} = 5500	n_N = 2300, n_{max} = 6000
Engine torque in Nm	M_N = 1.3, M_{max} = 2.7	M_N = 4.2, M_{max} = 12.5	M_N = 10.8, M_{max} = 24.4
Current in A	I_N = 1.1	I_N = 3.6	I_N = 5.5
Colour	black	black	black
Dimensions in mm (l x w x h)	220 x 210 x 170	305 x 210 x 265	400 x 210 x 300
Mass in kg	5.0	9.2	26.0

Sets of Equipment "Servo Drive and Brake System"

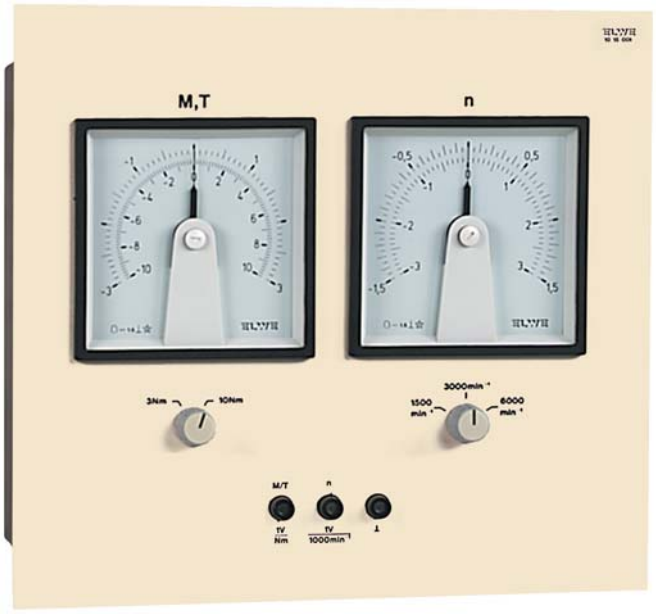
Every set of equipment contains:

- **Control unit**
- **Servo machine**
- **Coupling collar**
- **Coupling cover**

Equipment Set	Power class	Article number
Servo drive and brake system	100 W	**03 07 040**
Servo drive and brake system with control unit in a table unit	100 W	**03 07 041**
Servo drive and brake system	300 W	**03 17 040**
Servo drive and brake system with control unit in a table unit	300 W	**03 17 041**
Servo drive and brake system with control unit in a table unit	1000 W	**03 27 041**

Note:
When using machines with two shaft ends, a shaft end cover (see next page) must also be used for a safe operation! When a second machine, a gyrating mass or a tachometer is connected, a coupling collar and a coupling cover are also needed.

Options for the Servo Drive and Brake System



Display panel n, M

The "Display Panel n, M" with its extra large moving-coil instruments is very suitable for displaying the machine speed and torque to a large group of people, e.g. when demonstrating an experiment. The panel is mounted to the top row of an experimental frame and connected to the 4-mm safety sockets on control unit for the servo machine with 4-mm safety cables.
Moving-coil instruments: 270° circular scale, pointer at centre position, class 1.5

Display panel n, M	300-W class	1000-W class
Art. no.	**10 15 001**	**10 25 001**
for control unit	10 15 000	24 05 000
Engine torque ranges in Nm	–3 ... 0 ... +3 –10 ... 0 ... +10	–10 ... 0 ... +10 –30 ... 0 ... +30
Speed ranges in rpm	–1500 ... 0 ... + 1500 –3000 ... 0 ... + 3000 –6000 ... 0 ... + 6000	
Dimensions in mm	319 x 297 x 115 (w x h x d)	
Mass	2.0 kg	


31 00 000


31 00 003


31 00 005

Coupling collar **31 00 000**
for all power classes.

Coupling covers
100-W class **31 00 002**
300/1000-W class **31 00 003**

Shaft end cover
100-W class **31 00 004**
300/1000-W class **31 00 005**

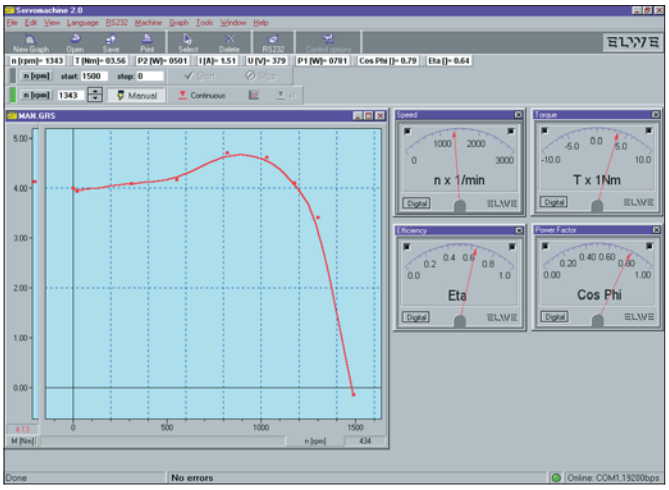
Software for the Servo Drive and Brake System

Analogue und digital indicator instruments

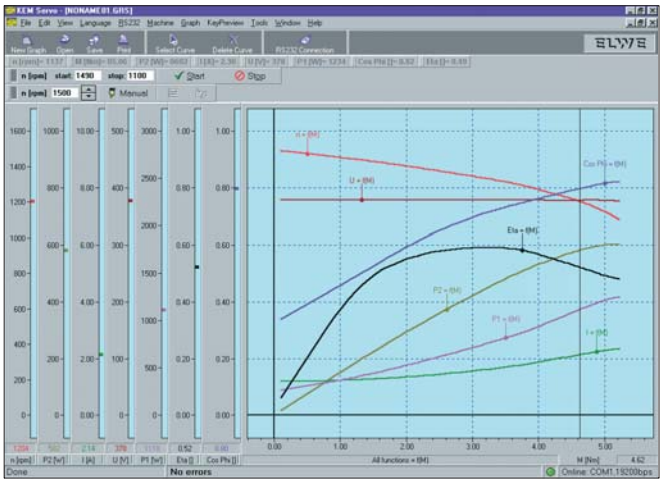
Software "Servo Machine" D, GB, F, E

The Windows® compatible software shows measured values and estimated values for all tested machines (DC, AC, three-phase machines), for example *M*, *n*, *I*, *U*, P_1, P_2, cosφ or η, in both analogue and digital mode, graphically displays characteristics and prints out and archives measurements and analysis of the results.
With the analogue or digital display of values, the size and the position of the indicating instruments can be varied.

Single licence **50 05 002**
Room licence **50 05 004**



Acceleration characteristic



Load characteristics

The program guarantees the work will be simple and intuitive. It offers predefined screens to show and record acceleration characteristics ($M = f(n)$) or load characteristics (n, I, U, P_1, P_2, $\cos \varphi$, $\eta = f(M)$).
With the setting up of self-defined screens, further options are available to display and examine how the machine is responding.

The program offers 2 operation modes:

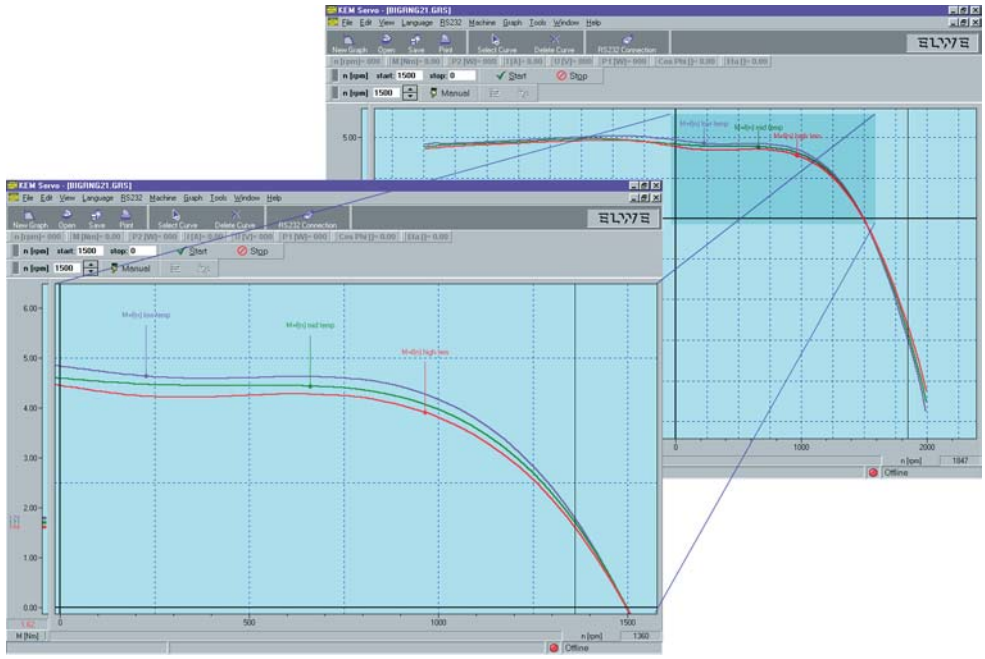
– The **manual mode** is suited to the progressive control and analysis of the test machine.
– The **automatic mode** gives an easy to use independent control and characteristic recording.

The curves describing the tested machine can be examined at the same time, using the mouse to move a vertical cursor within a graph range. The values of the characteristics, drawn using vertical cursors, can be indicated in a digital or analogue mode on each axis at the same time.
Colours, line widths, markers for the measured value or descriptions for each single curve can be changed with a double click.

A separate editable header is generated in order to print out a graph. The mouse can be used to change the size of the graph. The graph can also be copied onto another program using Windows clipboard.

Further tools are available

- Axes, grids, colours and line widths are definable.
- Curve markings can be freely located. Measured values can be marked on every curve.
- Zoom and shift functions are also standard with the software.



Zoom function

Hardware requirements:
PC 486 or higher, 8 MB Ram min.,
Hard disk requirements: 5 MB,
Operating system:
Windows 3.1 or higher

Equipment "Magnetic Powder Brake as 2-quadrant Load, Control Unit with Built-in Measured-value Displays"

Magnetic powder brake 30 17 010 01

This equipment essentially consists of an easily operated magnetic powder brake and the appropriate control unit.

The magnetic powder brake enables to load the tested electrical machines clockwise as well as anti-clockwise that means they are braked in the 2nd quadrant. The characteristic curves of the machines can be recorded past the motor breakdown torque.

The torque is recorded by means of a strain gauge bridge and the speed frequency by means of an incremental encoder.
The control unit and the magnetic powder brake are connected electrically via non-detachable cables at the magnetic powder brake.

The brake is protected against overload by means of an integrated thermostatic switch.

Power class	**100 W**	**300 W**
Equipment Art. no.	**03 07 050 01**	**03 17 050 01**
consisting of:		
Magnetic powder brake	**30 07 010 01**	**30 17 010 01**
Nominal torque	2 Nm	6 Nm
max. speed	6000 rpm	6000 rpm
Dimensions in mm (l x w x h)	240x210x210	340x210x240
Mass	6.8 kg	14.6 kg
Control unit of the magnetic powder brake with built-in measured-value displays; conceived as a drawer for the 19" power supply system (description see next page) Installation width:	**67 10 602 01** 49 PU*	**67 10 606 01** 49 PU*
Housing for the control unit, portable	**67 15 049 01**	**67 15 049 01**
Coupling collar	2x **31 00 000**	2x **31 00 000**
Coupling cover	2x **31 00 002**	2x **31 00 003**
Shaft end cover	2x **31 00 004**	2x **31 00 005**

* 1 PU = 1 partial unit = 5.08 mm = 0.2"

Note:
The control unit is built into the portable housing at the factory.

The Control Unit of the Magnetic Powder Brake with Built-in Measured-value Displays

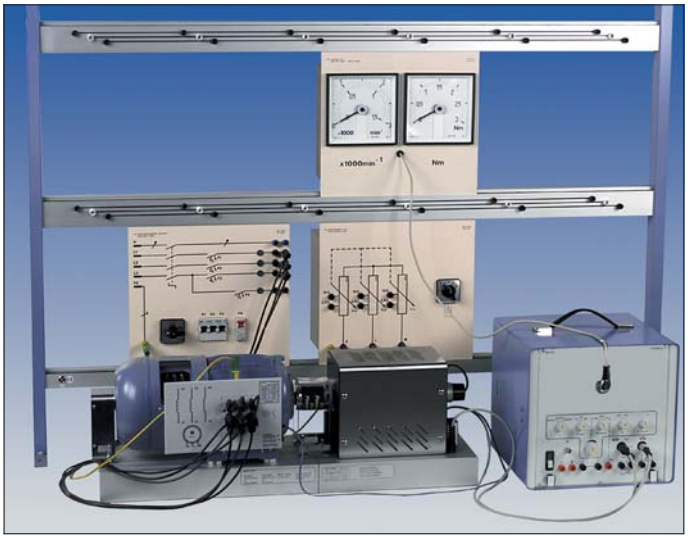
The control unit is used to operate the magnetic powder brake and to measure speed frequency and torque. 4 functions can be selected by means of a selector switch.

- off
- manual setting of torque
- manual setting of speed frequency
- external control via the ±10-V input

Furthermore the torque can be increased automatically and the speed frequency can be reduced down to a standstill in order to realize the automatic recording of characteristics.
The amounts of speed frequency and torque are displayed on two 270° circular-scale moving-coil elements. The measured values are additionally applied as measuring-circuit voltage to 4-mm safety sockets.

Power class	**100 W**	**300 W**
Speed frequency ranges	1500 / 3000 / 6000 rpm	
Torque ranges	1/2 Nm	3/6 Nm
Voltage supply	230 V AC; 50(60) Hz	
Dimensions in mm (l x w x h)	300 x 290 x 285	
Mass	7.5 kg	

Equipment "Magnetic Powder Brake as 2-quadrant Load, Control Unit with External Measured-value Display"



An experimental set-up including the control unit of the magnetic powder brake with external measured-value display

This equipment is very suitable for presenting the measured values of speed frequency and torque to larger groups.
This equipment contains two large 270° circular-scale moving-coil elements mounted on a separate display panel instead of the two measuring elements of the control unit. The display panel is inserted in the top area of the experimental frame so that it can be seen from a far distance.
The functional characteristics and the technical data of the control unit correspond to the data of the 300-W control unit given above.

Power class	**300 W**
Equipment **Art. no.**	**03 17 051 01**
consisting of:	
Magnetic powder brake	**30 17 010 01**
Control unit of the magnetic powder brake, for external measured-value display	**67 10 607 01**
Housing for the control unit, portable	**67 15 049 01**
Display panel (n, M)	**10 15 008**
Coupling collar	2 x **31 00 000**
Coupling cover	2 x **31 00 003**
Shaft end cover	2 x **31 00 005**

Equipment "Transformers for 400-V Three-phase Systems" 03 15 410 01

The experimental transformers are mounted to a metal basic panel and are equipped with solid plastic feet. The front is equipped with 4-mm safety sockets for the electrical connection of the windings. With printed graphic symbol and technical data of the transformer.

The experiments that can be carried out according to the experimental manual 53 05 012 are listed on page 8.

The equipment consists of:

T1 Single-phase isolating transformer 30 00 110 01

Primary:	230 V, 50(60) Hz
Secondary:	2 x 115 V; 0.9 A
Power:	200 VA
Dimensions in mm:	120 x 90 x 105 (l x w x h)
Mass:	3.5 kg

T2 Single-phase isolating toroidal transformer 30 00 120 01

Primary:	230 V, 50(60) Hz
Secondary:	2 x 115 V; 0.9 A
Power:	200 VA
Dimensions in mm:	110 x 110 x 120 (l x w x h)
Mass:	2.6 kg

T3 Single-phase auto-transformer 30 00 130 01

Primary:	230 V, 50(60) Hz
Secondary:	115 V; 1.8 A / 240 V; 0.9 A
Power:	200 VA
Dimensions in mm:	115 x 75 x 100 (l x w x h)
Mass:	2.2 kg

T4 Three-phase experimental transformer. . . 30 00 140 01

suitable for: Star-star connection
Delta-star connection
Star-delta connection
Star-zigzag connection

Primary:	3 x 230/400 V, 50(60) Hz
Secondary:	3 x 2 x 115 V; 0.9 A
Power:	600 VA
Dimensions in mm:	230 x 270 x 145 (l x w x h)
Mass:	11.7 kg

Equipment "Transformers for 230-V Three-phase Systems" 03 15 411 01

For technical data, please see the equipment specified above. Only the input data of the T4 transformer are varied:
Primary: 3 x 133/230 V, 50(60) Hz

The equipment consists of:
T1 Single-phase isolating transformer 30 00 110 01
T2 Single-phase isolating toroidal transformer 30 00 120 01
T3 Single-phase auto-transformer 30 00 130 01
T4 Three-phase experimental transformer. . . 30 00 140 11

Control Gearing

Control gearing

The three-phase induction motor with slip-ring rotor or the multifunctional three-phase asynchronous/synchronous machine can be operated as rotary transformers by means of the control gearing. The gearing is adjusted by means of a handwheel.

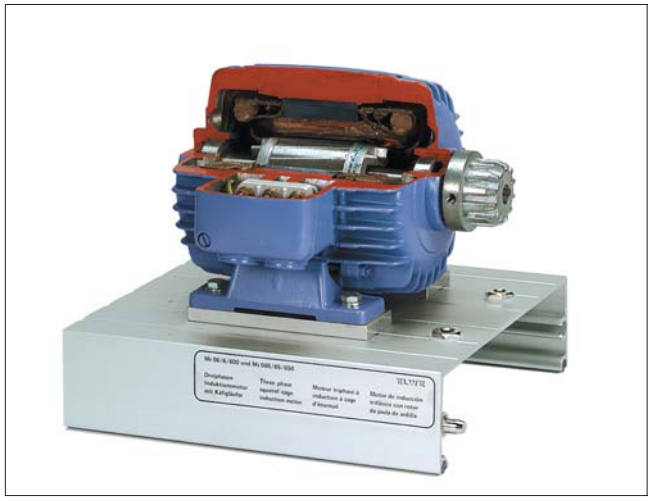
The experiments that can be carried out according to the experimental manual 53 05 012 are listed on page 8.

Power class	**100 W**	**300 W**	**1000 W**
Article number	**31 07 003**	**31 17 003**	
Dimensions in mm (l x w x h)	170 x 210 x 210/230		
Mass	1.9 kg		

Intersection Models

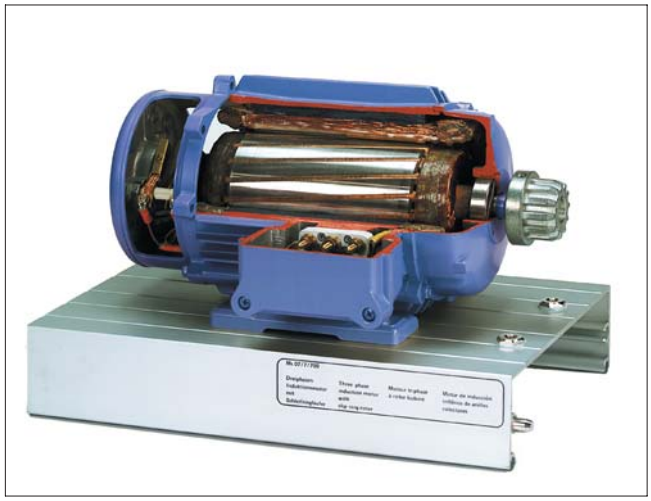
The intersection models are electrical machines of industrial productions. The stator has a 45° cutout so that the inner structure can be seen.

DC shunt-wound machine **30 07 101 01**



Three-phase induction motor with squirrel-cage rotor **30 07 601 01**

Three-phase induction motor with slip-ring rotor **30 07 701 01**



Three-phase synchronous motor with smooth-core rotor **30 07 901 01**

Tachogenerators

DC tachogenerator

AC tachogenerator

Digital tachogenerator

DC tachogenerator

A high-quality industrial tachogenerator with 2 shaft ends for measuring the speed frequency of electrical machines which are operated without using servo machines or magnetic powder brakes.
The polarity of the output voltage depends on the sense of rotation:
U = ± 20 V DC / 1000 rpm

Recommended for the voltage display:
1 multimeter UM5 (Art. no. 14 00 950)
for demonstrated experiments
or
1 multimeter AF-M 1.0 (Art. no. 25 00 010)
for training and for experiments in practical courses

AC tachogenerator

A high-quality industrial tachogenerator with 2 shaft ends for measuring the speed frequency of electrical machines which are operated without using servo machines or magnetic powder brakes.
The polarity of the output voltage does not depend on the sense of rotation: U = 30 V DC / 1000 rpm

Recommended for the voltage display:
1 multimeter UM4 (Art. no. 14 00 940)
for demonstrated experiments
or
1 multimeter AF-M 1.0 (Art. no. 25 00 010)
for training and for experiments in practical courses

Digital tachogenerator

with 2 shaft ends for measuring the speed frequency of electrical machines digitally.
The voltage supply, the analogue display of speed frequency and the digital and analogue output signal are either supplied via the control unit of the magnetic powder brake or via the experimental panel EDM (art. no. 14 00 230 1, see page 60). The unit can be connected electrically by means of a multi-strand cable and a DIN plug.

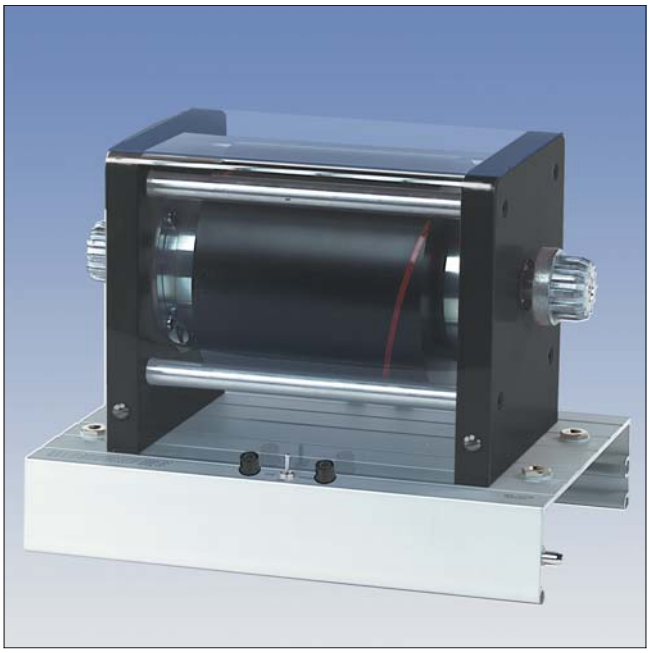
Output:	60 pulses per rotation
Level:	0 V, 15 V
max. speed frequency:	6000 rpm

Power class of electrical machines	**100 W**	**300/1000 W**
	Art. no.	
DC tachogenerator	**31 07 001 01**	**31 17 001 01**
AC tachogenerator	**31 07 004 01**	**31 17 004 01**
Digital tachogenerator	**31 07 005 01**	**31 17 005 01**
Dimensions in mm (l x w x h)	180 x 210 x 210	180 x 210 x 230
Mass	3.0 kg	3.1 kg

Information about metering shafts of electrical machines for high-precision measurements of torque and speed frequency will be supplied upon request.

Gyrating Masses

Gyrating mass



Gyrating mass, switched electromagnetically

The starting and deceleration performance of drives essentially depends on the gyrating masses or the mass moment of inertia. The gyrating masses developed by ELWE are solidly connected to the shafts so that it is for example possible to study the effect of gyrating masses upon the starting and deceleration constants as well as upon the starting current. The operation of soft start and soft deceleration units as well as DC braking units can thus be demonstrated effectively.

Further interesting experiments can be carried out with the gyrating masses that can be electromagnetically started, isolated and braked abruptly in the isolated state. It is for example possible to examine the fall of speed or the efficiency of speed frequency control when an impact load is acting upon the drive.

Gyrating mass

for simulating heavy starting and energy store.
Rigid connection between shaft and gyrating mass.

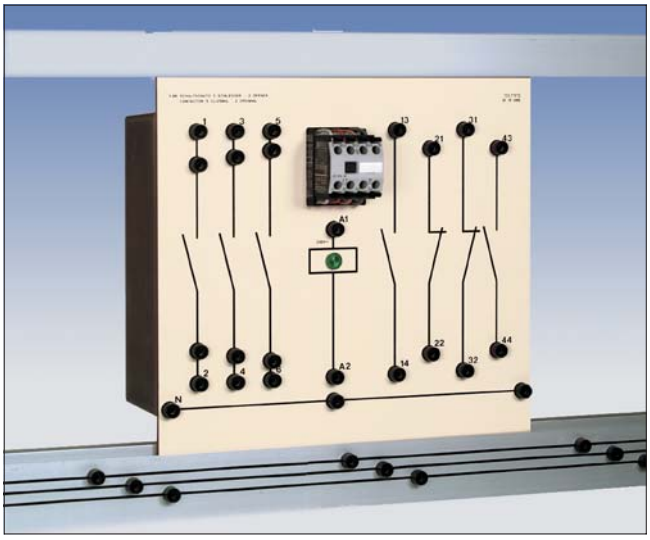
Power class of electrical machines		**100 W**	**300/1000 W**
		Art. no.	
Gyrating mass, 200 kgcm^2		**31 07 012**	**31 17 012**
Gyrating mass, 400 kgcm^2		**–**	**31 17 013**
Dimensions in mm (l x w x h)		320 x 210 x 210	320 x 210 x 240
Mass:	200 kgcm^2	18.1 kg	18.3 kg
	400 kgcm^2	–	22.8 kg

Gyrating mass, switched electromagnetically

for simulating heavy starting, energy store and Stoßlast;
Equipped with an electromagnetic coupling between shaft and gyrating mass. The gyrating mass can be coupled and decoupled as well as braked electromagnetically during operation.
One input (4-mm socket) is available for external 24-V control signals.
Required power supply: 24 V DC, 0.3 A

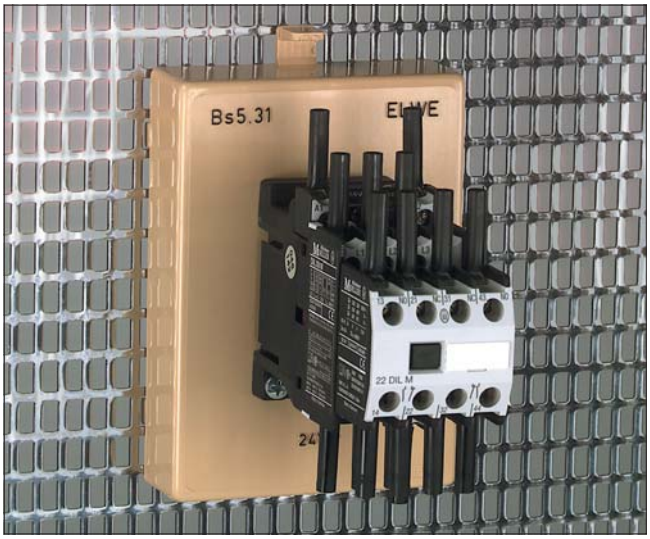
Power class of electrical machines	**100 W**	**300/1000 W**
	Art. no.	
Gyrating mass, 200 kgcm^2 switched electromagnetically	**31 07 010 11**	**31 17 010 11**
Gyrating mass, 400 kgcm^2 switched electromagnetically	**–**	**31 17 011 11**
Dimensions in mm (l x w x h)	320 x 210 x 210	320 x 210 x 240

Experimental Systems for Electrical Machines



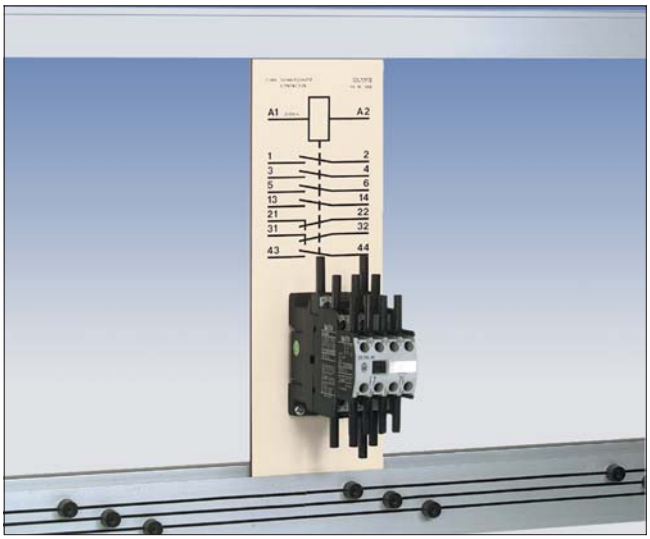
The experimental panel system for theoretical lessons

The experimental panel system guarantees the set-up of clear and large-surface experiments which can be seen from a far distance. It allows to teach the theoretics of the action and operational performance of electrical machines visually. Only the experimental panels which are required for the experiment are placed into the experimental frame and the experimental set-up will then be extended or changed according to the progress of learning.
The current flow diagram is blotch printed on the front. All connections of the electrical components run to the 4-mm safety sockets on the front . The devices are electrically interconnected by means of jumper plugs or short connection leads.



The experimental module system for laboratory exercises

The experimental module system consists of handy and solid experimental modules which can be arranged clearly and free to move about on a high-quality-steel mounting panel according to the current flow diagram. The electrical components are connected by means of connection leads directly to the 4-mm safety sockets of the components. With the aid of the module system, the student will be able to achieve the educational objects of the curriculum by working in a practice-oriented and almost independent way. Easy handling and high reliability are the distinguishing features of the system.



The experimental panel system PU for laboratory exercises

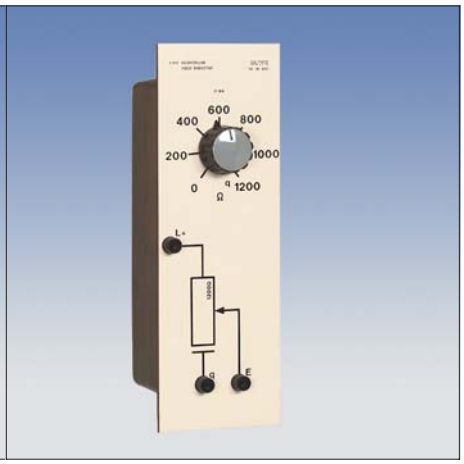
The experimental panel system PU can be used as an alternative to the experimental module system in exercises and practical courses. As with the experimental panel system for theoretical lessons, an experimental frame is used for the arrangement of the experimental panels. The PU panels are only used for the mounting of electrical components. Easy handling and high reliabilty are the distinguishing features of the system.

Sets of Equipment for the Operation of DC Machines

System	Panel system		Module system		Panel system PU	
Power class	**300 W**	**1000 W**	**100 W**	**300 W**	**100 W**	**300 W**
Equipment Art. no.	**01 15 010**	**01 25 010**	**02 05 010**	**02 15 010**	**01 16 010**	**01 15 010**
consisting of:						
Starter Wire-wound rheostat with scale for all DC motors	**10 15 002**	**10 25 200**	**22 05 001**	**22 15 100**	**10 16 002**	**10 15 002**
Resistance	0 ... 32 Ω	0 ... 16 Ω	0 ... 120 Ω	0 ... 32 Ω	0 ... 120 Ω	0 ... 32 Ω
max. current	2.5 A	6 A	1 A	2.5 A	1 A	2.5 A
Field rheostat without Q-contact Wire-wound rheostat with scale for DC shunt-wound motor and DC compound-wound motor	**10 15 003**	**10 25 300**	**22 05 004**	**22 15 400**	**10 16 003**	**10 15 003**
Resistance	0 ... 820 Ω	0 ... 390 Ω	0 ... 1200 Ω	0 ... 820 Ω	0 ... 1200 Ω	0 ... 820 Ω
max. current	0.3 A	0.45 A	0.18 A	0.3 A	0.18 A	0.3 A
Field rheostat with Q-contact Wire-wound rheostat with scale and short-circuit contact for DC shunt-wound generator and compound-wound generator	**10 15 012**	**10 25 120**	**22 05 002**	**22 15 200**	**10 16 012**	**10 15 012**
Resistance	0 ... 820 Ω	0 ... 390 Ω	0 ... 1200 Ω	0 ... 820 Ω	0 ... 1200 Ω	0 ... 820 Ω
max. current	0.3 A	0.45 A	0.18 A	0.3 A	0.18 A	0.3 A
Reversing field rheostat Two synchronously adjustable wire-wound rheostats to reverse the field current of the generator in the Ward-Leonhard system	**10 15 005**	**10 25 500**	**22 05 005**	**22 15 500**	**10 16 005**	**10 15 005**
Resistance	2 x 0 ... 820 Ω	2 x 0 ... 560 Ω	2 x 0 ... 1200 Ω	2 x 0 ... 820 Ω	2 x 0 ... 1200 Ω	2 x 0 ... 820 Ω
max. current	0.3 A	0.5 A	0.18 A	0.3 A	0.18 A	0.3 A

Field rheostat with Q-contact 10 15 012

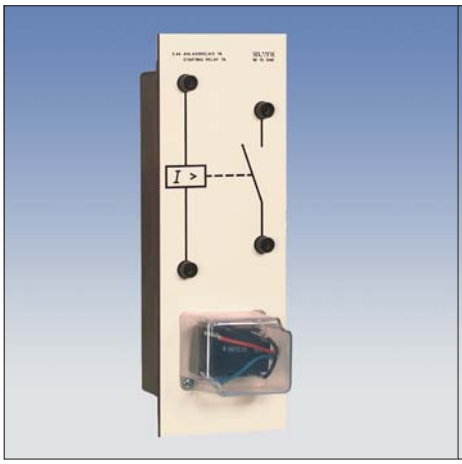
Field rheostat with Q-contact 22 05 002



Field rheostat with Q-contact 10 16 012

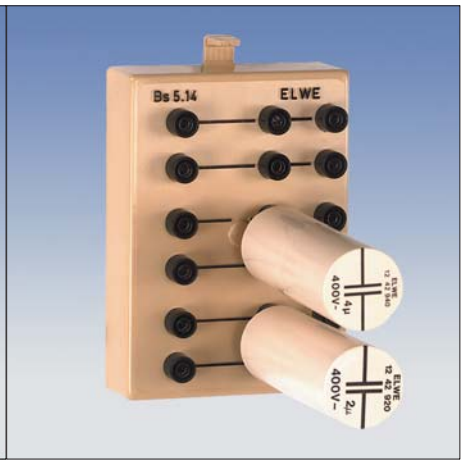
Sets of Equipment for the Operation of AC Machines

System	Panel system		Module system		Panel system PU	
Power class	**300 W**	**1000 W**	**100 W**	**300 W**	**100 W**	**300 W**
Equipment Art. no.	**01 15 020**	**01 25 020**	**02 05 020**	**02 15 020**	**01 16 020**	**01 15 020**
consisting of:						
Combination panel/module Socket section to plug and combine different operating capacitors	**10 15 043**	**10 15 043**	**22 05 014**	**22 05 014**	**10 15 043**	**10 15 043**
Starting capacitor for the capacitor motor; also usable for continuous operation max. operating voltage Nominal capacity	**10 15 042** 400 V AC 12 µF	**10 25 420** 400 V AC 30 µF	–	**22 15 220** 400 V AC 12 µF	–	**10 15 042** 400 V AC 12 µF
Starting relay Relay for current-operated connecting of the starting capacitor Starting current	**10 15 044** > 7 A	**10 25 440** > 16 A	**22 05 021** > 2.3 A	**22 15 210** > 7 A	**10 16 044** > 2.3 A	**10 15 044** > 7 A
Plug-in capacitor Operating capacitor or starting capacitor for the capacitor motor max. voltage: 400 V AC 4 µF	2 x **12 42 940**	2 x **12 42 940**	3 x **12 42 940**	2 x **12 42 940**	3 x **12 42 940**	2 x **12 42 940**



Starting relay 10 15 044

Starting relay 22 05 021

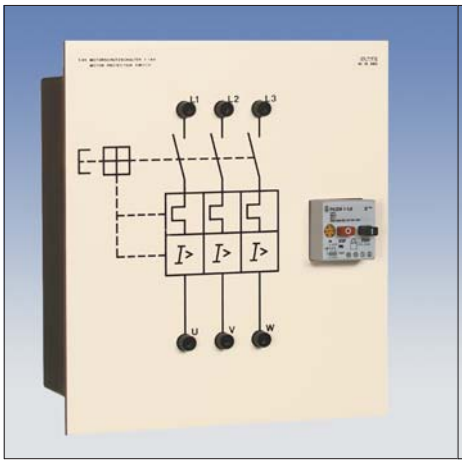


Combination module 22 05 014
Plug-in capacitors

Sets of Equipment for Operation of three-phase Machines

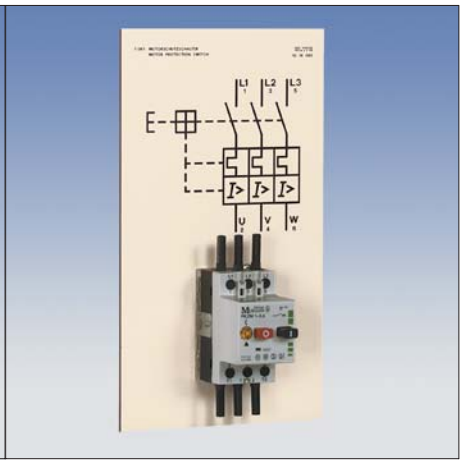
System	Panel system		Module system		Panel system PU	
Power class	**300 W**	**1000 W**	**100 W**	**300 W**	**100 W**	**300 W**
Equipment Art. no.	**01 15 031**	**01 25 031 01**	**02 05 031**	**02 15 031**	**01 16 030**	**01 16 031**
consisting of:						
Circuit breaker 3 x Circuit breakers C 1 x Circuit breaker B	–	–	**22 05 009** 1 A 6 A	**22 15 900** 4 A 10 A	**10 16 009** 1 A 6 A	**10 16 900** 3 A 10 A
Protective motor switch Three-pole motor circuit-breaker, with thermal and magnetic overcurrent trip Tripping current adjustable	**10 15 065** 1.0 ... 1.6 A	**10 25 650** 2.4 ... 4 A	**22 05 012** 0.24 ... 0.4 A	**22 15 120** 1.0 ... 1.6 A	**10 16 065** 0.24 ... 0.4 A	**10 16 650** 1.0 ... 1.6 A
On/Off switch Four-pole two-step switch 0-1 400 V AC, 10 A	–	–	**22 05 010**	**22 05 010**	**10 16 010**	**10 16 010**
Star-delta switch Three-pole three-step switch 0-Y-Δ 400 V AC, 10 A	**10 15 062**	**10 15 062**	**22 05 011**	**22 05 011**	**10 16 062**	**10 16 062**
Reversing switch Three-pole three-step switch 2-0-1 400 V AC, 10 A; to reverse the direction of rotation of three-phase machines	**10 15 064**	**10 15 064**	**22 05 013**	**22 05 013**	**10 16 064**	**10 16 064**
Pole-changing switch I Three-pole three-step switch 2-0-1 400 V AC, 10 A; to change the speed of a pole-changeable motor in Dahlander circuit	**10 15 082**	**10 15 082**	**22 05 041**	**22 05 041**	**10 16 082**	**10 16 082**
Pole-changing switch II Three-pole three-step switch 2-0-1 400 V AC, 10 A; to change the speed of a pole-changeable motor with two separate windings	**10 15 083**	**10 15 083**	**22 05 042**	**22 05 042**	**10 16 083**	**10 16 083**
Star-delta-reversing switch Three-pole five-step switch Δ-Y-0-Y-Δ 400 V AC, 10 A; to change from star to delta operation for both directions of rotation	**10 15 085**	**10 15 085**	**22 05 018**	**22 05 018**	**10 16 085**	**10 16 085**
Combination panel/module Socket section to plug-in different compensating capacitors in star and delta circuit	**10 02 007**	**10 02 007**	**22 05 014**	**22 05 014**	**10 02 007**	**10 02 007**
Capacitor to operate the three-phase squirrel-cage induction motor on 230 V AC in Steinmetz circuit. max. operating voltage 240 V AC Capacity	**10 15 086** 25 µF	**10 25 860** 60 µF	–	**22 15 190** 25 µF	–	**10 15 086** 25 µF

System	Panel system		Module system		Panel system PU	
Power class	**300 W**	**1000 W**	**100 W**	**300 W**	**100 W**	**300 W**
Rotor starter Three resistors, synchronously adjustable by 6 steps for three-phase induction motor with slip-ring rotor	**10 15 072**	**10 25 720 11**	**22 05 015**	**22 15 150**	**10 16 072**	**10 15 072**
Resistance values of the switch positions	20-10-5.5-2.5-1-0 Ω	10-5-2.75-1.25-0.5-0 Ω	50-25-12.5-6-2.5-0 Ω	20-10-5.5-2.5-1-0 Ω	50-25-12.5-6-2.5-0 Ω	20-10-5.5-2.5-1-0 Ω
Synchronizing panel 3 lamp sockets E14 with series resistors, three-pole switch to connect the synchronous generator to the mains voltage	**10 15 093**	**10 15 093**	**–**	**–**	**10 15 093**	**10 15 093**
Synchronizing module Lamp socket E14 with series resistor for synchronising circuits	**–**	**–**	2 x **22 05 093**	2 x **22 05 093**	**–**	**–**
Incandescent lamp E14, 230 V, 25 W	3 x **59 50 725**	3 x **59 50 725**	**–**	**–**	3 x **59 50 725**	3 x **59 50 725**
Incandescent lamp E14, 230 V, 7 W	**–**	**–**	2 x **59 50 705**	2 x **59 50 705**	**–**	**–**
Plug-in capacitor, for compensation of reactive power or Steinmetz circuit, max. voltage: 400 V AC						
1 µF	**–**	**–**	3 x **12 42 910**	**–**	3 x **12 42 910**	**–**
3 µF	3 x **12 42 930**	**–**	**–**	3 x **12 42 930**	**–**	3 x **12 42 930**
4 µF	**–**	3 x **12 42 940**	2 x **12 42 940**	**–**	2 x **12 42 940**	**–**

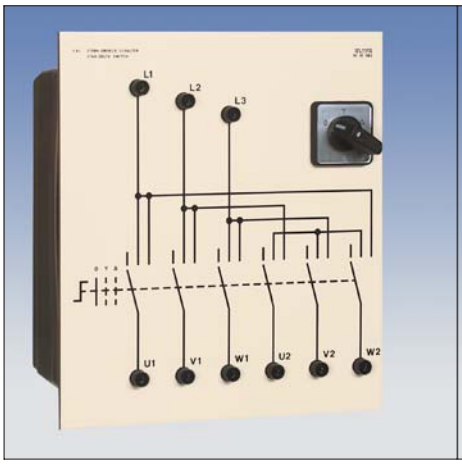


Protective motor switch 10 15 065

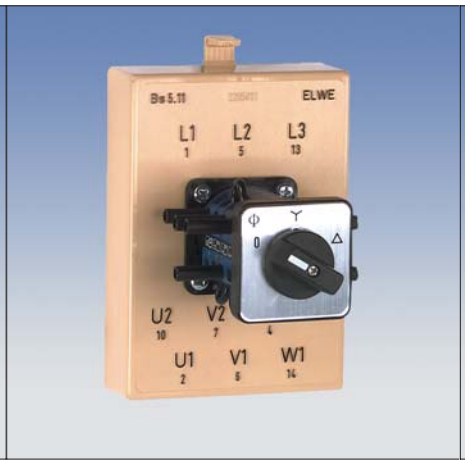
Protective motor switch 22 05 012



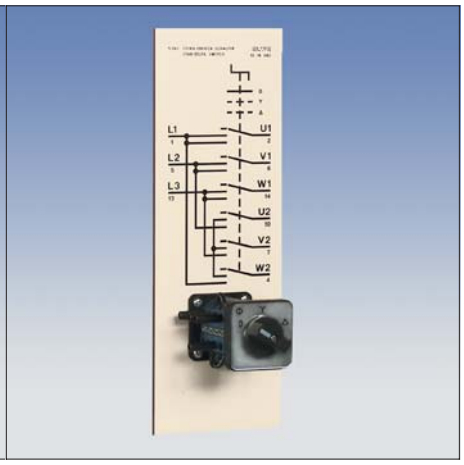
Protective motor switch 10 16 065



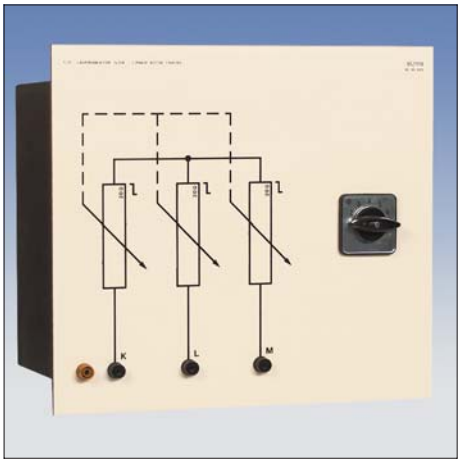
Star-delta switch 10 15 062



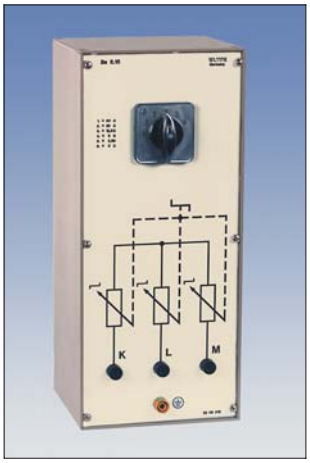
Star-delta switch 22 05 011



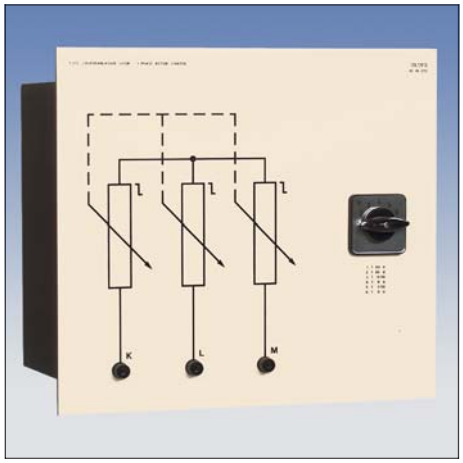
Star-delta switch 10 16 062



Rotor starter 10 15 072



Rotor starter 22 05 015

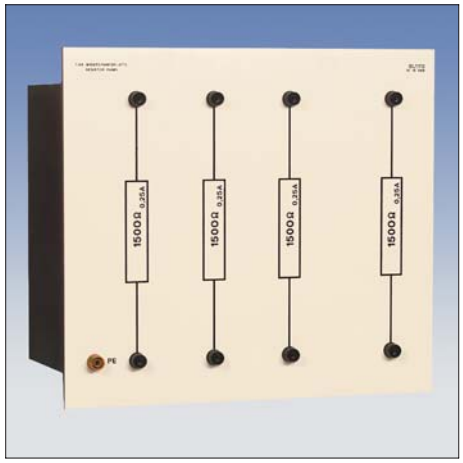


Rotor starter 10 16 072

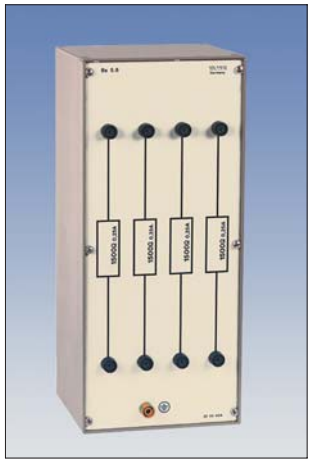
Experimental Unit for three-phase AC Basic Circuits

Experimental unit for three-phase AC basic circuits according to the experimental manual 53 05 012 on page 8.

Every unit is equipped with 4 resistors of 1500 Ω, 93 W each.



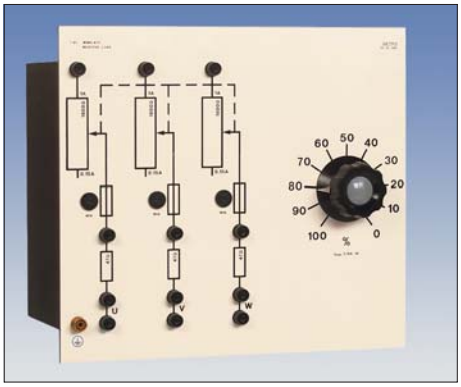
Resistors 10 15 069
for the experimental panel systems



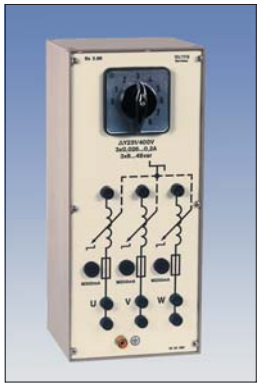
Resistors 22 05 008
for the experimental module system

Sets of Equipment "Load Units for Transformers and Machines"

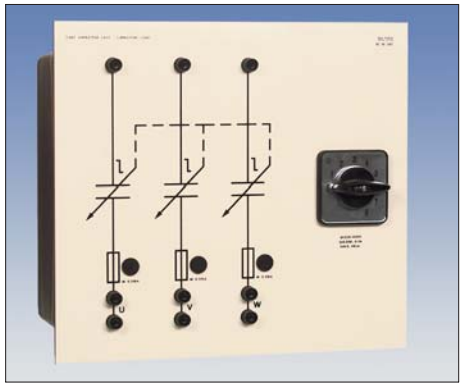
System		Panel system		Module system		Panel system PU	
Power class		**300 W**	**1000 W**	**100 W**	**300 W**	**100 W**	**300 W**
Equipment	**Art. no.**	**01 15 090**	**01 25 090 01**	**02 05 090**	**02 15 090**	**01 16 090**	**01 15 090**
consisting of:							
The units can operate in single or three-phase circuits.							
Resistive load Three synchronously adjustabel wire-wound rheostats with series resistor and fuse in each wipe contact line; suitable for parallel, series, star or delta connections		**10 15 095**	**10 25 950 11**	**22 05 095**	**22 15 950**	**10 16 095**	**10 15 095**
Nominal resistance	3 x	0 ... 1800 Ω	0 ... 1000 Ω	0 ... 5600 Ω	0 ... 1800 Ω	0 ... 5600 Ω	0 ... 1800 Ω
Series resistor	3 x	47 Ω	22 Ω	220 Ω	47 Ω	220 Ω	47 Ω
Current	3 x	0.15 ... 1 A	0.25 ... 2.5 A	0.025 ... 0.3 A	0.15 ... 1 A	0.025 ... 0.3 A	0.15 ... 1 A
Power	3 x	150 W	400 W	100 W	150 W	100 W	150 W
Inductive load Three inductors, synchronously adjustable by 8 steps, with overload protection by fuses; suitable for parallel, series, star and delta connections		**10 15 096**	**10 25 960 11**	**22 05 096**	**22 15 960**	**10 16 096**	**10 15 096**
max. input voltage at 50 Hz		ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V
Current at 50 Hz	3 x	0.08 ... 0.64 A	0.2 ... 1.56 A	0.026 ... 0.2 A	0.08 ... 0.64 A	0.026 ... 0.2 A	0.08 ... 0.64 A
Power at 50 Hz	3 x	19 ... 152 var	45 ... 360 var	6 ... 48 var	19 ... 152 var	6 ... 48 var	19 ... 152 var
Capacitive load MP-capacitors, synchronously adjustable by 8 steps, with overload protection by fuses; suitable for parallel, series, star and delta connections		**10 15 097**	**10 25 970**	**22 05 097**	**22 15 970**	**10 16 097**	**10 15 097**
max. input voltage at 50 Hz		ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V	ΔY 230/400 V
Current at 50 Hz	3 x	0.07 ... 0.6 A	0.18 ... 1.45 A	0.036 ... 0.3 A	0.07 ... 0.6 A	0.036 ... 0.3 A	0.07 ... 0.6 A
Power at 50 Hz	3 x	17 ... 136 var	42 ... 336 var	8.5 ... 68 var	17 ... 136 var	8.5 ... 68 var	17 ... 136 var



Resistive load 10 15 095



Inductive load 22 05 096

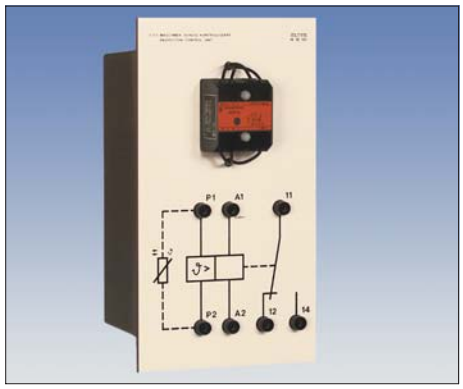


Capacitive load 10 16 097

Sets of Equipment "Machine Protective Systems"

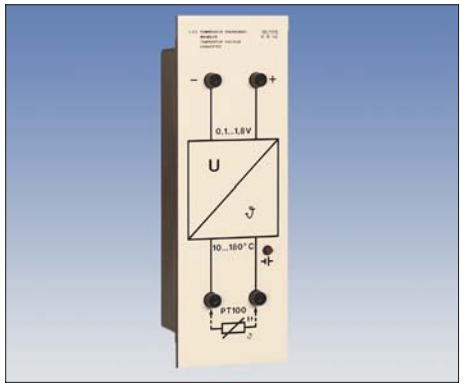
The experiments can be conducted as described in the experimental manual 53 05 042 for the "Protection of Electrical Machines" (see page 11) with the equipment "Three-Phase Induction Motor for Machine Protective Systems" (see page 22) and this equipment, as well as the experimental devices circuit breaker, protective motor switch, protective motor relay I, contactor, push-button switch 0-1-2 and triple signal lamp (see page 39, 45, 46).

System	Panel system	Module system
Power class	**300/1000 W**	**100/300 W**
Equipment Art. no.	**01 15 070**	**02 05 070**
consisting of:		
Machine protection controller The controller operates in connection with the PTC-resistors of the winding in the electrical machines; 1 change-over contact 250 V, 6 A. Operating voltage	**10 15 131** 230 V AC	**22 05 131** 24 V AC
Temperature voltage converter Measuring converter to observe the temperature of the winding in the machine with different temperature sensors. Input for temperature sensor Pt 100; Output 0.1 ... 1.8 V (for +10 °C ... 180 °C); Voltage supply by 9-V battery (in the scope of delivery included)	**10 15 132**	**22 05 132**

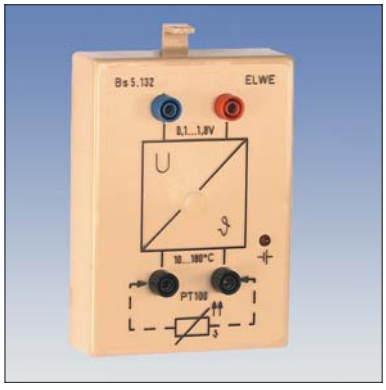


Machine protection controller 10 15 131

Machine protection controller 22 05 131



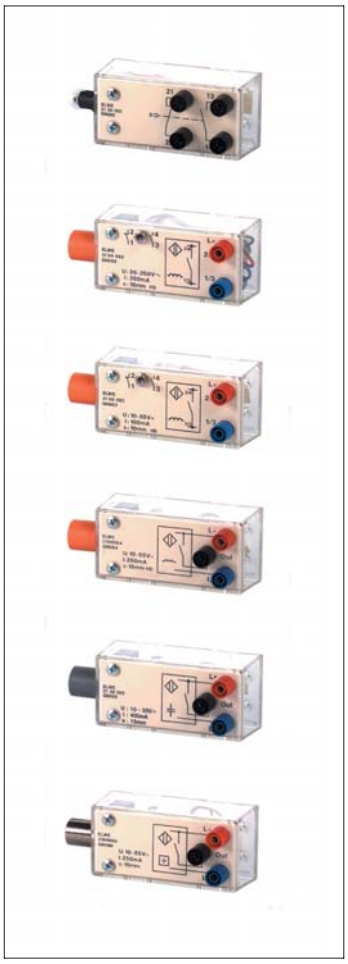
Temperature voltage converter 10 15 132



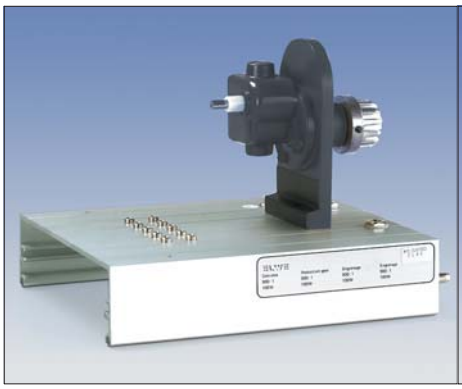
Temperature voltage converter 22 05 132

Sets of Equipment "Limit and Proximity Switches"

This equipment allows to examine the properties and the application of limit and proximity switches practically.
To carry out the experiments according to the experimental manual 53 05 052 (see page 11) this equipment plus the equipment for contactor circuits are require. Depending on the circuit problem definition, you should preferably use three-phase induction machines as drives.

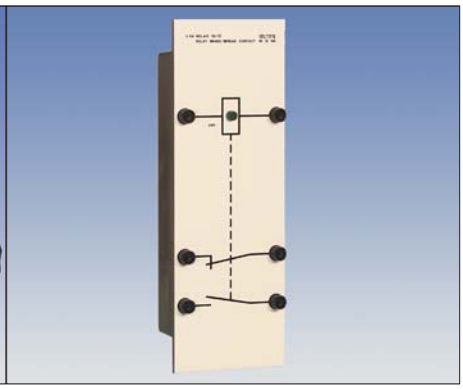


System	Panel system		Module system	
Power class	**100 W**	**300/1000 W**	**100 W**	**300 W**
Equipment Art. no.	**01 16 061**	**01 15 061**	**02 05 061**	**02 15 061**
consisting of:				
Reduction gear mounted on a aluminium chassis, reduction ratio 900:1, with support for 2 limit or proximity switches	**31 07 002 01**	**31 17 002 01**	**31 07 002 01**	**31 17 002 01**
Switching lever made of metal, to be fixed with a knurled screw on the shaft of the reduction gear, for actuation of limit switches and inductive proximity switches	**31 00 052**	**31 00 052**	**31 00 052**	**31 00 052**
Switching lever made of plastic, lever with one white reflecting surface, to be fixed with a knurled screw on the shaft of the reduction gear; for actuation of limit switches and inductive proximity switches	**31 00 053**	**31 00 053**	**31 00 053**	**31 00 053**
Limit switch, mechanical 1 make contact, 1 break contact	2x **31 00 060**	2x **31 00 060**	2x **31 00 060**	2x **31 00 060**
Inductive proximity switch for AC 1 change-over contact with make and break function	**31 00 062**	**31 00 062**	**31 00 062**	**31 00 062**
Inductive proximity switch for DC, 2-wire design 1 change-over contact with make and break function	**31 00 063**	**31 00 063**	**31 00 063**	**31 00 063**
Inductive proximity switch for DC, 3-wire design	**31 00 064**	**31 00 064**	**31 00 064**	**31 00 064**
Capacitive proximity switch for DC, 3-wire design	**31 00 065**	**31 00 065**	**31 00 065**	**31 00 065**
Optical proximity switch for DC, 3-wire design	**31 00 066**	**31 00 066**	**31 00 066**	**31 00 066**
Relay 1 make contact 1 break contact 240 V, 6 A Coil voltage: 24 V DC	**10 15 114** 250 V, 1.25 A 250 V, 1.25 A (125 VA)	**10 15 114** 250 V, 1.25 A 250 V, 1.25 A (125 VA)	**22 30 056** 240 V, 6 A 240 V, 6 A	**22 30 056** 240 V, 6 A 240 V, 6 A



Reduction gear 31 07 002 01

Switching levers 31 00 052 / 53
Relay 22 30 056

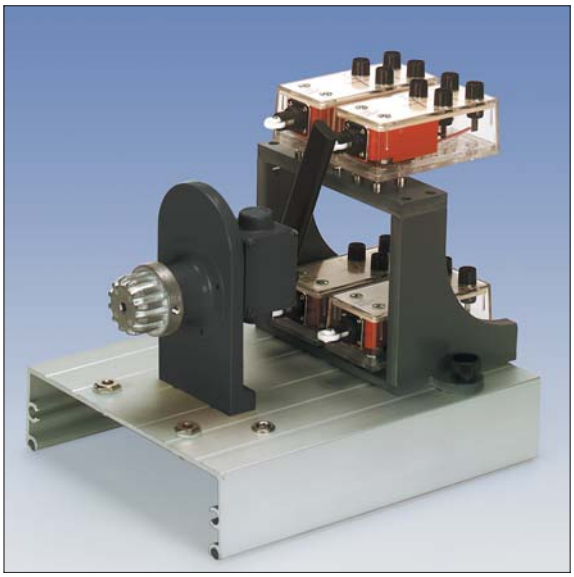


Relay 10 15 114

Optional:
Holder for a second switch plane

Two more limit or proximity switches can be placed on the gear support by means of this holder. Extensive control circuits, e.g. in combination with a PLC and a frequency inverter, can also be realized.

For gearings 31 07 002 01
and 31 17 002 01: Art. no. **31 00 050**



Sets of Equipment for Contactor Circuits
inclusive Experimental Manual on CD

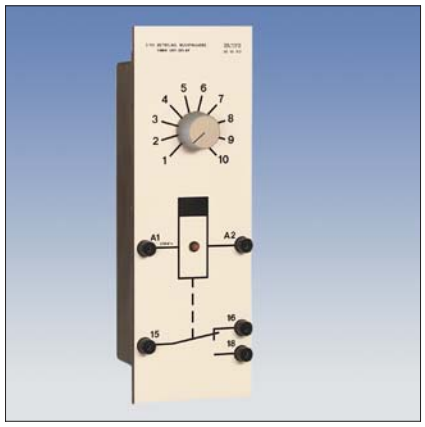
System	Panel system		Module system				Panel system PU	
Power class	**300 W**	**1000 W**	**100 W**		**300 W**		**100 W**	**300 W**
Equipment Art. no.	**01 15 051**	**01 25 051**	**02 05 052**	**02 05 053**	**02 15 051**	**02 15 052**	**01 16 051**	**01 16 052**
Coil voltage	230 V AC	230 V AC	24 V AC	230 V AC	24 V AC	230 V AC	230 V AC	230 V AC
consisting of:								
Contactor 3 x 3 make contacts 400 V AC, 16 A 2 make contacts 400 V AC, 16 A 2 break contacts 400 V AC, 16 A Coil voltage	**10 15 066** 230 V AC	**10 15 066** 230 V AC	**22 05 031** 24 V AC	**22 05 231** 230 V AC	**22 05 031** 24 V AC	**22 05 231** 230 V AC	**10 16 066** 230 V AC	**10 16 066** 230 V AC
Protective motor relay I Three-phase relay 1 change-over contact 400 V AC, 10 A Minimum operating current	**10 15 067** 0.6 ... 1 A	**10 25 670** 1.6 ... 2.4 A	**22 05 032** 0.16...0.24 A	**22 05 032** 0.16...0.24 A	**22 15 320** 0.6 ... 1 A	**22 15 320** 0.6 ... 1 A	**10 16 067** 0.16...0.24 A	**10 16 670** 0.6 ... 1 A
Protective motor relay II Three-phase relay 1 change-over contact 400 V AC, 10 A Minimum operating current	**10 15 068** 1 ... 1.6 A	**10 25 680** 2.4 ... 4 A	**22 05 039** 0.24 ... 0.4 A	**22 05 039** 0.24 ... 0.4 A	**22 15 390** 1 ... 1.6 A	**22 15 390** 1 ... 1.6 A	**10 16 068** 0.24 ... 0.4 A	**10 16 680** 1 ... 1.6 A
Time relay, on-delay 2 x Time delay, 1...10 s adjustable 1 change-over contact 250 V AC, 5 A Coil voltage	**10 15 112** 230 V AC	**10 15 112** 230 V AC	**22 05 033** 24 V AC	**22 05 233** 230 V AC	**22 05 033** 24 V AC	**22 05 233** 230 V AC	**10 15 112** 230 V AC	**10 15 112** 230 V AC
Time relay, off-delay Time delay, 1...10 s adjustable 1 change-over contact 250 V AC, 2 A Coil voltage	**10 15 113** 230 V AC	**10 15 113** 230 V AC	**22 05 030** 24 V AC	**22 05 230** 230 V AC	**22 05 030** 24 V AC	**22 05 230** 230 V AC	**10 15 113** 230 V AC	**10 15 113** 230 V AC
Wiping-contact relay 1 wiping contact 250 V AC, 2 A Coil voltage	**10 15 115** 230 V AC	**10 15 115** 230 V AC	**22 05 029** 24 V AC	**22 05 229** 230 V AC	**22 05 029** 24 V AC	**22 05 229** 230 V AC	**10 15 115** 230 V AC	**10 15 115** 230 V AC

System	Panel system		Module system				Panel system PU	
Power class	**300 W**	**1000 W**	**100 W**		**300 W**		**100 W**	**300 W**
Coil voltage	230 V AC	230 V AC	24 V AC	230 V AC	24 V AC	230 V AC	230 V AC	230 V AC
consisting of:								
Control transformer Primary: 400 V AC Secondary: Power: 100 VA	**10 15 026** 230 V AC	**10 15 026** 230 V AC	**22 05 026** 24 V AC	**22 05 226** 230 V AC	**22 05 026** 24 V AC	**22 05 226** 230 V AC	**10 15 026** 230 V AC	**10 15 026** 230 V AC
Emergency push-button 1 make contact 400 V, 10 A 1 break contact 400 V, 10 A	**10 15 100**	**10 15 100**	**22 05 000**	**22 05 000**	**22 05 000**	**22 05 000**	**10 15 100**	**10 15 100**
Limit switch 2x 1 make contact 240 V, 3 A 1 break contact 240 V, 3 A	**10 15 111**	**10 15 111**	**22 05 034**	**22 05 034**	**22 05 034**	**22 05 034**	**10 16 111**	**10 16 111**
Push-button switch 0-1-2 Three push-button switches, each with 1 make contact 400 V, 10 A 1 break contact 400 V, 10 A	**10 15 117**	**10 15 117**	**22 05 381**	**22 05 381**	**22 05 381**	**22 05 381**	**10 15 117**	**10 15 117**
Signal lamp, triple 1 lamp, yellow 1 lamp, green 1 lamp, red Operating voltage	**10 15 119** 230 V	**10 15 119** 230 V	**22 05 350** 24 V	**22 05 351** 230 V	**22 05 350** 24 V	**22 05 351** 230 V	**10 15 119** 230 V	**10 15 119** 230 V
Experimental Manual on CD	**53 05 051 0**							

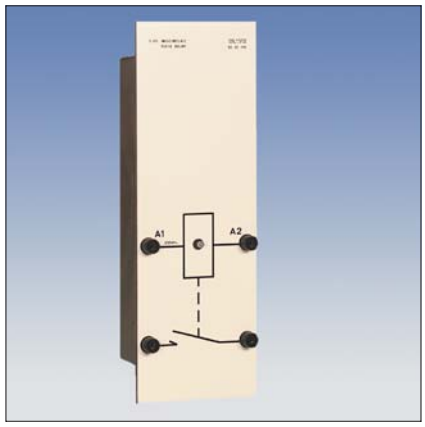
Contactor 10 15 066 | Contactor 22 05 031 | Contactor 10 16 066

Protective motor relay I 10 15 067 | Protective motor relay I 22 05 032 | Protective motor relay I 10 16 067

Time relay, on-delay 10 15 112



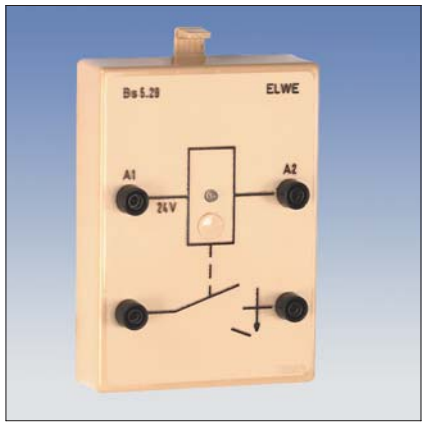
Time relay, off-delay 10 15 113



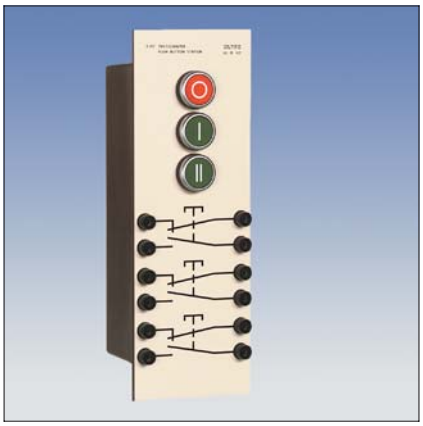
Wiping-contact relay 10 15 115

Time relay, on-delay 22 05 033

Time relay, off- delay 22 05 030

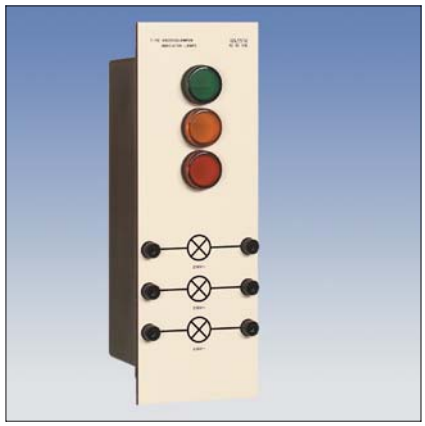


Wiping-contact relay 22 05 029



Push-button switch 10 15 117

Limit switch 10 15 111



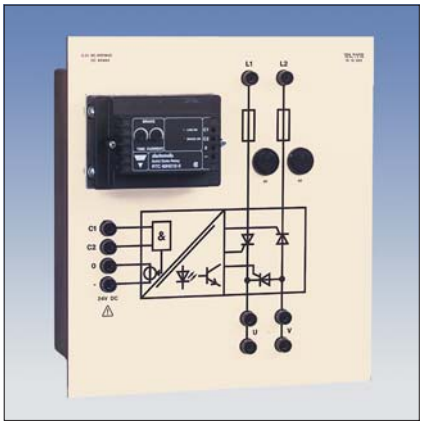
Signal lamp, triple 10 15 119
(incandescent lamp 90 05 567)

Push-button switch 0-1-2 22 05 381

Limit switch 22 05 034

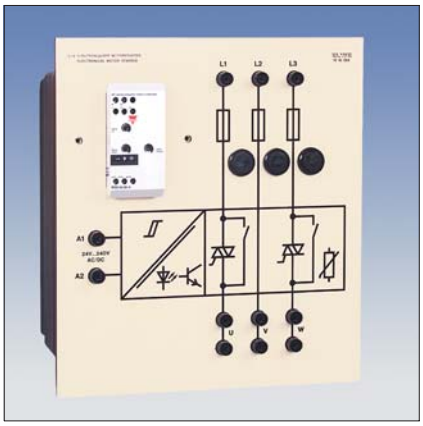
Signal lamp, triple 22 05 351
(incandescent lamp 90 05 567)

Options to the Equipment "Contactor Circuits"

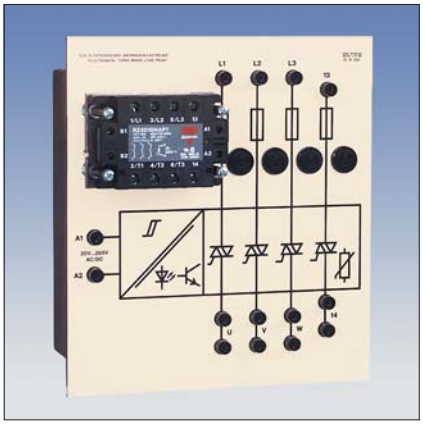


DC brake for 50 cycles 10 15 023

System	Panel system	Module system	Panel system PU
DC brake for 50 cycles **DC brake for 60 cycles** for braking squirrel-cage induction machines dynamically	**10 15 023** **10 15 023 1**	**22 05 023** **22 05 023 1**	**10 15 023** **10 15 023 1**
Operating voltage	220 ... 420 V AC	220 ... 420 V AC	220 ... 420 V AC
Rated operational current	18.5 A DC	18.5 A DC	18.5 A DC
Required control voltage	24 V DC	24 V DC	24 V DC
Braking time, variable	350 ms ... 40 s	350 ms ... 40 s	350 ms ... 40 s
Electronic motor starter for the soft start and deceleration of three-phase induction machines	**10 15 024**	**22 05 024**	**10 15 024**
Operating voltage	230/400 V AC	230/400 V AC	230/400 V AC
Rated load current	8 A max.	8 A max.	8 A max.
Start and deceleration time, separately adjustable	0.5 ... 5 s	0.5 ... 5 s	0.5 ... 5 s
Control voltage	24 ... 440 V AC, DC	24 ... 440 V AC, DC	24 ... 440 V AC, DC
Electronic three-phase load disconnecting relay for operating heating elements. machines and transformers.	**10 15 025**	**22 05 025**	**10 15 025**
Operating voltage	440 V AC max.	440 V AC max.	440 V AC max.
Rated load current	10 A max.	10 A max.	10 A max.
Control voltage	20 ... 265 V AC, DC	20 ... 265 V AC, DC	20 ... 265 V AC, DC
Multifunctional relay 8 different variable time functions (e.g. ON delay, OFF delay)	**10 15 027**	**22 05 027**	**10 15 027**
Operating voltage	24 DC or AC 110 ... 240 V AC	24 DC or AC 110 ... 240 V AC	24 DC or AC 110 ... 240 V AC
Voltage switched	250 V max.	250 V max.	250 V max.
Current switched	5 A max.	5 A max.	5 A max.
Interval time	0.05 s ... 60 h	0.05 s ... 60 h	0.05 s ... 60 h
Contactor relay 24 V 4 break contacts, 4 make contacts, 240 V, 6 A	**10 15 028**	**22 05 028**	**10 16 028**
Contactor relay 230 V 4 break contacts, 4 make contacts, 240 V, 6 A	**10 15 228**	**22 05 228**	**10 16 228**



Electronic motor starter 10 15 024

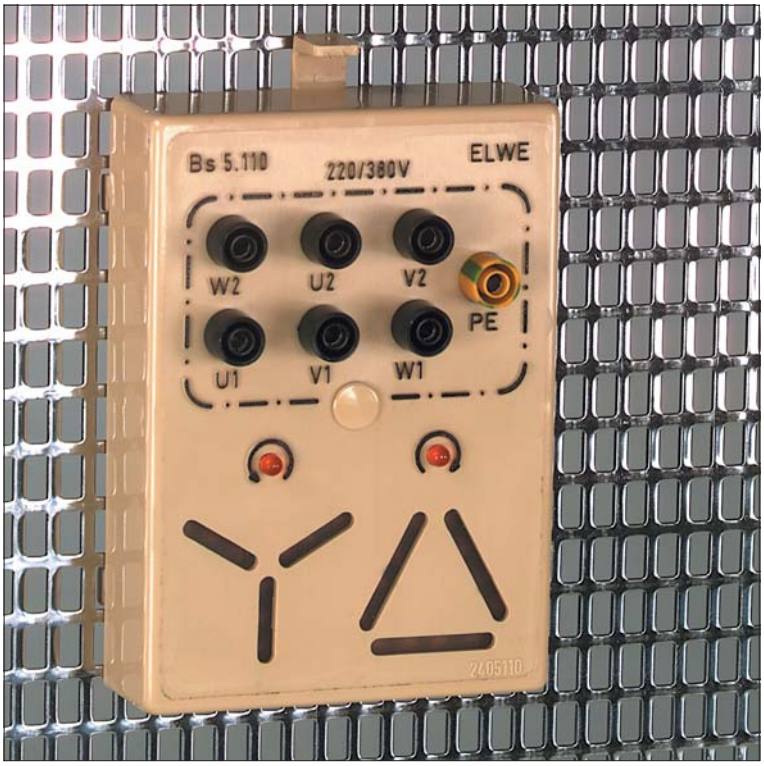


Electronic three-phase load disc. relay 10 15 025

Multifunctional relay 22 05 027

Contactor relay, 230 V 22 05 228

Electronical three-phase Motor Simulator 24 05 110



The motor simulator can be used instead of a real three-phase squirrel-cage induction motor in typical control circuits such as the star-delta connection or the reversing connection. The star-type and delta-type graphic symbols of the winding phases are connected to LEDs. Additional LEDs indicate the phase sequence so that the operational status of the motor can be seen:
– the selected method of connection Y or Δ
– the phase sequency
– the possible failure of an outer conductor

Since the simulator does not contain any rotating parts, there is no danger of mechanically caused injuries or any noise emission.

Input voltage:	3 x 230/400 V, 50(60) Hz
Dimensions in mm:	150 x 95 x 40 (l x w x h)
Mass:	0.2 kg

Motor Fault Simulator

This motor fault simulator is used, amongst others, for carrying out the experiment group "Motor Fault Simulator" according to the experimental manual 53 05 062 (see page 12). The motor simulator is plugged onto the terminal board of the three-phase induction machine and can simulate the typical faults occuring in reality:

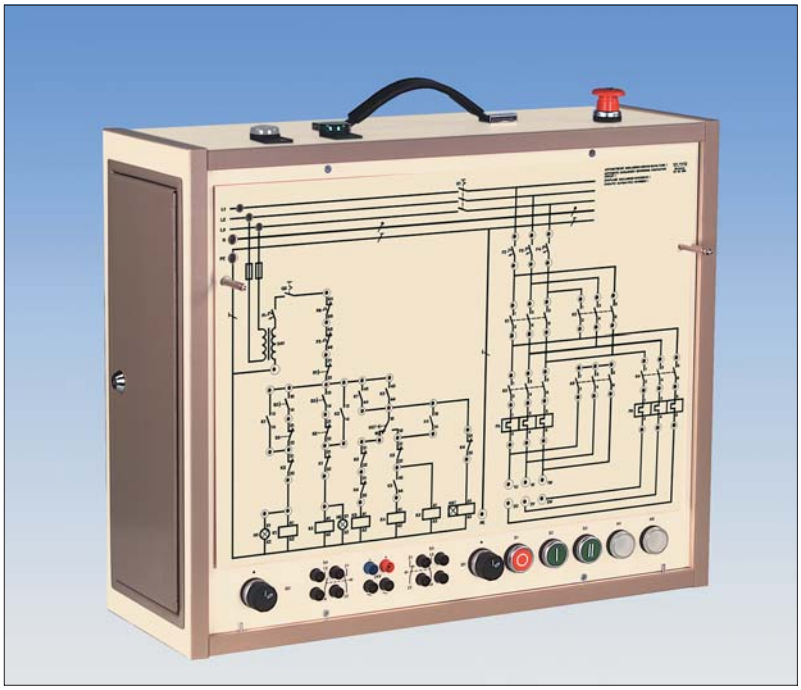
– interturn fault
– interwinding fault
– open winding phase

216 fault combinations can be adjusted by means of three step switches. All tests are carried out off circuit by means of standard ohmmeters or insulation resistance meters.

Dimensions in mm:	150 x 120 x 100 (l x w x h)
Mass:	0.4 kg

Art. no. for 100-W machines	**24 05 100**
Art. no. for 300-W machines	**24 15 100**
Art. no. for 1000-W machines	**24 25 100**

Fault Simulator for Contactor Circuits



A fast elimination of faults occuring in control circuits with contactors presuppose a systematic and rational trouble shooting. By means of the fault simulator, developed by ELWE, the required knowledge can be deepened and the necessary experience for purposeful trouble shooting can be gained by practising.

The front of the unit is equipped with a large number of measuring and termination points for the contactor circuits. Due to the attachment of a mask, only the measuring and termination points which are required for the circuit that is printed on the mask are revealed. All points that are not required are hidden by the mask.

The bottom part of the front panel contains the control panel with switches, buttons, indicator lights and sockets for the connection of external limit switches and electrical machines.

The switchboard is located behind a lockable door at the left side of the training unit. It contains the main fuses, the main switch, the "On" button for the load circuit and a group of switches for entering faults.

Two indicator lights for the control and load circuits and an emergency-stop button are mounted on the top of the training unit and can be seen by the trainer from a far distance.

In order to put the selected circuit into operation, the mask with the respective current flow diagram is attached to the front panel of the unit. A rotary switch serves to set up the function of the circuit and to select the appropriate program of each mask. The circuit can also be extended by a real electrical machine and external limit switches.

Numerous, even several simultaneously acting faults can be set by means of the switch group.

The trouble shooting is carried out in two instructional, consistent steps:
– direct trouble shooting at the measuring points on the current flow diagram of the used mask.
– trouble shooting on a special mask which displays the devices of the circuit including its connections and designations in a practice-oriented way.

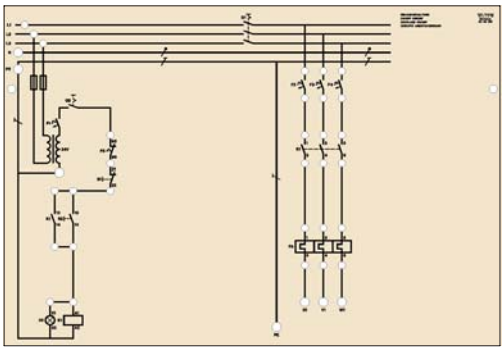
As in reality, the trouble shooting is done with the aid of the current flow diagrams illustrated on the exercise sheets of the ELWE experimental manual. The compact fault simulator is very suitable for an application in exams.

Technical data:

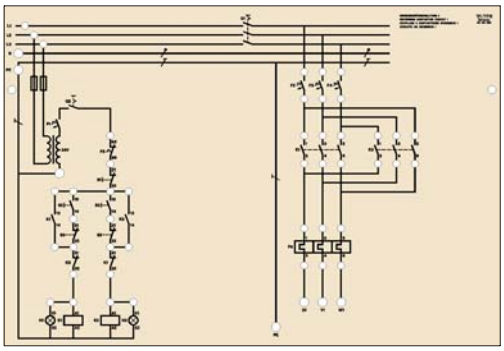
Output voltage	
for the control circuit:	24 V AC
for the load circuit:	3 x 230/400 V AC
Mains supply:	3 x 230/400 V, 50(60) Hz via Cekon plug
Dimensions in mm:	600 x 230 x 500 (l x w x h)
Mass:	24 kg

	Art. no.
Equipment for 100-W machines	**24 05 200**
Equipment for 300-W machines	**24 15 200**
Equipment for 1000-W machines	**24 25 200**

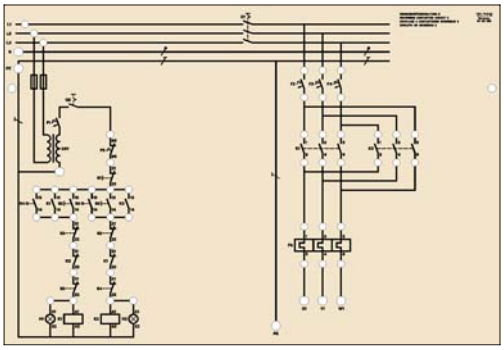
consisting of:
1 basic unit with covering cap
1 voltage and continuity tester
2 limit switches with pins
as well as the following 8 masks.



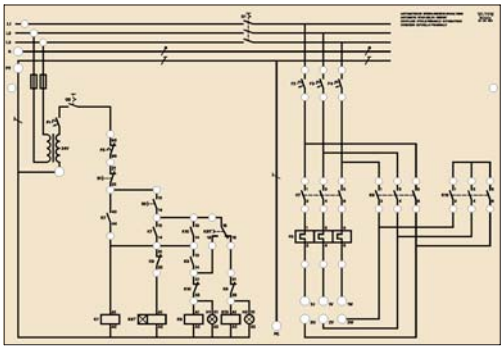
Mask "On/Off Circuit"



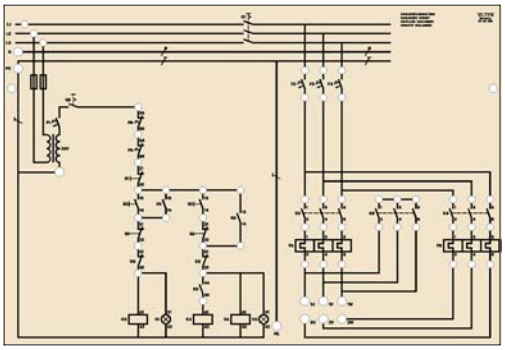
Mask "Reversing Contactor Circuit"



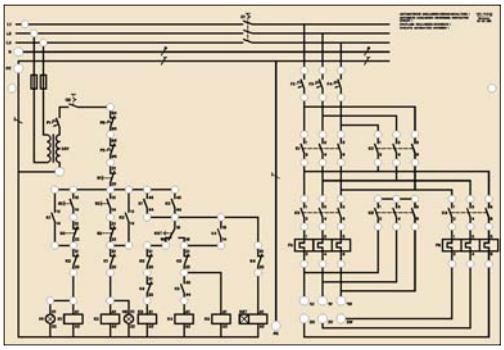
Mask "Reversing Contactor Circuit with Limit Switches"



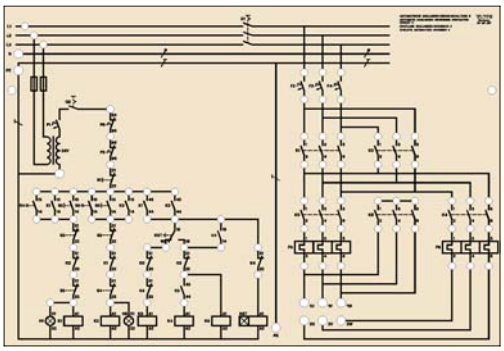
Mask "Automatic Star-delta Circuit"



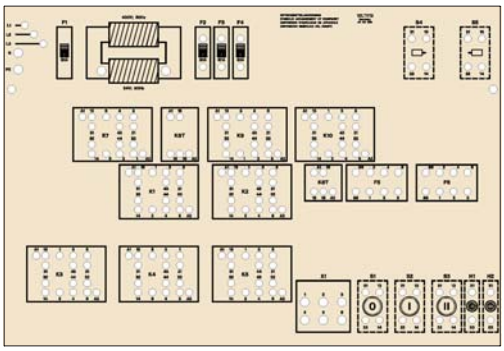
Mask "Dahlander Circuit"



Mask "Automatic Dahlander Reversing Circuit"



Mask "Automatic Dahlander Reversing Circuit with Limit Switches"



Mask "Symbolic Representation of the Equipment with Designations of Contacts and Connections Conforming to Standards"

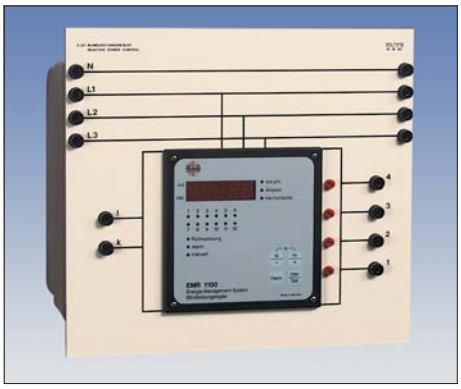
Required accessories

Power class	100 W	300 W	1000 W
Induction motor with squirrel-cage rotor	30 07 600 01	30 17 600 01	30 27 600 01
Connection mask	31 05 601	31 15 601.1	31 25 601
Induction motor, pole-changeable, Dahlander	30 07 800 01	30 17 800 01	30 27 800 01
Connection mask	31 05 801	31 15 801	31 25 801
Gear 900:1	31 07 002 01	31 17 002 01	

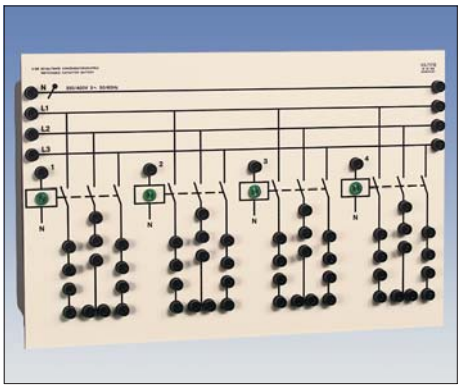
Power class	100 W	300 W	1000 W
Coupling collar	31 00 000		
Coupling cover	31 00 002	31 00 003	
Switching lever, metal	31 00 052		
Limit switch	2 x 31 00 060		
Set of safety connection leads	57 00 010		
Experimental manual	53 05 062		

Sets of Equipment "Compensation of Reactive Power"

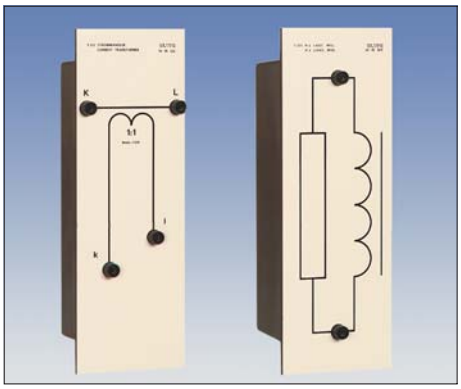
The power supply companies try to run their systems with as little reactive power as possible. Therefore, especially industrial companies use central compensation systems which automatically connect and disconnect capacitor groups according to the connected current-consuming equipment with reactive components (motors, transformers). The structure and method of operation of such systems can be examined by means of this equipment in a practice-oriented way.
This equipment and the equipment "Load Units" (see page 42) is required to carry out the experiments according to the experimental manual 53 05 072 (see page 12).



Reactive-power controller 10 15 121



Switchable capacitor battery 10 15 126

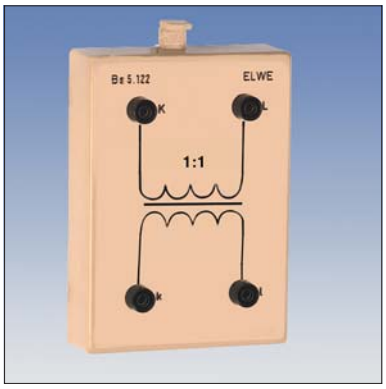


Current transformer 10 15 122

Resistive and inductive load 10 15 125

System	Panel system		Module system
Power class	**300 W**	**1000 W**	**100/300 W**
Equipment Art. no.	**01 15 041**	**01 25 041**	**02 15 040**
consisting of:			
Circuit breaker 3 circuit breakers C1A 1 circuit breaker B6A	–	–	4 x **22 05 009**
Reactive-power controller Modern industrial-type device for an automatic operation of compensating capacitors in inductive load systems Input voltage: 3 x 400 (±50) V AC Frequency: 50/60 Hz Minimum operating current: 0.05 ... 1.5 A, continuously adjustable No. of steps: 4 Step mode: full-step/ step-backstep Capacitance graduation: 1:1:1:1 or 1:2:2:2	**10 15 121**	**10 15 121**	**22 05 121**
Current transformer to measure the apparent current, Transformer ratio 1:1	**10 15 122**	**10 15 122**	**22 05 122**
Resistive and inductive load Load for basic experiments of compensation of reactive power	**10 15 125**	**10 15 125**	**22 05 125**
Switchable capacitor battery The experimental panel contains 4 switching levels which can be connected and disconnected using power contactors. They are actuated by the reactive power control unit. Each switching level consists of a socket section to plug compensating capacitors in star or delta connection. Coil voltage: 230 V AC	**10 15 126**	**10 15 126**	–
Contactor 230 V Contactor with three make-contact elements each for the operation of compensating capacitors. They are actuated by the reactive-power controller; Coil voltage: 230 V AC	–	–	4 x **22 05 231**
Combination module Socket sections to plug a group of compensating capacitors in star or delta connection	–	–	4 x **22 05 014**
Plug-in capacitor allowed voltage: 400 V AC			
0.47 µF	3 x **12 42 905**	–	3 x **12 42 905**
1 µF	9 x **12 42 910**	3 x **12 42 910**	9 x **12 42 910**
2 µF	4 x **12 42 920**	9 x **12 42 920**	4 x **12 42 920**
4 µF	4 x **12 42 940**	4 x **12 42 940**	4 x **12 42 940**

Reactive-power controller 22 05 121



Current transformer 22 05 122

Resistive and inductive load 22 05 125

Contactor 230 V 22 05 231

Combination module 22 05 014

Plug-in capacitors

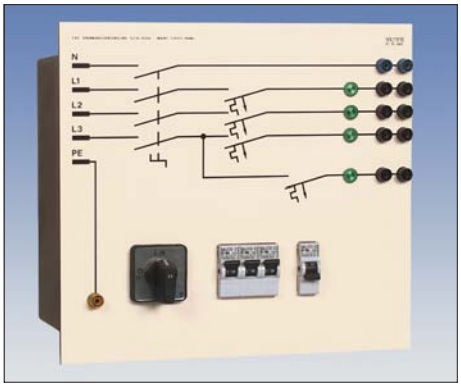
Power Supply Units

The following three devices are exclusively used for the experimental panel system.
They are mounted to an experimental frame and connected to the mains network with a Euro or Cekon plug.

AC power supply

AC power supply
Experimental panel for the mains supply of AC machines;
with alarm indicator for interchanged L and N lines.
Equipped with: - Two-pole mains switch
- Signal lamps
- Circuit breaker
B10A (at 300-W type)
C16A (at 1000-W type)
Dimensions in mm: 159 x 297 x 90 (w x h x d)
Mass: 1.0 kg

Article no. 300-W class 10 04 001 1
Article no. 1000-W class 10 25 400



Three-phase power supply

Three-phase power supply
Experimental panel for the mains supply of three-phase machines.
Equipped with: - Four-pole mains switch
- 4 signal lamps
- 3 circuit breakers
C3A (at 300-W type)
C10A (at 1000-W type)
Connection: Cekon-plug
Dimensions in mm: 319 x 297 x 90 (w x h x d)
Mass: 2.3 kg

Article no. 300-W class 10 15 060
Article no. 1000-W class 10 25 600

DC power supply

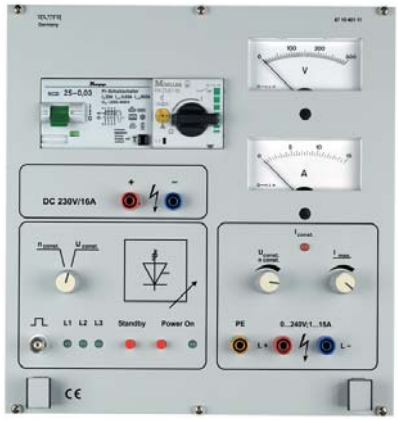
The following experimental panel is only necessary when measuring the high starting currents of the 1000-W DC machines.

DC power supply. 10 25 100
Experimental panel for the mains supply of 1000-W DC machines
(only necessary when measuring high starting currents).

Equipped with: - Two-pole mains switch
- Circuit breaker B10A
- Rectifier 400 V, 15 A
Dimensions in mm: 159 x 297 x 90 (w x h x d)
Mass: 1.3 kg

Drawer "DC Stabilizer" 67 10 400 21

Drawer "DC Stabilizer" 67 10 402 21



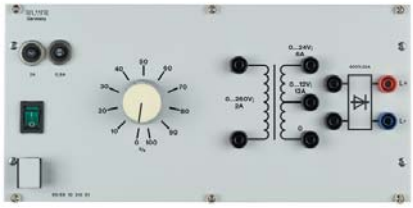
Drawer "DC Stabilizer" 67 10 401 21

In the case of training systems with experimental modules or PU experimental panels, the voltage for the electrical machines is supplied via the service duct of the working place.
For detailed information on the duct system KKS and the 19" modular system, please see the ELWE catalogue "Technical Room Furniture and Equipment".

A DC stabiliser of 0 ... 240 V corresponding to the machine power class is required for the power supply of the DC machines. The following three modules have a height unit of 6 HU. They are also available in a portable housing.

Power supply unit to be mounted to the service duct at the working place or in a portable housing						
Power class	**100 W**		**300 W**		**1000 W**	
Art. no.	**67 10 400 21**	**67 15 400 01**	**67 10 402 21**	**67 15 402 01**	**67 10 401 21**	**67 15 401 01**
Design	drawer	in a portable housing	drawer	in a portable housing	drawer	in a portable housing
DC stabilizer	0 ... 240 V, 0 ... 2 A		0 ... 240 V, 0 ... 6 A		0 ... 240 V, 0 ... 15 A	
Continuously variable DC voltage of 0 ... 240 V with continuously variable current limiting of:	0 ... 2 A		0 ... 6 A		0 ... 15 A	
Input voltage	230 V AC				3 x 230 V AC	
Output voltage 1	U_A = 0 ... 240 V stabilized		U_A = 0 ... 240 V stabilized		U_A = 0 ... 240 V stabilized	
Output current	I_{max} = 2 A, permanent short circuit-proof		I_{max} = 6 A, permanent short circuit-proof		I_{max} = 15 A, permanent short circuit-proof	
Ripple voltage	U_{ripple} < 1 V (at 240 V, 2 A)		U_{ripple} < 1 V (at 240 V, 6 A)		U_{ripple} < 10 V (at 240 V, 15 A)	
	LED display when using the current limiting					
Output voltage 2	U = 230 V DC, 10 A max.		U = 230 V DC, 10 A max.		U = 230 V DC, 16 A max.	
Input control	0 ... 10 V DC				—	
Components	1 measuring element of 0 ... 300 V					
	1 measuring element of 0 ... 2 A		1 measuring element of 0 ... 6 A		1 measuring element of 0 ... 15 A	
	—		—		Residual-current-operated protective device (RCD), activated with direct current	
	7 4-mm safety sockets		7 4-mm safety sockets		5 4-mm safety sockets	
Colour	RAL 7035 light grey					
Mounting width	248 mm (49 PU)					
Mass	5.5 kg	9.3 kg	5.5 kg	9.3 kg	9.0 kg	12.8 kg

One of the three following power supply units is required for adjusting the field voltage for a three-phase synchronous machine independent of the machine power class,. The power supply unit is also used for measuring the starting currents of the 100-W and 300-W DC machines (for 1000-W DC machines, see 10 25 100 on page 54).



Duct unit 6510 310 01, cassette 68 10 310 01

Drawer 6710 310 01

Duct unit "Low and Extra-low Voltage" 65 10 310 01
(for the duct system KKS)
Continuously variable AC and DC voltages in the low and extra-low voltage range. Protection through excess-current circuit-breaker.
Specifications:
Variable transformer connected in incoming circuit, 0... 260 V; 2.5 A
Safety isolating transformer, 250 V / 24 - 12 V; 6 - 12 A
Rectifier connected in outgoing circuit, 400 V; 25 A
Output: 0 ... 12 V AC, 12 A
0 ... 24 V AC, 6 A
0 ... 260 V AC, 2.5 A
via 4-mm safety sockets,
DC voltages via rectifier connected in outgoing circuit
Colour: RAL 7035 light grey
Mounting width: 263.9 mm (52 PU)
Mass: 6.8 kg

Cassette "Low and Extra-low Voltage" 68 10 310 01
(with 3 height units, for the 19" modular system)
Specifications as with 65 10 310 01.

Drawer "Low and Extra-low Voltage" 67 10 310 01
(with 6 height units, for the 19" modular system)
Continuously variable voltages:
0 ... 24 V AC, 15 A (18 A for a short time),
0 ... 260 V AC, 3 A (4 A for a short time),
DC voltages via rectifier connected in outgoing circuit
Equipped with:
1 Variable transformer, 0 ... 230 V; 3.2 A
1 Isolating transformer, 0 ... 230 V / 250 V; 3 A
1 Measuring instrument, 0 ... 30 V AC,
1 Measuring instrument, 0 ... 300 V AC
1 Measuring instrument, 0 ... 20 A AC,
1 Measuring instrument, 0 ... 3 A AC
1 Rocker switch with control lamp
8 4-mm safety sockets
2 Excess-current circuit-breakers of 3 A
1Eexcess-current circuit-breaker of 15 A
2 Rectifiers, 400 V, 25 A
Colour: RAL 7035 light grey
Mounting width: 248.6 mm (49 PU)
Mass: 18.5 kg

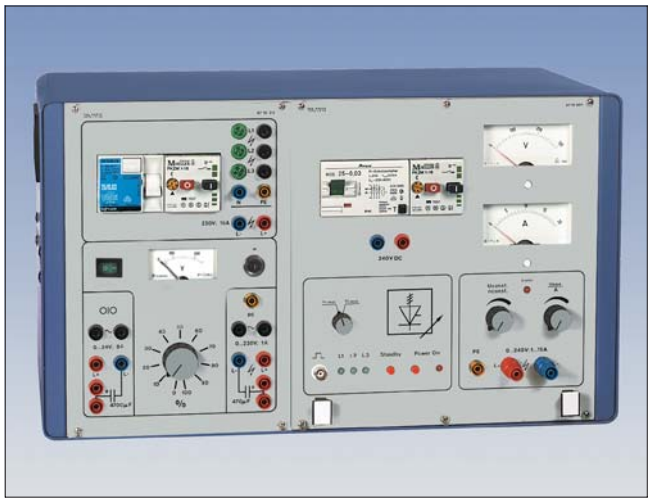
Compact Portable Power Supply Units

Power supply unit for 100-W machines
15 05 001 01

The compact portable power supply units are very suitable for machine laboratories that are not equipped with service ducts but with respective modules at the working places. With machine power classes of 100 W, 300 W and 1000 W, they supply all voltages that are necessary to conduct the experiments to all machine types. Their power corresponds to the power of the respective supply duct module "DC Stabiliser" (see page 55) or "Low and Extra-Low Voltage" (see above):

- continuously variable AC voltage of 0 ... 230 V AC for AC machines
- continuously variable DC voltage of 0 ... 24 V DC for the field current of the synchronous machine
- continuously variable stabilised DC voltage of 0 ... 240 V DC for the DC machines
- 230-V DC voltage for the field current of the DC machines
- and also the mains connections L1, L2, L3 for AC and three-phase machines.

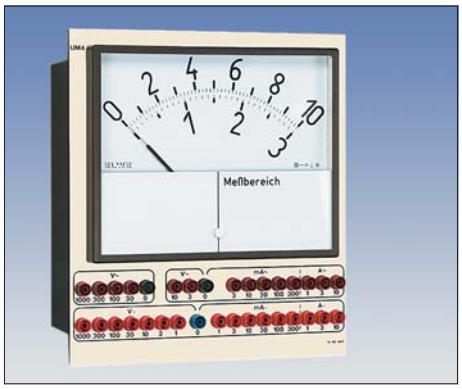
Power supply unit for 300-W machines
15 05 002 01



Power supply unit for 1000-W machines
15 05 003 01

Portable power supply units			
Power class	**100 W**	**300 W**	**1000 W**
Article number	**15 05 001 01**	**15 05 002 01**	**15 05 003 01**
Part: Low and extra low voltage equipped with:			
Residual-current-operated protective device, ΔI_F= 30 mA, 25 A	•	•	•
Circuit breaker, three poles	6 A max.	16 A max.	16 A max.
Output with 3 signal lamps AC 230/400 V, 3/N/PE, 50 ... 60 Hz, and DC outlet via a rectifier connected in outgoing circuit	6 A max.	16 A max.	16 A max.
The following voltages are switched on and off together, are protected with overvoltage circuit-breakers and are continuously variable.			
Output: 0 ... 24 V AC	2 A max.	8 A max.	max. 8 A
Electrical isolation with safety isolating transformer, DC outlet via a rectifier connected in outgoing circuit, connectable smoothing capacitor	1000 µF	4700 µF	4700 µF
Output: 0 ... 24 V AC	1 A max.	1.6 A max.	1.6 A max.
Electrical isolation with safety isolating transformer, DC outlet via a rectifier connected in outgoing circuit, connectable smoothing capacitor	470 µF	470 µF	470 µF
Part: DC stabilizer equipped with:			
Output: 0 ... 240 V DC, stabilised, short-circuit-proof			
Continuously variable current limiting	0 ... 2 A	0 ... 6 A	0 ... 15 A
Input control 0 ... 10 V DC	•	•	—
Degree of protection: Residual-current-operated protective device	—	—	•
Voltmeter	•	•	•
Ammeter	•	•	•
LED display for current limiting	•	•	•
Output: 230 V DC (via rectifier)	10 A max.	10 A max.	16 A max.
	All outputs are connected to 4-mm safety sockets.		
Mains connection via Cekon plug	AC 400/230 V, 3/N/PE, 50(60) Hz		
Housing colour / front colour	RAL 5014, pigeon blue / RAL 7035, light grey		
Dimensions in mm (w x h x d)	470 x 280 x 280		
Mass	19.1 kg	19.1 kg	22.6 kg

Measuring Instruments for the Panel System



Multimeter UM4

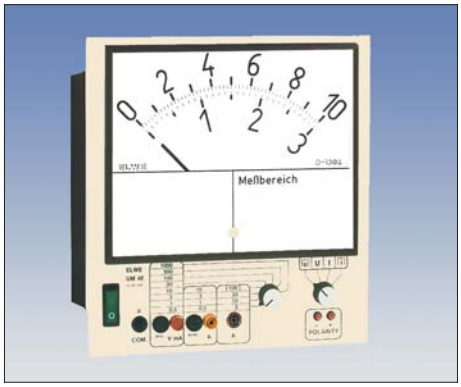
Multimeter UM4 . . . . . 14 00 940

Standard multimeter for current and voltage measurements including moving-coil element and 30 measuring ranges; the scale zero is on the left hand side.

Scale length: 170 mm

Measuring ranges:	DC voltage:	1, 3, 10, 30, 100, 300, 1000 V
	AC voltage:	3, 10, 30, 100, 300, 1000 V
	DC current:	1, 3, 10, 30, 100, 300 mA; 1, 3, 10 A
	AC current:	3, 10, 30, 100, 300 mA; 1, 3, 10 A
Input resistance:		4 kΩ/V at 1 V DC, 1 kΩ/V at 3 V AC
Quality class:		1.5
Dimensions in mm:		297 x 259 x 90 (h x w x d)
Mass:		1.9 kg

Alternatively to the universal meter UM4:



RMS-responding meter UM4e

RMS-responding meter UM4e 14 00 945

Electronical measuring instrument to measure the r.m.s.-value or the mean value of the absolute values of voltages or currents in **any wave shape**. Overload protection within all range of 1000 V and 10 A. The polarity indication results via two LEDs.

Measuring ranges:

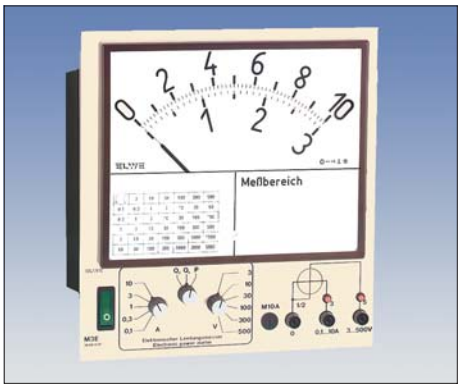
	DC/AC voltage:	0.3, 1, 3, 10, 30, 100, 300, 1000 V
	DC/AC current:	0.3, 1, 3, 10, 30, 100, 300, 1000 mA
		3, 10, 30, 100 A
		(voltage drop 300 mV max.)
Measuring way:		r.m.s. or mean value
		of the absolute value
Internal impedance:		10 MΩ II 20 pF
Frequency response:		0 ... 100 kHz
Quality class:		2.0
Voltage supply:		230 V AC, 50(60) Hz
Dimensions in mm:		297 x 259 x 110 (h x w x d)
Mass:		2 kg

Shunt 30 A– / 1 V– 25 00 915

suitable for all multimeter.

Current transformer 30 A~ / 0.3 A~ 25 00 920

suitable for all multimeter.



Wattmeter UM3e

Wattmeter M3e 14 00 035

for the manifold use in low and extra-low voltage circuits.

- Active power ranges on DC current: 3 ... 5000 W
- Active power ranges on AC current (from 10 Hz to 1 kHz): 3 ... 5000 W
- Inductive and capacitive reactive power up to 50(60) Hz: 3 ... 5000 var
- Overload protection in all measuring ranges
- No disconnection of the circuit during changing the ranges
- Display of overload via LEDs

Voltage ranges:	10, 30, 100, 300, 500 V
Current ranges:	0.3, 1, 3, 10 A
Power ranges:	20
Input resistance:	10 MΩ (voltage path);
	0.05 Ω (current path)
Overload protection:	up to 600 V and 10 A within all ranges
Frequency response:	DC ... 1 kHz
Quality class:	2.5
Voltage supply:	230 V AC, 50 (60) Hz
Dimensions in mm:	297 x 259 x 120 (h x w x d)
Mass:	2.1 kg

Power factor and phase-angle meter M5e

Power factor and phase-angle meter M5e 14 00 055

Battery-powered meter of low power consumption because the voltage supply is automatically connected during the measurement and disconnected afterwards. A connectable 50/60 Hz filter allows to measure system frequencies without having interferences.
The unit is protected against overload of 1000 V and 10 A max. within all ranges.

Phase-angle indication:	-90° ... +90°
Power factor indication:	0 capacitive ... 1 ... 0 inductive
Voltage range:	1 ... 1000 V
Input resistance:	1 MΩ
Current range:	0.1 ... 2 A; 1 ... 10 A
Max. voltage drop:	1 V
Frequency response:	20 Hz ... 5 kHz, from 1 V to 20 kHz
Quality class:	2.5
Voltage supply:	9-V battery (IEC 6 F 22)
Dimensions in mm:	297 x 259 x 110 (h x w x d)
Mass:	1.8 kg

Double frequency meter M8

Double frequency meter M8 . . . . . 14 00 080 1

with two independent reed-type frequency meters for a comparative frequency measurement in 50 Hz AC or three-phase systems of synchronizing circuits.

Frequency range:	45 ... 55 Hz
Resolution:	0.5 Hz
Input voltage:	230 V AC max.
Dimensions in mm:	297 x 259 x 105 (h x w x d)
Mass:	1 kg

Double voltmeter M9

Double frequency meter M8/60 . . . . . 14 00 086 1

as 14 00 080 1 but for 60 Hz AC or three-phase circuits.

Frequency range:	55 ... 65 Hz

Double voltmeter M9 . . . . . 14 00 090 1

with two independent iron movements for a comparative voltage measurement in AC or three-phase systems of synchronizing circuits.

Measuring range:	0 ... 300 V AC
Quality class:	1.5
Dimensions in mm:	297 x 259 x 185 (h x w x d)
Mass:	2.3 kg

Zero voltmeter M10

Zero voltmeter M10 . . . . . 14 00 100

for balancing the zero voltage in synchronizing circuits. The initial range of the scale (almost zero) is very much stretched. The end-scale deflection occurs when the supply voltage is doubled.

Measuring range:	0 ... 800 V AC
Quality class:	1.5
Dimensions in mm:	297 x 259 x 185 (h x w x d)
Mass:	1.0 kg

Synchronoscope M11

Synchronoscope M11 . . . . . 14 00 110 1

for comparing the frequencies and the phase position of two AC or three-phase systems. The round LEDs show the nature of asynchronization. When synchronization is achieved a rectangle LED lights.

Input voltage:	230 V AC max.
Frequency range:	50 ... 60 Hz
Dimensions in mm:	297 x 259 x 120 (h x w x d)
Mass:	1.8 kg

Electronic tachometer EDM

Electronic tachometer EDM 14 00 230 1

The instrument is used to display the speed frequency and the sense of rotation of electrical machines and it additionally supplies a voltage signal that depends on the speed frequency. The values are measured by a tachogenerator (art. no. 31 07 005 01 or 31 17 005 01, see page 34) and are applied to the measuring instrument via a DIN socket. The meter EDM also applies the operating voltage to the digital tachogenerator. The speed frequency is displayed by a large 270° circular-scale moving-coil element and the sense of rotation by LEDs.

Measuring ranges:	1500, 3000, 6000 rpm
Output, digital:	60 impulses (level 0/15 V) per rotation
Output, analogue:	±1 V per 1000 rpm
Voltage supply:	230 V AC, 50(60) Hz
Dimensions in mm:	259 x 297 x 130 (w x h x d)
Mass:	1.6 kg

Measuring Instruments for the Module System

Multimeter AF-M1.0 . . . . . 25 00 010.9

Folding meter with 46 ranges for measuring voltage, current and resistances. When the instrument is folded, the controls and displays are completely protected. The battery switches off automatically. The mirror scale is 100 mm long, the reading angle of the scale is freely adjustable.

Measuring ranges:	
DC and AC voltage:	0.1, 0.3, 1. 3, 10, 30, 100, 300, 1000 V
DC and AC current:	0.01, 0.1, 1, 10, 100 mA; 1, 10 A
Resistance:	2, 20, 200 kΩ; 2, 20 MΩ
Input resistance:	10 MΩ
Overload protection:	250 V AC/DC, from 10 V to 1200 V AC/DC
Quality class:	1.5 on DC and resistance; 2.5 on AC
Voltage supply:	1 flat cell 9 V (IEC 6 F 22)
Dimensions in mm:	146 x 118 x 44 (h x w x d), folded
Mass:	0.65 kg

Meter holder. 25 00 006

The holder is used to hang the meter AF-M1.0 directly on the mounting wall.

Voltmeter AF-M4.4

Ammeter AF-M4

Multifunctional measuring instrument PX-120

As an alternative to the multimeter AF-M1.0:

Voltmeter AF-M4.4 . . . . . 25 00 044
including moving-coil element and 8 measuring ranges. The element is protected by semiconductors. The scale division is linear for the alternating-voltage measuring range as well.
Experimental module which is hung on the ELWE mounting wall directly.
Measuring ranges:

DC and AC voltage:	30, 100, 300, 600 V
Input resistance:	1 kΩ/V
Quality class:	2.5
Dimensions in mm:	88 x 137 x 44 (h x w x d)
Mass:	0.2 kg

and

Ammeter AF-M4 . . . . . 25 00 040
including moving-coil element and 8 measuring ranges. The element is protected by diodes in anti-parallel connection. The scale divisions of the AC range are also linear.
Experimental module which is hung on the ELWE mounting wall directly.
Measuring ranges:

DC and AC current:	0.3, 1, 3, 10 A
Input resistance:	DC 0.8, 0.25, 0.1, 0.05 Ω
	AC 0.3, 0.06, 0.015, 0.008 Ω
Quality class:	2.5
Dimensions in mm:	88 x 137 x 44 (h x w x d)
Mass:	0.2 kg

Current transformer 30 A, 60 A / 0.3 A 25 00 910
Current transformer 30 A AC / 0.3 A AC 25 00 920
(see page 76)

The following meter PX-120 can be used alternatively to the multimeter AF-M1.0 or the voltmeter AF-M4.4 and the ammeter AF-M4:

Multifunctional measuring instrument PX-120. . . 25 00 140
to measure the voltage, the current, the active, reactive and apparent power, the power factor, the true r.m.s. values (TRMS) for the AC and DC variables in four quadrants, also when the signals are interfered or distorted by harmonic waves.
The instrument has been designed for the measurement of power in symmetrical three-wire three-phase systems and in single-phase systems.
All measuring functions can be easily selected by pressing the 6 operator buttons. The automatic range selection helps to prevent operator input errors.
The instrument has an additional smoothing function (averaging of the measured values above approx. 3 s) when the digital display is unstable, and allows you to measure the starting current (INRUSH) of electrical loads (peak measurement of a half-wave).
The display indicates three measured values simultaneously in three lines (full 4 digits), with the respective symbol for each measuring function. The digits are 14 mm high.
The instrument corresponds to safety standard IEC 61010-1, Cat. III, 600 V, degree of soiling 2. The housing is coated with elastomer to protect it against shock and impact and the built-in support helps to set it up with an inclined surface of 30°.

Active power:	10 W ... 1 kW, 1 kW ... 6 kW
Reactive and apparent power:	10 ... 1 kVA(var), 1 k ... 6 kVA(var)
	(in the case of three-phase current, sine-wave signals are provided)
Power factor:	0.00 ... 1.00
Voltage:	0.5 ... 600 V (RMS)
Input impedance:	1 MΩ
Current:	10 mA ... 2 A, 2 A ... 10 A (RMS)
Starting current:	5 A à 65 A (peak)
Power supply:	6 x 1.5 V battery (LR6)
Battery operation time:	40 h
Safety standard:	EN 61010-1, cat. III, 600 V
Dimensions in mm:	108 x 60 x 211 (w x h x d)
Mass:	0.84 kg

Power supply unit HX-0021
to be plugged into meter PX-120 . . . . . 25 00 141
Output voltage: 9 V CC; Power supply: 230 V CA, 50(60) Hz

Double frequency meter AF-M6F

Double frequency meter AF-M6F 25 00 062 1

with two independent reed-type frequency meters for a comparative frequency measurement in 50 Hz AC or three-phase systems of synchronizing circuits.

Frequency range:	45 Hz ... 55 Hz
Resolution:	0.5 Hz
Input voltage:	230 V max.
Dimensions in mm:	131 x 220 x 131 (w x h x d)
Mass:	1.4 kg

Double voltmeter AF-M6S

Double frequency meter AF-M6/60F 25 00 064 1

with two independent reed-type frequency meters for a comparative frequency measurement in 60 Hz AC or three-phase systems of synchronizing circuits.

Frequency range:	55 Hz ... 65 Hz
Resolution:	0.5 Hz
Input voltage:	230 V max.
Dimensions in mm:	131 x 220 x 131 (w x h x d)
Mass:	1.4 kg

Double voltmeter AF-M6S 25 00 068 1

with two independent iron movements for a comparative voltage measurement in AC or three-phase systems of synchronizing circuits.

Measuring range:	0 ... 300 V AC
Quality class:	1.5
Dimensions in mm:	131 x 220 x 131 (w x h x d)
Mass:	1.4 kg

Zero voltmeter AF-M7

Zero voltmeter AF-M7 . . . . . 25 00 070

for balancing the zero voltage in synchronizing circuits. The initial range of the scale (almost zero) is very much stretched. The end-scale deflection occurs when the supply voltage is doubled.

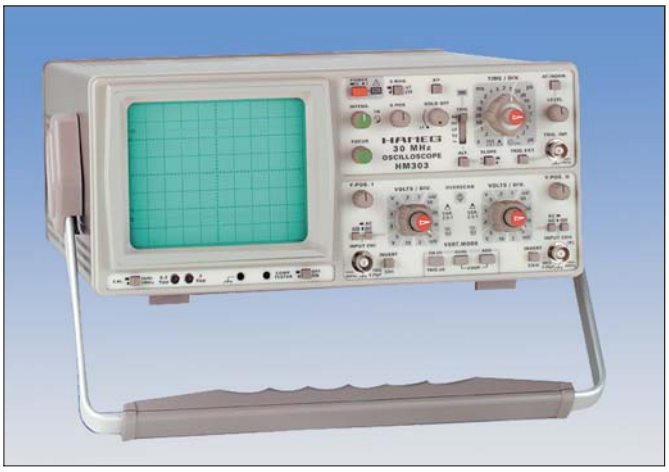
Measuring range:	0 ... 800 V AC
Quality class:	1.5
Dimensions in mm:	131 x 220 x 131 (w x h x d)
Mass:	1.4 kg

Synchronoscope AF-M8

Synchronoscope AF-M8 . . . . . 25 00 080 1

Measuring instrument for comparing the frequencies and the phase position of two AC or three-phase systems. The round LEDs show the nature of asynchronization. When synchronization is achieved a rectangle LED lights.

Input voltage:	230 V AC max.
Frequency range:	50 Hz ... 60 Hz
Dimensions in mm:	131 x 220 x 131 (w x h x d)
Mass:	1.8 kg



Two-channel oscilloscope HM 303

Three-channel isolation amplifier M 35

Two-channel oscilloscope HM 303. . . . . 25 00 302

with stable triggering at signals ranging from DC to 100 MHz. The integrated component tester allows to represent characteristics of double-pole devices.
Variable hold-off time, TV-sync-separator, trigger LED, 2 switch-selectable probes 1:1 / 10:1

Frequency range:	0 ... 35 MHz
Sensitivity:	5 mV/cm ... 20 V/cm
Time base:	0.2 s/cm ... 10 ns/cm
Triggering:	0 ... 100 MHz
Monitor:	8 cm x 10 cm
Dimensions in mm:	285 x 125 x 380 (w x h x d)
Mass:	6.3 kg

Accessories for HM 303/305 . . . . . 25 00 312

2 x Adapters BNC/4 mm, 2 x 4mm plug for probe.

Note :
With the oscilloscopes we reserve the right to supply devices of an equal or higher quality corresponding to the technical advances.

Three-channel isolation amplifier M 35 . . . . . 25 00 350 11

The device combines three isolating amplifiers for ground-potential-free measurements and a three-channel switch. Therefore it is possible for three independent measuring channels to develop from one channel of the oscilloscope. The electrically isolated measuring signals are therefore available independently of the three-channel switch. The trigger source is selected with the selector switch and applied to the external trigger input of the oscilloscope.

Max. input voltage:	600 V CC (400 V CA)
Input resistance:	1 MΩ
Input attenuator:	1:1 / 1:10 / 1:100
Frequency range:	CC ... 60 kHz, without switching mode
Max. output voltage:	6 V CC (4 V CA)
Output resistance:	10 kΩ
Voltage supply:	230 V CA, 50(60) Hz
Dimensions en mm :	300 x 110 x 257 (w x h x d)
Masse :	3.34 kg

The scope of delivery contains: 2 BNC/BNC-cables, 1 m

Measuring Interface "Comenius"

Measuring interface "Comenius"

The measuring interface "Comenius" is used for measuring and controlling by means of a PC. It is connected to the PC via the interface RS232. An intervention into the PC is not necessary.

The measuring interface **Comenius-T** is a portable table-top unit equipped with 4 isolated channels and measuring ranges of up to 1000 V max.

The **Comenius-E** is designed as an experimental panel to fit in the experimental panel system. It measures voltages up to 100 V. The unit allows the connection of the **four-channel isolation amplifier P 34** to a PC. The four-channel isolation amplifier can also be applied independently of the measuring interface "Comenius-E", e.g. as an auxiliary oscilloscope.

The scope of delivery of every measuring interface contains a measuring and evaluation software executable under DOS or Windows depending on your choise.

Technical data of Comenius-T:

Analogue inputs:
- 4 inputs of 12-bit resolution, electrical isolation, scanning time of 1 µs
- Measuring error of ±0,5 %, plus 0,2 % of the range limit value
- Measuring ranges ±1 V, ±10 V, ±100 V, ±1000 V (adjustable via software)
- Input resistance of 1 MΩ
- Sample-Rate:
  - 1 MHz maximum at the same time at two-channel operation
  - 0.5 MHz maximum at the same time at four-channel operation

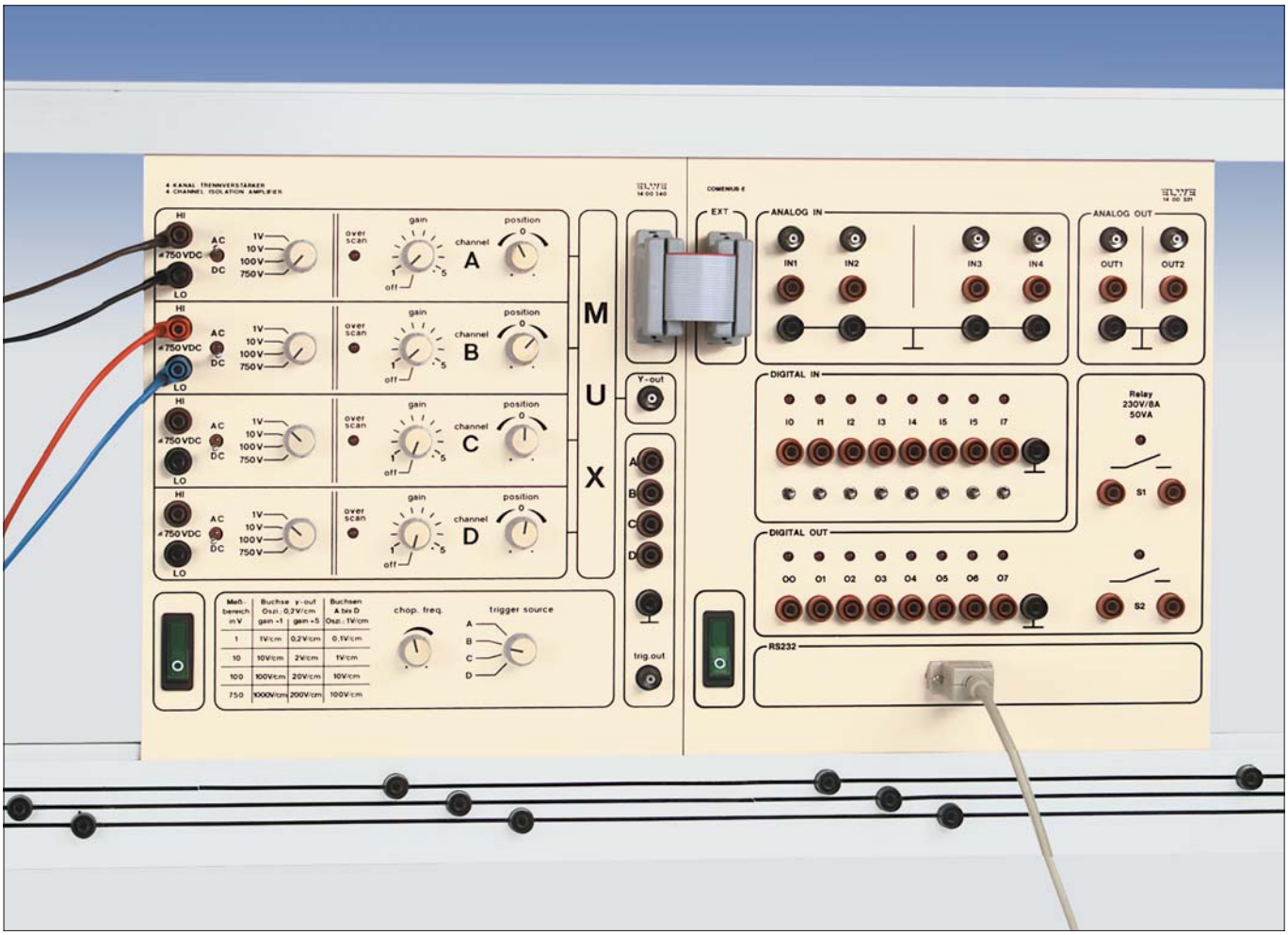
Analogue outputs:
- 2 outputs of 12-bit resolution, conversion rate simultaneously of 1 µs
- Output voltage of Us = ±10 V max., error of 0.5 %
- Output resistance of 500 Ω
- All outputs are short-circuit-proof

8 digital inputs:
- TTL level, short-circuit-proof, resistant to overvoltage up to 250 V,

  input resistance of 10 kΩ
- LED display of the input levels
- Scanning time simultaneously of 0.5 µs
- 8 decoupled toggle switches with push-grid position for sending signals

8 digital outputs:
- TTL level, output resistance of 100 Ω, short-circuit-proof
- Switching time of 0.5 µs simultaneously
- LED display of the output states

2 relay-type outputs:
- Contact rating of 230 V AC max., 8 A max., 50 W/2000 VA max.
- LED display of the output states



Four-channel isolation amplifier and measuring interface "Comenius-E"

Connections:
- All inputs and outputs dispose of 4-mm safety sockets, additionally, all analogue inputs and outputs are connected to BNC sockets.

25-pin D-sub-socket:
- for a fast connection of ELWE additional units

RS232 interface for the connection to the PC:
- Sub-D socket, 9 pins
- Electrical isolation
- Transmittion rate of 9.6 KB to 38.4 KB, programmable

Data memory:
- 18 KB with user-programmable organization

Mains connection:
- AC voltage of 230 V ±10 %,
  can be switched over to 115 V ±10 %, 50 to 60 Hz

Type of construction:	Table-top unit
Dimensions in mm:	360 x 150 x 280 (w x h x d)
Mass:	4 kg

Technical data of Comenius-E:

like Comenius-T but all 4 analogue inputs without the measuring range ±1000 V and without potential isolation (input resistance of 100 kΩ).

Type of construction:	Experimental panel
Dimensions in mm:	259 x 297 x 140 (w x h x d)
Mass:	2.4 kg

Four-channel isolation amplifier 14 00 340

The connection to the measuring interface "Comenius-E" will be done with a 25-pole ribbon cable (55 10 025).

Channels:	A, B, C, D
Input voltage:	4 x U_p max. = 750 V
Input resistance:	1 MΩ
Measuring ranges:	10:1, 1:1, 1:10, 1:100
Gain:	1 ... 5
Frequency range:	0 ... 20 kHz
Accuracy:	0.5 %
Overload detector:	as from ±10 V
4 channels:	Separate activation, separate positioning of the zero line
4 single-ended outputs:	± 10 V max.
1 multiplex output:	± 1 V max., R(out) = 1 kΩ
Trigger source:	channel A ... D selectable
Voltage supply:	230 V AC, 50(60) Hz

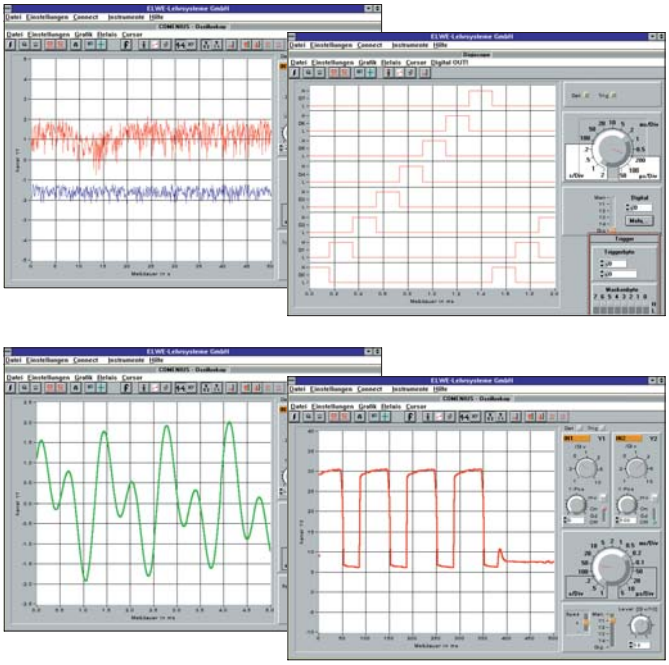
Type of construction:	Experimental panel
Dimensions in mm:	297 x 259 x 140 (w x h x d)
Mass:	2.3 kg

Measuring interface "Comenius-T" in a portable housing with software under Windows "Measuring and Analysis"
(see next page) **65 15 631**

Measuring interface "Comenius-E" as experimental panel with software under Windows "Measuring and Analysis"
(see next page) **14 00 330**

required in addition to the "Comenius-E":
Four-channel isolation amplifier 14 00 340
25-pole ribbon cable 55 10 025

Software "Measuring and Analysis" for the Measuring Interface "Comenius"



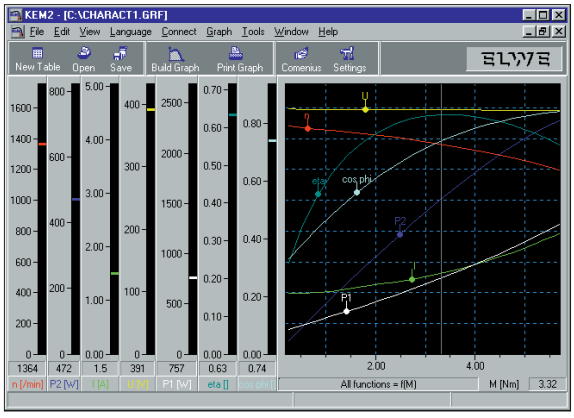
The software "Measuring and Analysis" is part of the standard equipment of every measuring interface "Comenius". It runs under Microsoft® WINDOWS and can be used in German, English, French, Spanish and Dutch. The input and output functions of the interface "Comenius" are very easy to operate because of the virtual instruments (oscilloscope, function generator).

The software contains the following functions:

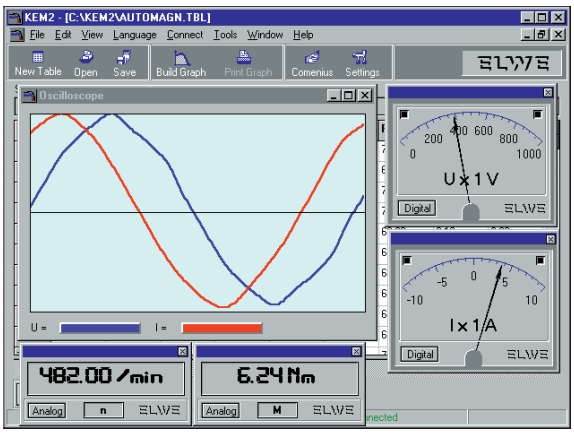
- Measurement of DC or AC RMS voltage
- Four-channel oscilloscope with mathematical measured-value logic operation, triggering and zoom function, max. scanning frequency of 1 MHz (0.5 MHz in case of four-channel operation)
- 2 function generators, sine-wave, delta, square-wave voltages, 100 kHz max.
- Digital output of 256 bytes max. from a freely programmable table, output frequency of 0.2 Hz … 200 kHz
- Digital oscilloscope: 8 bit with zoom function, scanning frequency of 0.03 Hz … 200 kHz

Hardware requirements:
– PC 386 or higher and coprocessor, 8 MB RAM, 33 MHz
– hard disk requirements: 4 MB
– graphics format: 800 x 600 (SVGA) min.
– operating system: Windows 3.1 or higher

Software "Recording Characteristic Curves of Electrical Machines" 50 05 028



Characteristic curves of an asynchronous machine $n = f(M)$, $P_2 = f(M)$, $I = f(M)$, $U = f(M)$, $P_1 = f(M)$, $\eta = f(M)$, $\cos\varphi = f(M)$



U/I characteristic at load

The software "Recording Characteristic Curves of Electrical Machines" enables one to record, analyse and show the characteristic curves of DC, AC and three-phase machines with the measuring interface "Comenius" and the U/I attachment (see next page) **in combination with a magnetic-powder brake**.
It is easy to handle intuitively and comprises many functions. It is, for example, possible to record the characteristic curves either manually (point-by-point) or automatically. It is thus possible to represent up to 10 characteristics on the monitor simultaneously.
With the zoom function an area within the menu can be selected and enlarged to increase the resolution and the accuracy significantly. The pan function enables one to shift the graph horizontally or vertically.

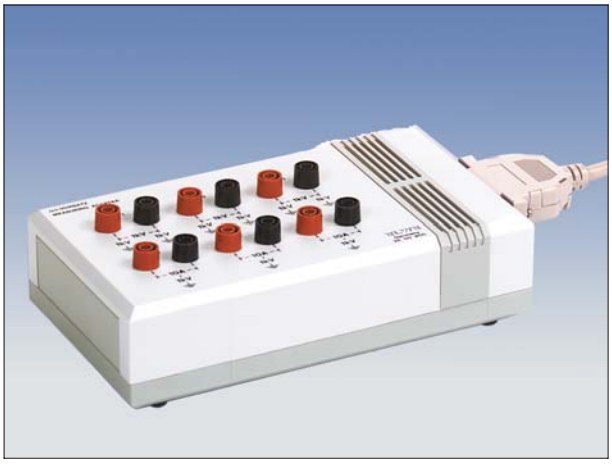
More tools are available for improving the graphic appearance of the characteristics:

- The scales of axes, grids as well as colours and thickness of the curves can be adjusted by the user.
- The graphic curves can be labelled at any position. The labels can then be placed anywhere on the curves by dragging them with the mouse.
- The oscilloscope function enables one to display the time lapse of the measured signals. The actual values can be exactly analysed with the cursor.
- The effective values of the measured signals, for example, can be displayed with virtual analogue instruments.
- Further functions: Printing, help

The user is guided in German, English, French or Spanish.

Hardware requirements:
– PC 386 or higher and coprocessor, 8 MB RAM, 33 MHz
– hard disk requirements: 4 MB
– graphics format: 800 x 600 (SVGA) min.
– operating system: Windows 3.1 or higher

U/I Attachment for Measuring Interface "Comenius", Software "Three-phase Analyser"



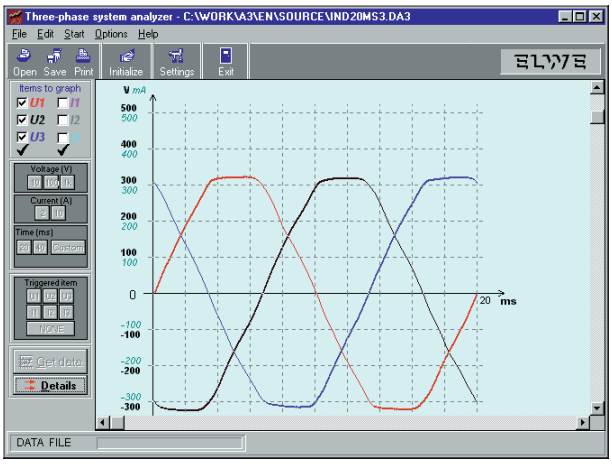
U/I attachment with 25-pin connection lead

U/I attachment
for measuring interface "Comenius" 25 00 900

In combination with the measuring interface "Comenius", the attachment is used to measure three voltages and currents in DC, AC or three-phase circuits potentialfrei, e.g. during the operation of DC, AC and three-phase machines. The current is measured directly via current transformers. All connections run to the terminals of 4-mm safety sockets. The measuring-circuit voltage may be 1 kV max. higher than the PE potential.
The power is supplied via the measuring interface "Comenius".

Input voltage:	1000 V max.
Input current:	10 A max.
Dimensions in mm:	200 x 115 x 65 (l x w x h)
Mass:	370 g

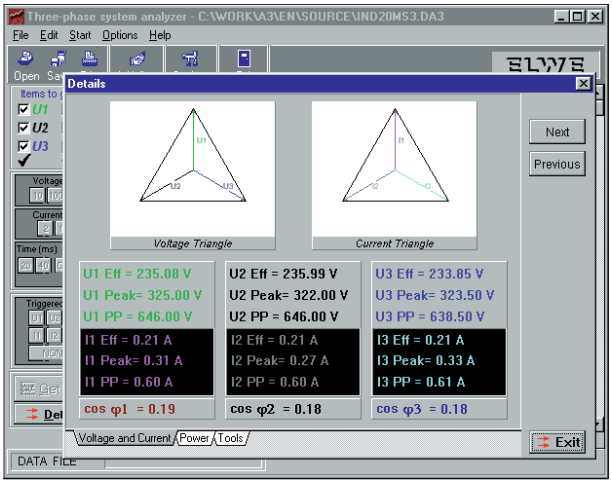
additionally required:
25-pin connection lead, 2 m 55 10 026



Voltage display in three-phase networks

Software "Three-phase Analyser" 50 05 032

In combination with the measuring interface "Comenius" and the U/Iattachment, the program allows the recording, the representation and the evaluation of the measured data of three-phase AC signals.
It is possible to measure up to 6 signals simultaneously and to display the chart.
Further functions are the representation of voltage, current and power as vector diagrams and the analysis of graphs by means of measuring cursors.
The following values can be calculated from all signals per mouse click:
RMS value, mean value, rectified mean value, peak value, peak-to-peak value, phase angle in degrees, effective power, apparent power, reactive power, power factor, form factor, crest factor.
All signals and the software settings can be stored and the signals can be issued graphically via a printer.



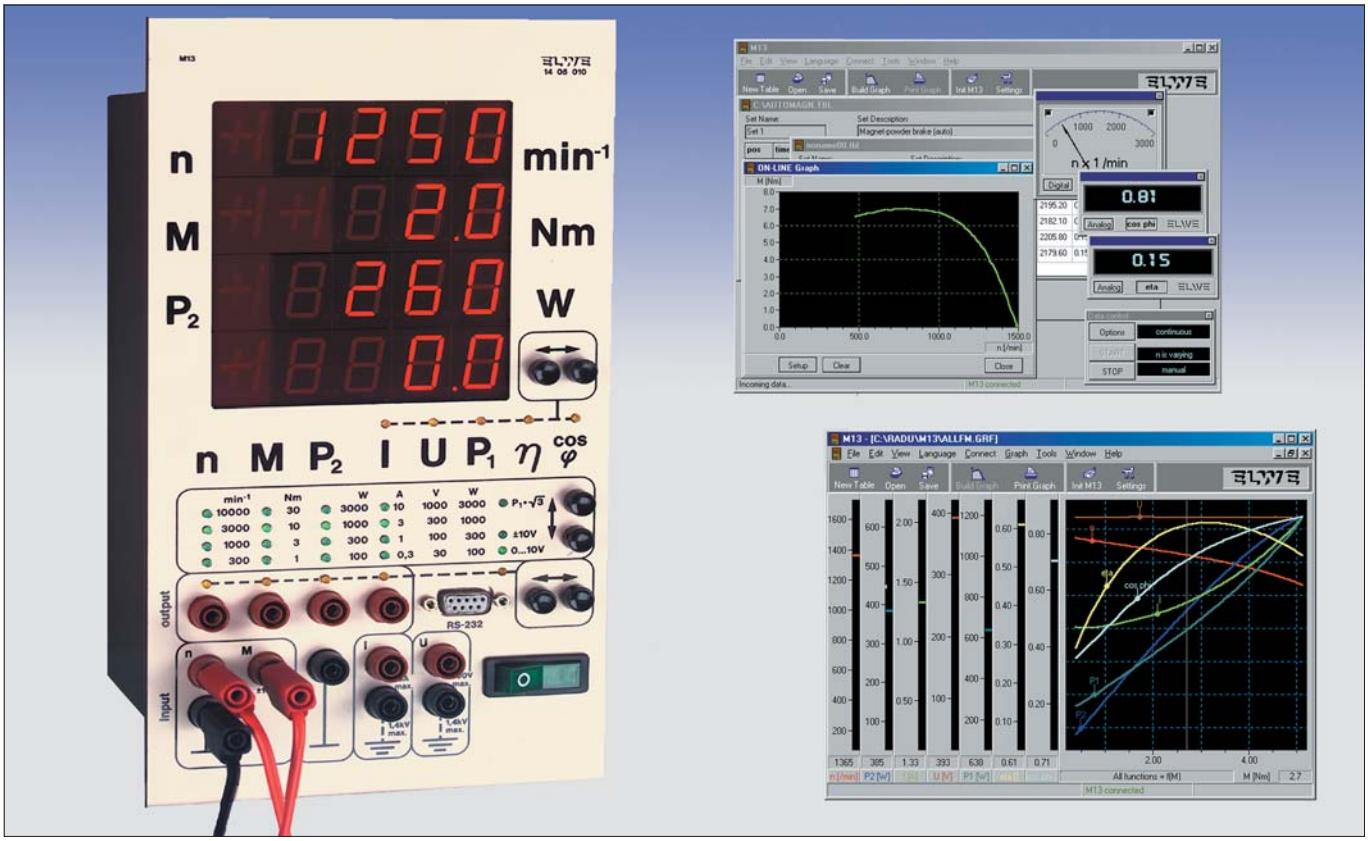
Pointer diagrams for the 3 voltages and currents

The measuring ranges can be adjusted with the software:

10 V, 100 V, 1000 V	(for U1, U2, U3)
2 A, 10 A	(for I1, I2, I3)
50 Hz, 60 Hz	(mains frequency)

Hardware requirements:
PC 386 or higher, RAM 2 MB or more, VGA graphics, mouse, Windows 3.0 or higher

Processor-controlled Multimeter M13 for Electrical Machines



Processor-controlled multimeter M13. . . . . 14 05 010
for electrical machines

The multimeter is used in combination with a magnetic-powder brake. It enables you to record and analyse the measured quantities of electrical machines. The quantities of speed frequency and torque are supplied as a DC voltage by the control unit associated with the load. The effective current and effective voltage are measured simultaneously to immediately calculate the values of the shaft output, the electric active power, the power efficiency and the power factor. The values of speed frequency, torque, shaft output and a further variable, which can be selected by pressing a button, are simultaneously shown on four large 7-segment LED displays that can be seen from far distance.

The variables speed frequency, torque, mechanical shaft output and either effective current, effective voltage or active power input, which can be chosen by pressing a button, are supplied to 4 analogue outputs to which for example 4 analogue measuring instruments can be connected. In order to obtain an excellent analogue display, you can select several measuring ranges for each quantity by pressing a button.

The instrument is equipped with an RS232 interface for the transfer of measured values to a PC (required: connection lead 55 12 232 1 and the display 50 05 014).

Measuring ranges:

Voltage:	0 ... ± 470 V
Current:	0 ... ± 8 A
Speed frequency:	0 ... ± 10000 rpm
Torque:	0 ... ± 30 Nm
Shaft output, electric active power:	0 ... 3000 W
Power efficiency, power factor:	0 ... 1

Inputs:

Input for speed frequency:	TTL-level
Input for torque:	0 ... ± 10 V
Input for current:	0 ... ± 8 A
Input for voltage:	0 ... ± 470 V

Changeover switches for single-phase or three-phase active power measurement as well as for selecting the ranges 0 ... 10 V or – 10 V ... +10 V of the analogue outputs.

Interface: RS232

Voltage supply:	230 V AC, 50(60) Hz
Dimensions in mm:	159 x 297 x 170 (w x h x d)
Mass:	3 kg

Software for M13 - D, GB, F, E - 50 05 014

The program under MS Windows enables the recording and evaluation of values measured by the multimeter for electrical machines M13:

- representation of the measured values on virtual pointer instruments
- graphical online display of the motor diagram *M* over *n*
- graphical online display of user-defined characteristics

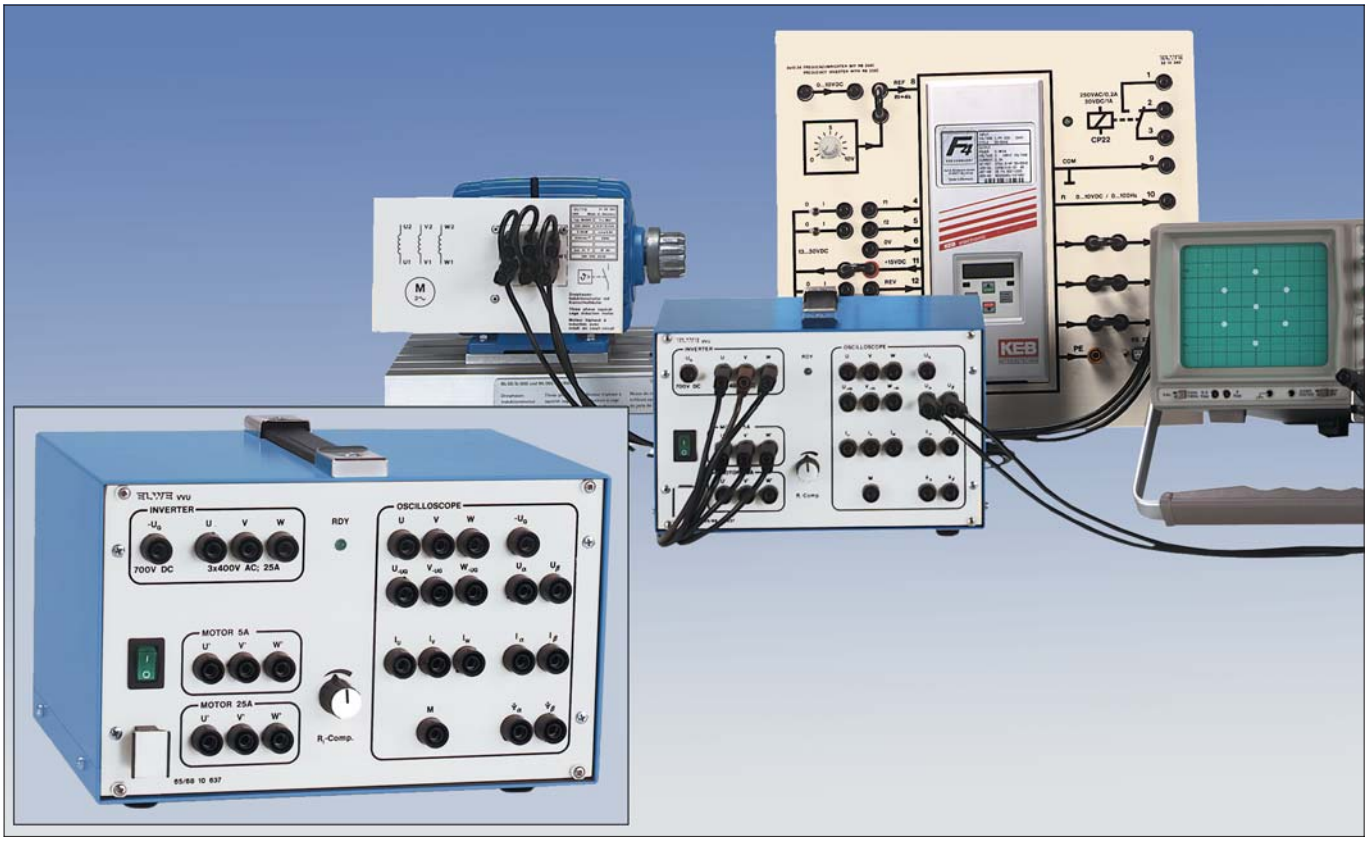
The diagrams can be printed or inserted into other documents via the Windows clipboard.

Additionally required:

Interface cable 55 12 232 1

For further information,
please see the prospectus "Multimeter M13".

Vector Visualizing Unit (VVU)



Vector Visualizing Unit (VVU) 65 15 637

The measuring instrument is used to study the characteristic magnitudes of AC and three-phase machines and to display the rotary-field response by means of an oscilloscope.
The unit is equipped with inputs for U, V and W voltage and if available also for the intermediate circuit voltage U(G) of a frequency inverter. The machine can be connected via outputs of 5 A or 25 A max.

The following measured variables can be displayed on an oscilloscope:

- machine voltage
- machine current
- α- and β-coordinate of the stator voltage vector
- α- and β-coordinate of the stator current vector
- α- and β-coordinate of the total flux vector
- torque of the machine

The oscilloscope is connected via isolated 4-mm safety sockets.
A green LED indicates the readiness for service.
The compensation of the winding resistance of the machine is adjusted by means of a potentiometer.
All inputs and outputs run to the terminals of 4-mm safety sockets.

Technical data:

max. input voltage:	3 x 400 V
max. input current:	25 A
min. output frequency of the inverter:	1 Hz
max. pulse frequency of the inverter:	30 kHz
Accuracy:	typ. 5 %
Outputs for the connection of an oscilloscope:	all 0 ... ± 10 V, isolated
Voltage supply:	230 V AC, 50(60) Hz
Dimensions in mm:	220 x 200 x 150 (lxwxh)
Mass:	3.9 kg

Machine Experimental Stands for Universities and Technical Colleges

ELWE also manufactures experimental stands with electrical machines and drives of different power classes meeting the customer's wishes.

The following experimental stands are good examples.

Experimental stand
"Two-axes Positioning System"

consisting of a vibration-absorbing frame with x-axis and y-axis drive and a separate control unit.

The x-axis drive consists of two toothed belt linear modules with a common drive shaft and the y-axis drive consists of a linear module. The drive for the z-axis can be retrofitted. The axes are driven by AC servomotors with planetary gearing. Dynamic processes and control characteristics can be studied by using a plotter output. The three-axes positioning controller and the two servo-controllers for the motors are contained in the separate control unit.

Experimental stand
"2-kW DC Machines"

The following units are rigidly mounted to a solid support frame: a 2-kW DC shunt-wound machine, a 20-Nm torque metering shaft, another 2-kW DC shunt-wound machine serving as a load as well as a connectable gyrating mass.

The high-quality industrial-type four-quadrant power converter with field rheostat for the two DC machines, indicators and isolated measuring points for all relevant measured variables are accomodated in a separate table-top unit.

Experimental stand
"Electronically Commutated Servo Ddrive"

The brushless DC motor (M_N = 3.2 Nm) can be connected selectively to a vertical toothed belt linear unit or via a torque metering shaft (20 Nm) to a three-phase squirrel-cage rotor induction motor (M_N = 4.2 Nm) serving as a load.

The power control elements for the DC motor and the three-phase induction motor are housed in a suspended base cabinet.
The positioning controller, the servo-drive, the indicators as well as the isolated measuring outputs for phase current, phase voltage and indirect voltage are accommodated in the table-top units.

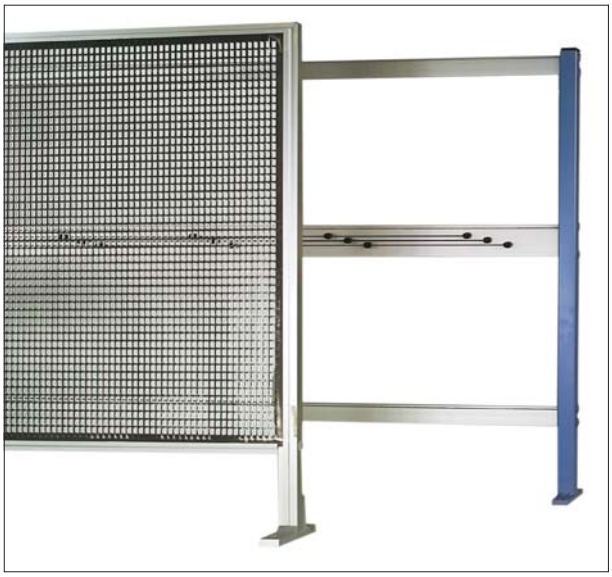
Experimental stand
"11-kW Subsynchronous Converter Cascade"

A 11-kW induction motor with slip-ring rotor, a 200-Nm metering shaft and a 13-kW DC shunt-wound machine are mounted to a solid mobile frame.

The energy recovery converter and transformer, the intermediate circuit and the starting resistances as well as all control components are housed in a mobile 19" rack.

The operator elements, the isolated measuring outputs and some indicators are accomodated in a duct-type table-top unit. A large current flow diagram with further measuring instruments and points according to the system is placed on top of it.

Accessories



For information and article numbers of mobile experimental stands, experimental frames and mounting walls, please see the prospectus "Experimental Frames and Mounting Walls" or the catalogue of "Special Technical Furnishings".

Storage magazine 31 00 090
25 connection masks of electrical machines can be stored in this synoptical and space-saving magazine.

Device platform 70 00 205 01
to be hung on the aluminium profile rails of the experimental frame. This device platform allows to integrate e.g. a transformer or an oscilloscope in the experimental set-up.
Dimensions in mm: 346 x 302 x 62 (l x w x h)
Mass: 2.2 kg

Set of storage trays 76 05 010 01
consisting of:
6 trays for experimental modules 76 00 020 01
4 trays without partitions 76 00 010 01
2 trays for connection leads 76 00 050 01
Dimensions in mm: 685 x 275 x 30 (l x w x h)
Mass: 1.65 kg

Set of safety connection leads, black
(not illustrated) **57 00 010**
line cross-section: 2.5 mm^2
4 safety connection leads, 10 cm; 10 safety connection leads, 25 cm
6 safety connection leads, 35 cm; 2 safety connection leads, 45 cm
5 safety connection leads, 60 cm; 5 safety connection leads, 100 cm

Coupling collar 31 00 000
Coupling cover, 100 W **31 00 002**
Coupling cover, 300/1000 W **31 00 003**
Shaft end cover, 100 W **31 00 004**
Shaft end cover, 300/1000 W **31 00 005**

Experimental Equipment Required for the Experiment Groups

1	Three-phase AC basic circuits, transformers
2	DC machines
3	AC machines
4	Three-phase machines
5	Control of electrical machines
6	Fault simulator for contactor circuits
7	Motor fault simulator
8	Automatic compensation of reactive power

Article description	Page	System	Class	Art. no.	8	7	6	5	4	3	2	1
Experimental manual	8			53 05 012								1
Experimental manual	8			53 05 022							1	
Experimental manual	9			53 05 032						1		
Experimental manual	10			53 05 042					1			
Experimental manual	11			53 05 052				1				
Experimental manual	12			53 05 062		1	1					
Experimental manual	12			53 05 072	1							
Equipment „Transformers, 400 V“	32			03 15 410 01								1[a]
Resistances	41	Panel		10 15 069								1
		Module		22 05 008								
Equipment "Load Units"	42	Panel	300 W	01 15 090	1			Δ	1		Δ	□
			1000 W	01 25 090 01								
		Module	100 W	02 05 090								
			300 W	02 15 090								
		Panel PU	100 W	01 16 090								
			300 W	01 15 090								
Equipment "DC Machines"	13		100 W	03 07 110 01								
			300 W	03 17 110 01							1	
			1000 W	03 27 110 01				alternatively				
alternatively												
Equipment "Multifunctional DC Machines"	14		100 W	03 07 120 01								
			300 W	03 17 120 01							1	
			1000 W	03 27 120 01								
Equipment "AC Machines"	15		100 W	03 07 210 11								
			300 W	03 17 210 01						1		
			1000 W	03 27 210 01				alternatively				
alternatively												
Equipment "AC Machines without Centrifugal Switch"	16		100 W	03 07 220 01								
			300 W	03 17 220 01						1		
			1000 W	03 27 220 01								
Equipment "Three-phase Machines for 400-V Three-phase Systems"	17		100 W	03 07 310 01								
			300 W	03 17 310 01				1[b]	1[b]			*
			1000 W	03 27 310 01				alternatively				
alternatively												
Equipment "Three-phase Machines with Multi-functional Asynchronous/Synchronous Machine for 400-V Three-phase Systems"	20		100 W	03 07 320 01								
			300 W	03 17 320 01					1[c]			
			1000 W	03 27 320 01								

a) Equipment "Transformers for 230-V Three-phase Systems": 03 15 411 01
b) Equipment for 230-V three-phase systems: 03 07 311 01 (100 W), 03 17 311 01 (300 W), 03 27 311 01 (1000 W)
c) Equipment for 230-V three-phase systems: 03 07 321 01 (100 W), 03 17 321 01 (300 W), 03 27 321 01 (1000 W)
⋆) The three-phase induction motor with slip-ring rotor is required from this equipment.
Δ) Only the "Effective Load" is required from the equipment.
□) An effective load from the 300-W or 1000-W range is required for the experiments:
22 15 950, 10 15 095 or 10 25 950 11 (see page 42)

1	**Three-phase AC basic circuits, transformers**
2	**DC machines**
3	**AC machines**
4	**Three-phase machines**
5	**Control of electrical machines**
6	**Fault simulator for contactor circuits**
7	**Motor fault simulator**
8	**Automatic compensation of reactive power**

Article description	Page	System	Class	Art. no.	8	7	6	5	4	3	2	1
Equipment "Three-phase Induction Motor for Machine Protective Systems"	22		100 W	03 07 390 01					1			
			300 W	03 17 390 01								
			1000 W	03 27 390 01								
Equipment "Servo Drive and Brake System"	23		100 W	03 07 040					1[d]	1[d]	1[d]	
			300 W	03 17 040								
alternatively			1000 W	03 27 041			alternatively					
Equipment "Magnetic Powder Break, Control Unit with Built-in Measured-value Displays"	30		100 W	03 07 050 01					1[e]	1[e]	1[e]	
			300 W	03 17 050 01								
Software "Servo Machine"	28	Single licence		50 05 002								(1)
		Room licence		50 05 004								(*)
Control gearing	33		100 W	31 07 003								1
			300/1000 W	31 17 003								
Gyrating mass	35							(1)	(1)		(1)	
Equipment for DC machines	37	Panel	300 W	01 15 010								
			1000 W	01 25 010								
		Module	100 W	02 05 010							1	
			300 W	02 15 010								
		Panel PU	100 W	01 16 010								
			300 W	01 15 010								
Equipment for AC machines	38	Panel	300 W	01 15 020								
			1000 W	01 25 020								
		Module	100 W	02 05 020						1		
			300 W	02 15 020								
		Panel PU	100 W	01 16 020								
			300 W	01 15 020								
Equipment for three-phase machines	39	Panel	300 W	01 15 031								
			1000 W	01 25 031 01								
		Module	100 W	02 05 031				1	1			
			300 W	02 15 031								
		Panel PU	100 W	01 16 030								
			300 W	01 16 031								
Equipment "Machine Protective Systems"	43	Panel	300/1000 W	01 15 070					1			
		Module	100/300 W	02 05 070								

d) alternatively: Equipment with control unit in a table top unit: 03 07 041 (100 W), 03 17 041 (300 W)
e) alternatively: Equipment "Magnetic Powder Break, Control Unit with External Measured-value Display": 03 17 051 01 (300 W)
(1) recommended
(*)additionally required: Interface cable (art. no. 55 12 232 1)

1	Three-phase AC basic circuits, transformers
2	DC machines
3	AC machines
4	Three-phase machines
5	Control of electrical machines
6	Fault simulator for contactor circuits
7	Motor fault simulator
8	Automatic compensation of reactive power

Article description	Page	System	Class	Art. no.	8	7	6	5	4	3	2	1
Equipment "Limit and Proximity Switches"	44	Panel	100 W	01 16 061								
			300/1000 W	01 15 061				1				
		Module	100 W	02 05 061								
			300 W	02 15 061								
Equipment for contactor circuits (inclusive experimental manual on CD)	45	Panel	300 W	01 15 051								
			1000 W	01 25 051								
		Module	100 W	02 05 052★				1				
			300 W	02 15 051•								
		Panel PU	100 W	01 16 051								
			300 W	01 16 052								
Three-phase motor simulator	49			24 05 110				(1)				
Motor fault simulator	49		100 W	24 05 100								
			300 W	24 15 100		1						
			1000 W	24 25 100								
Fault simulator for contactor circuits	50		100 W	24 05 200								
			300 W	24 15 200			1Δ					
			1000 W	24 25 200								
Equipment "Compensation of Reactive Power"	52	Panel	300 W	01 15 041								
			1000 W	01 25 041	1							
		Module	100/300 W	02 15 040								
AC power supply	54	Panel	300 W	10 04 001 1								
			1000 W	10 25 400						1		
Three-phase power supply	54	Panel	300 W	10 15 060								
			1000 W	10 25 600	1			1	1			1
DC power supply	54	Panel	1000 W	10 25 100							(1)	
Compact portable power supply units[o]	56		100 W	15 05 001 01								
			300 W	15 05 002 01					1	1	1	
			1000 W	15 05 003 01								
Multimeter UM4	58	Panel		14 00 940□	3				4[h]	3[g]	4	4

★) alternatively: Equipment "Contactor Circuits for 100-W Machines, Modules with 230-V Coil Voltage": 02 05 053
•) alternatively: Equipment "Contactor Circuits for 300-W Machines, Modules with 230-V Coil Voltage": 02 15 052
(1) recommended
Δ) For accessories, see page 51
□) alternatively: r.m.s. meter UM4e 14 00 945 (see page 58)
g) additionally required for the 300-W and 1000-W program: measuring transformer AC 25 00 920 (see page 58)
h) additionally required for the 1000-W program: Shunt 25 00 915 (see page 58)
o) see also alternatives: page 55 and 56

1	**Three-phase AC basic circuits, transformers**												
2	**DC machines**												
3	**AC machines**												
4	**Three-phase machines**												
5	**Control of electrical machines**												
6	**Fault simulator for contactor circuits**												
7	**Motor fault simulator**												
8	**Automatic compensation of reactive power**												
Article description		**Page**	**System**	**Class**	**Art. no.**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Wattmeter M3e		58	Panel		14 00 035	1				1	1		
Power factor and phase-angle meter M5e		59	Panel		14 00 055	1				1	1		1
Double frequency meter M8		59	Panel		14 00 080 1★					1			
Double voltmeter M9		59	Panel		14 00 090 1					1			
Zero voltmeter M10		59	Panel		14 00 100					1			
Synchronoscope M11		60	Panel		14 00 110 1					1			
Multimeter AF-M1.0	alternatively	60	Module		25 00 010.9	1	alternatively			1k	1i	2	2
Voltmeter AF-M4.4	and	61	Module		25 00 044	1				1	1	2	2
Ammeter AF-M4		61	Module		25 00 040	1	and			1k	1i	2	2
Multifunctional measuring instrument PX-120		61	Module		25 00 140	1				1	1		
Double frequency meter AF-M6F		62	Module		25 00 062 1Δ					1			
Double voltmeter AF-M6S		62	Module		25 00 068 1					1			
Zero voltmeter AF-M7		62	Module		25 00 070					1			
Synchronoscope AF-M8		62	Module		25 00 080 1					1			
Four-channel isolation amplifier		65	Panel		14 00 340•								1
Three-channel isolation amplifier		63			25 00 350 11•								1
Two-channel oscilloscope HM303	alternatively	63			25 00 302•		alternatively						1
Accessories for HM303/305					25 00 312•								1
Set of safety connections, black		72			57 00 010	2	1	1	2	2	1	1	1
Accessories for panel systems:													
Device platform		72			70 00 205 01				1	2	2	2	2
Accessories for module systems:													
Tray for experimental modules		72	a total of 6 parts		76 00 020 01	2			3	2	1	1	
Tray without partitions		72	a total of 4 parts		76 00 010 01	2			1	2	1	1	1
Tray for safety connection leads		72	a total of 2 parts		76 00 050 01	2	1	1	2	2	1	1	1

•) alternatively: Measuring interface "Comenius-T" (see page 64)
★) alternatively for systems of 60 cycles: 14 00 086 1
Δ) alternatively for systems of 60 cycles: 25 00 064 1
i) additionally required: Measuring transformer AC: 25 00 920 (see page 61)
k) additionally required: Measuring transformer AC: 25 00 910 (see page 61)

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