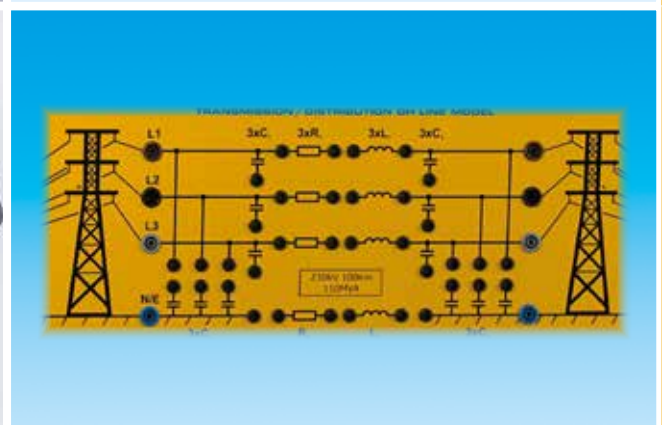


Transmission Line, Transformer & Protection Laboratory





TERCO offers comprehensive manuals for each product upon delivery. On request we can also offer them in digital form.

Guarantee & Terms

All overseas deliveries are dispatched in special, made to order wooden crates, extremely sturdy and damage resistant.

The guarantee is valid for 24 months from delivery and covers repair or exchange of parts, defective due to faulty design or workmanship at our factory. Detailed conditions of guarantee are specified in our Terms of Guarantee.

Spare parts for 2-5 years of normal operation can be offered on request.

Regular after-sales service is performed by the worldwide network of Terco representatives, along with the advice and support of our engineers.

Commissioning and training is normally offered separately. Special training can be arranged on request either in Sweden or on site.

Terco is ISO 9001 certified

Manuals.....	CONTENT	Page
		3
Core Products		
Transmission Laboratory.....		4-9
Line Model MV1420.....		6
Line Model MV2221.....		6
Line Model MV2222.....		7
Line Model MV1424.....		7
Line Model MV1425.....		8
Cable Model MV1438.....		9
Transformer Laboratory.....		10-11
Transformer Single-Phase MV1911.....		10
Transformer 3-Phase MV1915.....		10
Protection Relays Laboratory.....		12-16
Universal Relay Trainer MV1431-1.....		12-13
Line Multi Protection Trainer MV1450.....		14-15
Differential Relay Trainer MV1455.....		16-17
Recommended Peripheral Equipment		
Power Supplies and Generators.....		18-19
Mobil Motor / Generator MV1305-405.....		18-19
Variable Transformer 3-phase MV1103.....		19
Power Pack MV1300.....		20
Loads.....		21-23
Load Resistor MV1100.....		21
Load Reactor MV1101.....		21
Load Capacitor MV1102.....		22
Load Capacitor MV1106.....		22
Load Reactor MV1107.....		23
Rheostats MV1957, MV1959, MV1963.....		23
Instruments and Data Acquisition.....		24-29
Digital Multimeter DMC9.....		24
Digital Clampmeter AC/DC current MAT220349.....		24
Ammeter MV1922/1923.....		25
Voltmeter MV1926.....		25
Wattmeter MV1937.....		25
Power Factor Meter MV1929, MV1976.....		26
Digital Timer MV1918-1.....		26
Differential Probe MV1971.....		26
AC Power Energy Meter MV1939.....		27
Analogue Output Module MV1943.....		28
Data Acquisition and Control Software MV2609.....		28-29
Other Accessories.....		30-32
Terminal Board MV1429.....		30
Load Switch MV1500.....		30
Push Button Panel MV1400.....		30
Contactors MV1402.....		31
Current Transformer MV1931.....		31
Three-phase Transformer MV1915-C.....		31
Petersen Coil, Multi Terminal Unit MV2225.....		32
Laboratory Flexes.....		33
Flex Stand MV1904.....		33
INDEX.....		34

Line Models

The following Line Models and Cable Model are designed for realistic conditions, such as overvoltage, overcurrent, and a certain magnetic coupling between the wires.

As linear behaviour for excess values is required, the line inductances must be represented by non-saturable induction coils. To withstand certain overvoltages, overdimensioning of wiring and capacitors is necessary.

One of the overhead models is representing a high voltage line of 220 kV, and the other a feeder at medium level 40 kV.

All models are constructed as π -links, the HV model and the cable model as a double π -link.

Flexibility to simulate typical situations, such as compensating a long line at both ends and also in the middle, must also be available. Combination of the π -links make it possible to create other characteristic data, e.g. capacitors can be connected in Δ instead of Y.



Recommended equipment for Transmission Laboratory

Cat. Code	Description	pc	page
MV1420	Line Model 3-phase, 230V	1	6
Recommended peripheral equipment for MV1420			
MV1103	Variable Transformer, 3-phase	1	19
MV1429	Terminal Board	1	30
MV1100-235	Load Resistor 3-ph, 3.3kW	1	21
MV1107	Load Reactor, 3-ph, 3 kVAr	1	21
MV1102	Load Capacitor, 3-phase, 2.8 kVAr	1	22
MV1500	Load Switch, 3-pole 16A	2	30
MV1915	Transformer, 3-ph 2 kVA 50-60 Hz	2	10
MV1939	AC Power Energy Meter	2	27
MV1830-HF	Flex Set, 100 Safety Leads, Safety Plugs	1	33
MV1904	Flex Stand	1	33
Optional:			
MV1424	Line Model, 3-ph, 400V, one phi-link (40kV, 40km)	1	7
MV1425	Line Model, 3-ph, 400, double phi-link (220kV, 100km)	1	8
MV1438	Cable Line Model 400V, 3-phase (11kV, 5km)	1	9
MV2221	Line Model 400V 3-phase (230kV, 100km)	1	6
MV2222	Line Model 400V, 3-phase (11kV, 5km)	1	7
MV2225	Petersen Coil, Multi Terminal	1	31
MV1439-235	Power Factor Control Unit	1	32
Additional Equipment: Measuring and Data Acquisition for PC			
MV1943	Analog Output Module	1	28
MV2609	Data Acquisition and Control Software	1	29
Alternative instrument			
MV1922/23	Ammeter 0-10A, AC/DC	4	25
MV1926	Voltmeter 0-50-250-500V AC/DC	3	25
MV1937	Wattmeter 1-ph, 1-5A; 50-250-500V AC/DC	3	25
MV1929	Power Factor Meter 3-ph, 0-5A, 230V	1	26
MV1976	Power Factor Meter 3-ph, 0-5A, 400V	1	26



The network model can be used to complete a series of experiments with transmission lines. Those listed and described in detail in the instruction manual include:

- Characteristic data of the line
- Voltage drop on the lines
- Short circuit tests
- Earth fault

MV1420 Line Model

Technical Specifications

The model corresponds to a power transmission line of a length 136 km, voltage 77 kV, amperage 100 A, power rating 13 MW.

Voltage	220-240 V, three-phase (corresponding to 77 kV)
Amperage	5 A (corresponding to 100 A)
Line resistance	1.5 ohms
Line reactance	3.15 ohms

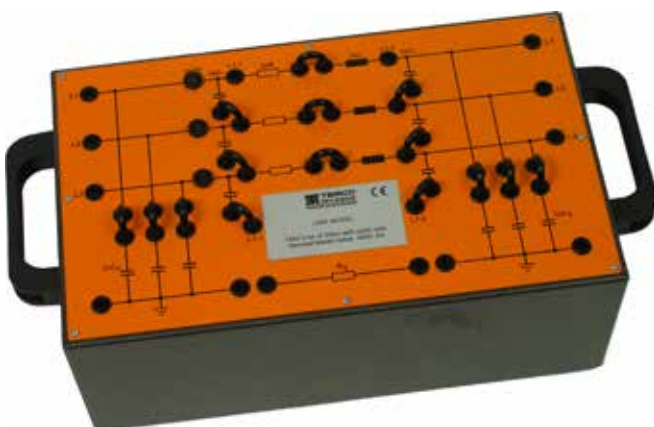
Line capacitance divided into capacitance to earth (4 μ F) and mutual line capacitance between phases (8 μ F).

Earth impedance	0.8 ohm
Fuses	5 A

Dimensions:	410 x 245 x 160 mm
Weight:	10 kg

The following studies can be made:

1. Measurements of characteristic data, resistance, reactance and capacitance of a line.
2. As transmission line:
Measurement of voltage drop and losses for different loads.
3. For two-phase and especially three-phase short circuit measurements with two three-phase transformers, one at each end.
4. For single-phase and two-phase earth fault measurements.



MV2221 Line Model

Line Model 230 kV, 100 km, 400 V 3-phase.

Three-phase model of an overhead power transmission line 100 km long, voltage 230 kV and ability 110 MVA.

Model value 400 V : R + 2.20 ohm, L 25 mH, C + 4uF, Co 2.5 uF.

The network model can be used to complete a series of experiments with transmission lines. Those listed and described in detail in the instruction manual include characteristic data of the line. Voltage drop on the lines. Short circuit. Earth fault.

Dimensions:	410 x 245 x 160 mm
Weight:	10 kg

Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations

MV2222 Line Model

Line Model 11 kV, 5 km, 400 V 3-phase.
Three-phase model of an overhead power transmission line 5 km long, voltage 11 kV and ability 5 MVA.
Model value 400 V : $R + 2.4 \text{ ohm}$, $L 17 \text{ mH}$, $C + 30 \text{ nF}$, $Co 20 \text{ nF}$.

The network model can be used to complete a series of experiments with transmission lines. Those listed and described in detail in the instruction manual include characteristic data of the line. Voltage drop on the lines. Short circuit. Earth fault.

Dimensions: 410 x 245 x 160 mm
Weight: 10 kg



MV1424 Line Model

Technical Specifications

Real line parameters

Nominal length: 40 km
Nominal voltage: 40 kV
Nominal current: 350 A

Positive sequence reactance X_+ : 15 ohm
Zero sequence reactance X_0 : 23 ohm
Positive sequence resistance R_+ : 8.4 ohm

Zero sequence resistance R_0 : 16.0 ohm
Positive sequence capacitance C_+ : 400 nF
Zero sequence capacitance C_0 : 265 nF

Line Model specifications

Represented length: 40 km
Nominal voltage: 400 V
Maximum voltage: 600 V

Nominal current: 10 A
Maximum current : 32 A (60 sec)

$R_1 = 4.7 \text{ ohm}$
 $R_0 = 0.8 \text{ ohm}$
 $X_1 = 2\pi\omega \times 5.45 \text{ mH}$
 $X_0 = 2.62 \text{ ohm}$
 $C_1 = 1.0 \text{ }\mu\text{F}$
 $C_0 = 0.6 \text{ }\mu\text{F}$

Dimensions: 600 x 600 x 1720 mm
Weight: 190 kg



MV1425 Line Model

Real line parameters

Nominal length is 100 km (2 sections, each 50 km).

Data for one 50 km section

Nominal voltage: 220 kV
Nominal current: 775 A

Positive sequence reactance X_+ : 18 ohm
Zero sequence reactance X_0 : 24 ohm
Positive sequence resistance R_+ : 1.77 ohm

Zero sequence resistance R_0 : 8.0 ohm
Positive sequence capacitance C_+ : 475 nF
Zero sequence capacitance C_0 : 315 nF

Technical Specifications

Represented length 100 km with two π -links, each corresponding to a 50 km section.

Data for one π -link
Nominal voltage: 400 V
Maximum voltage: 600 V
Nominal current: 10 A
Maximum current (60 sec): 32 A

$R_1 = 0.5$ ohm
 $R_0 = 0.8$ ohm
 $X_1 = 2\pi\omega \times 3.77$ mH
 $X_0 = 1.57$ ohm
 $C_1 = 8.9$ μ F
 $C_0 = 0.6$ μ F

Dimensions: 600 x 600 x 1720 mm
Weight: 220 kg



MV1438 Cable Model

MV 1438 consists of two cable sections with a nose section cable area of 150 square mm and 240 square mm respectively.

Real line parameters

PEX Cable 150 square mm Al

Length	5 km	corr. 5 km
Nominal voltage	11 kV	400 V
Nominal current	260 A	6 A
Transmission ability	5.0 MVA	2.4 kVA
Positive sequence capacitance C+	0.45 μ F	0.28 μ F
Zero sequence capacitance C0	0.45 μ F	0.28 μ F
Inductance	1.8 mH	2.84 mH
Resistance	1.1 ohm	1.8 ohm
Zero sequence reactance X ₀ (approx.)	2.3 ohm	3.7 ohm

Real line parameters

PEX Cable 240 square mm Al

Length	5 km	corr. 5 km
Nominal voltage	11 kV	400 V
Nominal current	340 A	6 A
Transmission ability	6.5 MVA	2.4 kVA
Positive sequence capacitance C+	0.55 μ F	0.26 μ F
Zero sequence capacitance C0	0.55 μ F	0.26 μ F
Inductance	1.6 mH	3.30 mH
Resistance	0.7 ohm	1.5 ohm
Zero sequence reactance X ₀ (approx.)	2.1 ohm	4.3 ohm

Dimensions: 600 x 600 x 1720mm
Weight: 190 kg

Line Model

Specifications

(one π -link)

corr. 5 km

400 V

6 A

2.4 kVA

0.28 μ F

0.28 μ F

2.84 mH

1.8 ohm

3.7 ohm

Line Model

Specifications

(one π -link)

corr. 5 km

400 V

6 A

2.4 kVA

0.26 μ F

0.26 μ F

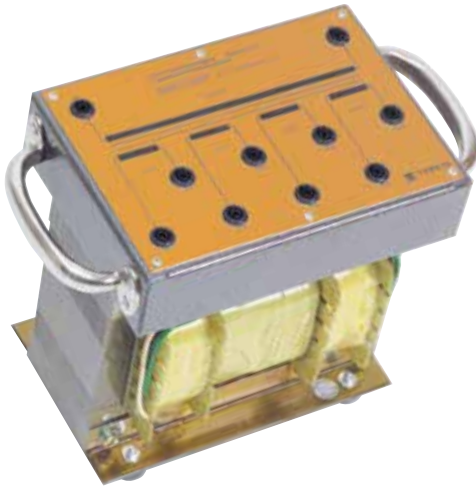
3.30 mH

1.5 ohm

4.3 ohm



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TRANSFORMER LABORATORY**MV1911 Transformer Single-Phase**

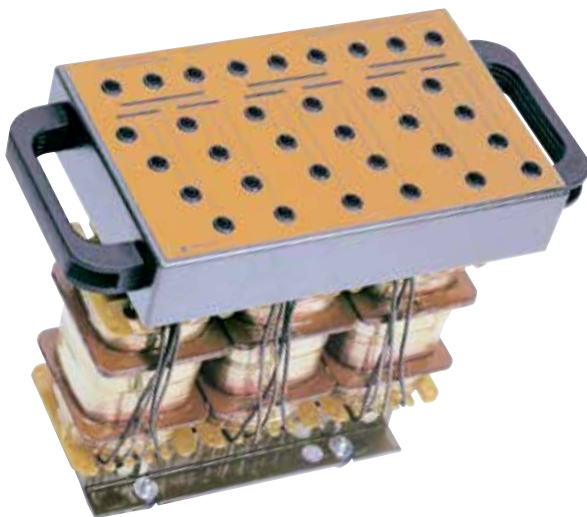
Ratings Single-phase 1 kVA, 50-60 Hz
Primary: 230 V \pm 5 %
Secondary: 4 x 57.5 V \pm 5 %

The secondary winding is divided into four windings for series or parallel connection.

No load losses $P_o = 25$ W
Impedance voltage $e_k = 8$ %
Resistance voltage $e_k = 3$ %

MV 1911 can be used for determination of operating characteristics, losses and efficiency of a single-phase transformer by means of no load, short-circuit and load tests. The transformer has safety sockets mounted on the frontpanel with mimic diagrams.

Dimensions: 210 x 150 x 210 mm
Weight: 22 kg

**MV1915 Transformer 3-Phase**

Ratings Three-phase, 2 kVA, 50-60 Hz,
230/2 x 66.5 V per phase
Primary 0-133-230 V \pm 5 % per phase
Secondary Two 66.5 V windings per phase,
each winding having tapings for
0-38.4-44-66.5 V (\pm 5 %)

The tapings are so arranged that 230 V (star or delta connection) and 133 V (star, delta or zig-zag connection) can be obtained for all standard connections.

This transformer has safety sockets mounted on the frontpanel with mimic diagrams.

No load losses $P_o = 35$ W
Impedance voltage $e_k = 8$ %
Resistance voltage $e_k = 3$ %

With MV 1915, asymmetrical loading and parallel connection of three-phase transformers for different three-phase combinations on the primary and secondary side, can be studied.

It can also be used for determination of operating characteristics, losses and efficiency.

Dimensions: 300 x 190 x 345 mm
Weight: 33 kg

Recommended equipment for Transformer Laboratory

Cat. Code	Description	pc	page
MV1911	Transformer Single-Phase	1	10
MV1915	Transformer 3-Phase	1	10
Recommended peripheral equipment for Transformer Laboratory			
MV1103	Variable Transformer, 3-phase	1	20
MV1429	Terminal Board	1	30
MV1100-235	Load Resistor	1	21
MV1101	Load Reactor, 3-phase, 2.5 kVAr	1	21
MV1102	Load Capacitor, 3-phase, 2.8 kVAr	1	22
MV1500	Load Switch, 3-pole 16A	1	30
MV1939	Power Energy Meter	1	27
MV1830-HF	Flex Set, 100 Safety Leads, Safety Plugs	1	33
MV1904	Flex Stand	1	33
DMC9	Digital Multimeter. Equivalent instruments can be delivered and used.	1	24
Optional:			
MV1915-C	Transformer 3-phase, sectioned	1	31
MV1931	Current Transformer	1	30
Alternative instruments instead of MV1939 above:			
MV1922/1923	Ammeter	4	25
MV1926	Voltmeter	2	25
MV1937	Wattmeter	3	25

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MV1431-1 Universal Relay Trainer

MV1431-1 is a Universal Relay Trainer intended for practical training in static relays and relay protection engineering for applications in power systems.

The Universal Relay Trainer MV 1431-1 is an integrated training system including different kinds of static relays, which are common in relay protection systems around the world.

The static relays used in the experiment unit belong to the well known ABB COMBIFLEX relay system.

The Universal Relay Trainer MV 1431-1 does not only include static relays, it also contains a current transformer, a voltage transformer and an internal power supply. These components are all fitted into a sturdy steel cabinet with a front panel on which all sub units can be connected using either 4 mm safety sockets or 2 mm signal plug terminals. The choice of 2 mm signal plug terminals makes the unit compact and suitable for experiments with the trainer standing on a table.

Mimic diagrams of the relays with large clear symbols are printed on the front panel. Sockets are also provided for test objects.

The rack carries a selection of the static relays used in modern electric power systems.

Following relays are provided:

1. Microprocessor operated double over- and under voltage relay
2. Microprocessor operated double over current relay
3. Microprocessor operated multi-function directional / reverse power relay
4. Instantaneous over current relay
5. Two types of auxiliary output relays
6. Multirange time-lag relay
7. Flag / signal relay, double unit

Built-in are also:

- One current transformer
- One voltage transformer
- Internal power supply

The laboratory manual for the Universal Relay Trainer MV 1431-1 covers from basic operation principles of each relay up to giving an introduction to the theory and the practical handling of typical situations where static relays are used to protect certain objects in for instance a power plant.

The protected object may for example be a transformer, a generator, a bus bar or a feeder.



The focus of the proposed experiments is not only the different measuring relays, but the surrounding auxiliary relays are also described and used to build a relay protection.

From the basic operation principles, which can be understood by the experiments, the students obtain knowledge about how relay protection systems are built and how they will work in different situations.

Experiment Manual

1. Introduction
2. Identifying the Relays
3. Auxiliary Equipment
 - Auxiliary relay
 - Signal/flag relay
 - Current measuring relay, classic
 - Current measuring relay, double
 - Voltage measuring relay, double
 - Power measuring relay
 - Multifunction time relay
 - Tripping relay
4. Basic Experiments
 - Operating the tripping relay
 - Operating the signal relay
 - Operating the current relay
 - Time delay of the tripping relay
 - Time delay of the current relay

Supply voltage 220-240 V, 50 Hz, 1-ph
MV1431-1 can also be delivered for 60Hz supply

Dimensions: 510 x 280 x 570 mm

Weight: 30 kg

5. Modern Multifunctional Time Relay
 - Time relay at DC-operation
 - Time relay at AC-operation
 - Time relay together with measuring current relay
6. Double Overvoltage Relay
 - Get familiar with the relay
 - Define time over/under voltage function
 - Inverse time over voltage function
 - The instantaneous over voltage function
 - The influence of voltage transformers
7. Double Over Current Relay
 - Get familiar with the relay
 - Define time over current function
 - Inverse time over current function
 - The instantaneous over current function
 - The influence of current transformer
8. Operating the Reverse Power Relay
 - Background and principle diagram
 - The phase lag circuit
 - Reverse power caused by low current
 - Reverse power caused by low voltage
 - Reverse power caused by the angle between the current and the voltage
 - Reverse power setting
 - Reverse power in unstable system
9. Advanced Experiments
 - Earth-fault protection (95%)
 - Earth-fault protection using a current measuring relay
 - Differential protection
 - Reverse power / Loss of synchronization protection

Recommended peripheral equipment for MV1431-1

Cat. Code	Description	pc	page
Accessories for MV 1431-1, Basic and Medium Level :			
MV1103	Variable Transformer, 3-phase	1	20
MV1429	Terminal Board	1	30
MV1500	Load Switch, 3-pole 16A	1	30
MV1918-1	Digital Timer 1 ms-99.99 s	1	26
MV1957	Rheostat 200 W 5 Ohm 6.3 A	1	23
MV1963	Rheostat 500 W 2500 Ohm 0.45 A	2	23
MV1971	Differential Probe	2	26
MV1830-HF	Flex Set, 100 Safety Leads, Safety Plugs	1	33
MV1904	Flex Stand	1	33
DM9C*)	Digital Multimeter	3	23
MAT220349*)	Digital Clamp Meter AC / DC current	1	24
Accessories for MV 1431-1, Extended Level in addition to the Basic and Medium Level :			
MV1957	Rheostat 200 W 5 Ohm 6.3 A	1	23
MV1400	Push Button Panel	1	30
MV1402	Contactor	1	31
MV1931	Current Transformer	2	30
MV1911	Transformer, 1-phase 1 kVA 50-60 Hz	1	10
MV1915	Transformer, 3-ph 2 kVA 50-60 Hz	1	10
MV1420	Line Model 3-phase, 230 V 3-phase	1	6
MV1100-235	Load Resistor 3-ph 3.3 kW	1	21
DM9C*)	Digital Multimeter	1	24
MAT220349*)	Digital Clamp Meter AC / DC current	1	24
Accessory for MV 1431-1, Advanced Level In addition to the levels above :			
MV1305-405-235	Mobile Motor Generator Unit	1	18-19

*) Equivalent instruments can be delivered and used

MV1450 Line Multi Protection Trainer

This unit is intended for advanced training in modern line distance protection technology.

The MV1450 Line Multi Protection Trainer is equipped with the fully IEC61850 compliant ABB protection REF630 which is one of the most modern and sophisticated protection units in the product family of Intelligent Electronic Devices (IEDs). The use of a highly advanced IED enables great possibilities to perform a wide range of laboratory experiments.

The unit is equipped with a large graphical Human Machine Interface (HMI) with a single line diagram. Control, monitoring and parameter setting can be performed either from the HMI or from a PC by means of the standardized Ethernet interface.

Technical Specification

Supply voltage: 230VAC/ (50/60) Hz. Possible to supply a compatible device with power (Appendix A at page 10)

Fuse: Two pole 1A/250 VAC, Slow blow, Cartridge fuse, Glass 5x20 mm

Mains control: Front panel switch

Power bus: 3ph, 400VAC, 2A

Power bus circuit breaker switch:
A two state switch (ON/OFF) with LED indication of CB status.
Internal circuitry prevents operation of the CB during an unacknowledged trip.

Trip reset button:
Button for quick reset of LEDs and acknowledgement of a trip

Current transformers (line currents):
Nom. Prim. 2A/ Sec. 1A.
Tolerance class 3: $\pm 3\%$

Current transformer (torus, residual current):
Nom. Prim. 50A/ Sec. 5A.

Voltage transformers:
Nom. Prim. 230V/Sec. 110V.
Tolerance $\pm 3\%$ (idling voltage 117V)



Dimensions: 483 x 356 x 422 mm.

Weight: 37 kg

Protective earth: one 4mm banana connector

REF630 feeder protection - Features

- Power bus Circuit breaker control and trip supervision/disconnection Control, monitoring and protection integrated in one IED.
- Fully IEC 61850 compliant
- Four independent parameter setting groups
- Large HMI with single line diagram
- RJ-45 interface for communication with PC

Important protection functions

- Capable of a 5 zone full-scheme high-speed line distance protection with mho, bullet and quadrilateral characteristics.
- Three stages of over-current protection (Low, high and instantaneous)
- Directional earth-fault protection
- Over-voltage protection
- Over-power protection (configurable direction)

MV1450-COMP PC with installed and pre-programmed software for MV1450

Recommended equipment for MV1450

Cat. Code	Description	pc	page
MV1450	Line Multi Protection Trainer	1	14
MV1450-COMP	PC with installed & pre-programmed software for MV1450	1	14
Recommended peripheral equipment for MV1450			
MV1103	Variable Transformer, 3-phase	1	19
MV1429	Terminal Board	1	30
MV1100-235	Load Resistor 3-ph, 3.3kW	1	21
MV1101	Load Reactor, 3-phase, 2.5 kVAr	1	21
MV1102	Load Capacitor, 3-phase, 2.8 kVAr	1	22
MV1500	Load Switch, 3-pole 16A	2	30
MV1959	Rheostat 200W, 50 ohm,, 2A	1	23
MV2221	Line Model 230kV, 100km, 400V, 3-phase	2	6
MV2222	Line Model 11kV, 5km, 400V 3-phase	2	7
MV1922/23	Ammeter 0-10A, AC/DC	2	25
MV1926	Voltmeter 0-50-250-500V AC/DC	2	25
MAT220349	Digital Clamp Meter AC / DC current	1	24
MV1830-HF	Flex Set, 100 Safety Leads, Safety Plugs	1	33
MV1904	Flex Stand	1	33

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MV1455 Differential Relay Trainer

The MV1455 unit is intended for advanced training in modern differential protection technology. The differential relay trainer is equipped with the fully IEC61850 compliant ABB RET615 protective relay which is one of the most sophisticated protection unit in the product family of intelligent electronic devices (IEDs). RET615 is designed for differential protection of transformers, generators, line sections and their combinations.

The use of a highly advanced IED enables great possibilities to perform a wide range of laboratory experiments.

The unit is encased in a robust chassis of sheet metal and is equipped with a large graphical Human Monitoring Interface (HMI) with a single line diagram. Control, monitoring and parameter setting can be configured either from the HMI or from a PC by means of the standardized Ethernet interface.

The protective relay RET615 used in MV1455 enables the student to learn and explore how to protect a variety of different power transformer connections with a differential protection scheme.

General Features

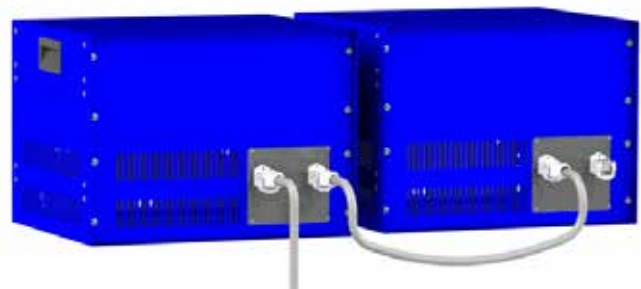
- Colour coded power inlet- and outlets for easy recognition of each phase.
- Three power lines; 1 incoming power line and 2 outgoing. Each line contain three phases L1, L2, L3 and Neutral wire.
- Accessible protective ground outlets on the front as well at the back of the unit.
- 12 current transformers which enables the student to study various CT-connections.
- Protection and Control IED Manager PCM600: Advanced software for configuration and parameter setting.
- Mimic diagrams of the circuit along with large clear symbols printed on the front panel
- Front panel switches that enables the student to test differential protection on a dual-busbar.



Technical Specification

Power Supply:	230V/50Hz. Possibility to power compatible device. (see appendix A)
Power bus:	(3-ph) 400V AC/ 2A with 4 mm banana plugs.
Size :	357 x 483 x 420 mm
Weight:	37 kg

Appendix A – Power supply



If a compatible device is used in conjunction with the MV1455 it can be powered from the MV1455 unit instead of occupying an additional wall outlet.

MV1455-COMP PC with installed and pre-programmed software for MV1455

Recommended equipment for MV1455

Cat. Code	Description	pc	page
MV1455	Line Multi Protection Trainer	1	16
MV1455-COMP	PC with installed & pre-programmed software for MV1450	1	16
Recommended peripheral equipment for MV1450			
MV1103	Variable Transformer, 3-phase	1	19
MV1429	Terminal Board	1	30
MV1100-235	Load Resistor 3-ph, 3.3kW	1	21
MV1101	Load Reactor, 3-phase 2.5kVAr	1	21
MV1102	Load Capacitor, 3-phase, 2.8 kVAr	1	22
MV1500	Load Switch, 3-pole 16A	1	30
MV1957	Rheostat 200W, 5 ohm, 6.3A	3	23
MV1959	Rheostat 200W, 50 ohm,, 2A	1	23
MV1400	Push Button Panel	1	28
MV1911	Transformer 1-phase, 1kVA, 50-60 Hz	1	29
MV1915	Transformer 3-phase, 2kVA, 50-60 Hz	1	29
MV1922/23	Ammeter 0-10A, AC/DC	5	30
MV1926	Voltmeter 0-50-250-500V AC/DC	2	30
MAT220349	Digital Clamp Meter AC / DC current	1	30
DMC9	Digital Multimeter	1	31
MV1830-HF	Flex Set, 100 Safety Leads, Safety Plugs	1	33
MV1904	Flex Stand	1	33

MV1305-405 Mobile Motor / Generator Unit



Modes of Operation

- Control of active power (frequency): AC-machine and frequency converter drive ("turbine") + synchronous machine (generator) in closed loop connection regarding frequency.
- Control of active power (frequency) and reactive power (voltage): Two closed loops regarding frequency and voltage.
- Synchronous compensating: AC-machine and frequency converter drive ("turbine") idling, electrically disconnected or mechanically disconnected, synchronous machine in closed loop connection for voltage (=reactive power) control.

A standard laboratory for power transmission normally consists of one or two generators, which are connected to one or more transmission links which finally reach transformers, distribution units and loads. This configuration may look like the very left line in figure 1.

However, a realistic network most likely looks like the complete network of figure 1. For example, here can be seen turbine/generators in parallel on the same busbar, a synchronous machine used as a synchronous compensator in the middle of a line, a single generator unit and a heavy group of generators.

Energy transfer, load shedding, static and dynamic stability at disturbances as well as sophisticated protection schemes can be studied under realistic forms. Not to forget compensation possibilities.

Power- and current- paths in grid networks are complicated. The TERCO system will give understanding for this problem.

The wide range flexibility will be given by the mobile generator station / synchronous alternator (compensator) MV 1305.

Two sets of MV 1305 can operate as described or work in parallel. In this case mechanical and electrical parameters might be changed by using e.g. flywheel (MV 1010) and different electrical connections.

Technical Specification

	MV1305-405-235
Power Supply AC 3-ph	380-415 V
Frequency	50 Hz
Max current	16A
Turbine/AC-machine freq.drive:	
Armature/stator Volt AC	323-528 V
Frequency	0-63 Hz
Armature/stator current	3.4 A
Input current	5.9 A
Rated output current	4.0 A
Rated output capacity	3.2 kVA
Speed	0-1800 rpm
Synchronous generator:	
Armature volt AC 3-ph	0-140 / 240 V
Power	1.2 kVA
Cos ϕ	0.8
Field volt	0-230 V DC
Speed Control	0-1800 rpm
Active power control	SCR-frequency converter, electronic current limit setting, start- and stop ramps.
Feedback systems	Manual frequency setting. Automatic/Constant setting
Field current supply	Integrated
Voltage control/ Reactive power control	PWM min. ripple-converter, electronic current limit setting
Feedback systems	Manual voltage setting. Automatic/Constant setting. Separate voltage feedback

Instruments

AC-machine freq.drive: Parameters and indications selected by 4-lines display in HMI-unit typically like:
Frequency setpoint (F 50,00Hz)
Stator Electric Frequency (H 51,00 Hz)
Actual motor speed (from encoder 1500 rpm)
Motor current (A 2,20 A)
DC-interlink voltage (V 520 V)
Speed control potentiometer (=frequency control)
Control method selector

AC-machine M/G: Armature voltage
Voltage selector switch
Armature current
Voltage control potentiometer
Control method selector
Field current ammeter

Synchronizing devices:
Synchronizing instrument
Double voltmeter
Double frequency meter
Synchronizing switch
Automatic or manual synchronizing

Auxiliary:
Machines mounted on machine bed with slirails.
Control panel integrated with machines to one mobile unit. Laboratory connections by 4 mm banana plug of safety type. Possibilities of connecting different types of step-up transformers
as well as other instruments and protections.

Dimensions: 1550 x 800 x 1200 mm
Weight: 200 kg (approx.)

Item	Power Supply	Synchronous Generator
MV1305-405-235	380-415V 3-ph, 50Hz	220-240V 3-ph, 50Hz
MV1305-405-236	380-415V 3-ph, 60Hz	220-240V 3-ph, 60Hz
MV1305-405-405	380-415V 3-ph, 50Hz	220-240V 3-ph, 50Hz
MV1305-405-406	380-415V 3-ph, 60Hz	220-240V 3-ph, 60Hz

MV1103 Variable Transformer 3-phase

Supplied with a scale showing output voltage.
Thermal overload protection for three output phases are placed on the front panel. A common shaft rotates all output voltage sliders in parallel. The unit is mobile on 4 wheels.

Input: 3 x 400 V, 8 A, 50-60 Hz
Output: 3 x 0-450 V, 8 A

Dimensions: 280 x 290 x 560 mm
Weight: 34 kg





General Data

Supply Voltage

MV1300-235	220-240 / 127-140 V 50 / 60 Hz 3-ph.
MV1300-405	380-400 / 220-230 V 50 / 60 Hz 3-ph.
MV1300-415	415 / 240 V 50 / 60 Hz 3-ph.

Output voltage	DC fixed	220 V 3.5 A
	DC variable	0-220 V 16 A
	AC fixed	230/133 V 10 A 3-ph
	AC variable	3 x 0-230 V 10 A 3-ph

Standard	Fixed AC	230 V 10 A
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Dimensions	660 x 435 x 790 mm
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Weight	103 kg
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MV1300 Power Pack

This power supply unit is especially adapted for laboratory experiments on electric machines and power systems.

It can be used where variable or fixed AC or DC is required and is particularly suited to the laboratory experiments with Terco's torque meters and test machines. It is designed to slide under the lab table so that controls and connections are in a comfortable working position.

The contactor for variable voltages has a safety limit switch which eliminates switching on high voltages by mistake, thus protecting students and equipment especially when working on electrical machines. All outputs are fused by MCB's and have load switches.

The Power Pack has also Earth Leakages Circuit Breaker (ELCB).

MV1302 Power Pack

Same as MV 1300-405 but with the following data

Output voltage	DC fixed	220 V 3.5 A
	DC variable	0-220 V 16 A
	AC fixed	400 / 230 V 10 A 3-ph
	AC variable	3 x 0-400 V 8 A 3-ph

Supply voltage 380-400 / 220-230 V 50 / 60 Hz 3-ph

MV1304 Power Pack

As MV1300-415 but with the following data

Output voltage	DC fixed	220 V 3.5 A
	DC variable	0-220 V 16 A
	AC fixed	415 / 240 V 10 A 3-ph
	AC variable	3 x 0-415 V 10 A 3-ph

Supply voltage 415 / 240 V 50-60 Hz 3-ph



MV1100 Load Resistor

MV1100 Load resistor contains three ganged resistors with continuous spindle regulation. The resistors are connected to terminals for 3-ph, single-phase or DC-voltage.

The current in the resistor is limited by tubular wire fuses in each phase. The unit has handles and wheels for simple and quick movement and is enclosed in a perforated metal cabinet. MV1100 is supplied with safety sockets and a load switch.

A cooling fan is placed at the bottom of the resistor.
 MV1100-235 Cooling fan supply 230 V AC 50 - 60 Hz
 MV1100-116 Cooling fan supply 110 V AC 60 Hz

General Data

3-phase 3.3 kW, continuously adjustable.

Star connection	400 / 230 V	0.8-5 A
Star connection	230 / 133 V	0.5-5 A
Delta connection	400 / 230 V	2.4-8.7 A
Delta connection	230 / 133 V	1.3-8.7 A
DC parallel connection	220 V	2.3-15 A

Overload capacity, brief duration, approx. 20 %.

Dimensions): 630 x 250 x 890 mm

Weight: 46 kg



MV1101 Load Reactor

Enclosed in a strong metal cabinet. The front panel has mimic diagram, terminals, fuses and electrical data. The unit can be used on 1- and 3-phase systems. 12 step regulation.

General Data

2.5 kVA_r, 50-60 Hz

V	Connection	Hz	A
230	star	50	0.2-2.2
230	delta	50	0.6-6.6
400	star	50	0.4-3.8
230	star	60	0.2-1.9
230	delta	60	0.5-5.6
400	star	60	0.3-3.3

Dimensions: 510 x 220 x 320 mm

Weight: 40 kg

MV1102 Load Capacitor

Housed in a metal cabinet. Electrical data and symbols on the front panel with terminals and fuses. This unit can be used on 1- and 3-phase systems. 6 step regulation.

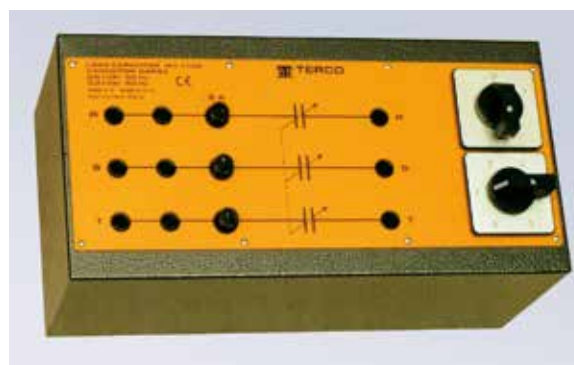
General Data

2.8 kVAr at 50 Hz, 3.3 kVAr at 60 Hz.

V	Connection	Hz	A
230	star	50	0.4-2.4
230	delta	50	1.2-7.2
400	star	50	0.7-4.2
230	III (parallel)	50	2.1-12.6
230	star	60	0.5-2.8
230	delta	60	1.4-8.6
400	star	60	0.8-5.0
230	III (parallel)	60	2.5-15

Dimensions: 185 x 370 x 170 mm

Weight: 7 kg



MV1106 Load Capacitor

The bank is made of metallized paper capacitors. The capacitors are fitted with discharging resistors. The capacitance of the bank can be varied in seven steps by means of rotary switches. It can be used in single-phase or three-phase circuits.

5.3 kVAr at 50 Hz, 6.3 kVAr at 60 Hz

V	Connection	Hz	A
230	delta	50	1.9-13.4
400	star	50	1.1-7.7
230	III	50	3.3-23.2
230	delta	60	2.3-16.1
400	star	60	1.3-9.2
230	III	60	3.9-27.8

Dimensions: 520 x 225 x 360 mm

Weight 13 kg





MV1107 Load Reactor

The reactor is continuously variable within the range 0.5-3.0 kVAr. When the reactor is connected to a system with 230 V between lines, the setting range can be increased to 0.15-3.0 kVAr by using Y-connection.

The required reactive power is set by means of a crank. For easier setting, the load reactor has a ten-turn scale with 100 scale divisions for each turn. Each winding is fitted with a fuse.

3-phase 0.5-3.0 kVAr, 400 V Y, 230 V Y, 50-60 Hz

V	Connection	Hz	A
230	star / delta	50	0.4-7.8
400	star	50	0.7-4.5
230	star / delta	60	0.3-7.6
400	star	60	0.6-3.7

Dimensions: 340 x 170 x 380 mm

Weight: 30 kg



MV1957, MV1959, MV1963 Rheostats

Each rheostat is enclosed in a robust metal case. The back, bottom and top of the case are perforated to provide optimum cooling. 2 glass fuses protect the resistor against excessive current and incorrect connection.

A scale with 100 scale divisions shows the resistance setting.

A front panel of yellow painted steel with black screen painted symbols simplifies series and potentiometer connection.

Constructional features

The insulation is of high class ceramic material. The resistance wire used is of highest quality with very good linearity.

Large flat brush with a sliding contact of copper graphite with specially balanced mounting guarantees perfect contact with negligible wear on the resistance.

Cat. no.	W	Ω	I (A)	Dimension HxWxD mm	Weight
MV1957	200	5	6.3	140 x 130 x 145	1.5
MV1959	200	50	2.0		
MV1963	500	2500	0.45	215 x 195 x 230	3.5

DMC9 Digital Multimeter

High-resolution, 3-3/4 digit LCD, 4000-count autoranging

- 7 functions / 23 ranges
- Battery Test function with Go/NoGo LED indicator
- Industry standard test leads, safety rated
- Protective holster included

Voltage

- DC Voltage 400 mV, 4V, 40V, 400V, 600V
- AC Voltage 400 mV, 40V, 400V, 600V

Current

- DC Current 40 mA, 400 mA, 8 A, (10A for 10 min)
- AC Current 40 mA, 400 mA, 8 A, (10A for 10 min)

Resistance

- 400 Ohm, 4 kOhm, 40 kOhm, 400 kOhm, 4 MOhm, 40 MOhm.

Buzzer Sounds

Diode Test

Overload Protection

Included accessories: Protective holster, test leads, battery and users manual.

Dimensions: 140 x 78 x 50 mm

Weight: 0.22 kg



MAT220349 Digital Clampmeter AC/DC current

MAT229349 is a small and pliable clamp meter for AC and DC current up to 200 A.

A clear and easy-to-read 3.5 digit LCD display with max reading of 1999.

The slim jaws have an inner diameter of 30 mm and is easy to fit in narrow places.

The data-hold function freezes the value, and is useful when working in the dark or hard to get areas where you cannot see the LCD.

The measuring values are updated 2 times / sec.

MAT220349 is delivered with manual, battery and soft case.

Conforms with IEC safety requirements.

Specifications:

- Current (AC): 0-20 A, 0-150 A, 150-199, 9A
- Current (DC): 0 - 20 A, 0 - 150 A, 150 - 199, 9A
- Low battery indication: "B" mark on LCD
- Power supply (battery): 2 pcs RS-44 or 2 pcs LR-44

Dimensions: 20 x 44 x 146 mm

Weight: 0.1 kg





MV1922/1923 Ammeter

A sturdy amperèmeter with high accuracy and reliability. Extremely safe with safety sockets and dual insulation. Moulded, water-resistant casing.

Range	AC 10mA - 10A (7 steps) DC 100 μ A - 10A (7 steps)
Accuracy	1,5% (DC), 2% (AC)
Operating frequency	45 - 400Hz
Fuse	1A and 10

Dimensions:	170 x 110 x 60 mm
Weight:	0.4 kg



MV1926 Voltmeter

A sturdy voltmeter with high accuracy and reliability. Extremely safety with safety sockets and dual insulation. Moulded, water-resistant casing.

Range	AC 3V - 1000V (6 steps) DC 100mV - 1000V (8 steps)
Accuracy	1,5% (DC), 2% (AC)
Operating frequency	20 - 400Hz
Fuse	Electronic Protection

Dimensions:	170 x 110 x 60 mm
Weight:	0.4 kg



Note : This wattmeter has a lamp and a buzzer warning for both overvoltage and overcurrent.

MV1937 Wattmeter

MV 1937 is an Electronic Wattmeter with active power transducer. The instrument is panel-type 96 x 96 mm and mounted in durable varnished sheet metal enclosures having plastic feet. The instrument has a 90° scale and manages temperatures between -20° and +50°C. It complies with IEC recommendations.

Technical Data

Voltage ranges:	50 – 250 – 500 V AC / DC
Current ranges:	5 – 10 A, AC / DC

The current ranges can be changed with a switch when measuring.

Voltage inputs:	max 600 V
Current inputs:	max 20 A
The current inputs and voltage inputs are insulated from each other : 1.5 kV	

Accuracy:	2.5 %
Frequency range:	DC – 20 kHz
Input impedance:	> 100 kohm (voltage input) < 3 mohm (current input)

Power supply:	220 – 240 V 50 – 60 Hz
Dimensions:	220 x 117 x 125 mm
Weight:	2 kg

MV1929 Power Factor Meter

Three-phase instrument, symmetric load.
 Measuring range cap. 0.5 ... 1 ... 0.5 ind.
 Current range 0-5 A
 Voltage range 220 V \pm 20 % 3-phase
 Frequency range 40-65 Hz
 Accuracy class 1.5
 Dimensions: 220 x 117 x 125 mm
 Weight: 2 kg



MV1976 Power Factor Meter

Three-phase instrument, symmetric load.
 Measuring range cap. 0.5 ... 1 ... 0.5 ind.
 Current range 0-5 A
 Voltage range 380 V \pm 20 % 3-phase
 Frequency range 40-65 Hz
 Accuracy class 1.5
 Dimensions: 220 x 117 x 125 mm
 Weight: 2 kg

MV1918-1 Digital Timer

Suitable for measuring the pick-up and drop-out times of relays and for physical experiments. The timer has two inputs that can be wired either to start or stop timing. Timing is started or stopped by every change at the inputs (make or break). It is also possible to connect the timer to one of the inputs only, in which case the closing of a make contact starts the timer, and the opening of the circuit stops it.

The inputs are protected for over-voltage, AC and DC.

General Data

Two measuring ranges Timer 1 msec - 60 sec
 Counter 1 - 65 000 counts
 230 V DC max.
 Accuracy \pm 0.1 % of reading \pm 1 digit
 Resolution 1 msec
 Height of digits 7 mm
 Mains supply 220-240 V, 50-60 Hz
 Dimensions: 175x200x90 mm
 Weight: 1 kg



MV1971 Differential Probe

Voltage up to 1200 V
 Frequency range: DC - 1 MHz
 Impedance in: approx. 1 Mohm
 Impedance out: approx. 500 ohm
 Dimensions (HxWxD): 40 x 120 x 65 mm
 Weight: 0.3 kg



MV1939 AC Power Energy Meter

The Terco MV1939 AC Power Energy Meter is a practical solution for the study of 1, 2 and 3-Phase AC power systems up to 500VAC/10A.

A microprocessor-based energy meter provides the user with an instant overview of the relevant three or four-wire, 3-Phase network parameters in balanced or unbalanced networks.

The simplified connection process means your laboratory experiments can be set up and taken down in just minutes, leaving more time to investigate and understand the characteristics and ambiguities of 3-Phase power networks.

The Terco MV1939 AC Power Energy Meter enables the measurement and visualization of a wide range of parameters in the study of symmetrical as well as non-symmetrical networks, such as: phase voltages, phase-to-phase voltages, line currents, mean three-phase current, mean three-phase voltage, mean phase-to-phase voltage, three-phase active, reactive and apparent powers, mean three-phase power factors.

The visualization of parameters is distributed over several pages (default preset to display five pages) where each page simultaneously displays four parameters.

The power Energy Meter is furthermore equipped with a standardized industrial data acquisition protocol (Modbus) and is compatible with the MV2609 Terco DAQ software (MV1943 Computer Interface is necessary).

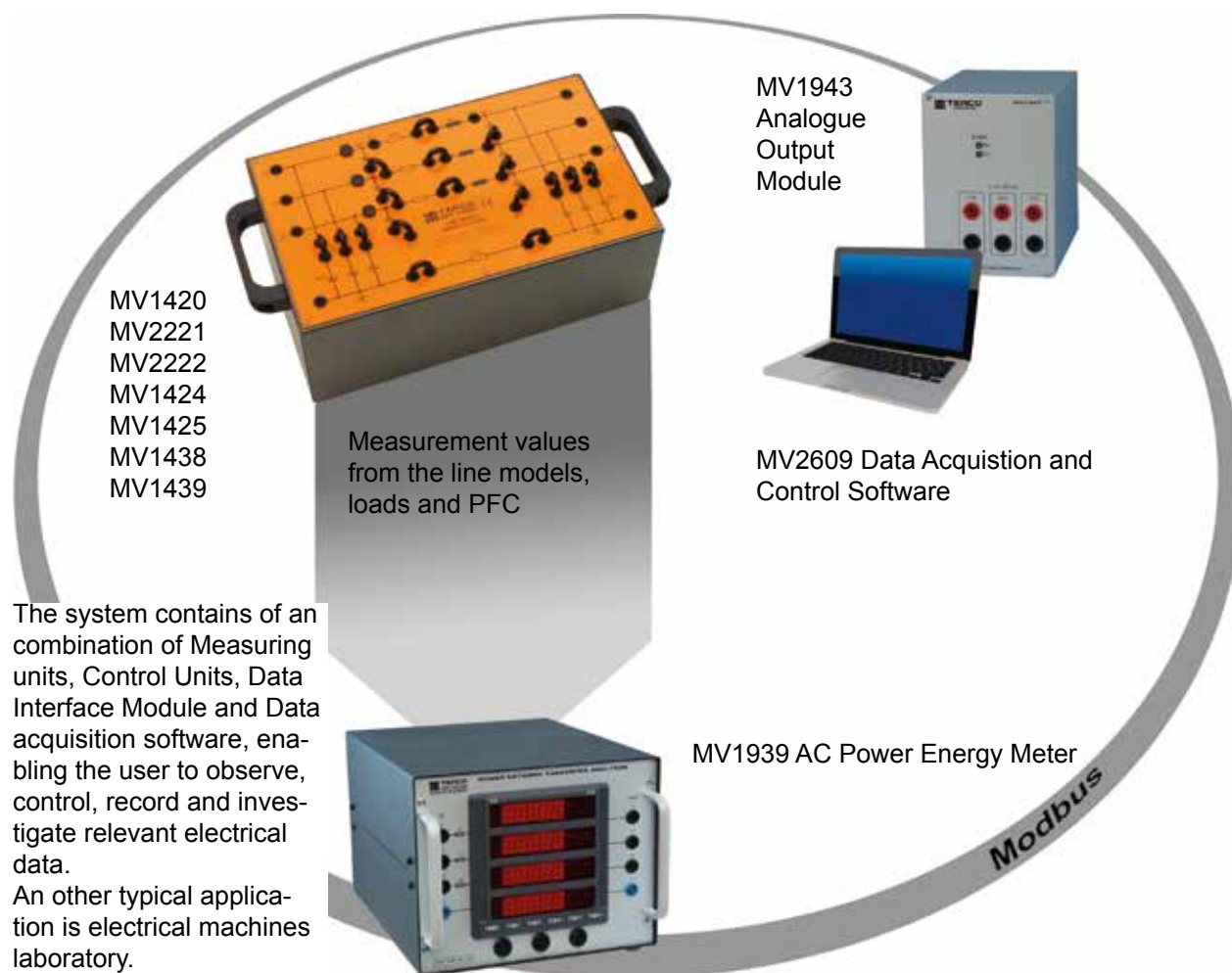
The MV2609 Terco DAQ software utilizes control and a real time graphical presentation programme incorporating data manipulation and export to Excel capabilities.



Technical Specifications

Power supply	220-240VAC, 50/60Hz
Measurement ratings	
Voltage, V	500VAC max
Current, I	10AAC max
Reactive Power	5 kVAr
Active Power	5 kW
Cos Phi	0-1-0
Communications	
Serial interface	RS485
Transmission protocol	Modbus RTU8N2
Baud Rate	19200kB
Environmental Conditions	
Ambient temperature	0...55°C
Air humidity	25...95% (no condensation)
Dimension:	255 x 205 x 335 mm
Weight:	10 kg

Additional Equipment: Measuring and Data Acquisition for PC



MV1943 Analog Output Module



The MV1943 Analog Output Module integrates the communication interface functionality of an USB to RS-485 adapter, with a 3-channel Modbus controlled 0-10V DC source in one compact unit.

Coupled with the MV2658 PWM Control unit, the MV1943 provides both communication

between Terco measuring units and a PC, as well as simultaneous motor control. The 3-channel analog output is controlled via PC using the Terco Data Acquisition Software and enables additional features such as fully automatic data acquisition.

Technical Specifications

Communication Interface	USB plug and play
Operating system	virtual serial port driver 7/Vista/XP
Field interface	RS485
Maximum devices	32 devices
Power source	USB port
Consumption	<100 mA
Voltage output Channels	3
Channel output	0-10 V
Resolution	12 bit (2.5 mV)
Isolation	1500 Vac, Field to Logic
Control system	Terco MV2609 Data Acquisition Software
General	
Power supply:	220-240VAC, 50/60Hz
Dimensions:	105 x 147 x 167 mm
Weight:	0.3 kg

Continued next page....

MV2609 Data Acquisition and Control Software

Acquisition functions

Data is read into the PC via Modbus to USB link and presented in real-time in both tabular and graph form. Data may be acquired using one of 4 possible acquisition modes: Single, Timed, Semi-Automatic and Full Automatic*. The saved data can then be exported in Excel format for further investigation.

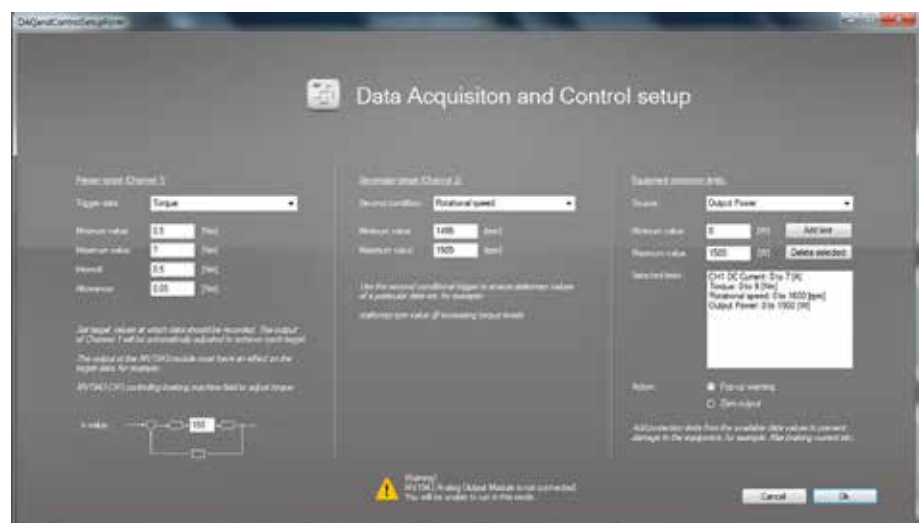


Pre-configured experiment setups are included but the experiment presentation window is fully customizable, allowing the user to select available hardware, define data columns and set up graph parameters such as data sources and titles. The software is designed to work with Terco Modbus instruments but may be set up to communicate with many Modbus devices.



Control functions*

When used together with the MV1943 Analog Output Module and the MV2658 PWM DC Control Module, the Data acquisition and Control software can be used to automatically control a DC machine which can be implemented, for example, as a mechanical brake.

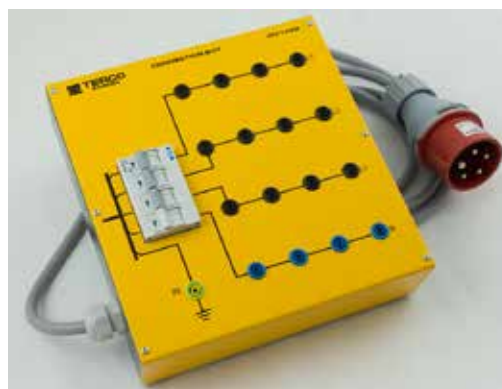


MV1429 Terminal Board

The box has outlets (three phases, zero and earth) for laboratory leads with 4 mm diameter plug ins. These outlets are connected to a 5 x 2.5 mm² cable with a 3-phase CEE plug rated 16A. The connection box is equipped with miniature circuit breakers for 16 A.

Dimensions: 250 x 240 x 75 mm

Weight: 2.0 kg



MV1500 Load Switch

Three-pole, 16 A, 250 V- DC / 440 V-AC, switch in metal case. Front panel showing symbols and technical data.

Marking of terminals	input	R, S, T
	output	U, V, W

Dimensions (HxWxD): 95 x 200 x 80 mm

Weight: 1 kg



MV1400 Push Button Panel

MV1400 is a suitable control device

It consists of :

- a signal lamp
- an OFF-button with one break and one make contact
- an ON-button with one break and one make contact.

The buttons are of non-locking type with instantaneous action so that contact operations are felt on depression of a button.

Dimensions (HxWxD): 75 x 175 x 130 mm

Weight: 1 kg



MV1931 Current Transformer

Primary: 20-15-5 A/Sec. 1 A

Safety sockets

Accuracy class:1.0

Dimensions (HxWxD): 95 x 200 x 80 mm

Weight: 6 kg





MV1402 Contactor

The contactor is one of the most common components in automation. It is used, for instance, in remote control and automatic control systems.

General data

- 3 main contacts with thermal current rating 25 A at resistive load
- 5 auxiliary contacts (3 make and 2 break) with thermal current rating 10 A
- Operating coil, 50 Hz or 60 Hz, 230 V

Dimensions (HxWxD) 150 x 245 x 130 mm

Weight: 1.3 kg



MV1915-C Three-phase Transformer

This transformer is cut-away to show the windings, coils, terminals, insulation, iron core etc.

Rated power: 2 kVA

Dimensions: 300 x 190 x 345 mm

Weight: 27 kg

Note: It is not possible to do any practical experiments with this transformer.



The 3 coils have following values:

L = 0.63 H and +/- 30 % terminals (70 kV)

L = 1.00 H and +/- 30 % terminals (230 kV)

L = 100 H and +/- 30 % terminals (11 kV)

MV2225 is to be used together with the Line Models MV1420, MV2221 and MV2222.

Dimensions: 410 x 245 x 160 mm

Weight : 11 kg

MV2225 Petersen Coil, Multi Terminal Unit

A Petersen coil is used together with OH-lines in the range of distribution voltage to medium voltage (MV).

The most common fault is line-to-earth where the current is limited by the phase voltage from the two healthy leads divided by the capacitive impedance added by the arc resistance and the remaining zero sequence impedance.

Since this current is mainly capacitive it could be balanced by an inductance between the neutral point of the transformer and ground. That is to say: when a line-to-earth fault occurs it will be extinguished automatically by the current in the Petersen coil and the re-closing device will connect power again in a fraction of a second.

Normally a HV-line has a firm ground. However, in this case we may also study a 230 kV model because of tutorial aspects.

Each inductance coil has three steps to optimize the reactance value for each line of "11 kV", "70 kV" and "230 kV".

MV1439-235 Power Factor Control Unit



General

TERCO Power Factor Controller (PFC) is also a module within our Classical electrical Machine Program.

With the PFC you can minimise the currents caused by reactive losses of power and thereby optimising the transfer of energy between generation and loading.

This is becoming more and more important today when "Saving energy" is vital in a world with focus on pollution and shortage of energy.

Field of application

Inductive or mixed inductive and resistive networks in need of compensation, for example when starting and running induction motors.

Principles of operation

Depending on the power factor of the loading network a microprocessor will connect groups of capacitors. By measuring phase voltages and current the microprocessor will calculate how many capacitive groups that has to be connected and also in which combinations.

Electrical details

Number of 3-ph groups	6
Power factor setting	0.7 inductive to 0.7 capacitive
Nominal voltage	3 x 230 V 50 – 60 Hz
	Code no. MV 1439-235
Nominal power	0 – 2 kVAr cap.
PF-Controller	Automatic or manual Adjustable delay times, switching sequences and strategies.

Monitoring and Measurement on the controller:

	Voltage, Current and Power factor
Switching modes:	Linear and circular
Indication lamps:	Indication lamps for the capacitor groups which are connected

Physical design

The Power Factor Control Unit is housed in a sturdy apparatus box with a clear mimic diagram explaining how to connect the supplying net from the left to the right side where the network in need for power factor compensation is connected.

Readings, parameters and sub parameters are indicated on the front of the controller. Other settings and programming than the defaults are simply performed from the keyboard and displayed on the controller front.

General data:

Power supply:	1-ph 220 - 240 V, 50 - 60 Hz
Dimensions:	510 x 570 x 280 mm
Weight:	24 kg

Typical Experiments with Terco PFC

- The concept of active power, apparent power and reactive power
- The concept of power factor and "cos"
- The concept of measuring methods
- Start current settings (C/k)
- Delay times
- Efficiency and losses
- Linear and circular switching modes
- PF-Controller design and schematics
- Programming the controller
- PF-Controller and resistive/inductive loads
- PF-Controller and induction motor loads
- Control range limits

Laboratory Flexes with Safety Plugs, Fixed Sleeve



MV1830-HF Flex Set Area 1.5 mm²

Set of 100 leads in 5 different colours, red, yellow, blue, black, yellow/green, and 4 different lengths, 25, 50, 100 and 200 cm, 5 of each.

	25 cm	50 cm	100 cm	200 cm
Red	5	5	5	5
Yellow	5	5	5	5
Blue	5	5	5	5
Black	5	5	5	5
Yellow/green	5	5	5	5

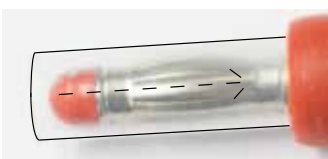
Alternative Flexes: Laboratory Flexes with Safety Plugs, Retractable Shroud

MV1830-H Flex Set Area 1.5 mm²

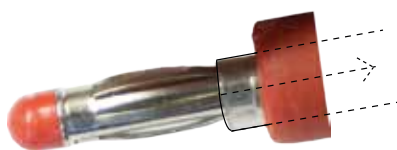
Set of 100 leads in 5 different colours, red, yellow, blue, black, yellow/green, and 4 different lengths, 25, 50, 100 and 200 cm, 5 of each.

Length	25 cm	50 cm	100 cm	200 cm
Red	5	5	5	5
Yellow	5	5	5	5
Blue	5	5	5	5
Black	5	5	5	5
Yellow/green	5	5	5	5

Safety lead with 2 covered spring plugs of 4 mm diameter, with retractable shroud covering the plugs, and 4 mm diameter axial bushings moulded with Polypropylen, fixed to 1.5 mm² copper thread, PVC isolated, outer diameter 4 mm. Rated current 16 A.



The pin is protected by a plastic sleeve when the flex is not connected.



The plastic sleeve is pushed in to the flex when the plug is connected to the equipment.

MV1904 Flex Stand

For suspension of laboratory flexes. The stand has 12 slots between parallel tubes with space for 10-15 laboratory flexes in each slot. Flexes of length 200 cm are suspended in a separate position above the stand. This rigid stand has a heavy steel plate pedestal.

General Data

Height:	1170 mm
Weight:	9 kg



INDEX

Item	Description	Page
DMC9	Digital Multimeter	24
HXXXX	Laboratory Flexes	33
MAT220349	Digital Clampmeter Current	24
MV1100	Load Resistor	21
MV1101	Load Reactor	21
MV1102	Load Capacitor	22
MV1103	Variable Transformer	19
MV1106	Load Capacitor	22
MV1107	Load Reactor	22
MV1300	Power Pack	20
MV1305-405	Mobil Motor/ Generator	18
MV1400	Push Button Panel	30
MV1402	Contactor	31
MV1420	Line Model	6
MV1424	Line Model	7
MV1425	Line Model	8
MV1429	Terminal Board	30
MV1431-1	Universal Relay Trainer	12
MV1438	Cable Model	9
MV1439-235	Power Factor Control Unit	32
MV1450	Line Multi Protection Trainer	14
MV1450-COMP	Line Multi Protection Trainer Software	14
MV1455	Differential Relay Trainer	16
MV1455-COMP	Differential Relay Trainer Software	16
MV1500	Load Switch	30
MV1904	Flex Stand	33
MV1911	Transformer Single-Phase	10
MV1915	Transformer 3-Phase	10
MV1915-C	Three Phase Transformer	30
MV1918-1	Digital Timer	25
MV1922/23	Ammeter	24
MV1926	Voltmeter	24
MV1929	Power Factor Meter	26
MV1931	Current Transformer	30
MV1937	Wattmeter	24
MV1939	AC Power Energy Meter	27
MV1943	Analogue Output Module	28
MV1957	Rheostat	23
MV1959	Rheostat	23
MV1963	Rheostat	23
MV1971	Differential Probe	26
MV1976	Power Factor Meter	26
MV2221	Line Model	6
MV2222	Line Model	7
MV2225	Petersen Coil, Multi Terminal Unit	31
MV2609	Data Acquisition and Control Software	29

TERCO HEADOFFICE



Terco headoffice and factory outside Stockholm, Sweden



TERCO AB was founded in 1963 with the aim of producing and supplying practically oriented equipment for technical education.

TERCO develops, manufactures and markets advanced equipment and systems for technical education. TERCO is today represented in more than 50 countries world wide.

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