

Electrical Machines Laboratory



Electrical Machines Laboratory

Colour Reference

"The World's State of the Art 1kW System".

Page 1-19

Data Acquisition and Control Package

Page 20-22

Drives and Electronics for Electrical Machines

Page 23-27

Renewable Energy

Page 28-29

Optional Electrical Machines

Page 30-37

Accessories as Loads, Instruments etc.

Page 38-47

Electrical Power Distribution System

Page 48-49

Manuals

Page 51

Index

Page 54

CONTENT

Page

| | |
|---|------------------|
| The World's State of the Art 1kW System | 1-19 |
| 4-Quadrant DC Controller | 23 |
| AC & DC Starter | 12 |
| AC Power Energy Meter | 16,20 |
| Accessories as Loads, Instruments etc | 38-47 |
| AC-Control | 24 |
| AC-Motor Drive (semi 4Q drive) | 27 |
| Ammeters | 43 |
| Analog Output Module | 22 |
| Asynchronous Test Machines | 8,10,30-32,34-37 |
| Asynchronous Motor, 3-Phase Demonstration Set | 32 |
| Asynchronous Wind Mill System including HVDC Light Transmission Cable | 28 |
| Digital Multimeter | 43 |
| Current Transformer | 45 |
| Dahlander Switch | 42 |
| Data Acquisition and Control Package | 20-22 |
| DC Measuring Unit | 17,20 |
| DC-brake / drive Machine | 6 |
| DC Control Module, PWM | 23 |
| DC-Machine | 6,8 |
| DC-Motor Drive Single Phase | 25 |
| DC-Motor Drive 3-phase | 26 |
| Digital Torque-, Speed- and Shaft Power Meter MV1054 | 5 |
| Documentation | 4 |
| Drives and Electronics for Electrical Machines | 23-27 |
| Electric Torque Meter System, Analogue Dial incl. DC-brake / DC-drive Machine | 7 |
| Electrical Power Distribution System | 48,49 |
| Flex Stand | 15,47 |
| Flywheel | 39 |
| Frequency Meter | 44 |
| Guarantee & Terms | 56 |
| Index | 54,55 |
| Induction Motor 2 Speed 2 Windings | 31 |
| Induction Motor Cap. Start and Run | 31 |
| Induction Motor Capacitor Start | 31 |
| Induction Motor Dahlander Motor | 30 |
| Induction Motor Slip Ring | 8 |
| Induction Motor Squirrel Cage | 10 |
| Induction Motor Thermistor Protected | 32 |
| Laboratory Flexes with Safety Plugs | 15,46,47 |
| Load Capacitor | 13 |
| Load Capacitor Bank | 38 |
| Load Reactor | 13,38 |
| Load Resistor | 13,38 |
| Load Switch | 12 |

| CONTENT | Page |
|--|-------------|
| Machine Bed | 10 |
| Machine Jack | 42 |
| Machine Test System | 6 |
| Manuals | 51 |
| Mobile Motor / Generator Unit | 34 |
| Mobile Test Bench | 14 |
| Motor-Generator Set-Up with Flywheel | 37 |
| Optional Electrical Machines | 30-37 |
| Pallet | 42 |
| Phase Sequence Indicator Phase Cop 2 | 17 |
| 3-Phase Squirrel Cage Motor with Fault Simulator | 33 |
| Power Distribution | 48-30 |
| Power Factor Control Unit | 40 |
| Power Factor Meter | 44 |
| Power Pack | 11 |
| PWM DC Control Module | 20,23 |
| Recommended Equipment, One Lab Station | 18-19 |
| Reluctance Motor | 30 |
| Renewable Energy | 28,29 |
| Reversing Switch | 12 |
| Revolution Counter | 45 |
| Sectioned Motors and Transformer | 36 |
| Selector Switch | 42 |
| Service | 4 |
| Shaft Lock | 5 |
| Shaft Spacer | 10 |
| Shunt Rheostat | 10 |
| Star / Delta Switch | 12 |
| Starter Direct-on-line | 39 |
| Stationary Laboratory Bench | 14 |
| Synchronizing Device | 11 |
| Synchronizing Unit | 45 |
| Synchronous Machine | 9 |
| Tachogenerators | 6 |
| Terminal Board | 39,42 |
| Terminal Board with Short-Circuit Buttons | 12 |
| Thermal Relay | 32 |
| Training | 4 |
| Universal Motor | 30 |
| Variable Transformer 3-phase | 39 |
| Wattmeter | 44 |
| Voltage, Current & Power Module | 24 |
| Voltmeter | 43 |

Electrical Machines Laboratory

For more than 50 years, Terco has developed and sold electrical machines for technical education. Terco systems are today installed in hundreds of schools all over the world. Through consultation, individual needs can be met with a customized package including hardware solutions and relevant study programs. The test motors and generators have a power output of approximately 1 kW. This size of machines is such that :

1. Standard instruments can be used.
2. Safety precautions can be observed easily.
3. It is possible to interchange the machines without using a crane or hoist.
4. They represent typical characteristics for electrical machines.
5. Prices are competitive.

Thanks to the top quality and robust construction of Terco products, they are able to withstand rough handling by young, unexperienced students.

With Terco Classic Machines it is possible to produce characteristics which are typical for machines with 6-8 kW ratings, partly because Terco Electrical Machines have a robust construction with a higher than normal iron and copper content. This makes it possible to overload the machines more before reaching saturation. If you compare the weight of corresponding machines from other manufacturer you will see the difference.

Service

Most of Terco's electrical machine systems have been in operation for decades and it is not very often we have to carryout service or repair. Should the need occur however,our well trained service and maintenace personnel are always here to support you.

Quality Control

All equipment is carefully checked and after approval provided with Terco's well known quality mark for our customers' safety and security.

TERCO is ISO 9001 certified.

NOTICE

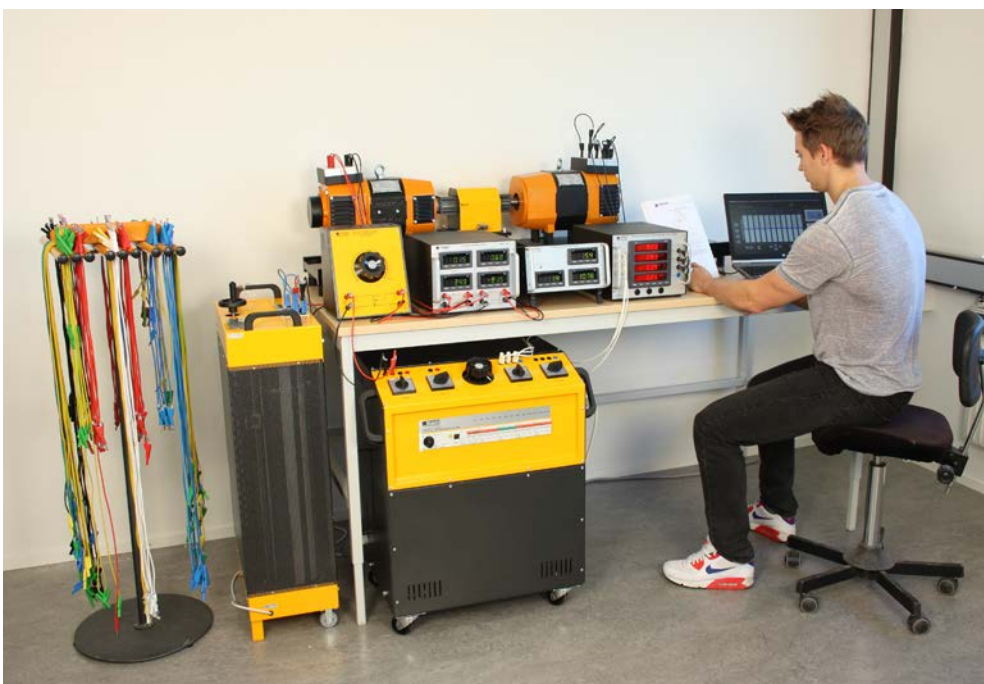
All products have safety sockets.

Training Courses

Terco organises training courses for most of our equipment both at our headquarters or at the customer's own site. Most of our courses are especially designed to teach you how to handle the equipment in the most efficient way and are always a very good investment.

Documentation

Every shipment includes comprehensive documentation including course literature, a teachers guide and a manual.



MV1054 Torque Meter System

Terco has a wide range of Torque Measuring Systems. It is always possible to find a good solution to measure torque when testing a motor. On the following pages you will find different ways of measuring torque, power and speed for electrical machines.



The picture shows MV1054 Digital Torque, Speed and Shaft Power Meter mounted on MV1004 Machine bed between MV1028 DC machine and MV1008 Synchronous machine

MV1054 Digital Torque-, Speed- and Shaft Power Meter

MV 1054 is a modern torque meter based on the latest sensor technology. It comprises a magnetically based contactless torque sensor together with data acquisition and a display unit for torque, speed and shaft power.

The sensor unit consists of a magnetically encoded torsion shaft with a magnetically based contactless sensor, together with a data acquisition unit with 15 bit resolution. (see pages 20-22).

Torque measurement is performed/presented within the range -17.50Nm - +17.50Nm with exceptionally high accuracy including stand still torque as it is possible to lock the shaft with a specially attached bar *). Speed measurement is performed/presented within the range -3000- +3000rpm and the shaft power is calculated and presented within the range -5.50kW- +5.50kW.

Technical Specifications

Technical Data

| | |
|---------------------------|----------------|
| Nominal torque | +/-17.50Nm |
| Max. mechanical torque | 25Nm |
| Nominal shaft power | +/-5.50kW |
| Nominal speed | 0 - 3000rpm |
| Data acquisition protocol | Modbus RTU 8N2 |
| Baud Rate | 9600kB/19200kB |
| Power supply | 220-240VAC |
| 1-phase, 50-60Hz | |

Dimensions / Weight

Sensor Unit

| | |
|--------------------------|---------------|
| Dimensions | 200x190x146mm |
| Length of mounting plate | 200mm |
| Length incl couplings | 170mm |
| Length incl shaft cover | 250mm |
| Shaft height (to center) | 162mm |
| Weight | 5kg |

Display Unit

| | |
|------------|---------------|
| Dimensions | 340x250x150mm |
| Weight | 5kg |



MV 1054 Sensor Unit



*) Shaft lock



MV 1054 Display Unit

DC-brake / drive Machine

Machine Test System

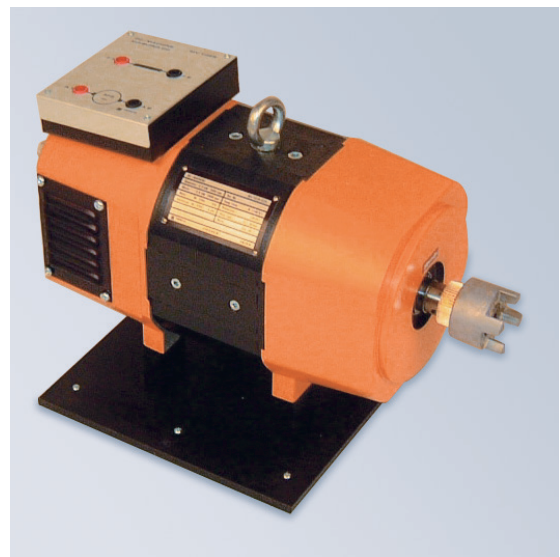
A DC-machine is used together with test machines, e. g. a synchronous machine as below in order to study characteristics. The DC-machine is placed on a machine bed on which different test machines can be mounted quickly and simply. The DC- machine can be connected either as brake generator or driving motor depending on the object to be tested. The connections are made as safety terminals on the panel, integrated with the machine. The machines have an anodized aluminium foundation, coupling, eyebolt and terminal block with mimic diagram. Guides and plastic rails under the foundation ensure that each machine is aligned accurately and slides easily on the stand.

MV1028 DC Machine

Complete with interpoles. This machine is used in test machine sets such as motors or generators, mounted on a 10 mm thick anodized aluminium plate to be placed on the machine bed MV 1004.

| General Data | MV1028-225 | MV1028-226 |
|-------------------|---|-----------------|
| Generator | 2.2 kW 1500 rpm | 2.2 kW 1800 rpm |
| Motor | 2.0 kW 1400 rpm | 2.0 kW 1700 rpm |
| Excitation | 220 V 0.8 A | 220 V 0.8 A |
| Armature | 220 V 12 A | 220 V 12 A |
| Moment of inertia | J = 0.012 kgm ² | |
| Dimensions | 465 x 310 x 310 mm Shaft height 162 mm | |
| Weight | 50 kg | |

MV1028-225 is designed for tests on AC motors with 50 Hz ratings.
 MV1028-226 is designed for tests on AC motors with 60 Hz ratings.



MV1034-225 and MV1034-226 DC-Machine

Same as MV 1028 but with through shaft with two couplings.
 For central mounting on the machine bed.

See also text under MV1026-225 resp. MV1026-226 (Page 7)

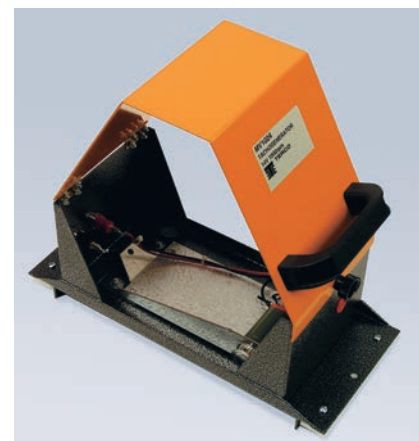
Tachogenerators

The generator is mounted inside a protective guard. The cover is hinged and can be fixed by a locking screw.

| | |
|---------------|--|
| MV1024 | DC Generator 14 V at 1000 rpm (with trim potentiometer) |
| MV1025 | DC Generator 14 V at 1000 rpm. (to be used with the MV1036 Electric Torque Meter System which has built-in trim potentiometer) |
| MV1029 | Protective Cover (only) |

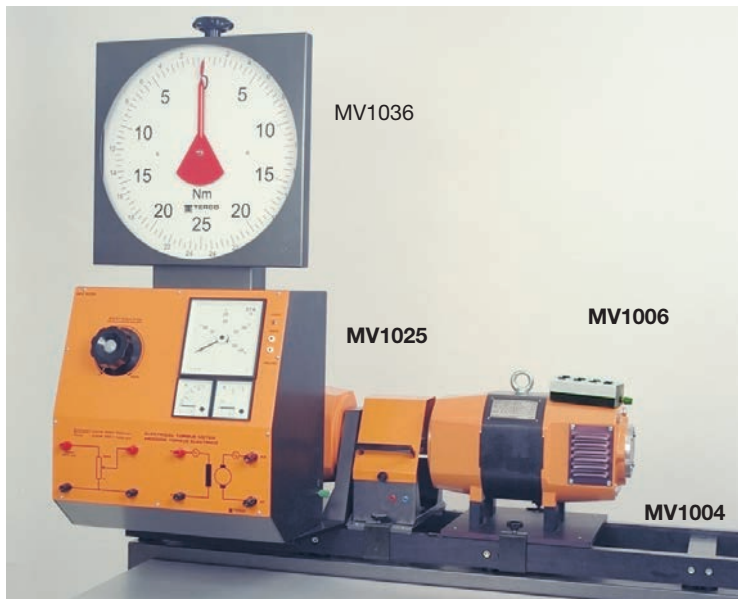
Dimensions
 Weight 2 kg

Please note : The protective guard can be fitted between the machines to cover the rotating couplings, thus minimising the risk of accidents from rotating machinery.



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

Electric Torque Meter System, Analogue Dial incl. DC-brake / DC-drive Machine



The picture shows MV1036 mounted on the machine bed MV1004 together with the tachometer generator MV1025 and the DC- test machine MV1006

A DC pendulum machine is freely suspended on plumber blocks and placed on an aluminium foundation plate. The front panel is fitted with the necessary meters, controls and connection terminals. The torque is read on an analogue dial. The DC-machine has interpoles.

This analogue torque measuring system is very pedagogical and easy to handle. It is a reliable product which has been sold to many technical schools worldwide.

MV1036-225 Electric Torque Meter System

| | |
|---------------|--------------------|
| Speed | 0-4000 rpm |
| Ammeter | 0-1 A (Field) |
| Ammeter | 0-15 A (Arm.) |
| Shunt Control | Potentiometer |
| Torque | Grad. 0 – ± 25 Nm |
| Scale diam. | 390 mm |
| Termination | 4 mm terminals |
| Generator | 2.2 kW 1500 rpm |
| Motor | 2.0 kW 1400 rpm |
| Excitation | 220 V 0.8 A |
| Armature | 220 V 12 A |
| Dimensions | 600 x 540 x 960 mm |
| Weight | 90 kg |

MV1036-226 Electric Torque Meter System

| | |
|--------------------------------------|--------------------|
| As MV1036-225 but following ratings. | |
| Generator | 2.2 kW 1800 rpm |
| Motor | 2.0 kW 1700 rpm |
| Excitation | 220 V 0.8 A |
| Armature | 220 V 12 A |
| Weight | 90 kg |
| Dim: | 600 x 540 x 960 mm |

DC machine MV 1036-226 is designed for tests on electrical machines with 60 Hz ratings.

DC Machine MV1036-225 is designed for tests on electrical machines with 50 Hz ratings but can be used for 60Hz (higher speed but less torque)

MV1026-225 Electric Torque Meter System

Same as MV1036-225, but the drive motor has a double ended shaft, enabling to couple two machines at the same time for experiments and studying 4Q drives with one AC- and one DC drive/motor, Ward-Leonard system, cascade, etc. For central mounting on the machine bed. Designed for tests on electrical machines with 50 Hz ratings.

MV1026-226 Electric Torque Meter System

Same as MV1036-226 except that the drive motor has a double ended drive shaft, making it possible to couple two machines at the same time for experiments and studying 4Q drives with one AC- and one DC drive/motor, Ward-Leonard system, cascade, etc. For central mounting on the machine bed. Designed for tests on electrical machines with 60 Hz ratings.

Test Machines

The characteristics and data of Terco electrical machines are similar to those of larger machines. The Terco test machines have a robust construction with more iron and copper than normal to enable overloading. Approximately 20 % overload is possible for a maximum duration of 10 minutes without damaging the machines. Terco machines boost higher saturation limits than machines with less iron. Please pay attention to the weight of Terco machines in comparison with other suppliers machines. The weight will give you an indication of how much iron and copper the machines have compared to other producers of the same power (ca 1kW).

The test machines have a foundation providing accurate alignment laterally and an accurate shaft height of 162 mm. Guides and plastic rails below the foundation simplify alignment and enable good positioning maneuverability on the machine bed. Special clamps are used to secure the machines to the machine bed. Connection is made via 4 mm safety terminal sockets mounted on a terminal panel showing the internal connections of the machine. Other voltages than those shown can be arranged on request.

MV1006 DC-Machine

The machine has a shunt and a series winding and can be connected as shunt motor, series motor, compound motor, shunt generator, series generator or compound generator.

MV 1006 has also commutating poles (interpoles) which improve the characteristics of the machine. The machine is mounted on a 10 mm thick anodized aluminium plate to be placed on the machine bed.

Suitable shunt rheostat : MV1905.



| General Data | MV1006-225 | MV1006-226 |
|--------------|-----------------|-----------------|
| Generator | 1.2 kW 1400 rpm | 1.2 kW 1700 rpm |
| Shunt motor | 1.0 kW 1400 rpm | 1.0 kW 1700 rpm |
| Series motor | 1.0 kW 1150 rpm | 1.0 kW 1400 rpm |
| Rotor | 220 V 5.5 A | 220 V 5.5 A |
| Excitation | 220 V 0.55 A | 220 V 0.55 A |

The series winding has an extra terminal at 2/3 of the winding.

| | |
|-------------------|---|
| Moment of inertia | J = 0.012 kgm ² (approx.) |
| Dimensions | 465 x 300 x 310 mm Shaft height 162 mm |
| Weight | 45 kg |

MV1007-405 Induction Motor Slip Ring

The machine is a 3-phase slip-ring asynchronous motor with means to connect a rotor starter to be used for starting. Terminals on anodized front panel with symbols and electrical data.

| General Data | 50 Hz | 60 Hz |
|-------------------|--|------------------|
| Power | 1.1 kW, | 1.1 kW, |
| Speed | 1440 rpm, 50 Hz | 1680 rpm, 60 Hz |
| Star connection | 380-415 V, 3.2 A | 380-415 V, 3.2 A |
| Delta connection | 220-240 V, 5.5 A | 220-240 V, 5.5 V |
| Secondary | 260 V, 3.0 A | 260 V, 3.0 A |
| Moment of inertia | J = 0.012 kgm ² (approx.) | |
| Dimensions | 465 x 300 x 310 mm, Shaft height 162 mm | |
| Weight : | 42 kg | |



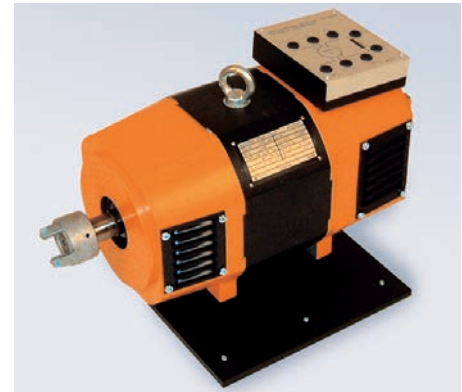
MV1007-695 Induction Motor Slip Ring

As MV1007-405 but for 380-415 V 3-phase, Delta, 50-60 Hz

MV1008 Synchronous Machine

The machine has a DC excited cylindrical rotor, operating on voltages up to 220 V DC (maximum excitation). The advantages rising from this type of machine are measurements and characteristics corresponding to those of larger machines and the excitation voltage is readily available in most laboratories. An additional damping winding will counteract and also facilitate return to synchronism if the rotor falls out of phase. The damping winding also allows the motor to be started as an asynchronous motor before energizing the field.

Suitable excitation rheostat : MV 1905.



General Data

| | MV1008-235 | MV1008-236 | MV1008-405 | MV1008-406 |
|-------------------|--|-----------------|-----------------|-----------------|
| Synch. Gen. | 1.2 kVA x 0.8 | 1.2 kVA x 0.8 | 1.2 kVA x 0.8 | 1.2 kVA x 0.8 |
| Synch. Motor | 1.0 kW 1500 rpm | 1.0 kW 1800 rpm | 1.0 kW 1500 rpm | 1.0 kW 1800 rpm |
| Star conn. | 220-240 V 3.5 A | 220-240 V 3.5 A | 380-415 V 2.0 A | 380-415 V 2.0 A |
| Delta conn. | 127-140 V 6.1 A | 127-140 V 6.1 A | 220-240 V 3.5 A | 220-240 V 3.5 A |
| Excitation DC | 220 V 1.4 A | 220 V 1.4 A | 220 V 1.4 A | 220 V 1.4 A |
| Moment of inertia | J = 0.012 kgm ² (approx.) | | | |
| Dimensions | 465 x 300 x 310 mm, Shaft height 162 mm | | | |
| Weight | 39 kg | | | |

MV1008-235 and -405 are designed for tests on 50 Hz networks.
 MV1008-236 and -406 are designed for tests on 60 Hz networks.

MV1027 Synchronous Machine

The machine has a DC excited rotor with salient poles, operating on voltages up to 220 V DC (maximum excitation)

The advantages rising from this type of machine are measurements and characteristics corresponding to those of larger machines and the excitation voltage is readily available in most laboratories. An additional damping winding will counteract oscillations and also facilitate return to synchronism if the rotor falls out of phase.

The damping winding also allows the motor to be started as an asynchronous motor before energizing the field.

Suitable excitation rheostat : MV1905.



General Data

| | MV1027-235 | MV1027-236 | MV1027-405 | MV1027-406 |
|-------------------|---|-----------------|-----------------|-----------------|
| Synch. Gen. | 1.2 kVA x 0.8 | 1.2 kVA x 0.8 | 1.2 kVA x 0.8 | 1.2 kVA x 0.8 |
| Synch. Motor | 1.0 kW 1500 rpm | 1.0 kW 1800 rpm | 1.0 kW 1500 rpm | 1.0 kW 1800 rpm |
| Star conn. | 220-240 V 3.5 A | 220-240 V 3.5 A | 380-415 V 2.0 A | 380-415 V 2.0 A |
| Delta conn. | 127-140 V 6.1 A | 127-140 V 6.1 A | 220-240 V 3.5 A | 220-240 V 3.5 A |
| Excitation DC | 220 V 1.4 A | 220 V 1.4 A | 220 V 1.4 A | 220 V 1.4 A |
| Moment of inertia | J = 0.012 kgm ² (approx.) | | | |
| Dimensions | 465 x 300 x 310 mm, Shaft height 162 m | | | |
| Weight | 39 kg | | | |

MV1027-235 and -405 are designed for tests on 50 Hz networks.
 MV1027-236 and -406 are designed for tests on 60 Hz networks.

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

MV1009-405 Induction Motor Squirrel Cage

A 3-phase squirrel cage asynchronous motor is mounted on a 10 mm thick anodized aluminium plate to be placed on the machine bed MV1004.

| General Data | 50 Hz | 60 Hz |
|-------------------|---------------------------------------|------------------|
| 4 pole machine | 1.1 kW 1400 rpm | 1.1 kW 1700 rpm |
| Star (Y) | 380-415 V, 2.4 A | 380-415 V, 2.4 A |
| Delta (D) | 220-240 V, 4.1 A | 220-240 V, 4.1 A |
| Moment of inertia | J = 0.0023 kgm ² (approx.) | |
| Dimensions | 355 x 300 x 310 mm | |
| | Shaft height 162 mm | |
| Weight | 19 kg | |



MV1009-695 Induction Motor Squirrel Cage

As MV1009-405 but for 380-415 V 3-phase Delta. With this machine it is possible to do star/delta starts for 380-415 V lab voltage.

MV1009-385 Induction Motor Squirrel Cage

A 4-pole motor of 1.5 kW. Same design and electrical voltages as MV1009-405.

MV1055 Shaft Spacer

To be used as an shaft extension between MV1054 torque/speed meter and either the test machine or the braking/driving machine to give space for the MV1024 tachometer generator when doing closed-loop experiments with DC-drives. MV1055 is also suitable between the MV1010 flywheel and the MV1054 torque/speed meter.



MV1004 Machine Bed

This strong, stable machine bed of anodized aluminum bars has rubber dampers on the underside to prevent transmission of vibration to the base. The torque meter unit is mounted on MV 1004 along with the test machines. Special clamps ensure a quick and secure fixing of the machines to the bed. These clamps are delivered with the electrical machines.

| | |
|------------|--------------------|
| Dimensions | 1500 x 300 x 65 mm |
| Weight | 15 kg |



MV1905 Shunt Rheostat

Used for field regulation of DC-machines MV 1006, MV 1028, MV 1034 and for synchronous machines MV 1008 and MV 1027. Enclosed in perforated metal case with front panel, carrying terminals, markings and symbols.

General Data

| | |
|-------------------------|--------------------|
| 440 ohms | |
| Potentiometer-connected | |
| Supply voltage | 220 V DC |
| Max current | 2 A |
| Dimensions | 215 x 190 x 230 mm |
| Weight | 3 kg |



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).



General Data

MV1300-235 Supply voltage 220-240 / 127-140 V 50 / 60 Hz 3-ph.

MV1300-405 Supply voltage 380-400 / 220-230 V 50 / 60 Hz 3-ph.

MV1300-415 Supply voltage 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 |
| | | |
| Dimensions | 660 x 435 x 790 mm | |
| Weight | 103 kg | |

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

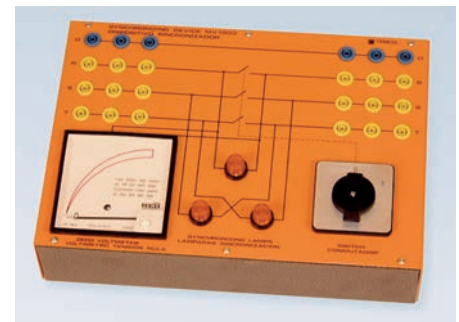
| | | |
|----------------|---------------------------|-----------------------|
| Output voltage | DC fixed | 220 V 3.5 A |
| | DC variable | 0-220 V 16 A |
| | AC fixed | 415 / 240 V 10 A 3-ph |
| | AC variable | 3 x 0-415 V 10 A 3-ph |
| Supply voltage | 415 / 240 V 50-60 Hz 3-ph | |

MV1903 Synchronizing Device

The equipment includes 1 zero voltmeter, 1 circuit breaker, 3 signal lamps and terminal bolts.

With MV 1903 it is an easy matter to synchronize synchronous machines to networks.

| General Data | MV1903-235 | MV1903-405 |
|-----------------|---------------------------------|---------------------------------|
| Zero Voltmeter | 2 x 140 V | 2 x 220 V |
| Circuit Breaker | 16 A 500 V | 16 A 500 V |
| Synch. Lamps | 130 V with resistor | 220 V with resistor |
| Supply Voltage | 220-240 / 127-140 V 50-60 Hz | 380-415 / 220-240 V 50-60 Hz |
| Dimensions | 315 x 240 x 90 mm | |
| Weight | 3 kg | |



Other voltages can be supplied on request.

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

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 | 95 x 200 x 80 mm | |
| Weight | 1 kg | |



MV1502 Reversing Switch

Suitable for 3-phase machine, 16 A, 500 V, Housed in a metal case.
 Front panel showing symbols and technical data.

| | | |
|----------------------|------------------|---------|
| Marking of terminals | input | R, S, T |
| | output | U, V, W |
| Dimensions | 95 x 200 x 80 mm | |
| Weight | 1 kg | |



MV1503 Star / Delta Switch

Suitable for 3-phase machine, 16 A, 500 V, Housed in a metal case.
 Front panel showing symbols and technical data.

| | | |
|----------------------|------------------|---------|
| Marking of terminals | input | R, S, T |
| | output 1 | U1, V1, |
| W1 | output 2 | U2, V2, |
| W2 | | |
| Dimensions | 95 x 200 x 80 mm | |
| Weight | 1 kg | |

MV2636 AC & DC Starter

This is an universal starter for both AC slip-ring induction motors like MV 1007 and for DC-motors like MV 1006, MV 1028, MV 1036 etc.
 The unit has clear symbols and mimic diagrams.

| | |
|------------|--------------------|
| Dimensions | 350 x 260 x 150 mm |
| Weight | 4 kg |



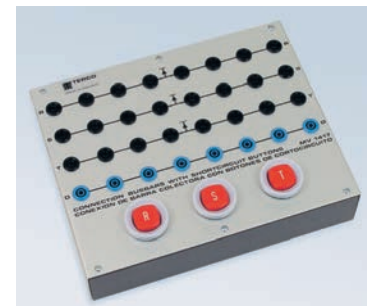
MV 1417 Terminal Board with Short-Circuit Buttons

Combined terminal and protection board for instruments. Current coils of ammeters and wattmeters connected to the board through a normally short-circuited contact which is opened during measurement. Opening of the contacts for phase R, S, T is done with a robust push-button for each phase.

Reading of the instrument can be done only when the button is pressed, which is of great advantage in the event of wrongly terminated instruments.

The terminal board is 4-pole with six terminals, two jacks and three push-buttons marked R, S, T.

| | |
|------------|-------------------|
| Dimensions | 245 x 195 x 50 mm |
| Weight | 1.5 kg |



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. A cooling fan is placed at the bottom of the resistor.

MV 1100-235 Cooling fan supply 230 V AC 50 - 60 Hz
 MV 1100-116 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 kVAr, 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

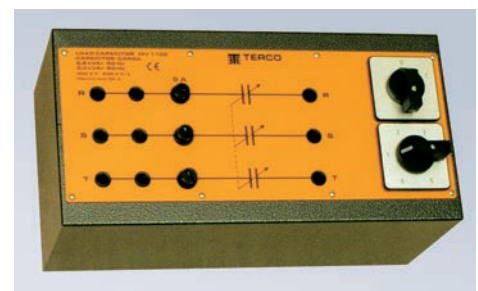
Housed in a metal cabinet. Electrical data and symbols on the front panel with terminals and fuses. This unit can be used on 1- and 3-phase systems. 6 step regulation.

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 |



MV1003 Mobile Test Bench

For mobile use, the torque meter or brake system and test machines with machine bed are placed on a mobile bench having one folding leaf, one fixed shelf and four wheels, of which 2 can be locked.

Dimensions of the folding leaf
1490 x 400 x 30 mm

Dimensions
1500 x 600 x 840 mm

Weight 55 kg

The MV1003 Mobile Test Bench is equipped with the MV1036 Torque Meter, MV1008 Synchronous Machine, MV1004 Machine Bed and MV1025 Tachometergenerator. Beside, are Power Pack MV1300 and flexes. Under is one test motor on pallet.



MV1700 Stationary Laboratory Bench

For stationary use, the torque meter or brake system with machine bed and test machine are placed at the rear of the stable laboratory bench.

The front of the bench is used to connect equipment and instruments.

See also page 5.

Dimensions 2000 x 800 x 850 mm
Weight 30 kg

The Laboratory Bench is equipped with a motor/generator set together with the Torque measuring system MV1054. Beside you find the Power Pack MV1300 and under is a testmachine on pallet.



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

Laboratory Flexes with Safety Plugs

Safety lead with 2 covered spring plugs of 4 mm diameter, with stiff protection sockets 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. Colours black, red, blue, yellow, green/yellow. Rated current 16 A.

MV1800-HF Flex Set of 120 leads. Area 1.5 mm²

2 colours

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------|-------|-------|--------|--------|
| Red | 10 | 20 | 20 | 10 |
| Blue | 10 | 20 | 20 | 10 |

MV1801-HF Flex Set of 200 leads. Area 1.5 mm²

5 different colours, red, yellow, blue, black and yellow/green, in 4 different lengths, 25, 50, 100 and 200 cm, 10 of each.

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------------|-------|-------|--------|--------|
| Red | 10 | 10 | 10 | 10 |
| Yellow | 10 | 10 | 10 | 10 |
| Blue | 10 | 10 | 10 | 10 |
| Black | 10 | 10 | 10 | 10 |
| Yellow/green | 10 | 10 | 10 | 10 |



MV1830-HF Flex Set of 100 leads. 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 |

Separate Flexes. Area 1.5 mm²

Please note, each Ref. No. refers to a pack of 10 leads.

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------------|-----------|-----------|-----------|-----------|
| Red | MV1802-HF | MV1807-HF | MV1812-HF | MV1817-HF |
| Yellow | MV1803-HF | MV1808-HF | MV1813-HF | MV1818-HF |
| Blue | MV1804-HF | MV1809-HF | MV1814-HF | MV1819-HF |
| Black | MV1805-HF | MV1810-HF | MV1815-HF | MV1820-HF |
| Yellow/Green | MV1806-HF | MV1811-HF | MV1816-HF | MV1821-HF |

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 |





Compact "all in one instrument"
 for AC measurements

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) |
| Size and weight | |
| W x H x D | 255 x 205 x 335mm |
| Weight | 10kg |

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

Compact "all in one instrument"
 for DC measurements



MV1941 DC Measuring Unit

The Terco MV1941 DC Measuring Unit is a practical solution for the study of DC circuits up to 350VDC/12ADC.

Microprocessor-based display instruments provide the user with an instant overview of DC voltage and current levels on two separate channels simultaneously.

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 the circuits being investigated.

Robust components provide a good level of protection against incorrect connection, mishandling and carelessness.

The DC Measuring Unit 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 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 | 350VDC max |
| Current, I | 12ADC max |
| Communications | |
| Serial interface | RS485 |
| Transmission protocol | Modbus RTU8N2 |
| Baud Rate | 19200kB |

Environmental Conditions

| | |
|---------------------|----------------------------|
| Ambient temperature | 0...55°C |
| Air humidity | 25...95% (no condensation) |
| Size and weight | |
| W x H x D | 255x205x335mm |
| Weight | 7kg |

Phase Cop 2 Phase Sequence Indicator

Tester for determining the direction of rotation or phase sequence in 3-phase systems.

- 3 LEDs indicate whether or not the 3-phase conductors are live
- Very large voltage and frequency range
- Simple operation
- Rugged design
- Permanently connected cables with contact-protected connector plugs, three plug-on test probes and one plug-on alligator clip

| | |
|---------------|------------------|
| Voltage range | 90-660 V |
| Frequency | 45-1000 Hz |
| Dimensions | 70 x 105 x 40 mm |
| Weight | 0.3 kg |



Electrical Machines Laboratory standard setup

Classic (approx. 1 kW) Experiment Voltage 3 x 230 V AC, 4 Lab Stations.
 Supply Voltage : 3 X 400 V or 3 x 230 V AC (MV 1300-405 is changeable).

| Code | Description | Qty | page |
|---|--|-----|-------|
| Torque Meter System | | | |
| MV1054 | Digital Torque-, Speed- and Shaft Power Meter | 4 | 5 |
| MV1028-225 | DC-Machine, 2.2 kW complete with interpoles 220V | 4 | 6 |
| Test Machines | | | |
| MV1006-225 | DC-Machine 1 kW 220 V 50 Hz | 4 | 8 |
| MV1007-405 | Induction Motor slip-ring *) 1.1kW 400/230V 50-60Hz 1.1kW | 4 | 8 |
| MV1008-235 | Synchronous Machine, 230 V Y 50 Hz 1.2 kVA x 0.8 | 4 | 9 |
| MV1009-405 | Induction Motor Squirrel Cage *), 400/230V 50-60 Hz 1,1 kW | 4 | 10 |
| *) Asynchronous Machines | | | |
| Power, Loads and Accessories | | | |
| MV1004 | Machine Bed | 4 | 10 |
| MV1055 | Spacer Shaft | 4 | 10 |
| MV1905 | Shunt Rheostat | 8 | 10 |
| MV1300-405 | Power Pack 3-ph, supply 400 V, out 230 V | 4 | 11 |
| MV1903-235 | Synchronizing Device 220-240 V 50-60 Hz | 4 | 11 |
| MV1417 | Terminal Board | 4 | 12 |
| MV1500 | Load Switch, 3-pole 16A | 4 | 12 |
| MV1502 | Reversing Switch | 4 | 12 |
| MV1503 | Star-Delta Starter for 3-ph Machines | 4 | 12 |
| MV2636 | Starter AC- and DC-Motors, Classic | 4 | 12 |
| MV1100-235 | Load Resistor 3-ph 3.3 kW | 4 | 13 |
| MV1101 | Load Reactor, 3-phase, 2.5 kVAr | 4 | 13 |
| MV1102 | Load Capacitor, three-phase 2.8 kVAr | 4 | 13 |
| MV1700 | Stationary Laboratory Table | 3 | 14 |
| MV1003 | Mobile Test Bench | 1 | 14 |
| MV1830-HF | Flex Set, 100 Safety Leads, Safety Plugs | 4 | 15 |
| MV1904 | Flex Stand | 4 | 15 |
| Instruments | | | |
| MV 1939AC | Power Energy Meter | 4 | 16 |
| MV 1941 | DC Measuring Unit | 4 | 17 |
| Phase Cop 2 | Phase Sequence Indicator | 4 | 17 |
| Options Electrical Machines | | | |
| MV1027-235 | Synchronous Machine, salient poles, 230 V Y 50 Hz | 4 | 9 |
| For other electrical machines see pages | | | 30-37 |
| Other Accessories see pages | | | 38-37 |
| Data Acquisition and Control Software see pages | | | 20-22 |

Equipment Lists

Torque Meter Set, Digital

Suitable equipment when using MV1054 Torque measuring unit. One of each product, unless otherwise indicated below.

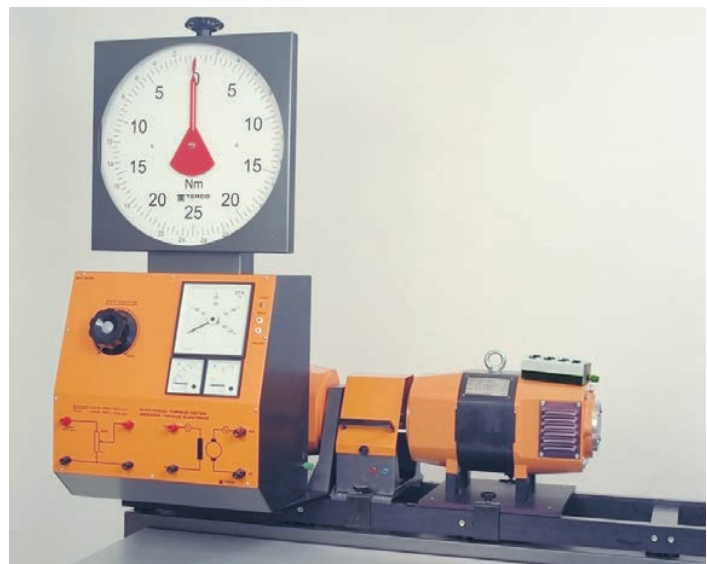
| | |
|--------|--------------------------------------|
| MV1054 | Torque and Power Meter |
| MV1028 | DC Machine (alt. MV 1034) |
| MV1003 | Mobile Test Bench (alt. MV 1700) |
| MV1004 | Machine Bed |
| MV1005 | Pallet for Machines (3 pcs) |
| MV1006 | DC Machine |
| MV1007 | Slip Ring Motor |
| MV1008 | Synchronous Machine |
| MV1009 | Squirrel Cage Motor |
| MV1010 | Flywheel |
| MV2636 | AC and DC Starter |
| MV1100 | Load Resistor |
| MV1101 | Load Reactor |
| MV1102 | Load Capacitor |
| MV1300 | Power Pack (alt. MV 1302 or MV 1304) |
| MV1903 | Synchronizing Unit |
| MV1417 | Terminal Board |
| MV1500 | Load Switch |
| MV1502 | Reversing Switch |
| MV1503 | Star-Delta Switch |
| MV1905 | Shunt Rheostat (2 pcs) |
| MV1830 | Lab Flex Set (alt. MV 1830-HF) |
| MV1904 | Flex Stand |



Electrical Torque Meter Set, Analogue Dial

Suitable equipment when using MV1036 Torque measuring unit. One of each product, unless otherwise indicated below.

| | |
|--------|--------------------------------------|
| MV1036 | Electric Torque Meter (alt. MV 1026) |
| MV1003 | Mobile Test Bench (alt. MV 1700) |
| MV1004 | Machine Bed |
| MV1005 | Pallet for Machines (3 pcs) |
| MV1006 | DC Machine |
| MV1007 | Slip Ring Motor |
| MV1008 | Synchronous Machine |
| MV1009 | Squirrel Cage Motor |
| MV1010 | Flywheel |
| MV2636 | AC and DC Starter |
| MV1025 | Tachogenerator with cover |
| MV1100 | Load Resistor |
| MV1101 | Load Reactor |
| MV1102 | Load Capacitor |
| MV1300 | Power Pack (alt. MV 1302 or MV 1304) |
| MV1903 | Synchronizing Unit |
| MV1417 | Terminal Board |
| MV1500 | Load Switch |
| MV1502 | Reversing Switch |
| MV1503 | Star-Delta Switch |
| MV1905 | Shunt Rheostat |
| MV1830 | Lab Flex Set (alt. MV 1830-HF) |
| MV1904 | Flex Stand |



Terco Data Acquisition and Control Package

The system contains of an combination of Measuring units, Control Units, Data Interface Module and Data acquisition software, enabling the user to observe, control, record and investigate relevant electrical data. A typical application is electrical machines laboratory.

Measuring units

Electrical and mechanical information about the monitored system are obtained by connecting one or more of the following products:

MV1941 DC Measuring Unit
See page 17



MV1939 AC Power Energy Meter
See page 16



Modbus System

MV1943 Analogue Output Module



MV2609 Data Acquisition and Control Software



MV2658 PWM DC Control Module See page 23



MV1054 Digital Torque-, Speed- and Shaft Power Meter.
See page 5



Each of these units are equipped with communication capability using the industry standard Modbus protocol.



Electrical Machines lab Setup

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.



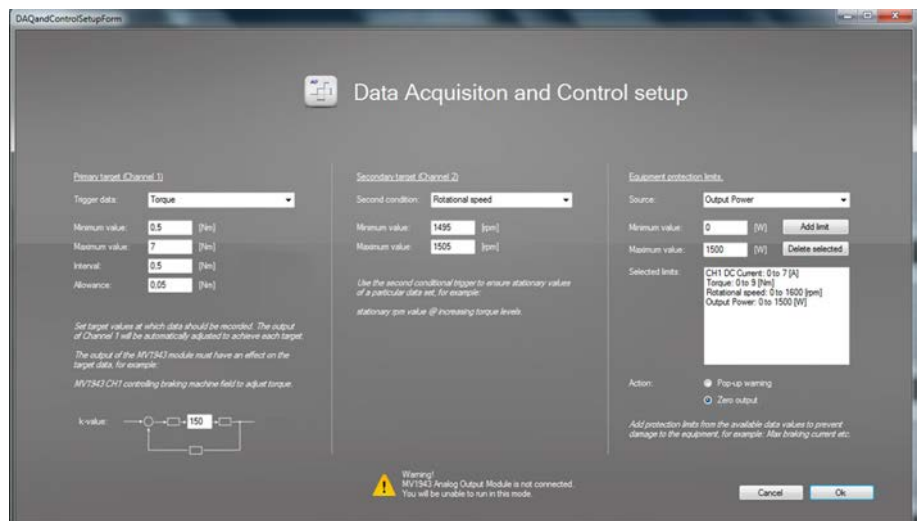
Pre-configured experiment setups are included but the experiment presentation window is fully customizable, allowing the user to select available hardware, define data columns and set up graph parameters such as data sources and titles.

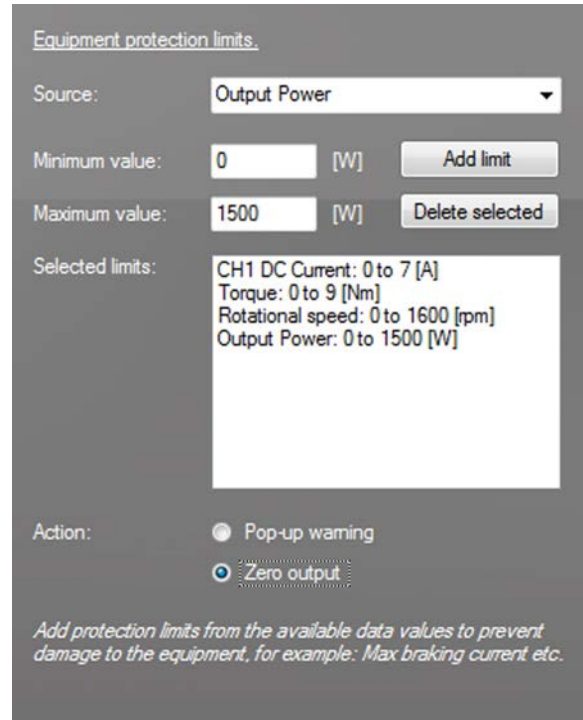
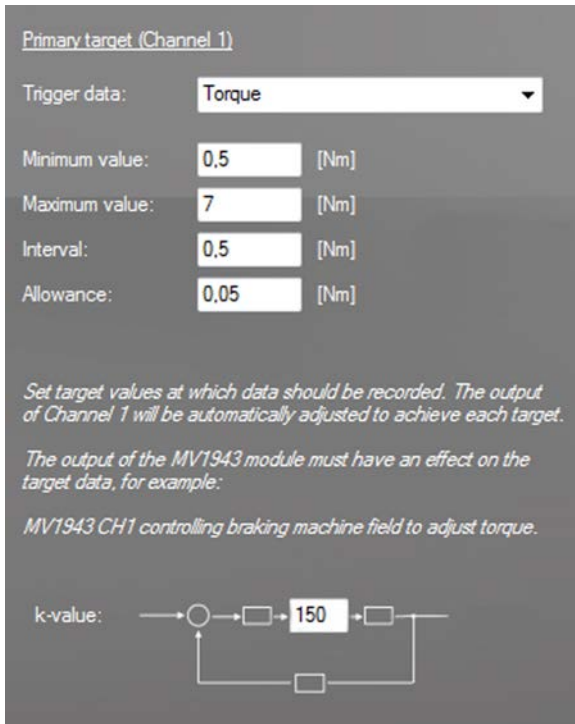
The software is designed to work with Terco Modbus instruments but may be set up to communicate with many Modbus devices.



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.





Desired measurement points may be entered, after which the software will attempt to steer the connected machine and attain the data automatically. Protection limits may also be set for all monitored instruments in order to eliminate mechanical and/or electrical overstressing of the system.

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 | 105mm x 147mm x 167mm |
| Weight | 300g |
| Operating environment | 0 to 70°C, 10 to 90% relative humidity, non-condensing |

MV2658 PWM DC Control Module

MV2658 is an indispensable equipment in the electrical machines laboratory as it can be used in several different types of applications. It can be used as a DC-Machine Drive in the range up to 1.2kW, a Generator Field Controller (VAR controller), or a Machine Brake Controller suitable with Terco equipment in the range up to 3.3kW (see section 3 applications).

Technical Specifications

- PWM (16kHz) Based Excitation Voltage 0-260VDC.
- Selectable Current Limit Levels (front panel switch): 1.7ADC, 2.5ADC, 3.5ADC, 5.0ADC, 7.5ADC.
- Fixed Excitation Output 200VDC (for DC Drive application).
- PWM Controlled Excitation on the front panel control (0-100% Duty Cycle) or from the control input (fully isolated, 0-10VDC = 0-100% Duty Cycle).

The control input can be used for instance in PC based control together with Terco DAQ software. (Optional analog output interface unit necessary).

- Control Methods selectable between PWM Controlled Excitation Voltage Feedback and External Analog Voltage Feedback.
- Power Supply 220-240VAC, 50/60Hz
- Dimensions: 255 x 195 x 330mm
- Weight: 8kg (approximatly)



SM 2652 4-Quadrant DC Controller

SM2652 is an isolated 4 Quadrant speed controller for separately magnetized or permanent motors. It utilizes speed feedback from the armature voltage (A_v), or from a shaft mounted tachogenerator. It incorporates a fully controlled anti-parallel thyristor bridge for supplying and absorbing power during the forward or braking conditions.

Technical Specifications

- Power Supply 220-240VAC, 50/60Hz
- Frequency 50 – 60 Hz
- Mains supply fuses Diazed, 250 V/20A, ultra fast.
- Mains voltage control Switch/ind. Lamp
- Armature voltage 0 – 170 V DC
- Armature current 0 – 6.8 A DC
- Field voltage, approximately 170 V DC
- Field current 2 A DC maximum
- Tacho voltage typically 15 V per 1000 rpm



- Dimensions 250 x 200 x 310mm
- Weight (kg) 1 kg

Potentiometer controls:

Settings which are available from the potentiometers include: Current limit, Current proportional (Current integral automatic), IR compensation, Speed proportional, Speed integral, Maximum speed calibration, Zero speed adjust, Ramp up, Ramp down.

Diagnostics LEDs:

Diagnostic indications are provided for: Power ON, Stall trip, Over current, PLL (Phase Locked Loop) and Current limit

Operational controls:

- Mains switch Mains to power terminals L1/N ON
- RUN (switch) on Trigger signals ON
- Feed back selector switch VA or tacho generator
- Experiment potentiometers 2 pc 10kohm
- Experiment switches 2-way 2-pole selector switches , 2 NO push buttons

MV4213 Voltage, Current & Power Module

The MV4213 Voltage, Current & Power Module is a very handy and useful probe for studying single and 3-phase rectifiers for 4Q-drives. The instantaneous values of voltage (u), current (i) and power (p) can be studied simultaneously on a standard type double beam oscilloscope in a 3-channel mode of operation by the built-in multiplexer function via two BNC-outputs. This will clarify and enable the understanding of the energy conversion between AC- and DC-networks when operating the machines between M/G and G/M modes.



Technical specifications

| | | | |
|-----------------------|------------------|-------------------------|---|
| Voltage input nominal | 500VAC/DC | Galvanic isolation | >1.5kV |
| Voltage output | (BNC u) +/-10V | Accuracy max | 5kHz 1% |
| Galvanic isolation | >1.5kV | Potentiometer controls: | GAIN (p), ZERO (p), GAIN (i), ZERO (i) |
| Accuracy max | 5kHz 1% | Auxiliary power supply: | 230VAC, 50VA |
| Current input nominal | 10AAC/DC | Dimensions | 330x250x145mm |
| Current output | (BNC i/p) +/-10V | Weight | 4.8kg |
| Galvanic isolation | >1.5kV | | |
| Accuracy max | 10kHz 1% | | |
| Power output | (BNC i/p) +/-10V | | |

Operating method of power section: Multiplication of the instantaneous values of voltage and current AC/DC

MV2661 AC-CONTROL

The MV2661 is an AC drive primarily designed for speed control of a 3-phase squirrel cage induction motor. Its purpose is to create a sinusoidal (or close to) 3-phase voltage that is connected to the stator of an AC-motor. The AC-drive controls the pulse width and the frequency of the supplied voltage and can therefore keep the motor running at constant speed although the mechanical load applied at the rotor shaft varies. The AC drive includes an autotune-function which automatically identifies the electrical and mechanical parameters of the connected induction motor.



The drive is capable of operating machines up to 1.5kW. It controls the output voltage 0-240V and frequency 0.1-600Hz. The maximum output current is 7.5A and the input current 15.7A (fuse size 15A).

It is mainly designed to operate together with Terco MV-machines, which are sized 1.1 – 1.5kW.

The AC CONTROL MV2661 is furtheron equipped with an internal brake chopper and an internal brake resistor which makes it possible to study short ramp time braking coarses.

All essential signals are connected to the front to make it possible not only to run typical experiments verifying the theory but also to make it possible to run the drive out of more advanced industrial aspects.

Technical specifications

| | | | |
|------------------------------|------------------------|---------------------|---------------------------------|
| Max. Applicable Motor Output | 1.5kW | Power Supply | 220-240VAC, 50/60Hz, 50/60Hz |
| Rated Output Capacity | 2.9kVA | Voltage Tolerance | +/-10% (180-264V) |
| Rated Output Current | 7.5A | Frequency Tolerance | +/-5% (46-63Hz) |
| Maximum Output Voltage | 3-ph prop. to input V. | Dimensions | 340x250x150mm |
| Rated Input Current | 15.7A (Fused 15A) | Weight | 6.2kg |

MV4207-1 DC-Motor Drive

Single-phase 4-Quadrant Rectifier. The Motor Drive is provided with a CE 3-Phase plug because neutral and phase must not be shifted.

Covers the latest development in DC-motor operation with analogue control. The equipment is designed to work according to different industrial environments. The drive has signal in- and outputs for connections to slave and/or master drives.

To cover a wider range of machines regarding voltage and speed the primary supply is taken from a standard 3-phase outlet which will supply the inverter bridges by 1-phase 230V.

The design will enhance the possibilities of learning the theory and practice of understanding the operation of 4Q-drives for both single drives and the basic understanding of three bridges and their commutation.

The 4-Q-DC-Drive can be used in the conception of speed/torque control versus electro-machine theory.

When braking, the energy is transferred directly to the supplying network by operating in all four quadrants.



Technical Specification

Input voltage: 3-phase 3 x 400 V + N + PE, 50-60 Hz

Input max current: 16 A, rotor inductance is included

Output voltage: 0-250 V DC

Output current: 0 - 12 A (max 16 A)

Nominal output power: 2 kW

Design: Tutorial where the 4Q industrial/professional aspects are enhanced

Control: Manually operated Digital / Analogue

Front control parameters: 12

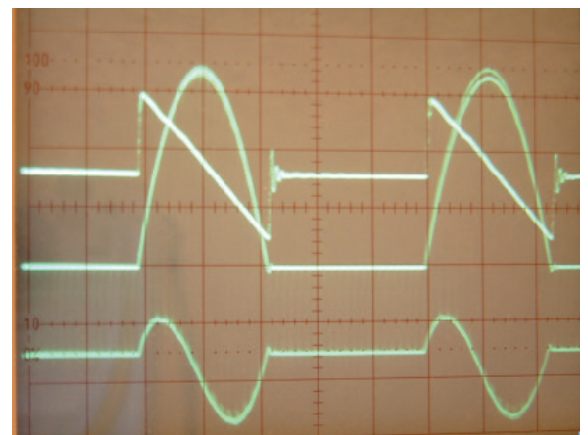
Feedback: DC-tacho or armature voltage

Built-in unit for immediate: U+I+P signals, isolated, including MUX for oscilloscope.

Built-in protections and contactor relays

Dimensions 520 x 450 x 280 mm

Weight 23 kg



Standard Settings

12 Parameters are set manually:

Typically: Speed, Max Speed, Acc ram, Flux, Ret ramp, Ilim, Current/Speed proportional, Current demand in/out, etc.

Floating switches and potentiometers are used to study step response and stability.

The results of the dynamic response regarding voltage, current and immediate power can be studied fully isolated on a standard oscilloscope via the built in isolation amplifier and multiplexer.



Manuals

Consist of a theory section and an exercise section. The theory part explains for example general theory of the conditions for torque developed in an arbitrary machine, while the exercise section contains theory sections that are directly connected to the different experiments. The Manual consists of a complete binder together with an additional section, which will explain the UIP-unit (Voltage/Current/Power – unit) together with oscilloscope snap-shots showing different operation modes of the rectifier.

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

MV4207-3 DC-Motor Drive

Three-phase 4-Quadrant Rectifier, Three-Phase supply

Covers the latest development in DC-motor PC-controlled operation with 6 pulse 4Q rectifiers. The equipment is designed to work according to different function principles and it is possible to explain several different types of DC-drives depending on the purpose and industrial environment from traction to paper- and steel mills.

Output current/voltage can be chosen to optimize torque/angular speed or to optimize other parameters by using a PC and the enclosed software.

When braking, the energy is transferred directly to the supplying network by operating in all four quadrants.

The field rectifier can be programmed manually or from a PC for optimized field control.

The 4Q DC Drive can be used in the conception of speed/torque control versus electro-machine theory. The equipment is also suitable for experiments and tests in industrial applications.



Technical Specification

Input voltage: 3-phase 3 x 400 V + N + PE, 50-60 Hz

Input max current: 16 A

Output voltage: 0 - 230 V DC (programmable to 0-400V)

Output current: 0 - 12 A (max 16 A)

Nominal output power: 2 kW (max 3 kW)

Design: Tutorial but with the PC-controlled industrial / professional aspects enhanced.

Control modes: Manually by front components, Manually by Operator Station, PC by RS 232 + "DELite" + software

Front controls: Manually Digital > 20, Analogue > 4

Configuration: by PC or Operator Station

Self-tuning: by PC or Operator Station

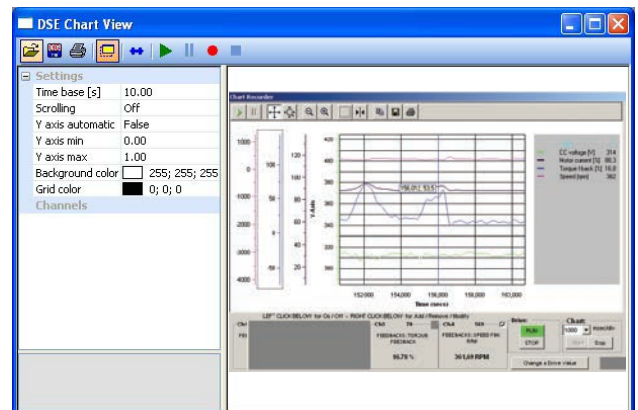
Built-in protections and contactor relays

Dimensions 520 x 450 x 280 mm

Weight: 25 kg

Built-in Instrument Functions

The enclosed software will make it possible to configure the internal connections and operating principles by using a standard PC. On the screen it is possible to monitor 3 analogue instruments and edit a number of signals/parameters in parallel, which can be saved and printed. The number of parameters/tags possible to study exceeds 200.



Standard Settings and Advanced Settings

Most parameters are set by default but settings can also be done manually from the front controls: Typically: Speed, Max Speed, Acc ram, Flux, Ret ramp, I-lim etc. Advanced settings, >200 parameters/tags, are performed by Operator Station on the unit, PC nearby the unit, connected to COM1 (COM2).

Manuals

Consists of a large quantity of experiments where related theoretical analyzes and explanations are performed in each experiment. Experiments furtheron covers basic operation and autotuning as well as more advanced operation directly from the drive keypad (operator station) or from PC where signal analysis also are possible by means of the chart recorder and the oscilloscope function.

MV4206-1 AC-Motor Drive

Three-Phase supply, semi 4-Quadrant Drive

Semi 4Q frequency converter with MOS FET technique and a fixed intermediate DC-link.

Covers the latest development in AC-motor operation with frequency converters. The equipment is designed to work according to different function principles and it is possible to explain several different types of frequency converters existing today.

4-Q-Drive: The Frequency Converter can be used in the conception of speed/torque control and electro-machine theory. The equipment is also suitable for experiments and tests in industries i.e. far beyond the area that the experiments show.

When braking, the energy is transferred by the DC-link and a brake chopper to a built-in load resistor.

There is also an additional adjustable DC-injection brake.

Technical Specification

Input voltage: 3-phase 3 x 400 V + N + PE, 50-60 Hz

Input current: 16 A max

Output Power: 1.5 kW

Output voltage: 3 x 230 V

Max output current: 7 A

Max output frequency: 100 Hz

Choice of polygon: automatic

Breaking points: automatic

Internal switch frequency: 3 kHz max

Type of modulation: PWM sensorless vector

Intermediate DC-voltage: average value 300 V DC

Inverter bridge: MOSFET

Control voltage: +/- 10V DC analog, 0-24V DC Digital

Dimensions 520 x 450 x 280 mm

Weight 16 kg

Built-in Instruments Functions

The enclosed software will make it possible to configure the internal connections and operating principles by using a standard PC. On the screen it is possible to monitor 3 analogue instruments and scroll a number of signals/parameters in parallel, which can be saved and printed. The number of parameters/tags possible to study exceeds 200.

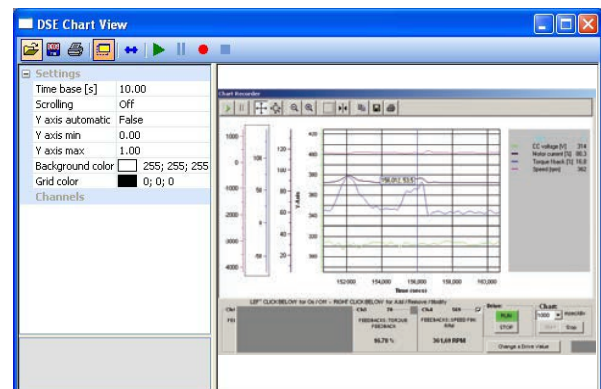
Standard Settings and Advanced Settings

Most parameters are set by default but settings can also be done manually from the front controls: Typically: Speed, Max Speed, Acc ram, Flux, Ret ramp, I-lim etc.

Advanced settings: >200 parameters/tags, are performed by Operator Station on the unit, PC nearby the unit, connected via the comport.

Manuals

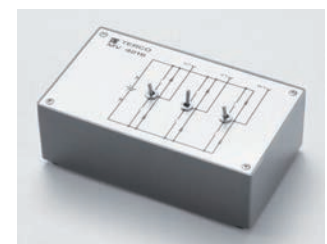
consist of a theory section and exercise section together with a software description. The theory part explains for example general theory of the conditions for torque developed in an arbitrary machine, while the exercise section contains theory that are directly connected to the different experiments. The instruction manual is enclosed as a complete binder together with a corresponding CD.



MV4216

Inverter Bridge

The MV 4216 is used to simulate AC-converter working principles. It is hand operated.



The unit consists of DC-input in connection with 3 two directional switches with zero position, and a 6 pulse rectifier bridge for feedback of reactive power to the DC-side.

Technical specifications

Dimensions 150 x 90 x 50 mm

Weight 0.3 kg

MV4250 Asynchronous Wind Mill System including HVDC Light Transmission Cable

The total system is integrated in one single unit:

- Controls for asynchronous machine
- Necessary instruments
- Magnetizing capacitors
- Compensating inductances
- Variable resistive load
- HVDC-light cable (two distances)
- Advanced 4Q 3-ph line inverter which is manually, MMI- or PC-operated.



Background

Depending on energy prices, negative influence on the environment, running on the edge of available power, transmission costs and the risk of local black-outs the need for alternative energy sources is obvious. Wind power has been existing in a smaller scale for decades but are now used as an important power producer in parallel with the classic energy sources.

The former drawbacks like expensive turbines, generators, gear-boxes and conventional transmission lines together with disturbances on the environment are now overcome to a great extent.

It is now possible to use a cheap turbine with firm blades designed for floating speed with an operating range from low to higher speeds. The turbine is connected mechanically to a conventional asynchronous machine (self exciting induction motor), which is the cheapest and most sturdy machine available in the market. For bigger units synchronous generators equipped with permanent magnets are standard. In this case we will study a type of wind mill used up to some hundred kW. These windmills can be put out in the sea along the coastline and the power is transferred to the grid network by HVDC-light cables on a floating voltage level which by means of modern technology is transformed to conventional 3-ph 50 (60) Hz energy.

Description

The Wind Mill Control Unit (MV4250) is designed to be connected to an external standard type induction machine (optional) to simulate the wind turbine, which speed can be varied. By means of the MV4250 the asynchronous motor/generator will be self excited and deliver a lower or higher 3-phase voltage of different frequencies. There is a continuously controllable built-in resistive load bank to give the induction generator different working points or break-down points. By the built-in capacitor bank the excitation can be increased gradually to buffer increasing load. A group of compensating inductances will keep the voltage level within reasonable limits. A 3-phase rectifier bridge will supply the output side with a floating DC-voltage which can either be loaded by the internal resistive loads or connected to a HVDC-light line model which is feeding an advanced 3-ph 6-pulse 4Q converter. The converter is operating against the infinite bus in a floating voltage current limitation mode turning the DC-energy to 3-ph 50 (60) AC.

There are instruments for AC- and DC voltages and ammeters for AC-input power, inductive current and capacitive current together with a DC-ammeter on the output to give a clear view of the generator operation.

The rather complex procedure of turning floating voltage DC-energy to 3-ph 50 (60) Hz AC is studied thoroughly since most types of windmills are using this method.

Jumpers will give possibilities to connect other instruments like watt-meters (optional).

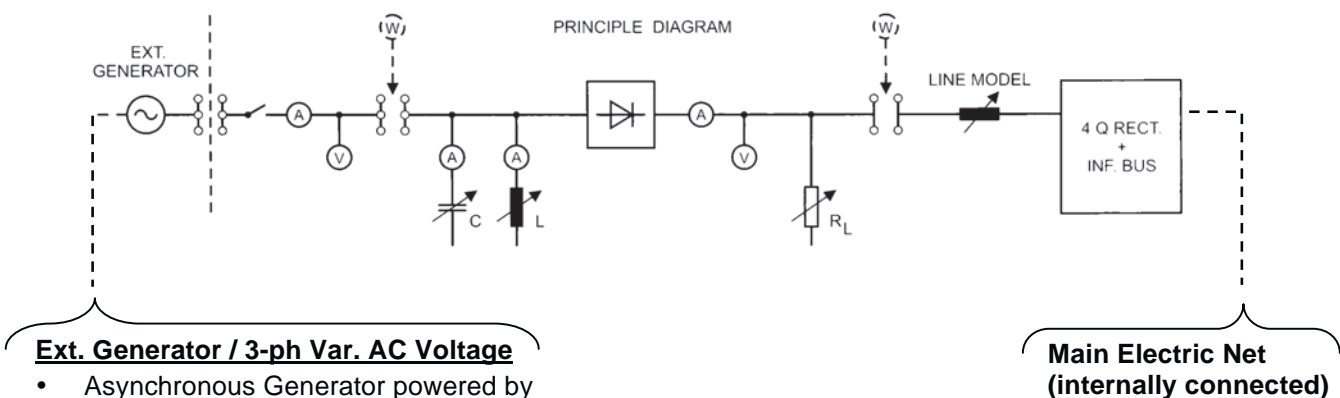
Principle diagrams are printed on the front plate (see below).

Examples of experiment setups

- Self exciting of an asynchronous motor/generator
- Working points depending on speed and capacitance
- Working characteristics depending on resistive loads
- The influence of compensating inductances
- Total efficiency depending on involved parameters
- Magnetising currents and risk for over-excitation
- Rotating currents
- Principles of floating speed and frequency
- HVDC-light cables
- Principles of DC energy transfer using a 4Q-converter operating in current limit mode at floating voltage
- Operating the main converter manually, via MMI or by PC

Technical Specifications

| | |
|--|--|
| Minimum/maximum power by design | 0,5 – 2,0 kVA input |
| Magnetising capacitors | by 3-step selector switch |
| Compensating inductors | by 3-step selector switch |
| Resistive load bank on DC-side | continuously controlled by PWM-unit |
| 3-phase rectifier block | |
| V-meter for AC-input | 250 V AC |
| V-meter for DC-output | 400 V DC |
| A-meter for AC-input | 6 A AC |
| A-meter for capacitive current | 6 A AC |
| A-meter for inductive current | 4 A AC |
| A-meter for DC-output | 6 A DC |
| Short- and long HVDC cable model | |
| | |
| Suitable induction machine std (or optional) | 0,75 – 1,5 kW |
| Advanced 4Q-converter including software | >1,5 kW |
| | |
| External alternative inputs from | 3x230 V generator, ind. or synchr., 3x230 V power supply max 300 V DC |
| | |
| Power supply | 3x400 V AC, 16A, 50 – 60 Hz |
| | |
| Dimensions | 510x360x570 mm |
| Weight | 45 kg |



Ext. Generator / 3-ph Var. AC Voltage

- Asynchronous Generator powered by Asynchronous Motor to simulate the windmill blades turning.
- 3-ph Variable AC Voltage directly connected to simulate the windmill generator.

Main Electric Net (internally connected)

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

MV1015-405 Reluctance Motor

A reluctance motor starts as an induction motor, but operates normally as synchronous motor. A three-phase reluctance motor is self-starting when started as an induction motor. After starting, in order to pull it into step and then to run it as a synchronous motor, the reluctance motor has low rotor resistance. Some rotor teeth are removed to form a typical construction of a four-pole rotor.

| | | |
|------------------|---------------------|------------------|
| General Data | 50 Hz | 60 Hz |
| Power | 0.9 kW | 0.9 kW |
| Speed | 1500 rpm | 1800 rpm |
| Delta Connection | 220-240 V, 6.4 A | 220-240 V, 6.4 A |
| Dimensions | 360 x 300 x 310 mm | |
| | Shaft height 162 mm | |
| Weight | 25 kg | |



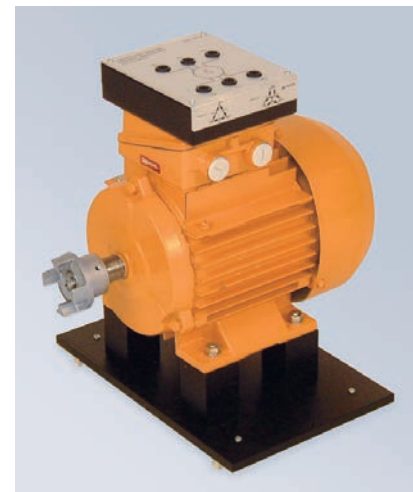
MV1015-695 Reluctance Motor

Same as MV 1015-235 but for 380-415 V, 3-phase, Delta.

MV1017-235 Induction Dahlander Motor

The winding of the Dahlander motor is arranged in a way, that by connecting in different formations 2 speeds are available. Switching can be performed using a cam switch or using contactors.

| | | |
|--------------|---------------------|------------------|
| General Data | 50 Hz | 60 Hz |
| Power | 0.9 / 1.3 kW | 0.9 / 1.3 kW |
| Speed | 1400 / 2800 rpm | 1680 / 3310 rpm |
| Voltage | D / YY 220-240 V | D / YY 220-240 V |
| | 3-phase | 3-phase |
| Current | 5.4 / 4.7 A | 5.4 / 4.7 A |
| Dimensions | 355 x 300 x 340 mm | |
| | Shaft height 162 mm | |
| Weight | 17 kg | |



MV1017-405 Induction Dahlander Motor

As MV 1017-235 but for 380-415 V 3-phase

MV1018 Universal Motor

This is a commonly used motor in domestic appliances. It can be run on DC or AC 1-phase. The rotor is connected in series with the field winding and supplied via the commutator and brushes.

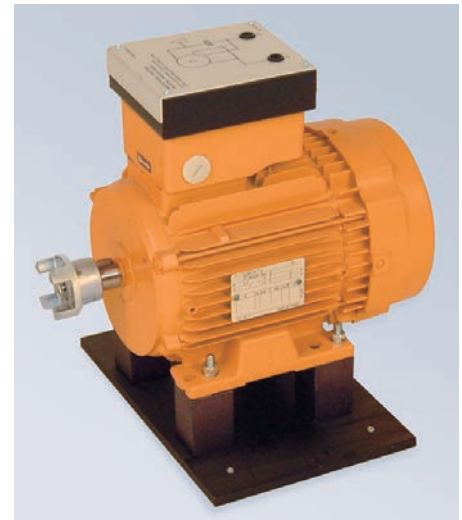
| | |
|--------------|---|
| General Data | |
| Power | 1 kW DC at 2600 rpm 0.4 kW AC |
| Speed | 3000 rpm at 50 Hz 3600 rpm at 60 Hz |
| Voltage | 220-240 V AC / DC |
| Current | 8 A AC 7 A DC |
| Dimensions | 465 x 300 x 310 mm Shaft height 162 mm |
| Weight | 39 kg |



MV1020 Induction Motor Capacitor Start

The capacitor assisted starting winding is disconnected from the circuit when the motor has built up speed, by means of a relay.

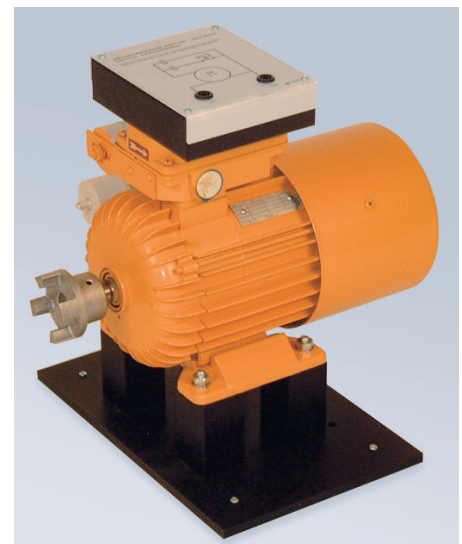
| | | |
|--------------|---------------------|-----------|
| General Data | 50 Hz | 60 Hz |
| Power | 0.75 kW | 0.75 kW |
| Speed | 1425 rpm | 1710 rpm |
| Voltage | 220-240 V | 220-240 V |
| | 1-phase | 1-phase |
| Current | 6.8 A | 6.8 A |
| Capacitors | 310 uF | 310 uF |
| Dimensions | 350 x 300 x 350 mm | |
| | Shaft height 162 mm | |
| Weight | 24 kg | |



MV1037 Induction Motor Cap. Start and Run

To obtain a higher starting torque, the starting winding has a capacitor connected in series. Continuous rating of start winding allows the circuit to remain the same during starting and running.

| | | |
|--------------|---------------------|------------------|
| General Data | 50 Hz | 60 Hz |
| Power | 0.75 kW | 0.75 kW |
| Speed | 1430 rpm | 1715 rpm |
| Voltage | 220-240 V | 220-240 V |
| | 1-phase | 1-phase |
| Current | 5.4 A | 5.4 A |
| Capacitors | 25uF and 100 uF | 25 uF and 100 uF |
| Dimensions | 320 x 300 x 350 mm | |
| | Shaft height 162 mm | |
| Weight | 20 kg | |



MV1030-235 Induction Motor 2 Speed 2 Windings

This motor unlike MV 1017 which has only one set of windings, has 2 separate sets of windings for high and low speed.

| | | |
|--------------|---------------------|-----------------|
| General Data | 50 Hz | 60 Hz |
| Power | 0.8 / 1.0 kW | 0.8 / 1.0kW |
| Speed | 930 / 1440 rpm | 1120 / 1730 rpm |
| Voltage | 220-240 V | 220-240 V |
| | 3-phase | 3-phase |
| Current | 4.7 / 6.0 A | 4.7 / 6.0 A |
| Dimensions | 450 x 300 x 340 mm | |
| | Shaft height 162 mm | |
| Weight | 24 kg | |



MV1030-405 Induction Motor 2 Speed 2 Windings

As MV 1030-235 but for 380-415 V, 3-phase.

MV1031 Induction Motor Thermistor Protected

This squirrel cage motor has a thermistor built into the windings for temperature control of the motor.

Thermal relay MV 1032 is used in conjunction with this motor.

| | | |
|--------------|---------------------|-------------------|
| General Data | 50 Hz | 60 Hz |
| Power | 1.1 kW | 1.1 kW |
| Speed | 1400 rpm | 1700 rpm |
| Voltage | 380-415/220-240 V | 380-415/220-240 V |
| | 3-phase | 3-phase |
| Current | 3.0 / 5.2 A | 3.0 / 5.2 A |
| Dimensions | 340 x 300 x 310 mm | |
| | Shaft height 162 mm | |
| Weight | 22 kg | |



MV1032 Thermal Relay

This is a control unit against overheating of motor MV 1031. Most electrical machines withstand today 140°C or more. However, it takes a long time to reach this temperature and the lab time is limited in the laboratory. Therefore we have chosen a cut off temperature at 60°C for the experiments.

| | |
|------------|-------------------|
| Dimensions | 130 x 245 x 95 mm |
| Weight | 1 kg |



MV1047 Asynchronous Motor, 3-Phase Demonstration Set

The components of a type MT 63 induction motor are mounted on a wooden board. Only a screwdriver is needed to assemble the motor, and to permit repeated assembly and dismantling.

A 40 V, 3-phase, 50/60 Hz supply is recommended for test-ing the operation of the motor.

| | |
|------------|--------------------|
| Dimensions | 480 x 400 x 150 mm |
| Weight | 7 kg |



MV1046 3-Phase Squirrel Cage Motor with Fault Simulator



The equipment MV 1046 comprises :

- 1 3-phase squirrel cage motor
- 1 Fault simulator
- 1 Plug-in device
- 1 Insulated cable 4 x 1.5 RDV
- 1 Technical description with instructions for fault switching positions.

Motor

The motor is a standard, 3-phase squirrel cage induction motor (MT 80 A) of which the windings are fitted with outputs to allow fault simulation. These outputs are connected to a terminal with a multi-pole socket.

Fault Simulator

The fault simulator, which comprises a wooden box with a lid and a built-in panel with 11 switches to simulate different faults, has a cable trunk fitted with a multi-pole plug. This plug is intended for connection to the multi-pole socket on the motor's terminal. This connection connects the switches of the fault simulator to the windings of the motor.

Plug-in Device

The fault simulator can be disconnected and replaced by a plug-in terminal device. The motor will then operate normally.

Insulated Cable

The insulated cable is used for the simulation of failures in the input voltage.

The equipment is particularly well suited for fault finding exercises with squirrel-cage induction motors. The following types of faults can be simulated: phase failure of supply voltage, open-circuit winding, short-circuit winding and earth fault.

General Data MV 1046

| | |
|----------------------------|--------------------|
| Supply voltage | |
| 380-415 V 3-phase (Y) | |
| Frequency | 50/60 Hz |
| Power | 0.55 kW |
| Dimensions Fault Simulator | 290 x 270 x 55 mm |
| Dimensions Motor | 270 x 150 x 205 mm |
| Weight (Total) | 13 kg |

MV1305 Mobile Motor / Generator Unit



MV1305 Mobile Motor / Generator Unit

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.

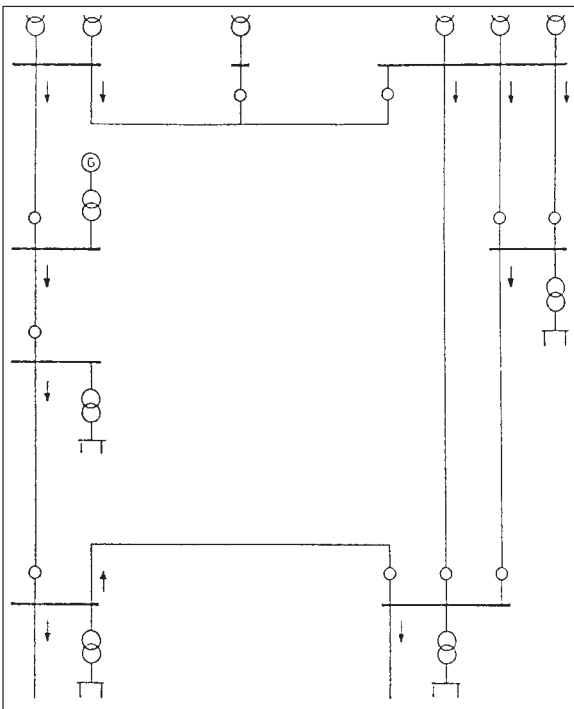
Modes of Operation

- A. Control of active power (frequency): AC-machine and frequency converter drive ("turbine") + synchronous machine (generator) in closed loop connection regarding frequency.
- B. Control of active power (frequency) and reactive power (voltage): Two closed loops regarding frequency and voltage.
- C. 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.

Technical Specification

| | | MV 1305-405 | MV 1305-235 |
|-------------------------------|-------------------------|---|--------------------|
| Power Supply | Voltage | 380-415 V AC 3-ph | 380-415 V AC 3-ph |
| | Frequency | 50 Hz | 50 Hz |
| | Max current | 16 A | 16 A |
| Turbine/AC-machine freq.drive | Armature/stator Volt | 323-528 V AC | 323-528 V AC |
| | Frequency | 47-63 Hz | 47-63 Hz |
| | Armature/stator current | 3,4 A | 3,4 A |
| | Input current | 5,9 A | 5,9 A |
| | Rated output current | 4,0 A | 4,0 A |
| | Rated output capacity | 3,2 kVA | 3,2 kVA |
| | Speed | 0-1800 rpm | 0-1800 rpm |
| Synchronous generator | Armature volt | 0-240 / 415 V AC | 0-140 / 240 V AC |
| | Power | 1.2 kVA | 1.2 kVA |
| | Cos | 0.8 | 0.8 |
| | Field volt | 0-230 V DC | 0-230 V DC |
| | Speed | 0-1800 rpm | 0-1800 rpm |
| Speed control/ | | | |
| 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 | |

Figure 1



A typical network with generators and synchronous compensators

MV 1305-406 Same as MV1305-405 but with a power supply and a synchronous generator for 60 Hz.

MV 1305-236 Same as MV1305-235 but with a power supply and a synchronous generator for 60 Hz.

Instruments:

AC-machine freq.drive (Turbine simulator) 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) (r 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 slid rails. 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.)

Sectioned Motors and Transformer

Not for connecting to the main and operation!

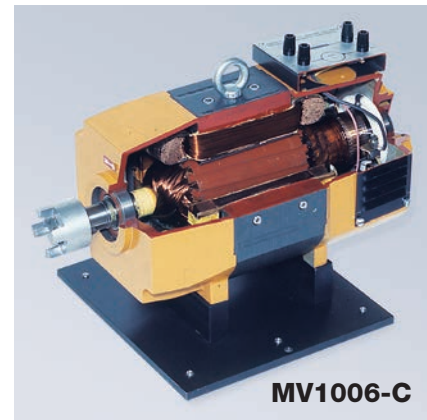
The machines are sectioned about 90° allowing all the main components to be demonstrated clearly and in an educational way.

Please note : It is not possible to do any practical experiments with the machines and transformer.

MV1006-C DC Machine

This machine is cut-away to show commutator, brushes, rotor, stator, windings, ball-bearings.

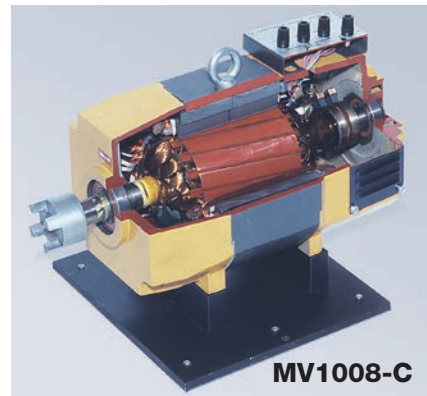
| | |
|--------------|--------------------|
| Rated power | 1.0 kW |
| Dimensions | 465 x 300 x 310 mm |
| Shaft height | 162 mm |
| Weight | 40 kg |



MV1008-C Synchronous Machine

This machine is cut-away to show slip-rings, brushes, rotor, stator, windings, poles, ball-bearings etc.

| | |
|--------------|--------------------|
| Rated power | 1.0 kW |
| Dimensions | 465 x 300 x 310 mm |
| Shaft height | 162 mm |
| Weight | 35 kg |



MV1007-C Induction Motor Slip-Ring

This motor is cut-away to show slip-rings, brushes, rotor, stator, windings, poles, fan, ball-bearings, etc.

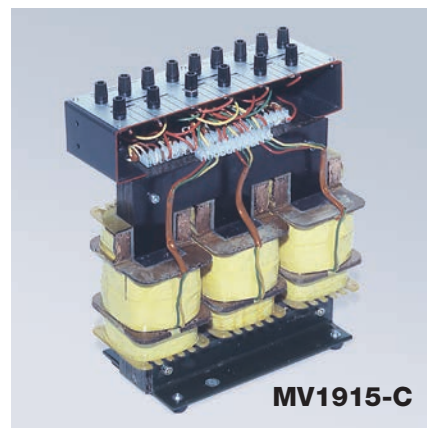
| | |
|--------------|--------------------|
| Rated power | 1.1 kW |
| Dimensions | 440 x 300 x 350 mm |
| Shaft height | 162 mm |
| Weight | 37 kg |



MV1009-C Induction Motor Squirrel Cage

This motor is cut-away to show rotor, stator, windings, poles, fan, ball-bearings, etc.

| | |
|--------------|--------------------|
| Rated power | 1.1 kW |
| Dimensions | 355 x 300 x 310 mm |
| Shaft height | 162 mm |
| Weight | 15 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 |

Other electrical machines and transformers than those above can be cutaway on request.

Motor-Generator Set-Up with Flywheel



MV1028 DC-machine is coupled via a MV1010 Flywheel to MV1008 Synchronous Machine. Either machine can act as a motor. The above motor-generator is a set to determine moment of inertia and losses in a synchronous machine with large moment of inertia, symbolized by a flywheel. Of course it is possible to add the MV1054 Torque Measuring unit to measure the torque if wanted. This set is also suitable for AC- generator tests as it is of little interest to know the torque when testing generators.

Machine Test Set

One of each product, unless otherwise indicated below.

| | |
|---------|--------------------------------------|
| MV 1028 | DC Machine (alt. MV 1034) |
| MV 1003 | Mobile Test Bench (alt. MV 1700) |
| MV 1004 | Machine Bed |
| MV 1005 | Pallet for Machines (3 pcs) |
| MV 1006 | DC machine |
| MV 1007 | Slip Ring Motor |
| MV 1008 | Synchronous Machine |
| MV 1009 | Squirrel Cage Motor |
| MV 1010 | Flywheel |
| MV 2636 | AC and DC Starter |
| MV 1025 | Tachogenerator with cover |
| MV 1100 | Load Resistor |
| MV 1101 | Load Reactor |
| MV 1102 | Load Capacitor |
| MV 1300 | Power Pack (alt. MV 1302 or MV 1304) |
| MV 1903 | Synchronizing Unit |
| MV 1417 | Terminal Board |
| MV 1029 | Protective cover |
| MV 1500 | Load Switch |
| MV 1502 | Reversing Switch |
| MV 1503 | Star-Delta Switch |
| MV 1905 | Shunt Rheostat (2 pcs) |
| MV 1925 | Revolution Counter |
| MV 1830 | Lab Flex Set (alt. MV 1830-HF) |
| MV 1904 | Flex Stand |

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

MV1105 Load Resistor

is enclosed in a perforated, semi-protected metal cabinet. 10-step regulation, terminals and mimic diagram are fitted to the front panel.

Single-phase 2.3 kW step regulation
Single-phase 230 V 0-10 A in steps of 1 A
DC 220 V 0-10 A in steps of 1 A

Dimensions 230 x 440 x 420 mm
Weight 14 kg



MV1106 Load Capacitor Bank, three-phase

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 | |



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 |



MV1103-415

| | |
|--------|------------------------|
| Input | 3 x 415V, 8 A, 50-60Hz |
| Output | 3x0-415V, 8 A, |

Same technical data as MV1103 above

MV1429 Terminal Board

The box has safety outlets for laboratory leads with 4 mm diameter plug pins. These outlets are connected to a 5 x 2.5 mm² cable of 1.5 m length and cable connection for a diameter of 5.5 mm.

The connection box is equipped with miniature circuit breakers for 16 A.

| | |
|------------|-------------------|
| Dimensions | 250 x 240 x 75 mm |
| Weight | 2.0 kg |



MV1010 Flywheel

The flywheel is stably journalled in 2 spherical bearings and secured to an aluminium foundation. This ensures correct shaft height and lateral alignment. The flywheel is dynamically balanced and has a protective casing with 2 couplings. It is used in retardation tests for determining total friction losses, iron losses and short circuit losses at different excitation levels.

MV 1010 is also suitable to use for tests with heavy load start.

| | |
|-------------------|-----------------------------|
| Moment of inertia | $J = 0.406 \text{ kgm}^2$. |
| Dimensions | 400 x 300 x 300 mm |
| Weight | 56 kg |



MV1057 Starter Direct-on-line

The unit consists of a contactor combined with a thermal overload relay. The relay has "trip-free" release, which means the contacts can not be closed again until the relay has cooled down. The contactor has 2 auxiliary contacts.

The thermal overload relay has one break contact. Main contacts : thermal rated current 20 A. Auxiliary contact : thermal rated current 10 A.

| | |
|-----------------------|----------------------|
| Operating voltage | 220-240 V, 50-60 Hz. |
| Current setting range | 5.5-8 A. |
| Dimensions | 183 x 325 x 158 mm |
| Weight | 1.6 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

MV1439 Power Factor Control Unit



Background

Terco Power Factor Controller is a module within our MV-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 3 x 400 V 50 – 60 Hz Code no. MV 1439-405 |
| 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

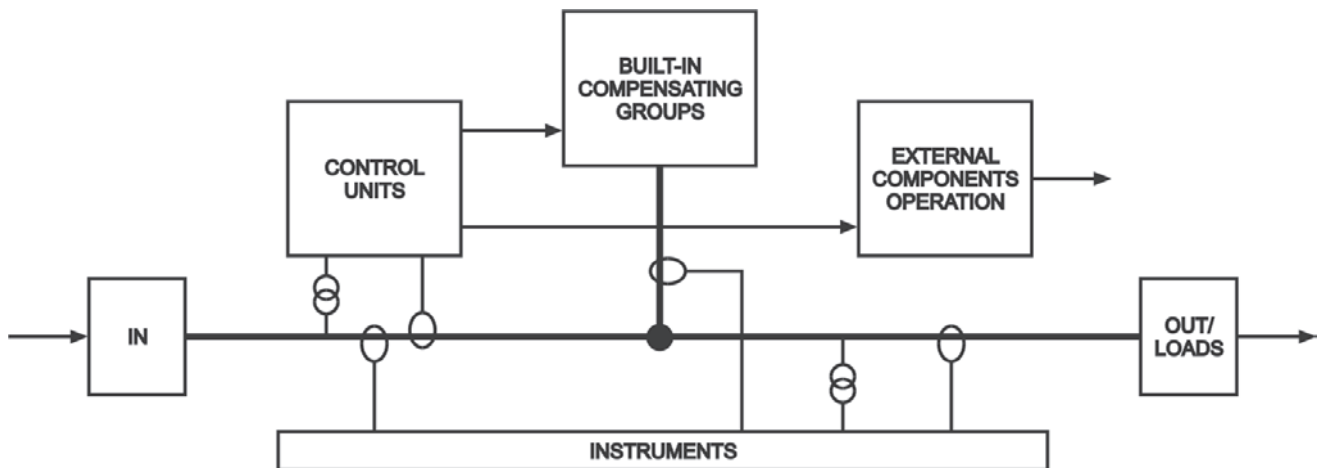
The Power Factor Control Unit is housed in a sturdy apparatus box with a clear mimic diagram explaining how to connect the supplying net from the left to the right side where the network in need for power factor compensation is connected. Readings, parameters and sub parameters are indicated on the front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

Block Schedule

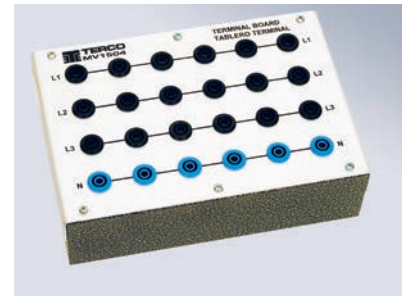
Terco reserves the right to make changes in the design and modifications or improvements of the products at any time without incurring any obligations

MV1504 Terminal Board

Four-pole terminal board with six terminals and two jacks per pole, (phase).
The case is of metal.

Poles marked R, S, T, O.

| | |
|------------|-------------------|
| Data | 16 A, 400 V AC/DC |
| Dimensions | 190 x 130 x 30 mm |
| Weight | 0.8 kg |

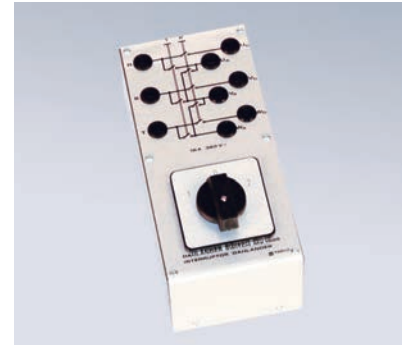


MV1505 Dahlander Switch

for Dahlander motor MV 1017, 16 A, 400 V, in metal case. Front panel showing symbols and technical data.

| | | |
|----------------------|----------|------------|
| Marking of terminals | input | R, S, T |
| | output 1 | Ua, Va, Wa |
| | output 2 | Ub, Vb, Wb |

| | |
|------------|------------------|
| Dimensions | 95 x 200 x 80 mm |
| Weight | 1 kg |



MV1501 Selector Switch

Three-pole, 2-way, 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 1 | R1, S1, T1 |
| | output 2 | R2, S2, T2 |

| | |
|------------|------------------|
| Dimensions | 95 x 200 x 80 mm |
| Weight | 1 kg |



MV1011 Machine Jack

MV1011 is an electrically powered mobile lift designed to be used in most of the common lifting situations e.g for lifting test machines or other heavy equipment in a laboratory. It can be adjusted to three heights to give the most appropriate lifting range. The material is white varnished steel.

Lifting capacity: 175 kg

| | |
|--------------|------------------------------------|
| Dim. approx. | 1190 x 650 x height 1420 - 2000 mm |
| Weight: | 43 kg |



MV1005 Pallet

For storage and movement of the electric machines. Constructed of durable metal plate with four double direction wheels.

| | |
|---------------------|-------------------|
| Dimensions approx.: | 360 x 360 x 95 mm |
| Weight | 4 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 |



Digital Multimeter

| | |
|---------------------------|---|
| Automatic range selection | |
| Voltage Range | 400mV to 600V AC/DC |
| Current | 40mA to 400mA AC/DC, 10A AC/DC |
| Resistance | 400, 4k, 400k, 4M Ω , 40M Ω |
| Continuity | Buzzer <90 Ω |
| Dimensions | 190 x 90 x 50 mm |
| Weight | 0.3 kg |



MV1924 Ammeter

This ammeter is a moving coil instrument with zero in the centre of the scale. It is used e.g. for determining the slip in slip-ring asynchronous machines. MV 1924 is connected in the rotor circuit in one of the leads between the motor and the rotor starter. By this means it is possible to determine the frequency and instantaneous value of the rotor current. The slip can then be calculated.

| | |
|-----------------|-------------------|
| Measuring range | 20-0-20 A |
| Accuracy | 1.5 |
| Scale length | 85 mm |
| Dimensions | 220 x 117 x 90 mm |
| Weight | 1.1 kg |



MV1930 Frequency Meter

| | |
|-----------------|-------------------|
| Measuring range | 46-54 Hz |
| Accuracy class | 0.5 |
| Dimensions | 220 x 117 x 90 mm |
| Weight | 1.2 kg |

MV1938 Frequency Meter

| | |
|-----------------|-------------------|
| Measuring range | 56-64 Hz |
| Accuracy class | 0.5 |
| Dimensions | 220 x 117 x 90 mm |
| Weight | 1.2 kg |



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 |



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

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 ± 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 ± 20 % 3-phase |
| Frequency range | 40-65 Hz |
| Accuracy class | 1.5 |
| Dimensions | 220 x 117 x 125 mm |
| Weight | 2 kg |



MV1925 Revolution Counter

The instrument is enclosed in an universal case equipped with connecting terminals.

MV 1925 is intended for use together with :
tachometer generator including protective cover, MV 1025 when e. g.
DC machine MV 1028 is used instead of the MV 1036 torque meter.

| | |
|--------------------|--------------------|
| Measuring range | 0-4000 rpm |
| Data | 1000 rpm at 14 V |
| Size of instrument | 144 x 144 mm |
| Accuracy | 1.5 % |
| Dimensions | 195 x 165 x 165 mm |
| Weight | 2 kg |



MV1909 Synchronizing Unit

The unit includes 1 dual voltmeter, 1 dual frequency meter and a LED type synchroscope.
To switch the synchronised supplies together, load switch MV 1500 is required.

| General Data | MV 1909-235 | MV 1909-236 | MV 1909-405 | MV 1909-406 |
|----------------------|--------------------|-------------|-------------|-------------|
| Dual Voltmeter | 2 x 250 V | 2 x 250 V | 2 x 500 V | 2 x 500 V |
| Dual Frequency Meter | 44-56 Hz | 54-66 Hz | 44-56 Hz | 54-66 Hz |
| Synchroscope | 220-240 V / | 220-240 V / | 380-415 V / | 380-415 V / |
| Supply Voltage | 127-140 V | 127-140 V | 220-240 V | 220-240 V |
| Dimensions | 350 x 140 x 160 mm | | | |
| Weight | 6.5 kg | | | |

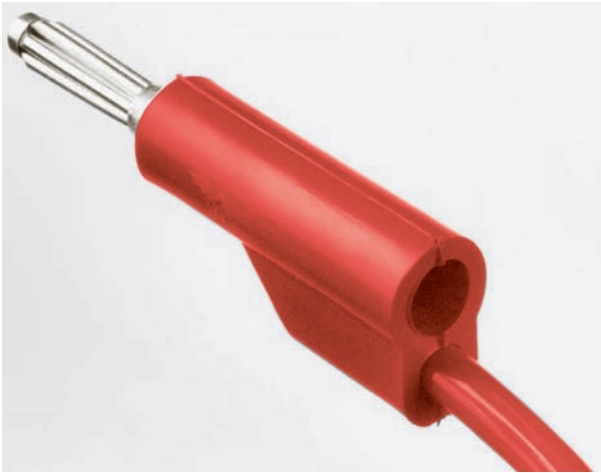


MV1931 Current Transformer

| | |
|--------------------------|--------------------|
| Primary 20-10-5 A / Sec. | 1 A |
| Accuracy class | 1.0 |
| Dimensions | 220 x 117 x 135 mm |
| Weight | 6 kg |



Flex and Flex Stand



Because of increased personal safety requirements, detailed specifications are imposed on laboratory flexes for use in schools.

The Terco Flex complies with the safety requirement that connection shall not be made sideways, as well as with all reasonable demands on a laboratory flex for use in physics, tele-communication and electric power laboratories.

Semi-protected axial termination. Six silver-plated resilient contact pins ensure a hard and uniform contact pressure.

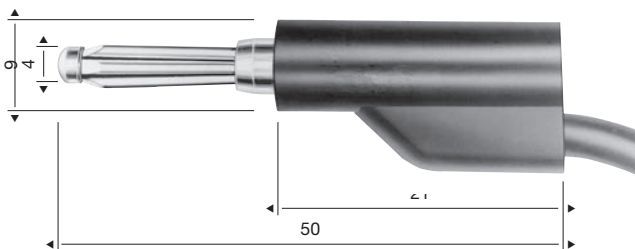
Central robust guide pin with hemispherical jacket protects against damage.

Moulded soft PVC covering for high reliability cable anchorage.

Especially soldered cable anchorage with 18 mm² contact surface.

General Data

Standard colours blue, red, yellow, black, yellow/green
 Standard area 2.5 mm² containing 650 wires of
 0.07 mm diameter
 Rated current 25 A



Standard Flex Sets

MV1800 Flex Set Area 2.5 mm²

Set of 120 Leads in 2 colours.

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------|-------|-------|--------|--------|
| Red | 10 | 20 | 20 | 10 |
| Blue | 10 | 20 | 20 | 10 |

MV1801 Flex Set Area 2.5 mm²

Set of 200 Leads in 5 colours.

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------------|-------|-------|--------|--------|
| Red | 10 | 10 | 10 | 10 |
| Yellow | 10 | 10 | 10 | 10 |
| Blue | 10 | 10 | 10 | 10 |
| Black | 10 | 10 | 10 | 10 |
| Yellow/green | 10 | 10 | 10 | 10 |

MV1830 Flex Set Area 2.5 mm²

Set of 100 Leads in 5 colours.

| 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 |

Separate Flexes Area 2.5 mm²

Please note, each Ref. No. refers to a pack of 10 leads.

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------------|--------|--------|--------|--------|
| Red | MV1802 | MV1807 | MV1812 | MV1817 |
| Yellow | MV1803 | MV1808 | MV1813 | MV1818 |
| Blue | MV1804 | MV1809 | MV1814 | MV1819 |
| Black | MV1805 | MV1810 | MV1815 | MV1820 |
| Yellow/green | MV1806 | MV1811 | MV1816 | MV1821 |

Flexes according to standard quotations you find on page 15

Laboratory Flexes with Safety Plugs, Retractable Shroud

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. Colours black, red, blue, yellow, green/yellow. Rated current 16 A.

MV1800-H Flex Set Area 1.5 mm²

Set of 120 leads in 2 colours. Length

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------|-------|-------|--------|--------|
| Red | 10 | 20 | 20 | 10 |
| Blue | 10 | 20 | 20 | 10 |

MV1801-H Flex Set Area 1.5 mm².

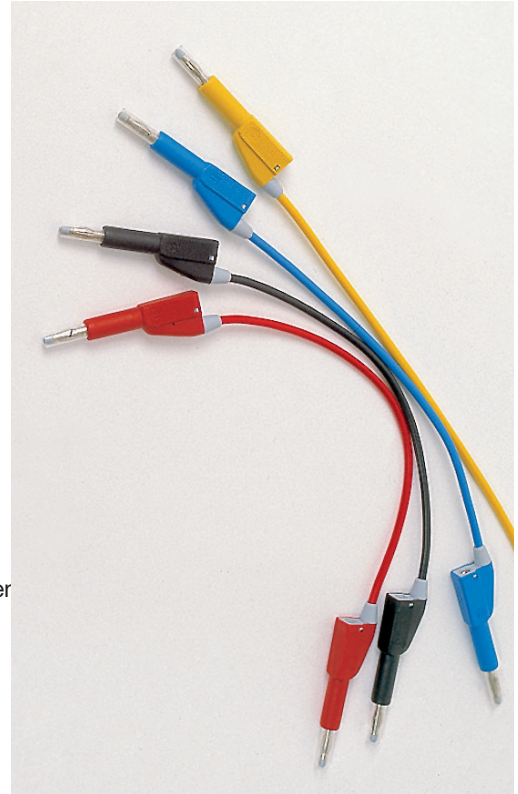
Set of 200 leads in 5 different colours, red, yellow, blue, black and yellow/green, in 4 different lengths, 25, 50, 100 and 200 cm, 10 of each.

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------------|-------|-------|--------|--------|
| Red | 10 | 10 | 10 | 10 |
| Yellow | 10 | 10 | 10 | 10 |
| Blue | 10 | 10 | 10 | 10 |
| Black | 10 | 10 | 10 | 10 |
| Yellow/green | 10 | 10 | 10 | 10 |

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 |



Separate Flexes Area 1.5 mm²

Please note, each Ref. No. refers to a pack of 10 leads.

| Length | 25 cm | 50 cm | 100 cm | 200 cm |
|--------------|----------|----------|----------|----------|
| Red | MV1802-H | MV1807-H | MV1812-H | MV1817-H |
| Yellow | MV1803-H | MV1808-H | MV1813-H | MV1818-H |
| Blue | MV1804-H | MV1809-H | MV1814-H | MV1819-H |
| Black | MV1805-H | MV1810-H | MV1815-H | MV1820-H |
| Yellow/Green | MV1806-H | MV1811-H | MV1816-H | MV1821-H |

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.

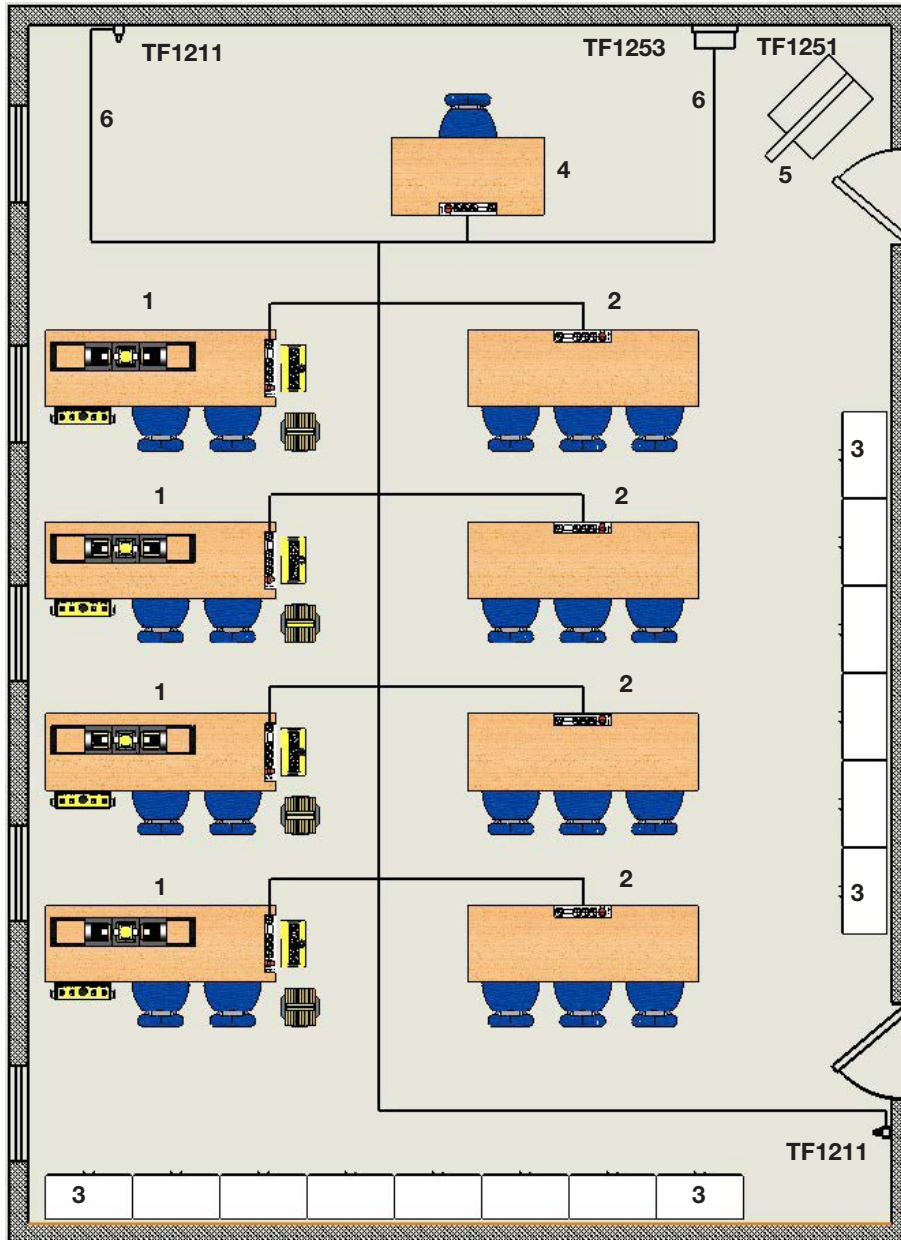
General Data

| | |
|--------|---------|
| Height | 1170 mm |
| Weight | 9 kg |

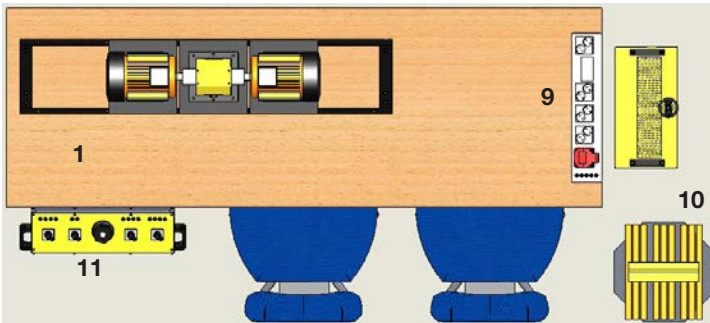


Safe Power Distribution in the laboratory

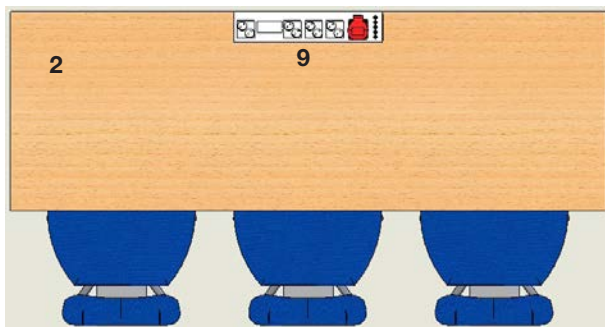
TERCO's system with insulating transformer ensures a safe working environment for the students. The layout is also most important when designing a functional laboratory. It is of great importance that equipment and furniture are taken into account early in the planning stage. A standard solution for planning a laboratory for 16 students can be seen below. If the space of the laboratory has been determined already, the standard solution may not be applicable. Our engineers will be pleased to advise on any individual requirements.



- 1 Four Torque Meter Benches complete with accessories such as motors, generators, loads, power supplies, switches, flex stands with flexes.
- 2 Four benches for experiments where the motor bench is not necessary and for theoretical follow-up of the experiments. Transformer tests, relay tests etc. can e.g. also be performed on these tables
- 3 Cabinets for instruments, tools and accessories.
- 4 Teacher desk.
- 5 Machine jack.
- 6 Terco Safety Power Distribution System with key-operated central, transformer, student-panels and emergency stops.



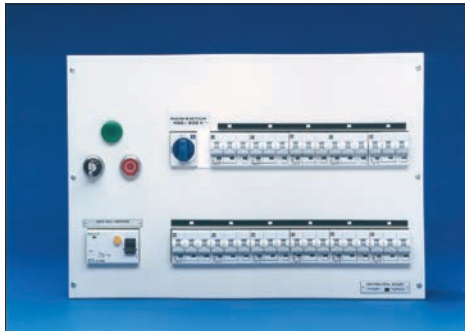
- 7. MV1054 Torque Meter System
- 8. MV1100 Load Resistor
- 9. TF1252 Student Panel
- 10. MV1904 Flex stand
- 11. MV1300/1302 Power Pack



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

Voltage system in the lab: 400/230 V 3-ph and 230 V 1-ph Incoming voltage 400/230 V 3-ph

Other voltages available on request.



TF1251 Distribution Panel

The distribution panel is manufactured in varnished sheet metal and used for separate distribution of power to each lab. group (student panel). It contains one main switch, eleven 3-pole 16 A MCB (miniature circuit breakers), one ELCB (earth leakage circuit breaker), one indicator lamp and lockable ON-key. The distribution panel breaks the supply voltage when a current > 30 mA flows in the protection lead.

TF 1251 is wired for connection of outgoing groups to each MCB. The incoming wires are to be connected to the main switch.

Dimensions 480 x 330 x 60 mm
 Weight 10 kg



TF1252 Student Panel for table mounting

Comprising:

- One 3-pole main switch 16 A
- One MCB (Micro Circuit Breaker) 10 A
- Three 2-pole, 2-way earthed wall sockets
- One 3-ph socket CEE.
- One protective earth terminal

Junction line for distribution of any AC or DC voltage

The Terco Power Pack can be plugged in to the CEE-Socket

Dimensions 600 x 120 x 75 mm
 Weight approx. 4 kg



TF1253 Transformer

10 kVA intermittent

The transformer is air cooled and enclosed in sheet metal for placement on the floor.

Main voltage 3-ph 380-415 V +/-5% 50-60 Hz
 Connection D/Y-0
 Secondary 3-ph 380-415 / 220-240 V 50-60 Hz
 Dimensions 420 x 250 x 420 mm
 Weight 85 kg



TF1229 Contactor with Thermal Protection

Enclosed in a plastic cover

Current: 16-24 A

For transformer TF 1226 and TF 1253
 Dimensions 142 x 115 x 112 mm
 Weight 1 kg



TF1211 Emergency Stop

Dimensions excluding the sign: 70 x 70 x 70 mm
 Weight 0.2 kg

Emergency sign in English enclosed

See also our brochure: *Power Distribution System and Furniture for Laboratories*

Manual

The equipment listed in this brochure is designed especially for educational purposes. The motors, generators, load units and power supply units are interchangeable so that in addition to the listed experiments it is also possible to demonstrate installation wiring requirements, meter connections, motor symptoms during overload and many other important conditions necessary in different syllabis.

A brief synopsis of experimental coverage is given below.

Machines Part 1

DC Generators, Series, shunt, compound, sep. excited.

DC Motors, Series, shunt, compound, sep. excited.

Synchronous Motor & Generator.

Slip Ring Motor.

Squirrel Cage Motor.

Machines Part 2

Dahlander Motor, 2 speed, 1 winding.

Universal Motor.

Reluctance Motor.

Capacitor Start Motor.

Capacitor Start and Run Motor

Induction Motor, 2 speed, 2 windings.

Induction Motor, thermistor protected.

Characteristics

| | | | |
|---------------|------------------|-------------------------|-------------------|
| No Load | $E = f(I_m)$ | Synch Gen. | $IA = f(I_M)$ |
| Load | $U = f(I_B)$ | Synch. Motor | $IA = f(P_{out})$ |
| Efficiency | $n = f(P_{out})$ | Synch. Gen. | $U = f(I_A)$ |
| Torque/Speed | $M = f(n)$ | Phase Compensation | |
| Speed / Field | $n = f(I_m)$ | Reverse Current Braking | |
| Speed / arm. | $n = f(U_A)$ | Loss Summation Tests | |

Additional

1. MV1054 Torque Meter System together with prime mover or brake unit MV 1028 (alt. MV 1034).
2. MV1036 Analogue Torque Meter (Dial) (alt. MV 1026).
3. MV1028 DC-Machine (alt. MV1034) for more simplified experiments on motor / generators. (No torque)

All above torque measuring equipment can be connected to the Terco test machines on Terco Machine Bed MV1004.



Examples of Experiment Manuals.

Electrical Machines Laboratory

Terco has delivered equipment to Electrical Machines Laboratories all over the world. Here you can see some pictures of laboratories fully equipped with the Terco Classic Electrical Machines. The laboratories show different solutions of measuring torque such as the analogue dial with DC-brake/drive machine or the digital torque measuring system, with the possibility to use data acquisition and control of electrical machines.



INDEX

| | | |
|----------|--|----|
| MV1003 | Mobile Test Bench | 14 |
| MV1004 | Machine Bed | 10 |
| MV1005 | Pallet | 42 |
| MV1006 | DC-Machine | 8 |
| MV1006-C | DC Machine. Sectioned. Not for use. | 36 |
| MV1007 | Induction Motor Slip Ring | 8 |
| MV1007-C | Induction Motor Slip-Ring. Sectioned. Not for use. | 36 |
| MV1008 | Synchronous Machine | 9 |
| MV1008-C | Synchronous Machine. Sectioned. Not for use. | 36 |
| MV1009 | Induction Motor Squirrel Cage | 10 |
| MV1009-C | Induction Motor Squirrel Cage. Sectioned. Not for use. | 36 |
| MV1010 | Flywheel | 39 |
| MV1011 | Machine Jack | 42 |
| MV1015 | Reluctance Motor | 30 |
| MV1017 | Induction Motor Dahlander Motor | 30 |
| MV1018 | Universal Motor | 30 |
| MV1020 | Induction Motor Capacitor Start | 31 |
| MV1024 | DC Generator 14 V at 1000 rpm (with trim potentiometer) | 6 |
| MV1025 | DC Generator 14 V at 1000 rpm. (to be used with the MV1036. Electric Torque Meter System which has built-in trim potentiometer) | 6 |
| MV1026 | Electric Torque Meter System | 7 |
| MV1027 | Synchronous Machine | 9 |
| MV1028 | DC Machine | 6 |
| MV1029 | Protective Cover (only) | 6 |
| MV1030 | Induction Motor 2 Speed 2 Windings | 31 |
| MV1031 | Induction Motor Thermistor Protected | 32 |
| MV1032 | Thermal Relay | 32 |
| MV1034 | DC-Machine | 6 |
| MV1036 | Electric Torque Meter System | 7 |
| MV1037 | Induction Motor Cap. Start and Run | 31 |
| MV1046 | 3-Phase Squirrel Cage Motor with Fault Simulator | 33 |
| MV1047 | Asynchronous Motor, 3-Phase Demonstration Set | 32 |
| MV1054 | Digital Torque-, Speed- and Shaft Power Meter | 5 |
| MV1055 | Shaft Spacer | 10 |
| MV1057 | Starter Direct-on-line | 39 |
| MV1100 | Load Resistor | 13 |
| MV1101 | Load Reactor | 13 |
| MV1102 | Load Capacitor | 13 |
| MV1103 | Variable Transformer 3-phase | 39 |
| MV1105 | Load Resistor | 38 |

INDEX

| | | |
|-----------|---|--------|
| MV1106 | Load Capacitor Bank, three-phase | 38 |
| MV1107 | Load Reactor | 38 |
| MV1300 | Power Pack | 11 |
| MV1302 | Power Pack | 11 |
| MV1304 | Power Pack | 11 |
| MV1305 | Mobile Motor / Generator Unit | 34, 35 |
| MV1417 | Terminal board with short-circuit buttons | 12 |
| MV1429 | Terminal Board | 39 |
| MV1439 | Power Factor Control Unit | 40, 41 |
| MV1500 | Load Switch | 12 |
| MV1501 | Selector Switch | 42 |
| MV1502 | Reversing Switch | 12 |
| MV1503 | Star / Delta Switch | 12 |
| MV1504 | Terminal Board | 42 |
| MV1505 | Dahlander Switch | 42 |
| MV1700 | Stationary Laboratory Bench | 14 |
| MV1800 | Flex Set of 120 Leads in 2 colours. Area 2.5 mm ² | 46 |
| MV1800-H | Flex Set of 120 leads in 2 colours. Length Area 1.5 mm ² | 47 |
| MV1800-HF | Flex Set of 120 leads. Area 1.5 mm ² | 15 |
| MV1801 | Flex Set of 200 Leads in 5 colours. Area 2.5 mm ² | 46 |
| MV1801-H | Flex Set Area 1.5 mm ² . Set of 200 leads in 5 different colours | 47 |
| MV1801-HF | Flex Set of 200 leads. Area 1,5 mm ² | 15 |
| MV1830 | Flex Set of 100 Leads in 5 colours. Area 2.5 mm ² | 46 |
| MV1830-H | Flex Set Area 1.5 mm ² . Set of 100 leads in 5 different colours | 47 |
| MV1830-HF | Flex Set of 100 leads. Area 1.5 mm ² | 15 |
| MV18XX | Separate flexes | 46 |
| MV18XX-H | Separate flexes | 47 |
| MV18XX-HF | Separate flexes | 15 |
| MV1903 | Synchronizing Device | 12 |
| MV1904 | Flex Stand | 15 |
| MV1905 | Shunt Rheostat | 10 |
| MV1909 | Synchronizing Unit | 45 |
| MV1915-C | Three-phase Transformer. Sectioned. Not for use. | 36 |
| MV1924 | Ammeter | 43 |
| MV1925 | Revolution Counter | 45 |
| MV1929 | Power Factor Meter | 44 |
| MV1930 | Frequency Meter | 44 |
| MV1931 | Current Transformer | 45 |
| MV1937 | Wattmeter | 44 |
| MV1938 | Frequency Meter | 44 |

INDEX

| | | |
|-------------|--|----|
| MV1939 | AC Power Energy Meter | 16 |
| MV1941 | DC Measuring Unit | 17 |
| MV1943 | Analog Output Module | 22 |
| MV1976 | Power Factor Meter | 44 |
| MV2609 | Data Acquisition and Control Software | 21 |
| MV2636 | AC & DC Starter | 12 |
| MV2652 | 4-Quadrant DC Controller | 23 |
| MV2658 | PWM DC Control Module | 23 |
| MV2661 | AC-Control | 24 |
| MV4206-1 | AC-Motor Drive | 27 |
| MV4207-1 | DC-Motor Drive | 25 |
| MV4207-3 | DC-Motor Drive | 26 |
| MV4213 | Voltage, Current & Power Module | 24 |
| MV4250 | Asynchronous Wind Mill System including HVDC Light Transmission Cable | 28 |
| Phase Cop 2 | Phase Sequence Indicator | 17 |
| TF1211 | Emergency Stop | 50 |
| TF1229 | Contactors with Thermal Protection | 50 |
| TF1251 | Distribution Panel | 50 |
| TF1252 | Student Panel for table mounting | 50 |
| TF1253 | Transformer | 50 |
| TMS301 | Ammeter | 43 |
| TMS302 | Voltmeter | 43 |

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

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

TERCO HEADOFFICE



Terco headoffice and factory outside Stockholm, Sweden



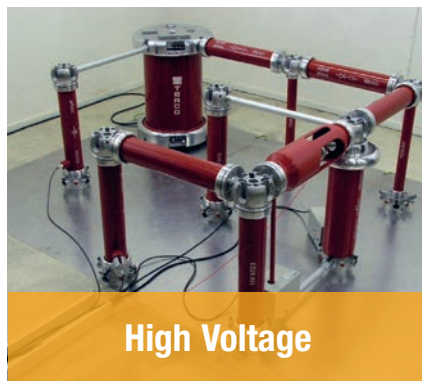
TERCO AB was founded in 1963 with the aim of producing and supplying practically oriented equipment for technical education.

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

TRAINING FOR TOMORROW'S WORLD



Power Systems



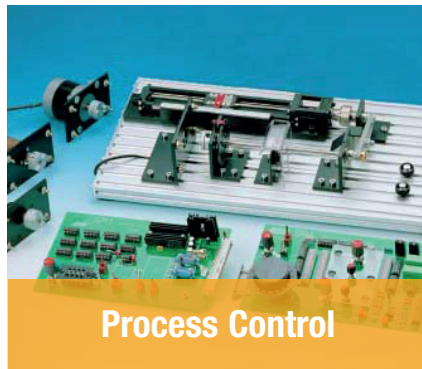
High Voltage



Electrical Machines & Drives



Mechatronics



Process Control



Energy



Material Testing



Furniture & Power Distribution



Training

TERCO AB

P.O. Box 5014
SE-14105 HUDDINGE
Sweden

Office/Works: Pyramidbacken 6
SE-141 75 Kungens Kurva
Stockholm

Phone: +46 8 506 855 00
Fax: +46 8 506 855 01
e-mail: export@terco.se
www.terco.se

