TERCO

Electrical Machines Laboratory

Contents

Electrical Machines Laboratory

For more than 45 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 machine 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.
Compare the weight of our test machines with others.

Service
Most of Terco´s electrical machine systems have been in operation for decades and it is not very often we have to carry out 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.

Training Courses
Terco organises training courses for most of the 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 often a very good investment.

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

NOTICE
All products have safety sockets.

Torque Meters

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.

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 (integrated with micro controller based shaft power calculation, resolution: 16bits on inputs and 15bits on output = shaft power).
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.

MV 1054 Technical Specifications

Technical Data

Nominal torque	-17.50Nm - +17.50Nm
Max. mechanical torque	25Nm
Nominal shaft power	-5.50kW - +5.50kW
Nominal speed	-3000rpm - +3000rpm
Tacho feedback output	14VDC/1000rpm
Data acquisition protocol	Modbus RTU 8N1
Baud Rate	9600kB/19200kB
Power supply 1-phase, 50-60Hz	220-240VAC

Dimensions / Weight
Sensor Unit

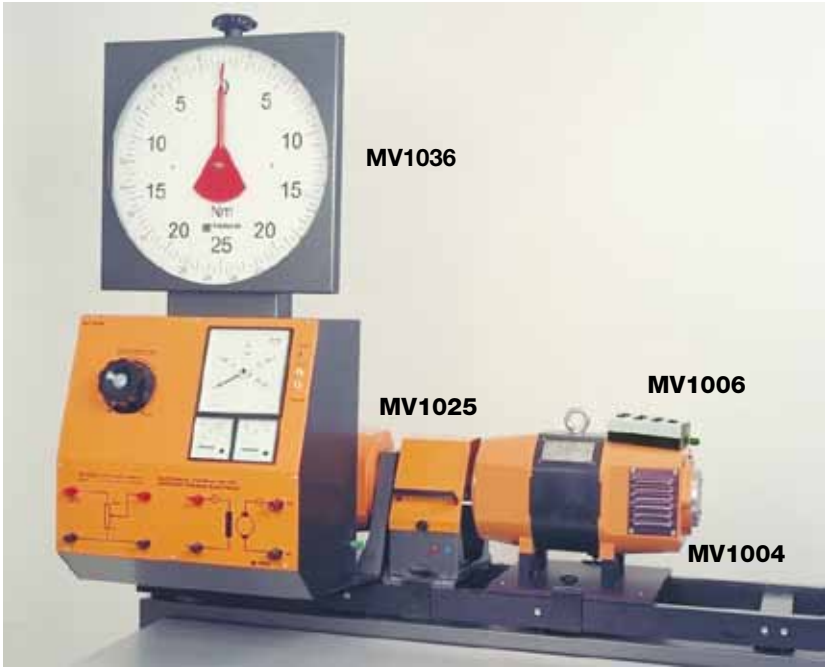
L x W x H	200x190x146mm
Length of mounting plate	200mm
Length incl couplings	170mm
Length incl shaft cover	250mm
Shaft height (to center)	162mm
Weight	5kg

Display Unit

L x W x H	340x250x150mm
Weight	5kg

MV 1054 Sensor Unit

MV 1054 Display Unit



Electric Torque Meter System, Analogue Dial

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 pedagogical and easy to handle. It is a reliable product which has been sold to many technical schools worldwide.

MV 1036-225 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 banana terminals
Generator	2.2 kW 1500 rpm
Motor	2.0 kW 1400 rpm
Excitation	220 V 0.8 A
Armature	220 V 12 A
Dim.	600 x 540 x 960 mm
Weight	90 kg

DC Machine MV 1036-225 is designed for tests on electrical machines with 50 Hz ratings.

MV 1036-226 Electric Torque Meter System

As MV 1036-225 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

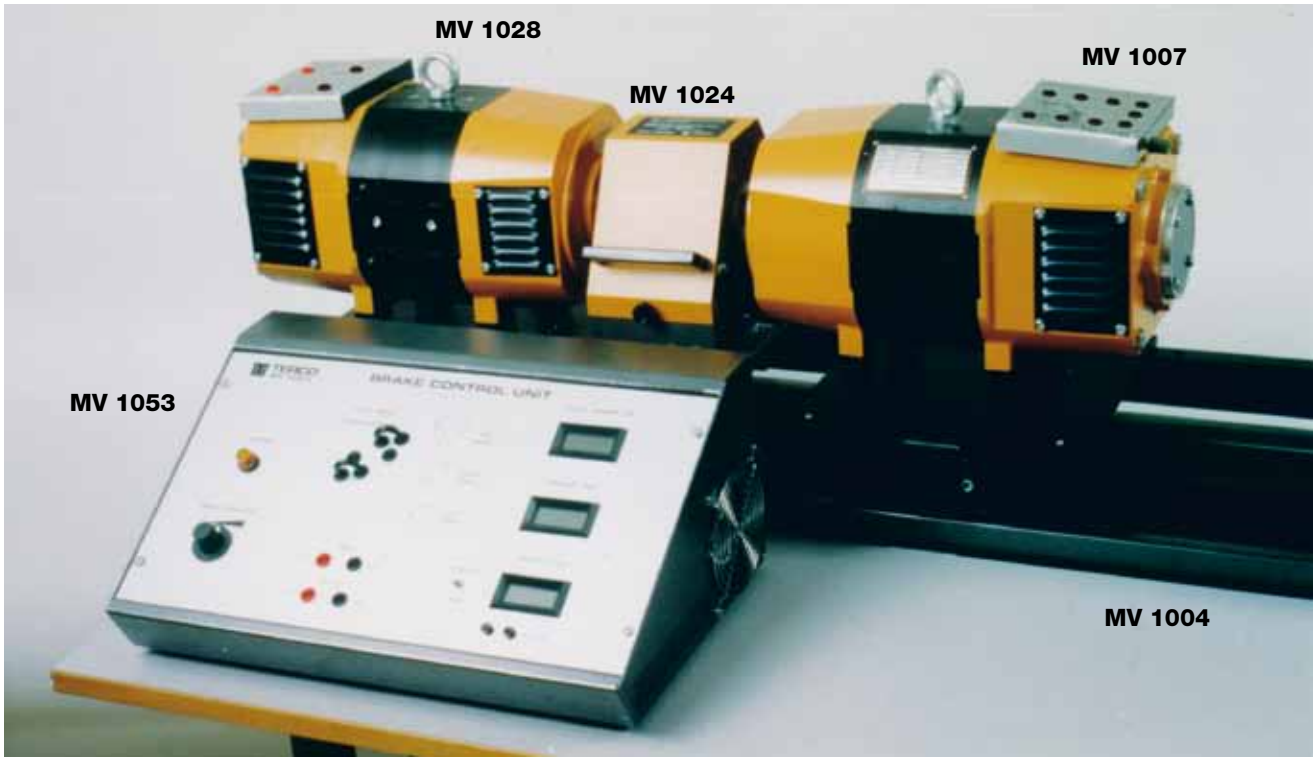
DC machine MV 1036-226 is designed for tests on electrical machines with 60 Hz ratings.

MV 1026-225 Electric Torque Meter System

As MV 1036-225, 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.

MV 1026-226 Electric Torque Meter System

As MV 1036-226 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.



MV 1053 Brake Control Unit

The MV 1053 Brake Control Unit is designed to operate with one Terco DC-Machine + one Terco DC-Tacho Generator (e.g. MV 1028 + MV 1024). The Control Unit is trimmed against the chosen machine and tacho generator to make it possible to calculate the air gap torque in the DC-machine. With a tacho signal also speed and shaft power is calculated. The result is displayed by three LCD-instruments.

Braking force is controlled by a potentiometer on the front.

To facilitate full braking force at high, medium, low and close to standstill speeds, the braking resistor can be configurated by two jumpers placed in the front plate. The braking resistors are cooled by a built-in fan.

MV 1053 can also be trimmed to already existing DC-machine and tachometer generator.

Technical specifications :

Factory trimmings	against specified DC-machine and tacho
Braking Power	max 1500 W 30 min.
Speed indication	0-4000 rpm
Torque indication	0-12.0 Nm
Power indication	0-2000 W
Accuracy speed	0.5 %
Accuracy Nm and W	5 % or better
Machine connections	four 4 mm safety terminals
Tacho connections	two 4 mm terminals
Size H x W x D (approx.)	210 x 480 x 300 mm (inclined front)
Power supply	220-240 V, 1-phase, 50-60 Hz
Weight approx.	9 kg

Other input voltages available on request.

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. Suitable connections are done on the terminal block, situated 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.

MV 1028 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	MV 1028-225	MV 1028-226
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	

MV 1028-225 is designed for tests on AC motors with 50 Hz ratings.
MV 1028-226 is designed for tests on AC motors with 60 Hz ratings.

MV 1034-225 and MV 1034-226 DC-Machine

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

See also text under MV 1026-225 resp. MV 1026-226 (Page 4)

Motor-Generator Set-Up with Flywheel

A DC-machine MV 1028 is coupled via a flywheel MV 1010 to a synchronous machine MV 1008.
Either machine can act as a motor. The above motor-generator is 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 also possible to add the Torque Measuring unit MV 1054 or measure the torque with the Brake Control Unit MV 1053.

Mobile and Stationary Workplace

MV 1003 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

MV 1700 Stationary Laboratory Bench

For stationary use, the torque meter or brake system with bed and testmachines 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 2.

Dimensions	2000 x 800 x 850 mm
Weight	30 kg

MV 1004 Machine Bed

This strong, stable machine bed of varnished aluminium 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

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.**

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.

MV 1006 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 : MV 1905.

General Data	MV 1006-225	MV 1006-226
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

MV 1007-405 Induction Motor Slip Ring

The machine is a 3-phase slip-ring 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	

MV 1007-695 Induction Motor Slip Ring

As MV 1007-405 but for 380-415 V 3-phase, Delta, 50-60 Hz

MV 1008 Synchronous Machine

The machine has a DC excited cylindrical rotor, operating on voltages up to 220 V DC. 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	MV 1008-235	MV 1008-236	MV 1008-405	MV 1008-406
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			

MV 1008-235 and -405 are designed for tests on 50 Hz networks.
MV 1008-236 and -406 are designed for tests on 60 Hz networks.

MV 1009-405 Induction Motor Squirrel Cage

A 3-phase squirrel cage motor is mounted on a 10 mm thick anodized aluminium plate to be placed on the machine bed MV 1004.

General Data	50 Hz	60 Hz
4 pole machine	1.1 kW 1400 rpm	1.1 kW 1700 rpm
Star (Y)	380-415 V, 3.0 A	380-415 V, 3.0 A
Delta (D)	220-240 V, 5.2 A	220-240 V, 5.2 A
Moment of inertia	J = 0.0023 kgm^2 (approx.)	
Dimensions	355 x 300 x 310 mm Shaft height 162 mm	
Weight	19 kg	

MV 1009-695 Induction Motor Squirrel Cage

As MV 1009-405 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.

MV 1009-385 Induction Motor Squirrel Cage

A 4-pole motor of 1.5 kW. Same design and electrical voltages as MV 1009-405.

MV 1016-405 Induction Motor Squirrel Cage

When doing experiments on Cascade set it is best to use one 4 pole (MV 1009) and one 6 pole induction motor (MV 1016). Same design as MV 1009-405 above.

General Data	50 Hz	60 Hz
6 pole machine	1.0 kW 900 rpm	1.0 kW 1100 rpm
Star connection	380-415 V 3.0 A	380-415 V 3.0 A
Delta connection	220-240 V 5.2 A	220-240 V 5.2 A
Dimensions	355 x 300 x 310 mm Shaft height 162 mm	
Weight	19 kg	

MV 1015-235 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	

MV 1015-405 Reluctance Motor

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

MV 1017-235 Induction Motor 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 3-phase	D / YY 220-240 V 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	

MV 1017-405 Induction Motor Dahlander Motor

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

MV 1018 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 0.4 kW AC
Speed	3000 rpm at 50 Hz 3600 rpm at 60 Hz
Voltage	220-240 V AC / DC
Current	9 A AC 6 A DC
Dimensions	465 x 300 x 310 mm Shaft height 162 mm
Weight	39 kg

MV 1020 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 1-phase	220-240 V 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	

MV 1037 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 1-phase	220-240 V 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	

MV 1030-235 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 3-phase	220-240 V 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	

MV 1030-405 Induction Motor 2 Speed 2 Windings

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

MV 1027 Synchronous Machine

The machine has a DC excited rotor with salient poles, operating on voltages up to 220 V DC.
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 : MV 1905.

General Data	MV 1027-235	MV 1027-236	MV 1027-405	MV 1027-406
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			

MV 1027-235 and -405 are designed for tests on 50 Hz networks.
MV 1027-236 and -406 are designed for tests on 60 Hz networks.

MV 1031 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 3-phase	380-415/220-240 V 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	

MV 1032 Thermal Relay

This is a control unit against overheating of motor MV 1031.
Most electrical machines withstand today 140ºC 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 60ºC for the experiments.

Dimensions	130 x 245 x 95 mm
Weight	1 kg

Power Supplies

MV 1300 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

MV 1300-235 Supply voltage 220-240 / 127-140 V 50 / 60 Hz 3-ph.
MV 1300-405 Supply voltage 380-400 / 220-230 V 50 / 60 Hz 3-ph.
MV 1300-415 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	

MV 1302 Power Pack

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	

MV 1304 Power Pack

As MV 1302 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	

MV 1103 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.
Same technical construction as MV 1104 above.

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

MV 1429 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.

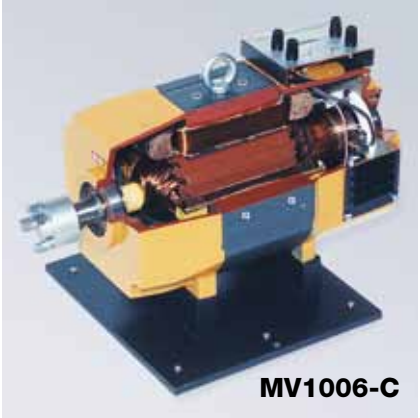
The connection box is equipped with miniature circuit breakers for 16 A.

Dimensions	250 x 240 x 75 mm
Weight	2.0 kg

Sectioned Motors and Transformer

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

MV 1006-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

MV 1008-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


MV1009-C

MV 1007-C Induction Motor Slip-Ring

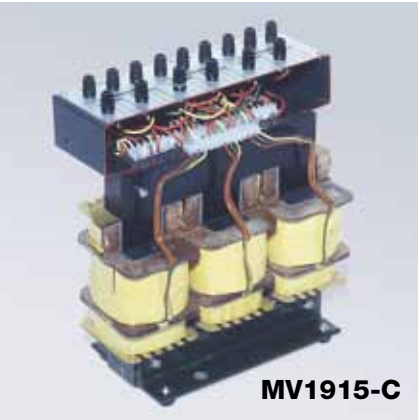
This motor is cut-away to show slip-rings, brushes, rotor, stator, windings, poles, fan, ball-bearings, etc.

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

MV 1009-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

MV 1915-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 cut-away on request.

Switch Panels

MV 1500 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	

MV 1501 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	

MV 1502 Reversing Switch

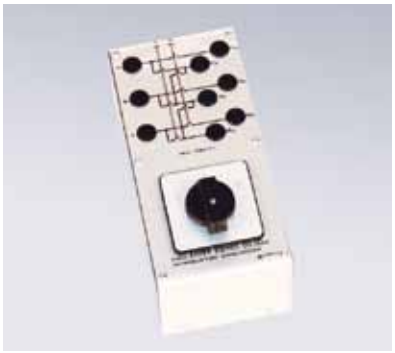
for 3-phase machine, 16 A, 500 V, in metal case. Front panel showing symbols and technical data.

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

MV 1503 Star / Delta Switch

for 3-phase machine, 16 A, 500 V, in 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	

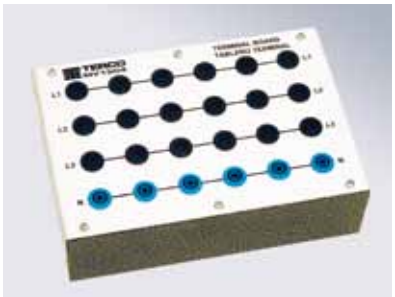


MV 1505 Dahlander Switch

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	

MV 1504 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

MV 1305 Mobile Motor / Generator Unit

MV 1305 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): DC-machine (”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.

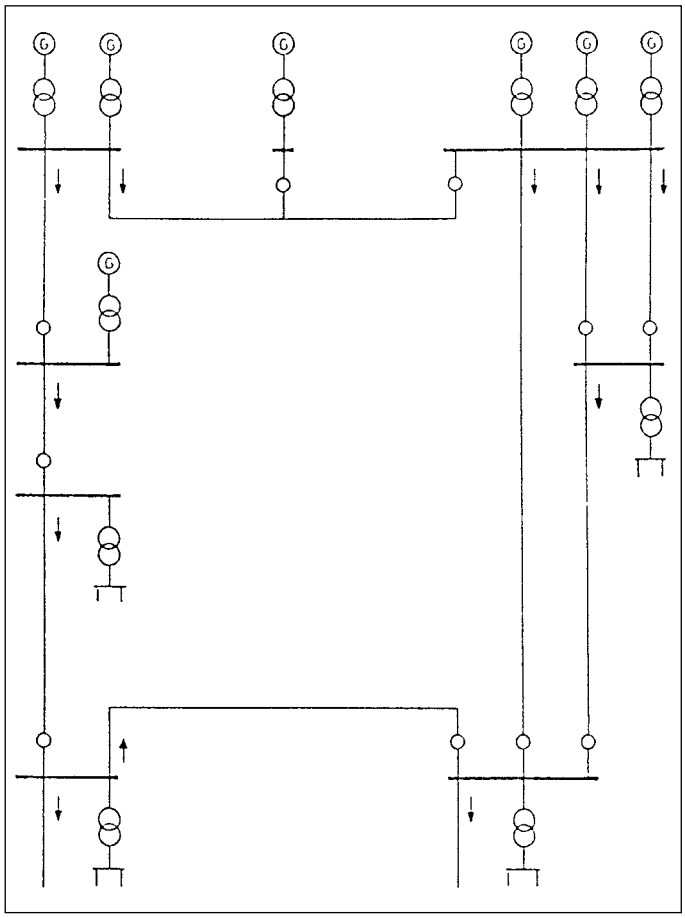
C. Synchronous compensating: DC-machine (”turbine”) idling, electrically disconnected or mechanically disconnected, synchronous machine in closed loop connection for voltage (=reactive power) control.

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/DC-machine	Armature Volt	0-240 V DC	0-240 V DC
	Field Volt	190 V DC	190 V DC
	Armature current	12 A	12 A
	Field current	0.8 A	0.8 A
	Power	2.0 kW	2.0 kW
	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 φ	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-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		

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.

Figure 1



A typical network with generators and sychronous compensators

Instruments:

DC-machine (Turbine simulator)	Armature voltage Armature current Indication lamp for field voltage Speed control potentiometer (=frequency control) Control method selector
AC-machine	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
Auxiliary	Machines mounted on machine bed with slide rails. Control panel integrated with machines to one mobile unit. Laboratory connections by 4 mm banana plugs 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.)

Electrical Machines Training Aids

MV 1046 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 voltages	380-415 V 3-phase 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	13 kg

MV 1047 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.

Accessories

Relevant audio-visual aids:

23-28125-5	Colour Slide Series incl. booklet : Maintenance of Rotating AC-machines
24-27219-1	Booklet : How to look after rotating machines.

Dimensions	480 x 400 x 150 mm
Weight	7 kg

MV 1048 3-Phase Squirrel-Cage Motor with Fault Simulator

The equipment consists of a standard 3-phase squirrel-cage motor (MT 80 B) with a 5-wire cable with 3-phase IEC-plug. The motor is star connected but can be changed on the terminals.

A control and fault simulator panel, which is lockable, is mounted on the motor.

The equipment enables the student to gain practice with the most common faults in a squirrel-cage asynchronous motor, like short circuit, open circuit in windings and between windings, as well as earth fault. This ensures the students to have confidence when they are to state the condition of a motor.

The simulation is performed with different switches and a potentiometer for each winding.

General Data

Data of the motor

0.75 kW, 50 / 60 Hz, 1410 / 1700 rpm
380-420 V Y 2.1 A
220-240 V D 3.6 A

Dimension	480 x 400 x 230 mm
Weight	13 kg

Load Units

MV 1100 Load Resistor

Load resistor MV 1100 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 in 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

MV 1101 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

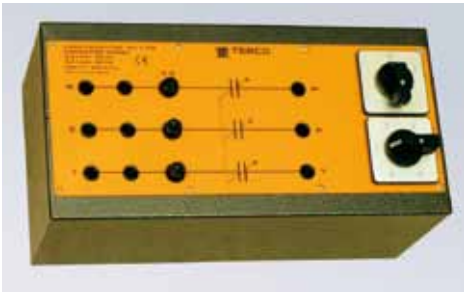
2.5 kVAr, 50-60 Hz

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

MV 1102 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	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	60	2.5-15

Dimensions	185 x 370 x 170 mm
Weight	7 kg

MV 1105 Load Resistor

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

General Data

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

MV 1106 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.

General Data

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

MV 1107 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.

General Data

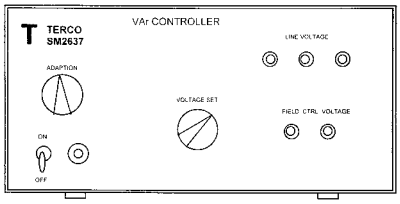
3-phase 0.5-3.0 kVAr, 400 V Y, 230 V Y, 50-60 Hz

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

SM 2637 VAr Controller

This unit is designed to be used together with Terco synchronous machines rating 1-2 kVAr when these are used as VAr compensating units or run as motors / generators with voltage stabilising ability.



Specifications :

Voltage feedback from controlled network	3-ph 220-400 V
Field winding controlled voltage	0-170 V DC
Field winding controlled current	0-3 A (max) DC
Supply voltage (1-ph)	220-240 V AC 50 / 60 Hz
Dim W x H x D	250 x 150 x 300 mm
Weight (approx.)	7 kg

Accessories

MV 1057 Starter Direct-on-line

The unit consists of a contactor combined with a thermal overload realy. 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

MV 2636 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 1905 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

MV 1010 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 kgm^2.
Dimensions	400 x 300 x 300 mm
Weight	56 kg

MV 1011 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

Tachogenerators

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

MV 1024	DC Generator 14 V at 1000 rpm
MV 1025	DC Generator 14 V at 1000 rpm
MV 1029	Protective Cover (only)
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.

MV 1925 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.

General Data

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

MV 1005 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

Phasing Instruments

MV 1903 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 synchronise synchronous machines to networks.

General Data	MV 1903-235	MV 1903-405
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.

MV 1909 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 Supply Voltage	220-240 V / 127-140 V	220-240 V / 127-140 V	380-415 V / 220-240 V	380-415 V / 220-240 V
Dimensions	350 x 140 x 160 mm			
Weight	6.5 kg			

Phase Cop 2 Phase Sequence Indicator

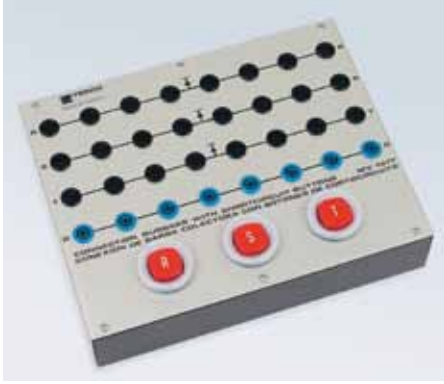
Tester for determining the direction of rotation or phase sequence in 3-phase systems.

- 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

General Data

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

MV 1417 Terminal board with short-circuit buttons



Combined terminal and protector 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

Electrical Measuring Instruments

Terco Instruments are panel-type 96 x 96 mm, mounted in durable painted sheet metal enclosures having plastic feet.

The instruments have a 90˚ scale and are produced for temperatures between -20 and +50˚C.
Ammeters can take ten times the rated current for short duration and voltmeters twice the nominal voltage for a short period. Test voltage - 2 kV, AC. All instruments comply with IEC recommendations.

MV 1924 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.

General Data

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

MV 1922 Ammeter

Moving iron instrument.

Measuring ranges	AC / DC 0-1-2 A
Accuracy class	2.5
Dimensions	220 x 117 x 90 mm
Weight	1.1 kg

MV 1923 Ammeter

Moving iron instrument.

Measuring ranges	AC / DC 0-6-12 A
Accuracy class	2.5
Dimensions	220 x 117 x 90 mm
Weight	1.1 kg

MV 1926 Voltmeter

Moving iron instrument.

Measuring ranges	AC / DC 0-50-250-500 V
Accuracy class	2.5
Dimensions	220 x 117 x 90 mm
Weight	1.3 kg

MV 1974 Voltmeter

Voltmeter, moving coil

Measuring range	0 – ± 300 V with centre zero scale.
Accuracy class	1.5
Dimensions	220 x 117 x 125 mm
Weight	2 kg

MV 1927 and MV 1928 are Electronic Wattmeters with active power transducer and adjusted for power factor 1.

MV 1927 Wattmeter, single-phase

Voltage ranges	50-250-500 V
Rated current	1 A
Supply voltage	180 - 260 V
Accuracy class	1.5
Dimensions	220 x 117 x 125 mm
Weight	2 kg

MV 1928 Wattmeter, single-phase

Voltage ranges	50-250-500 V
Rated current	5 A
Supply voltage	180-260 V
Accuracy class	1.5
Dimensions	220 x 117 x 125 mm
Weight	2 kg

MV 1929 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

MV 1976 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

MV 1930 Frequency Meter

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

MV 1938 Frequency Meter

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

MV 1931 Current Transformer

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

SM 2627 Universal Meter

With this useful unit voltage, current and power with difficult waveforms can be measured individually with instantaneous value, TRMS value or average value on the display or through terminals. Signal values and signal terminals are galvanically isolated. The unit includes multiplexer with two channels to make it possible to study voltage, current and power on the same time on the display and also by an oscilloscope.
The digital instrument shows all values in percent (0-199.9 %).

Technical Data

Voltage	20, 50, 100, 500 V, AC / DC
Current	1, 2, 5, 10 A, AC / DC
Power	20 steps 50-2000 W
Instrument	LCD $3^1/_2$ digit 0-199.9 %
Power supply (1-ph)	220-240 V AC 50-60 Hz
Dimensions	250 x 340 x 150 mm
Weight	2 kg

SM 2628 3-ph/1-ph Measuring Unit, Voltage / Current / Power

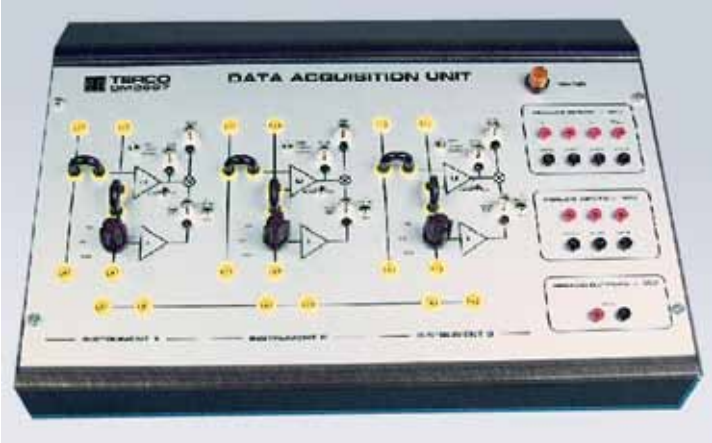
This unit is designed to be used together with Terco electrical machines rating 0.4-2 kVA.
The instrument functions can be used also for DC-quantities.

Specifications

Voltage with selector switch LL or L neutral or DC-voltage	1-ph/3-ph, 127-400 V
Current selector switch IL1, IL2 or IL3	0-6 A
Wattmeter for 1-ph or 3-ph (2-wattmetermet.)	0-4000 W (max)
Wattmeter for DC	0-2000 W (max)
Supply voltage (1-ph)	220-240 V AC 50-60 Hz
Dimensions	250 x 340 x 150 mm
Weight	6 kg

Measuring and Data Acquisition with PC

The increased use and availability of computers in the schools made it natural to adopt our Classic Lab System to this environment. Terco has developed equipment and software for measuring, control and acquisition of important parameters.



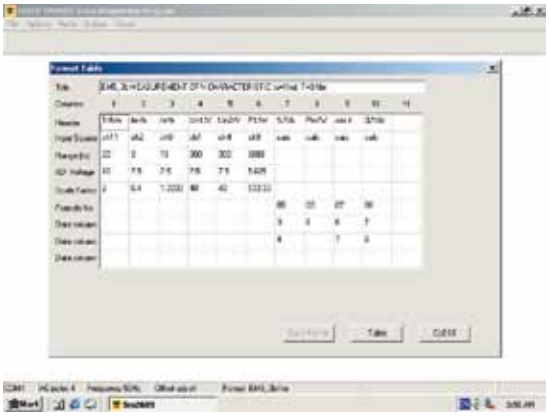
SM 2607 Measuring, Data Processing & Control Unit

SM2607 consists of two main blocks: the measuring module and the data processing unit together with the PC-interface. They are built into a sturdy steel enclosure on which the experiment connections are easily made on the front panel. Connections to a PC or other instrument groups are made from the rear.

The measuring module consists of three complete measuring groups, each one with voltage and current inputs together with electronics for analogue calculating of mean values and RMS values together with power expressed as W or VAr. The six inputs (3xvoltage and 3xcurrent) are galvanically isolated from the signal circuits by a 1.5 kV isolating barrier The analogue measuring channels processes AC, DC or mixed quantities.

If not operating together with a PC the measuring module can be used together with an external instrument box (SM2629, optional) where three LCD instruments plus selector switches are used to perform the readouts in percents (0-199,9%).
In this case connections are performed by a multiple lead cable together with a multiple contact placed in the rear plate of the SM2607. The cable is included in the code number SM2629.

PC-monitor : Measurements initiated.



Programming mode

Technical specifications for the measuring module

Analogue inputs:		number of channels
Voltage, ranges	30 V, 100 V, 300 V AC or DC or mixed	3
Current, ranges	1 A, 3 A, 10 A AC or DC or mixed	3
Analogue outputs:		
Voltage mean value	+/- 10 V, buffered	3
Voltage RMS value	+/- 10 V, buffered	3
Voltage, immediate value	+/- 10 V	3
Current mean value	+/- 10 V, buffered	3
Current RMS value	+/- 10 V, buffered	3
Current, immediate value	+/- 10 V	3
Power W/VAr	+/- 10 V,	3
Output impedance	< 10 kohm	
Accuracy	1 %	
Frequency response within the accuracy	20 kHz	
Voltage input impedance	> 1Mohm	
Current input impedance	0,1-1 ohm	

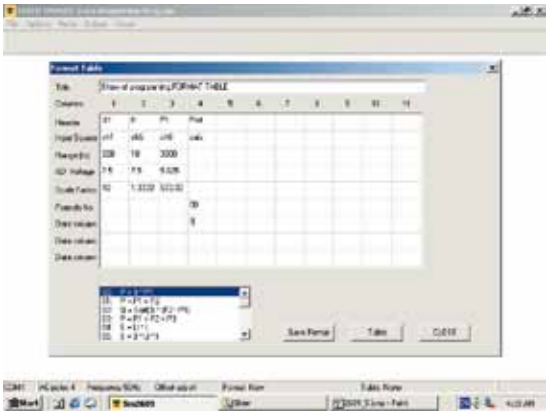
Technical specifications for the data acquisition module

Analogue internal inputs: number of channels

Corresponding to all output channels from the measuring module above	21

Analogue external in- and outputs:

Frequency*	0-10 V	1
Torque*	± 10 V	1
Speed*	± 10 V	1
Shaft power*	± 10 V	1
(* or any feedback signal)		
Aux. Inputs	± 10 V	3
Analogue outputs (control)	± 10 V	1
Output impedance	< 10 kohm	

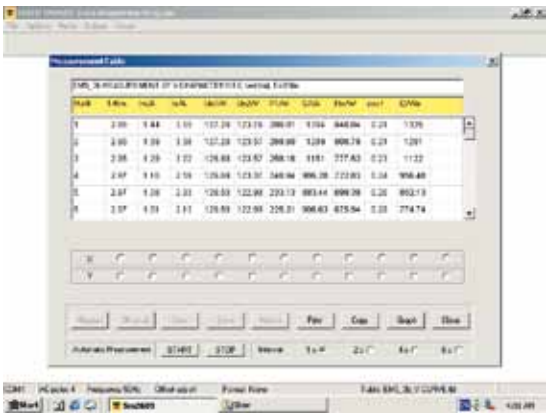


Program mode including formulas

Power inputs are connected by safety terminals.
Outputs are constituted by 4 or 2 mm pin connectors for buffered signals and by BNC connectors for immediate values.

Communication between the SM2607 and the PC is performed by a standard Serial port (RS 232).
No extra sub units have to be installed in the PC.
The data acquisition module in the SM2607 is based on a Motorola microprocessor. The unit is tailored to suit Terco modules like MV1051 (Torque Meter System) but can also be used with other objects via BNC, 2 mm and 4 mm terminals.
All inputs and outputs have standard signal levels.

Power supply	230 V AC, 50-60 Hz
Dimensions	490 x 200 x 350 mm
Weight	7.5 kg



Measured and calculated values

SM 2609 Data Collecting Software

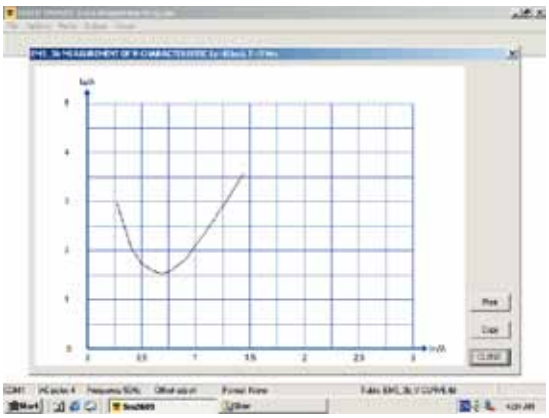
To be used together with SM2607 and a PC for collecting and evaluating of experimental values. Data processing can be done simultaneously with feedback control of, for example, torque or speed or for any controlled situation.
The characteristics of a machine can automatically be collected through programmed control and data processing.

The software is designed to let the user define the experiment setup. Together with an amount of standard experiments, tailor made for the Terco Electrical Machines Lab, following program modules are available:

A. Table generator.
B. Data acquisition defined by the Table generator.
C. On-line readouts (instruments) of values defined by the Table generator.
D. Print-out.
E. File processing: save/load table format, table, graph.
F. Export: Export of tables and/or graphs for other program processing.

SM 2609 comprises 3.5″ discs and manual.

No computer cards are necessary.

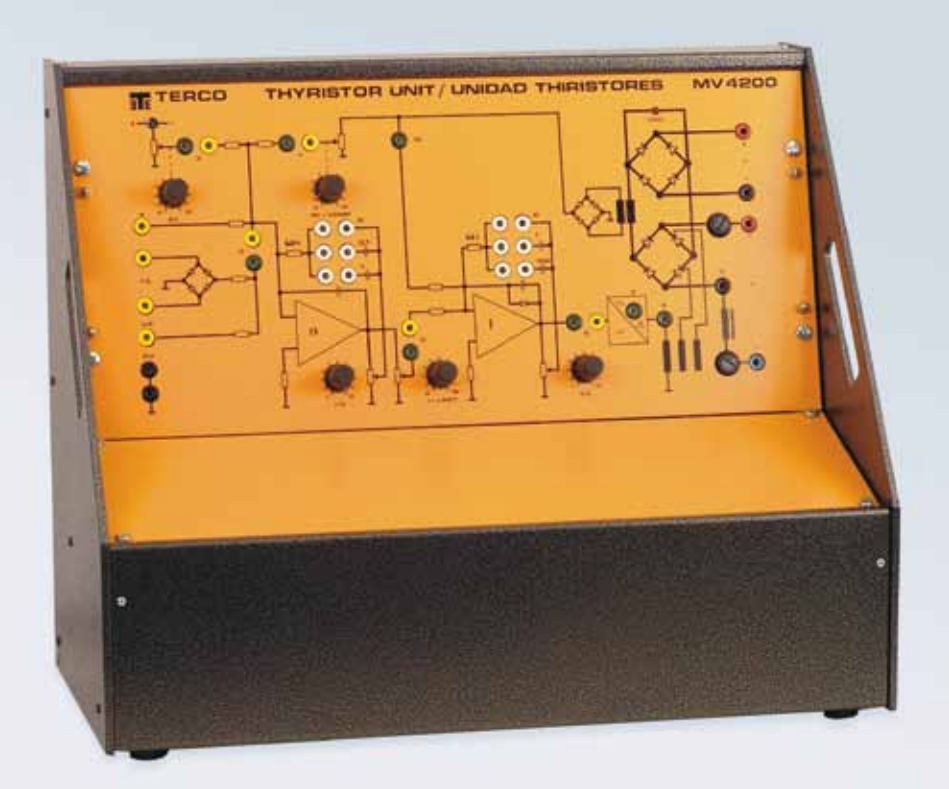


Print out of results

AC- and DC-Drives

The industrial applications of drive systems having electronic controlled machines, increased rapidly over the last years. Consequently, there is an increasing demand for skilled personnel to design, operate and maintain electronic control systems for electrical machines.

Therefore, Terco has developed, in co-operation with the teaching staff from the Institute for Electric Machinery, Royal Institute of Technology, Stockholm, modern electronic units for educational purposes, intended for practical studies in electric power engineering, control and system engineering as well as industrial electronics.



MV 4200 Thyristor Unit

The Thyristor Unit MV 4200 is equipped with a speed regulator, a current regulator and a SCR-trigger. The time constant of the regulators can be set in steps with three different values each. The gain is continuously adjustable from 1 - ∞ (. The other potentiometers are for speed setting, current limitation and RI-compensation.

To be able to measure on the regulation circuits with an oscilloscope in a simple way, they are separated from the mains voltage by an isolating transformer.

The Thyristor Unit MV 4200 can also be used together with a micro computer with D/A-A/D-converter which has an output/input voltage of 0-10 V.

Technical Specification

Power	1.9 kW
Tachometer input	10 V at 1000 rpm
Field control output	200 V DC, 2 A
Rotor control output	0-200 V DC max 10 A
Mains voltage	220-240 V 50- 60Hz 1-ph
Dimensions	500 x 420 x 260 mm
Weight	23 kg

The speed of the DC-motor can be regulated either by tachometer feedback or by rotor voltage feedback. By rotor voltage feedback the losses of the motor are compensated by the RI-compensator.

Manual

In the manual the basic theory is explained together with the exercises.

Part A

To illustrate the speed control characteristics with different types of feedback and gain in the controller.

Part B

To illustrate the dynamic characteristics of the control system with different controllers (P and PI) and different gain.

Part C

To illustrate optimisation of the control system.

MV 4206-1 AC-Motor Drive

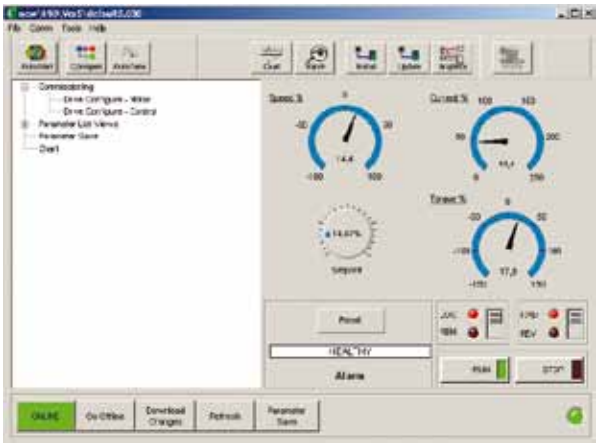
Three-Phase supply, semi 4-Quadrant Drive

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: +/- 12 V

Dimensions 520 x 450 x 280 mm
Weight 16 kg



Built-in Instruments and Oscilloscope 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 to COM1 (COM2).

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 software is enclosed as a complete binder together with a corresponding CD.

MV 4216 Inverter Bridge

The MV 4216 is used to simulate AC-converters 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

MV 4207-1 DC-Motor Drive

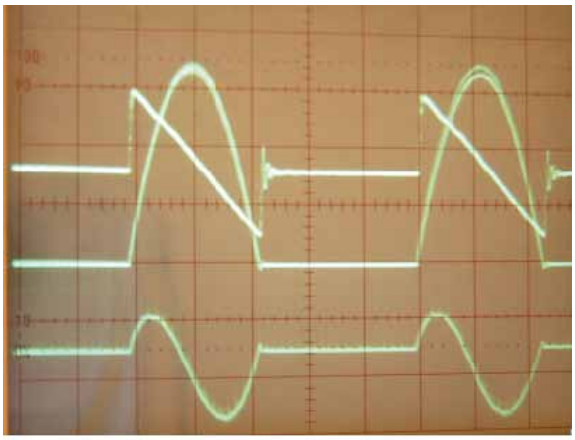
Single-phase 4-Quadrant Rectifier, Three-Phase supply

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 400 V.
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.

MV 4207-3 DC-Motor Drive

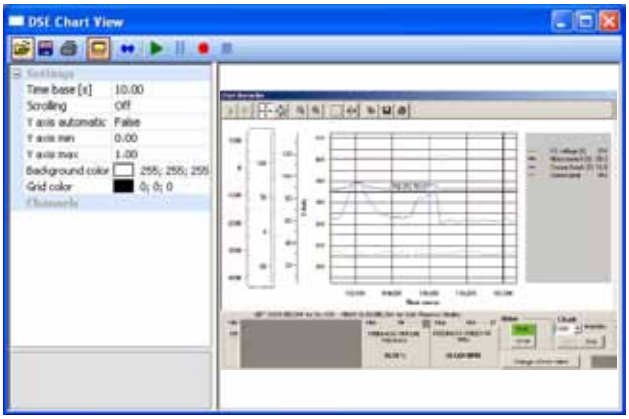
Three-phase 4-Quadrant Rectifier, Three-Phase supply

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

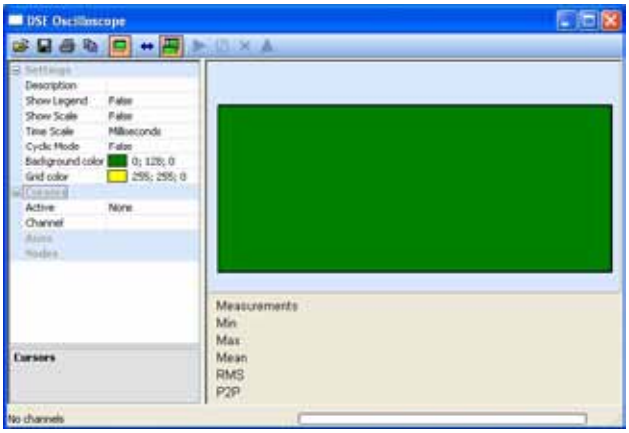
Input voltage: 3-phase 3 x 400 V + N + PE, 50-60 Hz
Input max current: 16 A
Output voltage: 0 - 400 V DC
Output current: 0 - 12 A (max 16 A)
Nominal output power: 2 kW (max 3 kW)
Design: Tutorial but with the PC-controlled industrial / professional aspects enhanced.
Control modes: Manually by front components, 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 Instruments and Oscilloscope 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 oscilliscope function.

MV 1439 Power Factor Control Unit

Background

Terco **P**ower **F**actor **C**ontroller is a new 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 **P**ower **F**actor **C**ontrol 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.

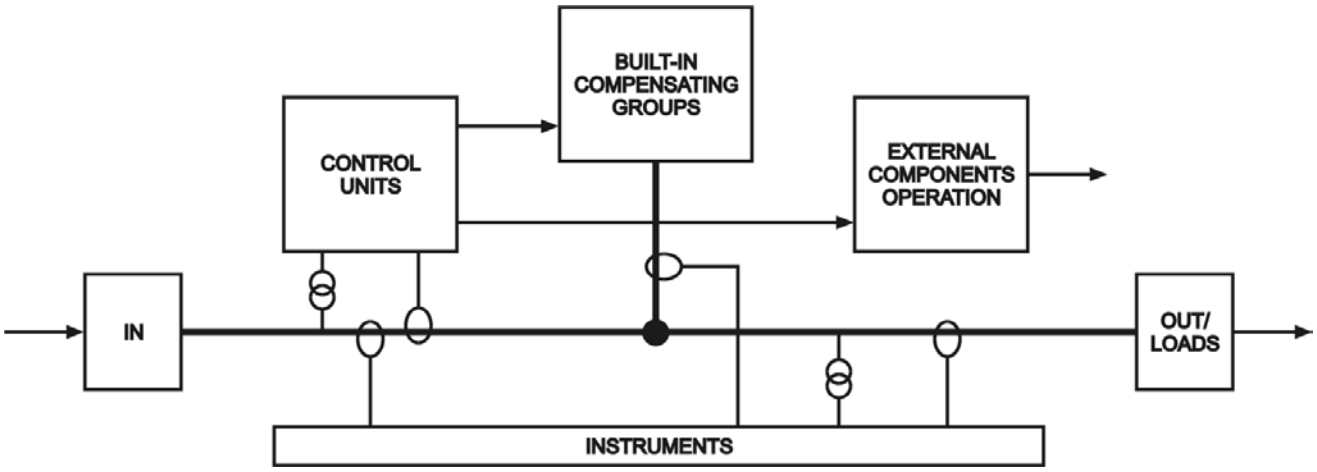
General data:

Power supply	1-ph 220 - 240 V, 50 - 60 Hz
Dimensions WxHxD	51 x 57 x 28 cm
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 ϕ”
- The concept of measuring methods
- Start current settings (C/k)
- Delay times
- Efficiency and losses
- Linear and circular switching modes
- **PF-C**ontroller design and schematics
- Programming the controller
- **PF-C**ontroller and resistive/inductive loads
- **PF-C**ontroller and induction motor loads
- Control range limits

Block Schedule



MV4250 Asynchronous Wind Mill System including HVDC Light Line

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

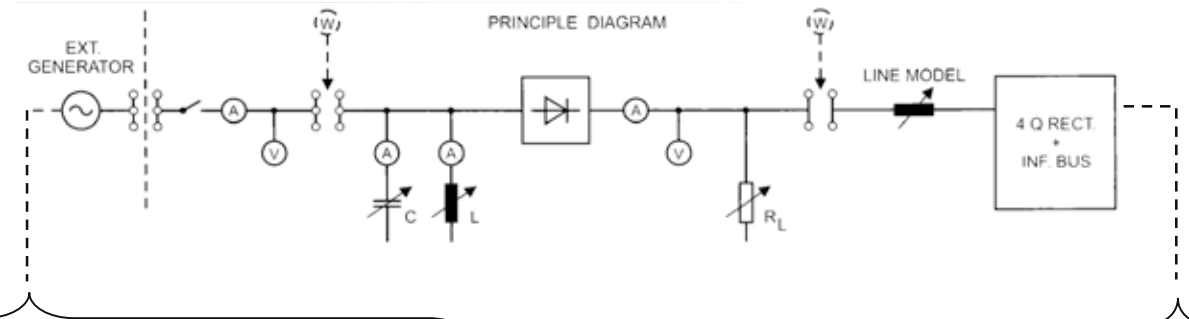
The Wind Mill Control Unit (MV4250) is designed to be connected to an external standard type induction machine (optional) to simulate the wind turbine, which speed can be varied. By means of the MV4250 the asynchronous motor/generator will be self excited and deliver a lower or higher 3-phase voltage 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	app. 45 kgs



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)

Flexes and Stand

Terco Flex

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 mm^2 contact surface.

General Data

Standard colours	blue, read, yellow, black, yellow/green
Standard area	2.5 mm^2 containing 650 wires of 0.07 mm diameter
Rated current	25 A

Standard Flex Sets

MV 1800 Flex Set

Set of 120 Leads in 2 colours. Area 2.5 mm^2

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

MV 1801 Flex Set

Set of 200 Leads in 5 colours. Area 2.5 mm^2

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

MV 1830 Flex Set

Set of 100 Leads in 5 colours. Area 2.5 mm^2

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

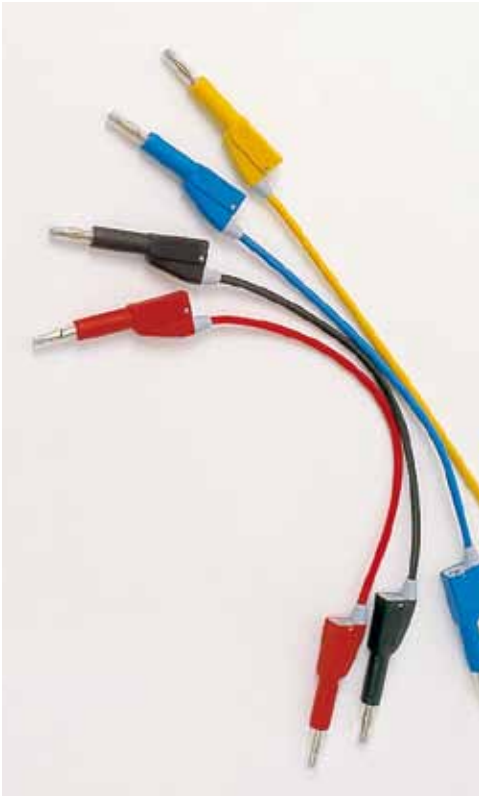
Separate Flexes.

Area 2.5 mm^2. Please note, each Ref. No. refers to a pack of 10 leads.

Length	25 cm	50 cm	100 cm	200 cm
Red	MV 1802	MV 1807	MV 1812	MV 1817
Yellow	MV 1803	MV 1808	MV 1813	MV 1818
Blue	MV 1804	MV 1809	MV 1814	MV 1819
Black	MV 1805	MV 1810	MV 1815	MV 1820
Yellow/green	MV 1806	MV 1811	MV 1816	MV 1821

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 mm^2 copper thread, PVC isolated, outer diameter 4 mm. Colours black, red, blue, yellow, green/yellow. Rated current 16 A.



MV 1800-H Flex Set

Set of 120 leads in 2 colours. Area 1.5 mm^2

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

MV 1801-H Flex Set

Area 1.5 mm^2.
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

MV 1830-H Flex Set

Area 1.5 mm^2
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 mm^2
Please note, each Ref. No. refers to a pack of 10 leads.

Length	25 cm	50 cm	100 cm	200 cm
Red	MV 1802-H	MV 1807-H	MV 1812-H	MV 1817-H
Yellow	MV 1803-H	MV 1808-H	MV 1813-H	MV 1818-H
Blue	MV 1804-H	MV 1809-H	MV 1814-H	MV 1819-H
Black	MV 1805-H	MV 1810-H	MV 1815-H	MV 1820-H
Yellow/Green	MV 1806-H	MV 1811-H	MV 1816-H	MV 1821-H

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.

MV 1800-HF Flex Set

Set of 120 leads in 2 colours. Area 1.5 mm²

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

MV 1801-HF 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

MV 1830-HF Flex Set

Area 1.5 mm²
Set of 100 leads in 5 different colours, red, yellow, blue, black, yellow/green, and 4 different lengths, 25, 50, 100 and 200 cm, 5 of each.

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	MV 1802-HF	MV 1807-HF	MV 1812-HF	MV 1817-HF
Yellow	MV 1803-HF	MV 1808-HF	MV 1813-HF	MV 1818-HF
Blue	MV 1804-HF	MV 1809-HF	MV 1814-HF	MV 1819-HF
Black	MV 1805-HF	MV 1810-HF	MV 1815-HF	MV 1820-HF
Yellow/Green	MV 1806-HF	MV 1811-HF	MV 1816-HF	MV 1821-HF

MV 1904 Flex Stand

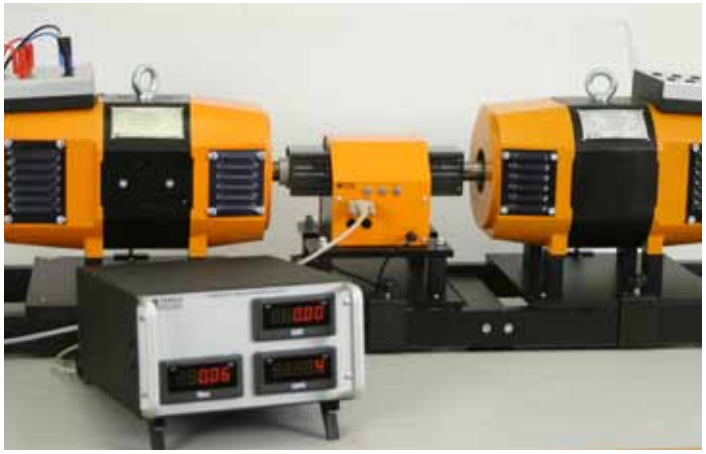
For suspension of laboratory flexes. The stand has 12 slots between parallel tubes with space for 10-15 laboratory flexes in each slot. Flexes of length 200 cm are suspended in a separate position above the stand. This rigid stand has a heavy steel plate pedestal.

General Data

Height	1170 mm
Weight	9 kg

Equipment Lists

Torque Meter Set, Digital



MV 1054	Torque and Power Meter
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 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 1500	Load Switch
MV 1502	Reversing Switch
MV 1503	Star-Delta Switch
MV 1905	Shunt Rheostat (2 pcs)
MV 1830	Lab Flex Set (alt. MV 1830-HF)
MV 1904	Flex Stand

Electrical Torque Meter Set, Analogue Dial

MV 1036	Electric Torque Meter (alt. MV 1026)
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 1500	Load Switch
MV 1502	Reversing Switch
MV 1503	Star-Delta Switch
MV 1905	Shunt Rheostat
MV 1830	Lab Flex Set (alt. MV 1830-HF)
MV 1904	Flex Stand

Brake Set

MV 1053	DC-Machine Brake Control
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 2636	AC and DC Starter
MV 1024	Tachogenerator with cover
MV 1300	Power Pack (alt. MV 1302 or MV 1304)
MV 1417	Terminal Board
MV 1500	Load Switch
MV 1502	Reversing Switch
MV 1503	Star-Delta Switch
MV 1905	Shunt Rheostat (2 pcs)
MV 1830	Lab Flex Set (alt. MV 1830-HF)
MV 1904	Flex Stand

Machine Test Set

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

Additional Test Machines

MV 1015	Reluctance Motor
MV 1016	Squirrel-cage Motor
MV 1017	Dahlander Motor, 2-speed
MV 1018	Universal Motor
MV 1020	Induction Motor, Capacitor Start
MV 1027	Synchronous Machine, Salient-poles
MV 1030	Induction Motor, 2-speed, 2 Windings
MV 1031	Induction Motor, Thermistor Protected
MV 1032	Thermal Relay for MV 1031
MV 1037	Induction Motor, Capacitor Start and Run






Instruments

MV 1922	Ammeter 0-2 A
MV 1923	Ammeter 0-12 A
MV 1924	Ammeter 20-0-20 A
MV 1926	Voltmeter (2 pcs)
MV 1929	Power Factor Meter (alt. MV 1976)
MV 1930	Frequency meter (alt. MV 1938)
MV 1931	Current Transformer (2 pcs)
MV 1937	Wattmeter (2 pcs)
Phase Cop 2	Phase Sequence Indicator Multimeter (2 pcs)


Optional Instruments

MV 1927	Wattmeter (2 pcs)
MV 1928	Wattmeter




Classic Electrical Machine System

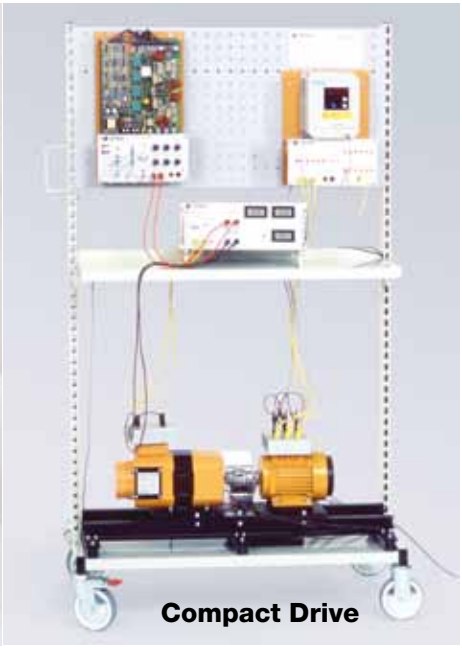
The Classic System is completely modular. The test motors and generators have a power of approximately 1 kW.
This size of machine is such that:

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.

Due to the top quality and robust construction of Terco products, they are able to withstand the rough handling by new, inexperienced students.

With Terco Classic Machines it is possible to produce characteristics which are typical for machines of ratings 6-8 kW, as our machines have a higher than normal iron and copper content. Compare the weight of our test machines with others.

Scan Lab System



Compact Drive

Scan Lab is completely modular, and the various modules can be bought separately and integrated as the demand arises. This enhances the use of Scan Lab and makes it flexible and economical.

All the electrical machines as well as the power electronics have been chosen to take uniquely industrial standard into consideration.

Terco Scan Lab is very accurate. Very small electrical machines give unrealistic measuring values. We have carefully considered this by optimising the winding data of the machines and by choosing an effect of approx 400 W.

Our Compact Drive is a cost effective solution to teach AC and DC drives.

Scan Drive System - SD 2000
Mobile Motor Drive Teaching Unit

A complete mobile system for teaching electrical machines and drives. The system covers everything from basic electrical machines to computerized 4-quadrant drive of induction motor.

The TERCO Scan Drive System is a learning system including both hardware and courseware, integrated to cover complete education in electrical machines and motor drives, thus opening a new path where teaching could reach the necessary goals to move industry ahead.

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.

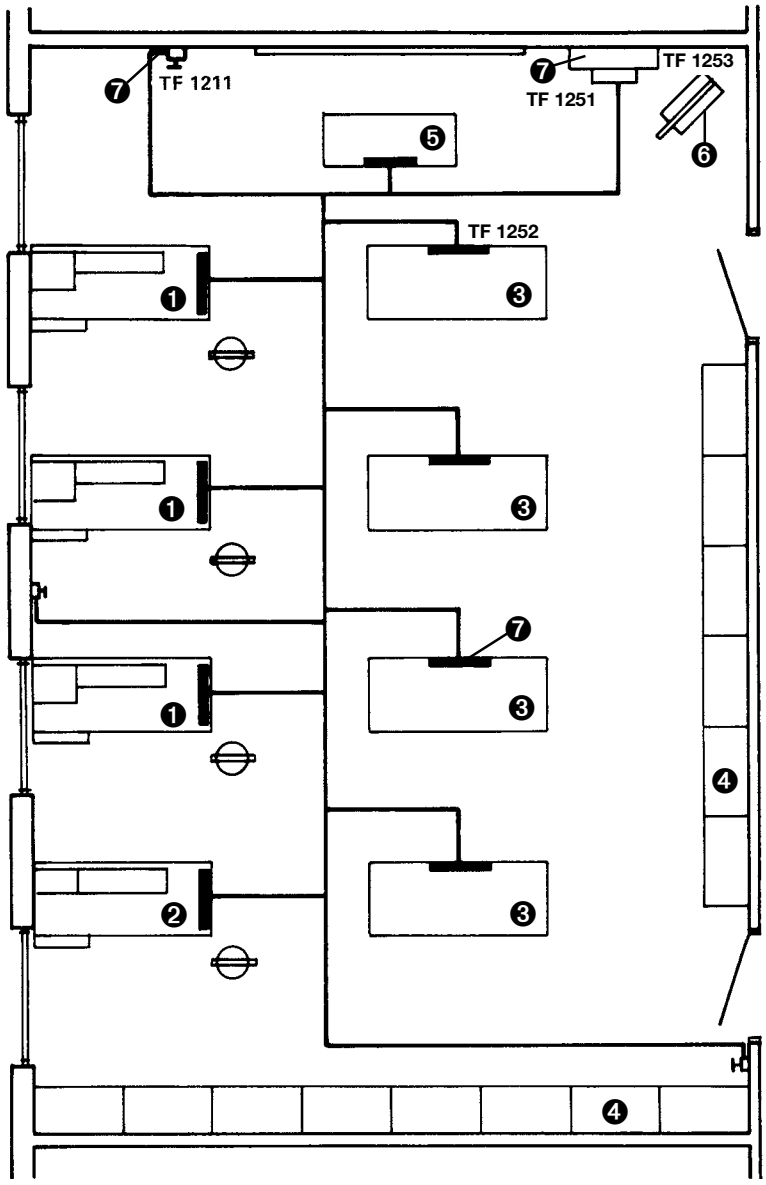
Regular after-sales service is performed by the worldwide network of Terco representatives, along with the advice and support of our engineers.

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

Laboratory Layout

The layout is 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.
See also our brochure "Power Distribution System and Furniture for Laboratories".



❶ Three Torque Meter Benches complete with accessories such as motors, loads, power supplies, switches, flex stands with flexes.

❷ One Brake Control Unit Bench or other type of brake complete with all accessories.

❸ Four benches for experiments where the motor bench is not necessary and for theoretical follow-up of the experiments.

❹ Cabinets for instruments, tools and accessories.

❺ Teacher desk.

❻ Machine jack.

❼ Terco Safety Power Distribution System with key-operated central, transformer, student-panels and emergency stops.

Power Distribution System increases Safety in School Laboratories

Terco´s Power Distribution System consists of a distribution board which is installed near the classroom. Each circuit is protected by a MCB, making energising and isolating a simple process for the teacher. There is also a protection device which breaks the voltage in the event of accidental disturbance in any phase. An emergency stop is placed in a prominent position in the classroom and will break all supplies when operated.

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.

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TF 1251 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 incomming wires are to be connected to the main switch.

Dimensions	480 x 330 x 60 mm
Weight	10 kg

TF 1252 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

TF 1253 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

TF 1229 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

TF 1211 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*

Experiment Manuals

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 syllabi.
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.
Split Phase Motor.
Capacitor Start Motor.
Capacitor Start and Run Motor
Induction Motor, 2 speed, 2 windings.

Additional

Induction Motor, thermistor protected.
Reluctance Motor.

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	

The foundation block on the modular system can be different Torque Measuring Systems:

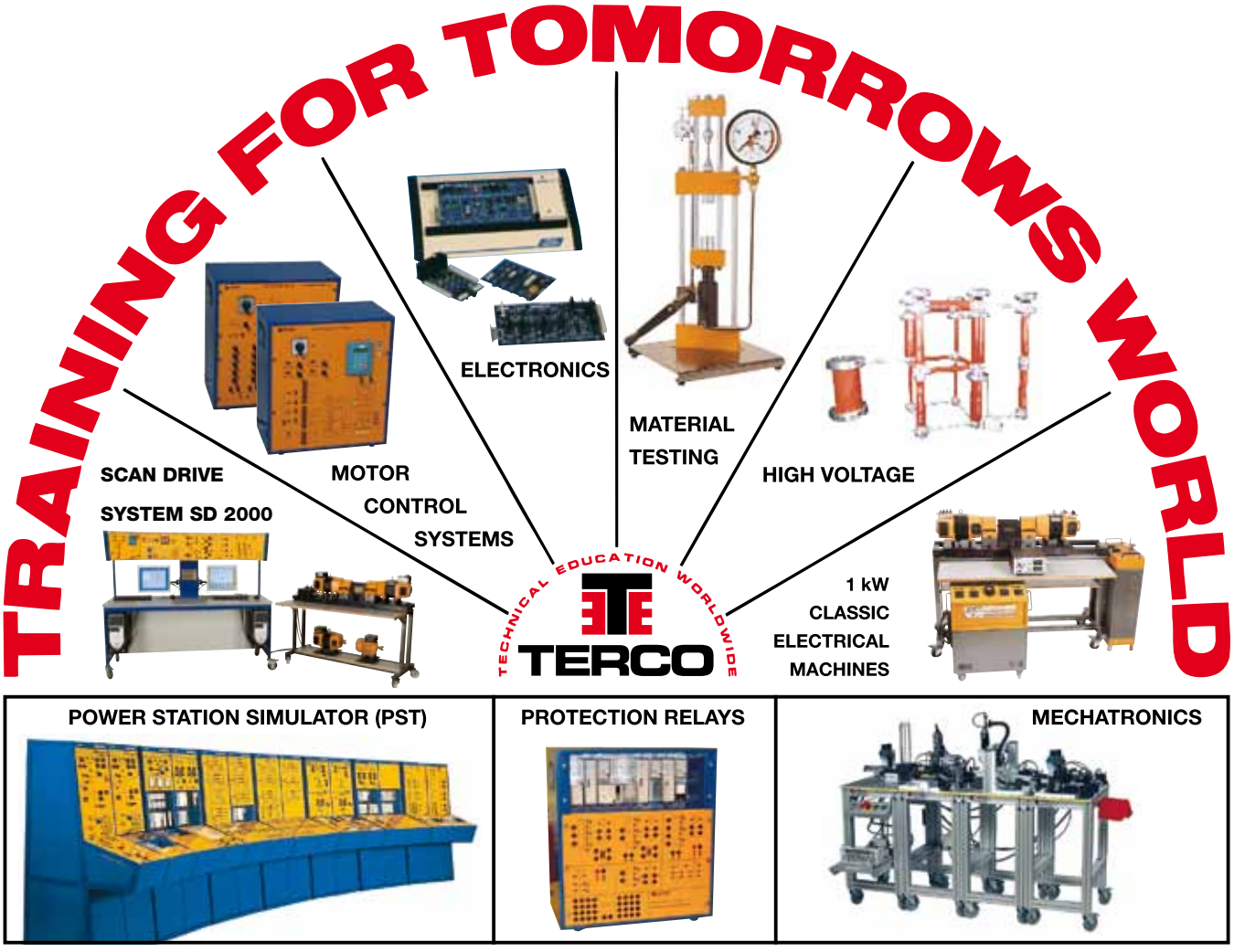
1. Torque and Power Meter MV 1054 together with prime mover or brake unit MV 1028 (alt. MV 1034).
2. Analogue Torque Meter (Dial) MV 1036 (alt. MV 1026).
3. Brake Control Unit MV 1053 together with prime mover or brake unit MV 1028.
4. DC-Machine MV 1028 (alt. MV 1034) for more simplified experiments on motor / generators. (No torque)

All above torque measuring systems can be coupled to the Terco test machines on Terco Machine Bed MV 1004.

Examples of Experiment Manuals.

Terco Headoffice

Terco headoffice and factory outside Stockholm, Sweden.



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