

PTG2000 Modular Power System

Power Generation
Transmission
Power Grid System



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

General Description

The system consists of equipment that together form a mini power system showing how the power system works from production to consumer. The electric power system has two voltage sources consisting of synchronous generator and one from the existing power distribution network.

Furthermore, one or more transformers can be used to connect the generator and load points to the mains. The switchgear has dual buses and three feeders for incoming and outgoing lines.

The system can be connected to renewable energy sources (solar and wind) via a grid inverter. At this point, it is also possible to connect three or single-phase loads.

The PTG1450 Line Multi Protection Trainer is equipped with the fully IEC61850 compliant ABB protection REF630 which is one of the most modern and sophisticated protection units in the product family of Intelligent Electronic Devices (IEDs).

The use of a highly advanced IED enables great possibilities to perform a wide range of laboratory experiments. This unit is intended for advanced training in modern line distance protection technology.

The unit is equipped with a large graphical Human Machine Interface (HMI) with a single line diagram.

Control, monitoring and parameter setting can be performed either from the HMI or from a PC by means of the standardized Ethernet interface.

Features

- **Multiple Generators are possible. Motor 2.2 kW, Generator 1.2 kW**
- **Active Load Sharing**
- **Grid System**
- **Colour coded power inlet / outlets for easy recognizing**
- **Mimic diagrams on the panels**
- **Solar/Wind Simulation 0,3 kW**
- **Basic and Advanced Relay Protection**
- **Power Factor Control of Transmission Lines**
- **Fully IEC61850 compliant ABB Relays**

Power supply and communication of modules

Monitoring and control of the modules are connected in a Local Area Network.

The modules Power Supply can be daisy-chained so that only one Power outlet is required



Every Module has two 1A fuse for Power Supply of the Module

Colouring of safety connections

EU	ASIA, Middle East
L1 Brown	L1 Red
L2 Black	L2 Yellow
L3 Grey	L3 Blue
N/E Blue	N/E Black

Note the difference in colour marking of phases and neutral conductors according to International Standards

Power System Overview



MAIN

Mobile Motor / Generator Unit
page 8,9

Busbar page 15

LAN network for:

- SCADA Control & monitoring
- Disturbance Record Analysis via PC

LINE & PROTECTION

Line Multi Protection
page 12

π Line page 11

TRANSFORMER & PROTECTION

Differential Relay Protection
page 13

Transformer page 10

RENEWABLE ENERGY

Renewable Power Interface
page 15

Fault Connection
page 17

LINE

AC Meters
page 20

π Line page 11

π Cable Line page 11

SCADA Module
page 18

CONSUMER

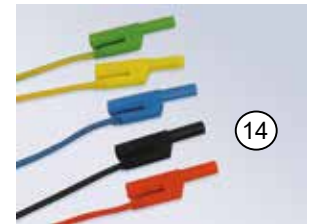
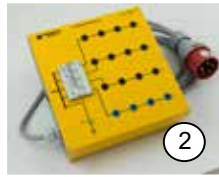
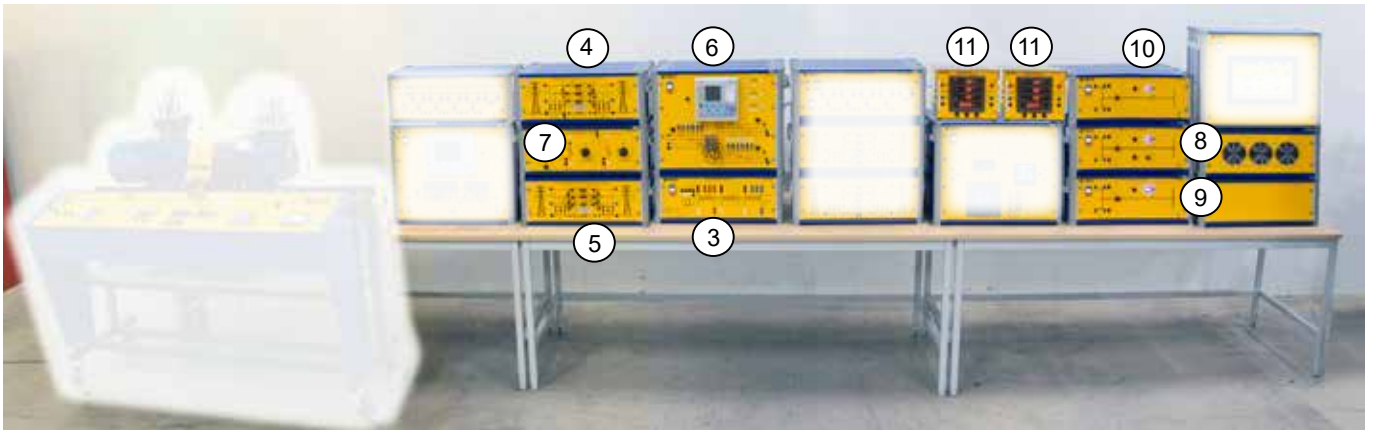
Ind. load page 14

Res. load page 14

Cap. load page 14

Power Factor Control
page 16

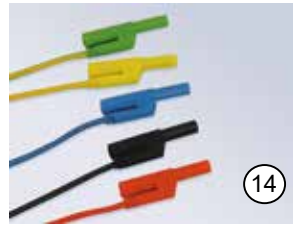
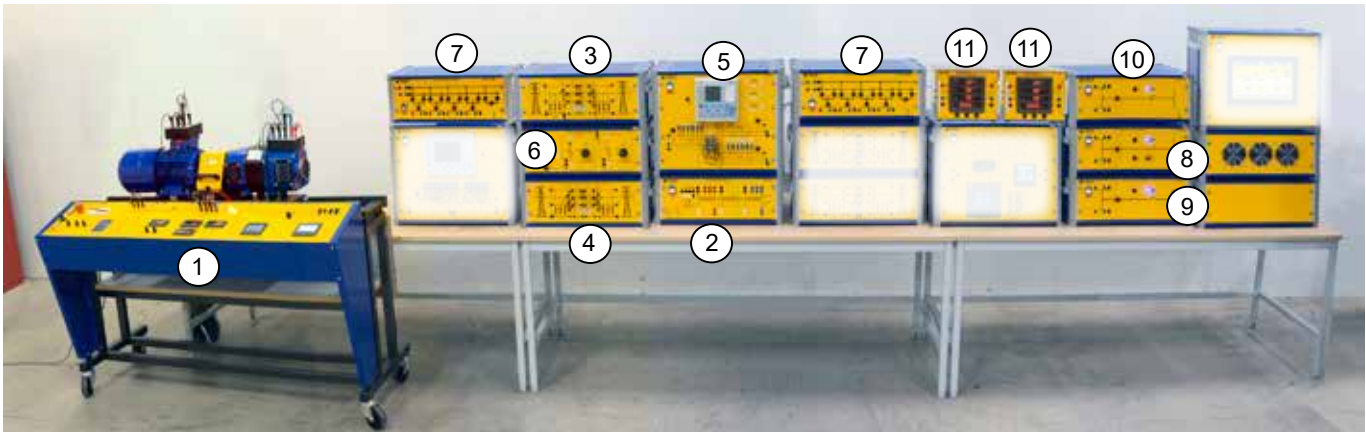
Content in PTG2000 Level 1 with Variable Transformer and Connection Box



ORDER DETAILS PTG2000 Level 1

- ① MV1103 Variable Transformer 3-phase
- ② MV1429 Connection Box / Terminal Board
- ③ PTG1965 Transformer Module
- ④ PTG1521 Transmission HV OH-Line 230 kV, 100 km
- ⑤ PTG1523 Transmission HV OH-Line 35 kV, 20 km
- ⑥ PTG1455 Differential Relay Module
- ⑦ PTG1570 Fault Connection Module
- ⑧ PTG1560 Resistive Load Module 400V, 1,5 kW in 15 steps
- ⑨ PTG1561 Inductive Module 400V, 2,5 kVAr in 15 steps
- ⑩ PTG1562 Capacitor Load Module 400V, 2,8 kVAr in 15 steps
- ⑪ PTG1939 AC Power Energy Meter
- ⑫ MAT220118 Digital Multimeter
- ⑬ DT-2330 Digital Clamp Meter AC / DC current
- ⑭ MV1801-HF Flex Set 200 pc Safety Leads 5 colours
- ⑮ MV1904 Flex Stand

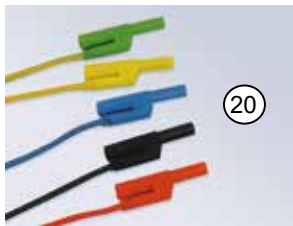
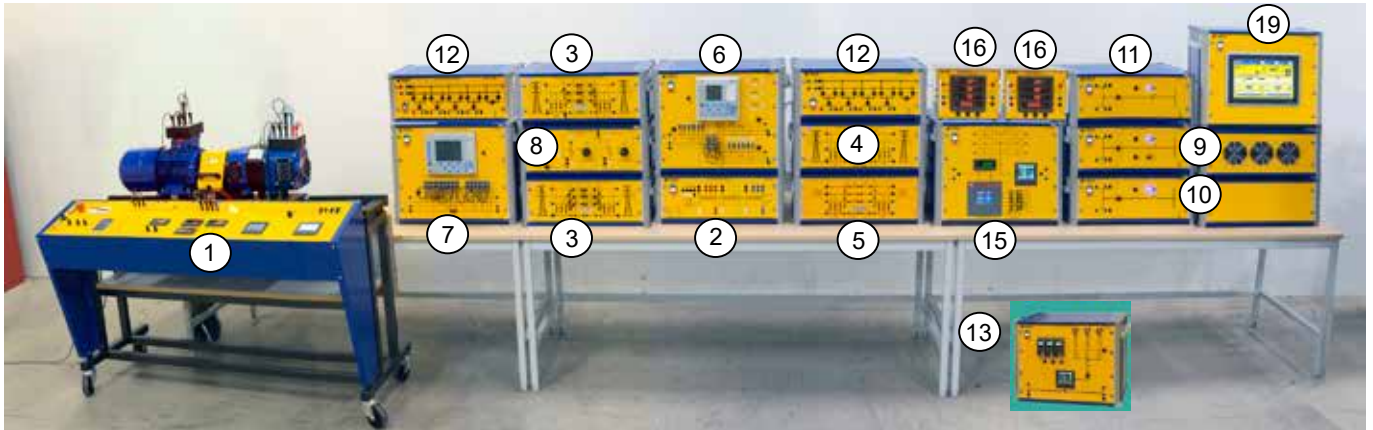
PTG2000 Level 1, 2 and 3 are examples of standard setup. For more information about content and setup of your own Laboratory, please contact us.

Content in PTG2000 Level 2 with Mobil Motor/Generator Module**ORDER DETAILS PTG2000 Level 2**

- ① PTG1305 Mobil Motor / Generator Module
- ② PTG1965 Transformer Module
- ③ PTG1521 Transmission HV OH-Line 230 kV, 100 km
- ④ PTG1523 Transmission HV OH-Line 35 kV, 20 km
- ⑤ PTG1455 Differential Relay Trainer
- ⑥ PTG1570 Fault Connection Module
- ⑦ PTG1565 Double Busbar Module with 4 feeders
- ⑧ PTG1560 Resistive Load Module 400V, 1,5 kW in 15 steps
- ⑨ PTG1561 Inductive Module 400V, 2,5 kVAr in 15 steps
- ⑩ PTG1562 Capacitor Load Module 400V, 2,8 kVAr in 15 steps
- ⑪ PTG1939 AC Power Energy Meter
- ⑫ MAT220118 Digital Multimeter
- ⑬ DT-2330 Digital Clamp Meter AC / DC current
- ⑭ MV1801-HF Flex Set 200 pc Safety Leads 5 colours
- ⑮ MV1904 Flex Stand

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Content in PTG2000 Level 3 Extended and Advanced System



(13)



(14)

ORDER DETAILS PTG2000 Level 3

- (1) PTG1305 Mobil Motor / Generator Module
- (2) PTG1965 Transformer Module
- (3) PTG1521 Transmission HV OH-Line 230 kV, 100 km
- (4) PTG1523 Transmission HV OH-Line 35 kV, 20 km
- (5) PTG1522 Transmission Cable MV Line 11 kV, 5km
- (6) PTG1450 Line Multi Protection Trainer
- (7) PTG1455 Differential Relay Trainer
- (8) PTG1570 Fault Connection Module
- (9) PTG1560 Resistive Load Module 400V, 1,5 kW in 15 steps
- (10) PTG1561 Inductive Module 400V, 2,5 kVAr in 15 steps
- (11) PTG1562 Capacitor Load Module 400V, 2,8 KVAr in 15 steps
- (12) PTG1565 Double Busbar Module with 4 feeders
- (13) PTG2291 Solar Power Module (incl. stand for outdoor use)
- (14) PTG2290 Wind Mill Module (incl. Wind Mill for outdoor operation)
- (15) PTG1439-405 Power Factor Control Module
- (16) PTG1939 AC Power Energy Meter
- (17) MAT220118 Digital Multimeter
- (18) DT-2330 Digital Clamp Meter AC / DC current
- (19) SCADA System
- (20) MV1801-HF Flex Set 200 pc Safety Leads 5 colours
- (21) MV1904 Flex Stand

PTG2000 Level 1, 2 and 3 are examples of standard setup. For more information about content and setup of your own Laboratory, please contact us.

PTG1305 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.

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.

Wide range of flexibility is achieved by the mobile generator station / synchronous alternator (compensator) PTG1305.

Two sets of PTG1305-405 can operate as described or work in parallel.



Voltage and frequency variants

Item	Power Supply	Synchronous Generator
PTG1305-405-235	400V 3-ph, 50Hz	230V 3-ph, 50Hz
PTG1305-406-236	400V 3-ph, 60Hz	230V 3-ph, 60Hz
PTG1305-405-405	400V 3-ph, 50Hz	400V 3-ph, 50Hz
PTG1305-406-406	400V 3-ph, 60Hz	400V 3-ph, 60Hz

**The Mobile Motor / Generator Module is equipped with Local Area Network communication for monitoring via PTG1631 SCADA Module.
Relevant faults can be connected for troubleshooting exercises via PTG1570 Fault Module**

Technical Specification

Power Supply:

Voltage	380-415 V AC 3-ph
Frequency	50 Hz/60Hz
Max current	16 A

Turbine/AC-machine freq.drive:

Armature/stator Volt	323-528 V AC
Frequency	47-63 Hz
Armature/stator current	3.4 A
Input current	5.9 A
Rated output current	4.0 A
Rated output capacity	3.2 kVA
Speed	0-1800 rpm

Speed control/

Speed	0-1800 rpm
Active power control:	Frequency converter, electronic current limit setting, start- and stop ramps.
Feedback systems	Manual frequency setting. Automatic/Constant setting
Field current supply	Integrated

Synchronous generator:

Armature volt	0-140 / 240 V AC
Power	1.2 kVA
Cos φ	0.8
Field volt	0-230 V DC

Voltage control/

Reactive power control	PWM min. ripple-converter, electronic current limit setting
Feedback systems	Manual voltage setting. Automatic/Constant setting. Separate voltage feedback

Modes of Operation

PTG1305-405 can also be used to compensate for system power characteristics (active and reactive) via turbine speed and generator magnetisation.

Instruments:

AC-machine freq.drive
(Turbine simulator)
Parameters and indications selected by 4-lines display in HMI-unit for example:

- Frequency setpoint 50Hz
- Stator Electric Frequency 50Hz
- Actual motor speed (from encoder) 1500 rpm at 50Hz, 1800 rpm at 60Hz
- Motor current 2,20 A
- DC-interlink voltage 520 V
- Speed control potentiometer (=frequency control)
- Feedback selector (Auto/ Man)

AC-machine M/G

- Armature voltage
- Voltage selector switch
- Armature current
- Voltage control potentiometer
- Feedback selector (Auto/ Man)
- Field current ammeter

Synchronizing device

- Synchronizing instrument
- Double voltmeter Δu
- Double frequency meter Δf
- 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 safety plugs. 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.)

Transformer



PTG1965 Transformer Module

Between the grid and generator station connects a generator. The transformer allows the user to configure the transformer with different vector groups such as Dyn / Yyn and so forth.

Power Supply: 1-ph 220 - 240 V, 50 - 60 Hz
 Three-phase: 2 kVA, 50-60 Hz
 Primary: 3 x 230V D, 3 x 400V, Y
 Secondary: 3 x 380-400-420V, y

Secondary current: 2.9A
 No load current: 0.25A
 U_k : 3.7%
 Losses: $P_o=40W$, $P_{cu}=107W$

Vector group: Selectable

Dimension: 600 x 420 x 420 mm
 Weight: 48 kg



PTG1939 AC Power Energy Meter

PTG1939 AC Power Energy Meter is a practical solution for the study of 1, 2 and 3-Phase AC power systems up to 500VAC/10A.

The 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.

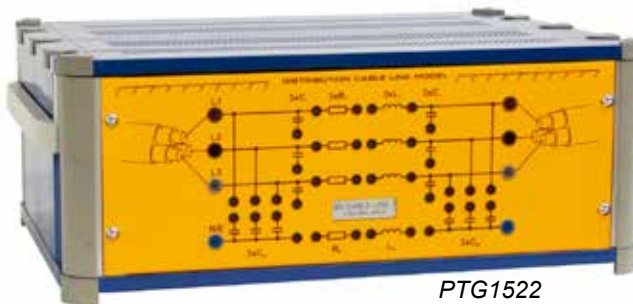
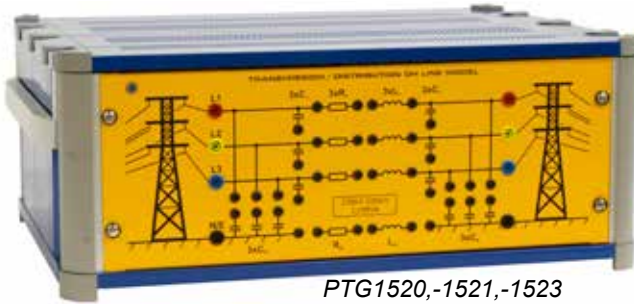
The visualization of parameters is distributed over several pages (default preset to display five pages) where each page simultaneously displays four parameters.

Technical Specifications

Power supply 220-240VAC, 50/60Hz
 Measurement ratings:
 Voltage / Current 500VAC max / 10AAC max
 Reactive / Active Power 5 kVAr / 5 kW
 Cos Phi 0-1-0

Communications:
 Serial interface RS485
 Transmission protocol Modbus RTU8N2
 Baud Rate 19200kB
 Dimension 255 x 205 x 335mm
 Weight 10kg

PTG1520-1523 Transmission / Distribution OH Line Modules



The Transmission Lines have scaled down 3-phase OH transmission lines with different values. For each Line it is possible to change and combine impedance elements to constitute other Overhead Lines (OH) High Voltages (HV) levels.

On the request other line values are possible to order.

All models have inductors, capacitors and resistors designed to withstand overload and surges for dynamic as well as for static experiments.

All parameters of the transmission models can be changed easily by both internal and external combinations, together with the possibilities of arranging the models in series, parallel or in grid networks.

Each line model consists of a three-phase pi-link and an earth link.

A safety switch is incorporated on the backside to ensure earthing of the Module

With our Transmission Line Modules, we have a unique combination of HV-lines, Medium-Voltage lines, OH-distribution Voltage lines and Distribution Voltage cables which will enable studies of the typical parameters and characteristics within the four main groups of AC-power transmission and corresponding need of compensation.

It is possible to isolate/separate the different R, L, and C characteristics of each line for individual analysis.

Relevant errors can be programmed for troubleshooting exercises via PTG1570 Fault Module

Technical Specification

PTG1520	OH-HV π -link	77 kV	13 MVA	136 km
PTG1521	OH-HV π -link	230 kV	110 MVA	100 km
PTG1522	Cable MV π -link	11 kV	5 MVA	5 km
PTG1523	MV-HV π -link	33 kV	20 MVA	20 km

Power Supply: 1-ph 220 - 240 V, 50 - 60 Hz
 Power bus: 3-phase 400V AC/ 2A with 4 mm safety connectors.

Dimension: 600 x 420 x 210 mm
 Weight: 15 kg

Protective Modules - Fully IEC 61850 compliant

PTG1450 Line Multi Protection Module



The PTG1450 Line Multi Protection Trainer module is intended for advanced training in modern line distance protection technology.

It is equipped with the fully IEC61850 compliant ABB protection REF630 which is one of the most modern and sophisticated protection units in the product family of Intelligent Electronic Devices (IEDs).

REF630 is designed for protection of transmission and distribution networks.

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

Relevant faults can be connected for troubleshooting exercises via PTG1570 Fault Module.

The protective relay REF630 used in PTG1455 enables the student to learn and explore how to protect a variety of different power line configurations from various fault conditions.

General Features

- Colour coded power inlet- and outlets for easy recognition of each phase.
 - Mimic diagrams of the circuit along with large clear symbols printed on the front panel
- Power bus circuit breaker switch:
- A two state switch (ON/OFF) with LED indication of CB (Circuit Breaker) status.
 - Internal circuitry prevents operation of the CB during an unacknowledged trip.
- Trip reset button:
- Button for quick reset of LEDs and acknowledgement of a trip.
 - Control, monitoring and protection integrated in one IED
 - Fully IEC 61850 compliant.
 - Four independent parameter setting groups.
 - Large HMI with single line diagram.
 - RJ-45 interface for communication with PC.
 - Protection and Control IED Manager PCM600: Advanced software for configuration and parameter setting.

Technical Specification

Power Supply:	1-ph 220 - 240 V, 50 - 60 Hz
	Possible to supply a compatible device with power (at page 3)
Power bus:	3ph, 400VAC, 2A
Dimension:	483 x 356 x 422 mm.
Weight:	37 kg

Protective earth: one 4mm safety connector for external components at the rear of the unit.

REF630 Important Protection functions

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

** In order to retain dependability and security in cases of close-in faults when the loop voltage is zero, mho distance elements use cross-phase and/or memory polarization.*

Full access to protections relays including parameter setting and Disturbance Records is possible via a standard web browser.

It is possible to view important analogue current and voltage sinus waveform vectors in a suitable diagram, together with protection's binary input and output status for in-depth fault analysis after such an event has occurred.

SCADA ready for remote control of Circuit Breaker and Trip Reset via HMI

PTG1455 Differential Relay Module



General Features

- Colour coded power inlet- and outlets for easy recognition of each phase.
 - Mimic diagrams of the circuit along with large clear symbols printed on the front panel.
- Power bus circuit breaker switch:
- A two state switch (ON/OFF) with LED indication of CB (Circuit Breaker) status.
 - Internal circuitry prevents operation of the CB during an unacknowledged trip.
- Trip reset button:
- Button for quick reset of LEDs and acknowledgement of a trip.
 - Control, monitoring and protection integrated in one IED
 - Fully IEC 61850 compliant.
 - Four independent parameter setting groups.
 - Large HMI with single line diagram.
 - RJ-45 interface for communication with PC
 - Three power lines; 1 incoming power line and 2 outgoing. Each line contain three phases L1, L2, L3 and Neutral wire.
 - 12 Current Transformers which enables the student to study various CT-connections.
 - Protection and Control IED Manager PCM600: Advanced software for configuration and parameter setting.
 - Front panel switches that enable the student to test differential protection on a double-busbar.

The PTG1455 Differential Relay Module module is intended for advanced training in modern differential protection technology.

It is equipped with the fully IEC61850 compliant ABB RET615 protective relay which is one of the most sophisticated protection unit in the product family of intelligent electronic devices (IEDs).

RET615 is designed for differential protection of transformers, generators, line sections and their combinations.

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

Relevant faults can be connected for troubleshooting exercises via PTG1570 Fault Module.

The protective relay RET615 used in PTG1455 enables the student to learn and explore how to protect a variety of different power transformer connections with a differential protection scheme.

Technical Specification

Power Supply: 1-ph 220 - 240 V, 50 - 60 Hz
 Power bus: (3-ph) 400V AC/ 2A with 4 mm safety connectors

Dimension: 357 x 483 x 420 mm
 Weight: 37 kg

Protective earth: one 4mm safety connector for external components at the rear of the unit.

RET615 Important Protection Functions

- Differential Fault Protection
- Three-phase non-directional overcurrent protection, low, high and instantaneous stage
- Non-directional earth-fault protection, low and high stage
- Negative-sequence overcurrent protection
- Residual overvoltage protection

Full access to protections relays including parameter setting and Disturbance Records is possible via a standard web browser.

It is possible to view important analogue current and voltage sinus waveform vectors in a suitable diagram, together with protection's binary input and output status for in-depth fault analysis after such an event has occurred.

SCADA ready for remote control of Circuit Breaker and Trip Reset via HMI

Loads



PTG1560 Resistive Load Module

The load can be changed in 15 steps with 100W / step at 400V. The unit can be programmed for a typical load curve over 24 hours.

Power Supply: 1-ph 220 - 240 V, 50 - 60 Hz
 Input Voltage: 3-phase 400V AC/ 2A with 4 mm safety connectors.
 Dimension: 600 x 420 x 420 mm
 Weight: 38 kg

PTG1560 consists of 2 units which can be split to optimize the bench top place.



PTG1561 Inductive Load

General

PTG1561 is housed in a metal cabinet with electrical data and symbols on the front panel. Both the 50 and 60Hz variants charge 1.5 kVAr and are Y-connected.

PTG1561 Inductive Load for 50 / 60Hz

Power Supply: 1-ph 220 - 240 V, 50 - 60 Hz
 Current: 0.15-2.2A / 0.12-1.8 A
 Input Voltage: 3-phase 400V 50Hz / 2A with 4 mm safety connectors

Dimension: 600 x 420 x 210 mm
 Weight: 40 kg

PTG1561 consists of 2 units which can be split to optimize the bench top place.



PTG1562 Capacitor Load Module

General

PTG1562 is housed in a metal cabinet with electrical data and symbols on the front panel. Both the 50 and 60Hz variants charge 1.5 kVAr and are Y-connected.

PTG1562 Capacitive Load for 50Hz / 60Hz

Power Supply: 1-ph 220 - 240 V, 50 - 60 Hz
 Current: 0.15-2.2A / 0.18-2.6A
 Input Voltage: 3-phase 400V 50Hz / 2A with 4 mm safety connectors

Dimension: 600 x 420 x 210 mm
 Weight: 15 kg

Power Components



PTG1565 Double Busbar Module

This unit is a double busbar module where the user has access to 4 feeders for incoming/outgoing power. Each feeder is connected to the two busbars through two isolators and one circuit breaker. Internal logic prohibits the user from incorrect switching (i.e breaking current with an isolator). This module can be used in the laboratory to assemble a larger power grid.

Relevant faults can be connected for troubleshooting exercises via PTG1570 Fault Module

Power Supply: 1-ph 220 - 240 V, 50 - 60 Hz
Power bus: 3-phase 400V AC/ 2A with 4 mm safety connectors.

Size: 600 x 420 x 210 mm
Weight: 10 kg

PTG1570 Fault Connection Module



PTG1570 is a fault simulator with the ability to simulate many different types of variable short circuit and earth faults.

The maintained / momentary switch allows safe and secure connection of permanent or instantaneous faults

Impedance errors can be connected individually, in parallel or in series.

PTG1570 is used together with Line Multi Protection Trainer and Differential Protection Trainer

Power supply: 1-ph 220 - 240 V, 50 - 60 Hz
Dimension: 600 x 420 x 210 mm
Weight: 15 kg

All Load Modules is equipped with Local Area Network communication for monitoring and control via PTG1631 SCADA Module.

Relevant errors can be programmed for troubleshooting exercises via PTG1570 Fault Module

PTG1439-405 Power Factor Control Unit



General

With the Power Factor Control Module (PFC) you can minimise the currents caused by reactive losses of power 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 as in industrial applications.

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 capacitive
Power factor setting: 0 to 0.7

MV1439-235 nominal voltage 3 x 230V, 50-60 Hz
MV1439-405 nominal voltage 3 x 400V, 50-60 Hz

Nominal voltage: 3 x 400 V 50 – 60 Hz
Nominal power: 0 – 2 kVAr capacitive
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
Dimension: 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 $\cos \varphi$
- 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

PTG2291 Solar Power Module



General Data

Power Supply: 240V 3-phase, 10A. Each module connects 3 pole (L1, N, Earth)

Cubicle Weight WxHxD 510 x 570 x 280 mm
24 kg



General

PTG2291 is a free standing module with the same form factor as the other modules. PTG2291 is a generator station where the generator consists of three solar panels delivering three-phase power to the module that can further be tied to a grid.

The module simulates a solar farm, containing all necessary equipment such as solar panels, inverters, switchgear, protection modules and voltage transformation before interfacing the grid.

A Solar Farm provides a variety of switching equipment that handles control and switching of both AC and DC.

Technical Specifications

Electrical Data

Rear side I/O: 1 phase + N + PE 230V/50Hz protected by a Fuses
Photovoltaic power in: 3 phase + N + PE 400V/50Hz (grid-tied) protected by a MCB and EF protection

DC - Switching

- DC CB Capable of switching the rated current remotely.

AC - Switching

- 6 x CB's 3 pole breaking of current

Photovoltaic Module

The photovoltaic module consists of three solar panels framed in a sturdy aluminium frame, designed to be mounted on ground or on a roof top. The panels together with the electrical equipment are all IP65 or higher classed, making them suitable for outdoor use in all weather conditions.

Panels Specification

- 3 x monocrystalline:
- Maximum Power (P_{max}): 265W
 - Short Circuit Current (typical A/Isc): 8.41
 - Open Circuit Voltage (typical V/Voc): 37.7

Inverter

3 x micro inverter to convert the DC to AC. 250W / inverter, Grid-tied.

Measurements

Each panel incl. stand
Cubicle WxHxD 1650 x 990 x 120 mm
Dimension specifies panel folded down without wheels.
Weight 22 kg

PTG2290 Wind Power Module

The PTG2290 Wind Power Module models the inherent principles, functions and challenges in the different stages of a wind power plant project. This includes both the operation of the individual wind turbine, as well as the connection of the plant to an electrical grid. It promotes hands-on experience in order to understand and overcome the challenges when incorporating modern renewable energy power plants into classic grid topologies.

The module includes an actual smallscale wind turbine that conveys the fundamental physical, mechanical and electrical principles when harvesting electrical energy from the wind. It is mounted on a 3 m mobile and foldable mast unit that allows quick and easy setup and repositioning at an optimal location in accordance with the local wind conditions.

Weather independent simulation is also made possible by a fully programmable variable three phase power source, integrated into the PTG2290 Wind Power Module. This allows full control over wind conditions even when the weather is calm, maximizing the efficiency of student lab time.

Additionally, a variable three phase electrical power source is integrated into the PTG2290 Wind Power Module, thus allowing the weather independent simulation of varying wind conditions and therefore maximizing the efficiency of student lab time.

Electrically, the module operates with a three phase permanent magnet alternator (PMA) connected to a three phase grid-tie inverter and includes all the necessary measuring, safety and display equipment for the operation of the wind power plant and execution of the provided experiments.

Aside from the three phase electrical data (voltage-current, active and reactive power as well as power factor), the data collected from the and included outdoor sensors on for wind speed, and wind direction, as well as air temperature and air pressure is displayed, logged and accessible for export.

The PTG2290 Wind Power Module can function as stand alone equipment but can also easily be integrated into the Terco PTG and PST power system models and corresponding SCADA systems.

Technical Specifications

Wind turbine type	Vertical, Upwind
Rated power	1000 W
Max power 1	200 W
Rated rotation speed	750 rpm
Start-up wind speed	6 m/s
Rated wind speed	12 m/s
Survival wind speed	50m/s
Rotor diameter	1.96 m
Swept area	3 m ²
Generator	3-phase PMA
Grid-tie inverter type	
Gridtie inverter type	3-phase
Rated power	5.5 kW

Weight

Windmill	32 kg
Mast	70 kg

Dimensions

Windmill	1120 x 420 x 430 mm
Mast	1000 x 1000 x 400 mm



SCADA System



PTG1631 SCADA System

PTG1631 SCADA System Module includes an advanced and stylish industrial standard HMI where measurement data from throughout the power system is collected, logged and presented.

Power system characteristics can be monitored and investigated in real-time on attractive virtual instruments. Time-lapse data tracked and presented clearly in trend charts and values stored in the data logger can be saved and exported for further investigation at a later date.

Clear indications of important system events help operators to understand the complicated relationships and balance required between modern components, in order to maintain a robust power supply.

PTG1631 SCADA System Module is designed to work with multiple PTG1939 Power Energy Meters. These measurement instruments provide information of over 30 3-phase parameters each and are connected via a LAN network.

The HMI can even be accessed and controlled remotely from a PC via a VNC Viewer. This allows for further presentation via projector, large-screen t.v. or other device.

Technical specifications

HMI

Housing material: Powder-coated aluminum, Gray
Screen: TFT-LCD 12", 1280x800 px
Class I (ISO9241-307)
LED Backlight and Industrial dimming
Resistive Touch Screen
Full colour

Power supply: 1-ph 220 - 240 V, 50 - 60 Hz
Dimension: 510 x 570 x 280 mm
Weight 17 kg

Instruments

PTG1939 Power Energy Meter



PTG1939 Power Energy Meter is a practical solution for the study of 3-Phase AC power systems.

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.

Each line is fused with a 500V, 10A slow fuse and together with 10:1A current transformers provide a good level of protection against incorrect connection, mishandling and carelessness.

Technical specifications

Power supply 220VAC, 50/60Hz

Measurement

Voltage, V: 500VAC max
VT ratio: Direct measurement
Current, I: 10A max
Active power, P: 0.0...(±)1999.9 W
Apparent power, S: 0.0...(±)1999.9 VA
Reactive power, Q: 0.0...(±)1999.9 VAR
Active power factor, Pf: -1...cos φ...1
Frequency, f: 15...500Hz

PTG1939 Power Energy Meter enables the measurement and visualisation of 46 power energy quantities and 25 harmonics for each phase of current and voltage. The analyser can display parameters of interest in the study of symmetrical as well as non-symmetrical networks, such as: phase voltages, phase-to-phase voltages, line currents, phase active powers, phase reactive powers, phase apparent powers, phase active power factors, phase reactive/active power factors, mean three-phase voltage, mean phase-to-phase voltage, mean three-phase current, three-phase active, reactive and apparent powers, mean three-phase power factors.

The visualization of parameters is distributed over programmable pages (max 20 pages) where each page simultaneously displays four parameters.

Communications

Communication with SCADA via Local Area Network

Dimension: 255 x 195 x 335mm
Weight: 10kg



MAT220118

This compact, comprehensive digital multimeter is equipped with all the functions required by electricians for maintenance of low and medium-power residential and tertiary equipment and installations. Ergonomic and simple to use, it is exceptionally easy to read with its 6,000-count backlit display with bargraph, 2 "Off" positions for greater effectiveness and a compact casing with a non-slip protective coating for excellent handling.

- CAT IV 600V
- TRMS measurements
- Large 6,000-count backlit display (digits 8 mm high)
- 61-segment bargraph
- Double OFF position
- No-contact voltage detection (NCV)
- VLow Z low-impedance voltage measurement to avoid stray voltages.
- Min, MAX and RELative functions
- Measurement up to 600 V
- AC or DC current measurement up to 10 A
- Frequency measurement
- Temperature measurement
- Capacitance measurement
- 60 mV range
- Compact IP54 casing with built-in shockproof protection
- Compatible with the multi-function mounting accessory



MAT220349 Digital Clampmeter AC/DC current

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

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

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

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

The measuring values are updated 2 times / sec.

MAT220349 is delivered with manual, battery and soft case.

Conforms with IEC safety requirements.

Specifications:

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

Dimension: 20x44x146 mm

Weight: 0.1 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

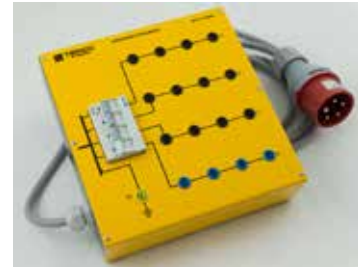
Dimension: 280 x 290 x 560 mm
Weight: 34 kg



MV1429 Terminal Board

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

Dimension: 250 x 240 x 75 mm
Weight: 2.0 kg



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



Laboratory Flexes with Safety Plugs, Fixed Sleeve

MV1801-HF Flex Set Area 1.5 mm²

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



ORDER DETAILS POWER GENERATION AND GRID MODULAR SYSTEM

Order code	Description	Pcs Level 1	Pcs Level 2	Pcs Level 3	Page
MV1103	Variable Transformer, 3-phase	1			200
MV1429	Connection Box / Terminal Board	1			218
PTG1305-405	Mobil Motor / Generator Module		1	1	35
PTG1965	Transformer Module	1	1	1	37
PTG1521	Transmission HV OH Line 230 kV, 100 km	1	1	1	38
PTG1523	Transmission MV OH Line 35 kV, 20 km	1	1	1	38
PTG1522	Transmission Cable MV Line 11 kV, 5 km			1	38
PTG1450	Line Multi Protection Trainer			1	39
PTG1455	Differential Relay Trainer	1	1	1	40
PTG1570	Fault Connection Module	1	1	1	42
PTG1565	Double Bus bar Module with 4 feeders		2	2	42
PTG1560	Resistive Load Module 400 V, 1,5 kW in 15 steps	1	1	1	41
PTG1561	Inductive Load Module 400V, 2,5 kVAr in 15 steps	1	1	1	41
PTG1562	Capacitor Load Module 400 V, 2,8 kVAr, in 15 steps	1	1	1	41
PTG2291	Solar Power Module			1	44
PTG2290	Wind Mill Module			1	45
PTG1439-405	Power Factor Control Module			1	43
PTG1939	AC Power Energy Meter	2	2	2	37
MAT220118	Digital Multimeter	1	1	1	214
MAT220349	Digital Clamp Meter AC / DC current	1	1	1	211
PTG1631	SCADA System Module			1	46
MV1801-H	Flex Set 200 Safety Leads 5 colours	1	1	1	221
MV1904	Flex Stand	1	1	1	222

Ref. 151,152,153

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



Electrical Machines & Drives



High Voltages lab



Modular Power system



Power Systems Trainer



Transmission



Process, Control & Servo System



Electronics & Mechatronics



Automotive Electronics



Material Testing



Power Distribution & Furniture for Lab