Protection Relays Test

ERP

Technical Teaching Equipment

ERP-UB. **Protection Relays Test Unit**
(common for the relays modules type "ERP")

Relays Modules
(for use with the Protection Relays Test Unit (ERP-UB))

ERP-SFT.
Overcurrent and Earth Fault Protection Relay Module

ERP-SDND.
Directional/Non Directional Overcurrent Protection Relay Module

ERP-PDF.
Differential Protection Relay Module

ERP-MA.
Feeders Management Relay Module

ERP-PD.
Distance Protection Relay Module

ERP-GMGPT.
Motor-Generator with protection relays and automatic regulation

Key features:

- **Study of real short circuits under different conditions. Three-pole short circuit, two-pole short circuit, two-pole to ground short circuit, single-pole short circuit. All these with and without fault impedance.**
- **Utilization of cutting edge protection relays with advanced microprocessor.**
- **Study of most important protection relays used in the industry: feeder management, overcurrent and earth fault, distance, directional/non-directional, differential and motor-generator protection relays.**
- **Analysis of the current transient waves after short circuit test through historical data reports.**
- **Possibility of relays free configuration through the provided software.**
- **Study of advanced turbine-generator controller for energy production. Automatic/manual current excitation and turbine speed control.**
- **Parallel operation of the synchronous generator.**
- **Isolated operation of the synchronous generator.**
- **Setting of the generator protection relay: unbalanced load protection, overcurrent protection, over/under voltage protection, over/under frequency, reverse power protection, etc.**
- **Study real short circuits in the synchronous generator. Three-pole short circuit, two-pole short circuit, two-pole to ground short circuit, single-pole short circuit. All these with and without fault impedance.**

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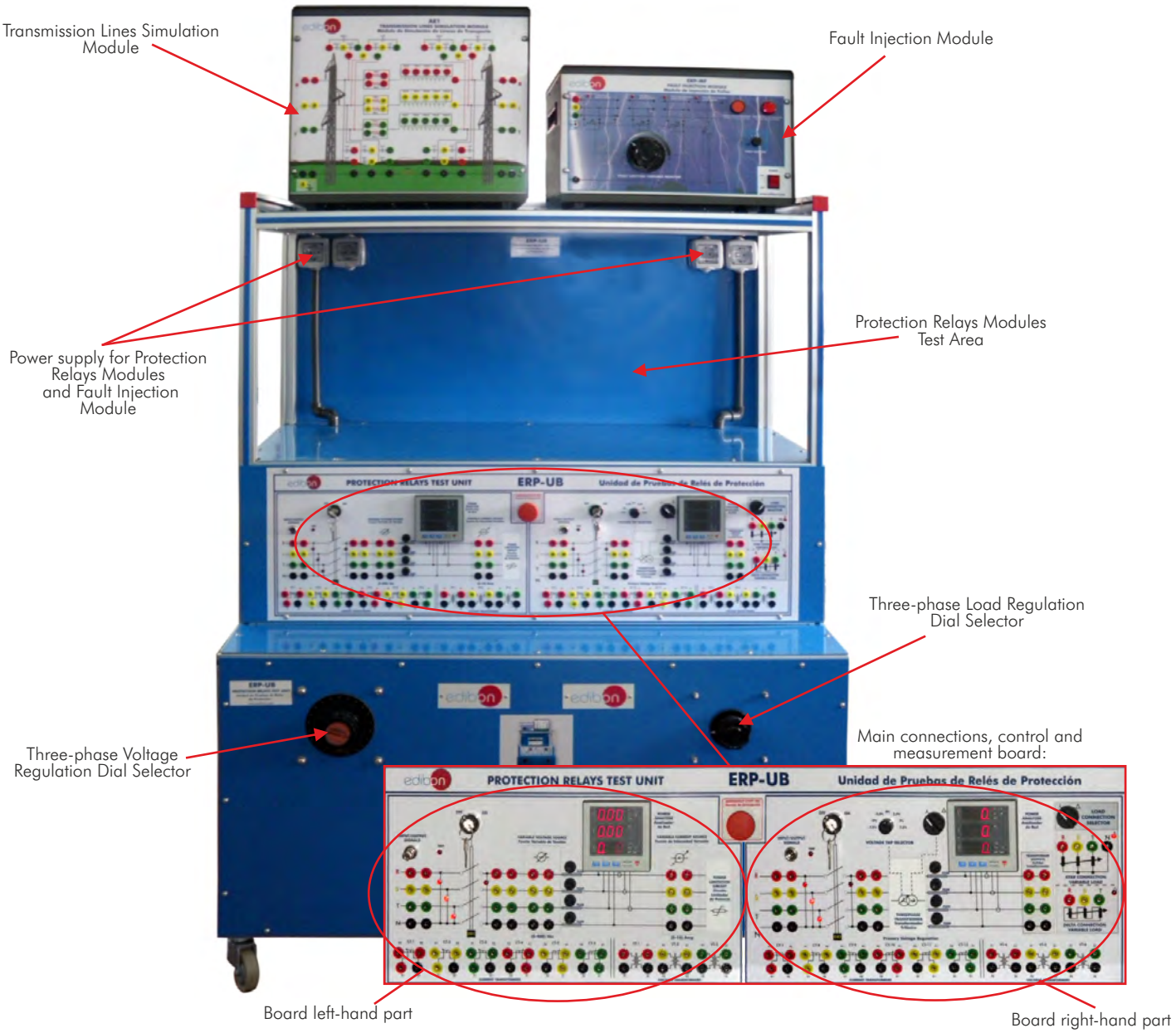
PRODUCTS
40.- ELECTRICITY AND 50.- ENERGY

ISO 9000: Quality Management
(for Design, Manufacturing, Commercialization and After-sales service)

European Union Certificate
(total safety)

Certificates ISO 14000 and **ECO-Management and Audit Scheme**
(environmental management)

Worlddidac Quality Charter Certificate and **Worlddidac Member**



INTRODUCTION

Electrical protection systems play an important role within power systems. Nowadays it is unthinkable a national grid without advanced and coordinated protection relays. Protection relays are essential to protect electrical and electronic devices, transmission lines, power stations, etc. which form the whole electrical system.

There are a great variety of protection relays in the industry: overcurrent protection relays, over/under frequency protection relays, over/under voltage protection relay, distance protection relay, directional/non-directional protection relay, feeder management protection relay, etc. However it is necessary a great amount of knowledge to understand how configure and manage these types of protection relays.

GENERAL DESCRIPTION

The ERP-UB is one of the most advanced units of the market to study under safety conditions how work electrical protection relays used in real power substations. Optionally, this unit includes cutting edge protection relays manufactured by SEL (Schweitzer Engineering Laboratories from USA). SEL revolutionized the protection industry by building the first microprocessor-based protective relays.

The protection relays are supplied with a programming software for commissioning of all parameters of the protection relays such as 21, 27, 32, 50, 51, 59, 67, 81, 87, etc.

GENERAL DESCRIPTION

This is a teaching unit which gives students theorical and practical experience with several industrial application relays.

The numerous devices, inputs and outputs, along with a modular structure, allow to use the ERP-UB for a wide range of protection applications simulation and real test of industrial application numerical relay system.

It includes experiments investigating earth fault, overcurrent, differential, directional, feeder management, overvoltage, undervoltage and distance numerical protection. The unit uses real industrial protection equipment and techniques.

This unit also covers relay setting and tripping characteristics, as well as grading and discrimination under fault conditions, and it allows students to compare individual relays characteristics and simultaneous comparison of any two relays to introduce the topic of discrimination and protection coordination.

Instrumentation, power supplies, power transformers, current transformers, voltage transformers and load resistors are incorporated in the unit and has an user-friendly desk space for users to work on.

The relays are housed in modern, portable enclosures.

The test unit will support up to two relays at once. These can be different relays or both the same type.

The relays are programmed either directly or using software, because this unit includes relays support software which enables users to program the relays modules on a suitable computer (computer no included)using software.

The students connect the relays to the console by plugging leads into terminals on the front panels, thus perform experiments and practices using the unit to set test conditions and control and monitor relay behaviour.

The unit and relay front panels have schematic diagrams which help users carry out and understand the experiments.

Each part of the ERP-UB is correctly identified in order to facilitate the operation and fast identification of installations problems.

The base unit includes the following modules:

ERP-UB. **Protection Relays Test Unit.**

AE1. **Transmission Lines Simulation Unit.**

ERP-MF. **Fault Injection Module.**

Optionally, the following modules can be included with the base unit:

ERP-SFT. **Overcurrent and Earth Fault Protection Relay Module.**

ERP-SDND. **Directional/Non Directional Overcurrent Protection Relay Module.**

ERP-PDF. **Differential Protection Relay Module.**

ERP-MA. **Feeders Management Relay Module.**

ERP-PD. **Distance Protection Relay Module.**

ERP-GMGPT. **Motor-Generator with protection relays and automatic regulation.**

SPECIFICATIONS

The ERP-UB unit has been designed for comprehensive investigations into the theory and practice of electrical power system protection.

This unit is common for the relays modules type "ERP" and can use one or more relays.

Floor-standing unit, mounted in anodized aluminum structure and panels of painted steel, enabling wide range of protection relay investigations.

It uses genuine industrial application relays, not simulations, with full range of safety features incorporated throughout.

Diagrams on the unit enable students to set up and perform practices and experiments with minimal supervision.

Comprehensive controls, transformers, supplies and instrumentation.

Modern, ergonomic and practical design which includes desk space for users or students to work on, and mounting area for relays.

It is supplied with relay support software.

Selection of up-to-date numerical protection relays, specially adapted for educational use. (See available relays)

This Unit consists of this main parts:

Main connections, control and measurement board:

This board has two parts: left hand, right hand and common emergency stop switch in the centre of them.

Elements of the board left hand part:

- Input/Output signals exchange connector and relay trip indicator.
- Fixed three-phase voltage output terminals.
- Power supply security connection key switch.
- Second fixed three-phase voltage output terminals.
- Variable three-phase voltage output terminals. (0-400 Vac).
- Measurements power analyzer.
- Variable three-phase current output terminals. (0-10 Amp.).
- Six current transformers with transformation relation 50/5 CT= 10.
- Three voltage transformers with transformation relation:
  - Primary= 400/√3.
  - Secondary= 110√3.
  - PT= Primary/Secondary= 3.64.
- Emergency stop switch.

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Elements of the board right hand part:

Input/Ouput signals exchange connector and relay trip indicator.

Fixed three-phase voltage output terminals.

Power supply security connection key switch.

Second fixed three-phase voltage output and transformer input terminals.

Transformer Primary Voltage Tap Changer© selector.

Transformer Secondary connection type selector. Wye/Star.

Measurements power analyzer.

Transformer three-phase voltage output terminals.

Load connection type selector. Wye/Star.

Wye and Star Load terminal connectors.

Six current transformers with transformation relation 10/5 CT= 2.

Three voltage transformers with transformation relation:

Primary= 400/√3.

Secondary= 110√3.

PT= Primary/Secondary= 3.64.

Emergency stop switch.

Three-phase Voltage Regulation Dial Selector.

Three-phase Load Regulation Dial Selector.

Unit Power Supply and Protection:

Three-phase Power Supply.

Current Source Overload Thermal Protection.

Left Board Part Magnetoghermal Protection.

Right Board Part Magnetothermal Protection.

Left Board Part Voltage Measurement Circuit Protection.

Right Board Part Voltage Measurement Circuit Protection.

Control Circuits Magnetothermal Protection.

Transmission Lines Simulation Module:

Module in steel box with carrying handles (dimensions: 490 x 450 x 470 mm. approx., weight: 10 Kg. approx.)

This module represents basic concepts of the Electric Energy high-voltage three-phase transmission lines operation. It simulates a value modifying concentrated parameter line that allows different configurations and consists on three conductor line (R, S, T) and a Neutral or return line (N).

Each of the phases is represented, following the concentrated parameters theoretical model, through a resistance series association and inductance, along with a parallel association between each one of them in a capacitance effect.

A way to reduce the earth short circuit current is to have impedance in the neutral-to-ground connections. This impedance has no repercussion in the normal functioning of the network but they introduce a repercussion in the increase of $3x\ Z_o$ (impedance on the zero sequence component), which reduces the short circuit current.

The return line is simulated through small value impedance that has a resistive-inductive characteristic. To simplify the effect, being a negligible inductance, it will be simulated with a pure 10 Ω resistance.

The phases have two terminals at the input and two at the output, and they are connected at the interior. Through one of them the module will be supplied. Through the last one the natural circuit will continue to the load module, the bar module, the transformer, etc. There are additional terminals for assembly of protection relay or other parallel configurations.

The supply of this unit will be done through line terminals (R, S, and T) and the neutral (N) through a 400V three-phase supply and it will be controlled by any power-circuit breaker of 4 poles placed between the supply and the lines module.

In the phases we can distinguish different resistance and inductance values, being able to simulate different length transport lines.

The resistive part is formed by two resistance values of 15 Ω and 33 Ω, with the possibility of making parallel-series connections between them, obtaining two additions resistive values of 10.31 Ω and 48 Ω.

The inductive part consists on a multistage coil of despicable resistance. In which it is possible to choose one of the following values: 33 mH, 78 mH, 140 mH, 193 mH, 236 mH.

The capacitive part will be divided into capacitance between conductors and capacitance between line and ground.

The capacitance between conductors is simulated with a pair of capacitors at the beginning and at the end of the line with different values: 0.5 μF and 1 μF for each conductor.

The capacitance between conductor and ground is 1 μF and 2 μF, also at the beginning and at the end of the line.

With all these values it is possible to simulate a great number of line configurations, beginning with different line distances with different types of conductor, through the unbalanced lines with different conductors groups (Simplex, Duplex, Triplex and Cuadruplex). At the same time it is possible to simulate transient state with different short-circuits injection using the Fault Injection Module.

This module is protected with a grounding connection that comes from the metallic caging and that is accessible through a terminal in the front of the module.

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Fault Injection Module:

Module in steel box with carrying handles (dimensions: 490 x 330 x 310 mm. approx, weight: 10 Kg.)

The module have the possibility to inject different kind of short-circuits, in any point of the ERP-UB including line module, directly or through a variable pure resistive element. Employing this element we can analyze the different protection elements functionality with different fault intensity.

The short-circuit injection possibility are:

Three-pole short-circuit.

Two-pole short-circuit.

Two-pole-ground short-circuit.

Single-pole-ground short-circuit.

Test circuits:

Configurable power transformer test circuit.

Configurable load test circuit.

Configurable measurement test circuit.

Relays test area.

Cables and Accessories, for normal operation.

Manuals:

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, Sofware and Practices, including unit description and procedure.

EXERCISES AND PRACTICAL POSSIBILITIES

-A wide range of practices and investigations into the performance and characteristics of a variety of different industrial application relays.

REQUIRED SERVICES

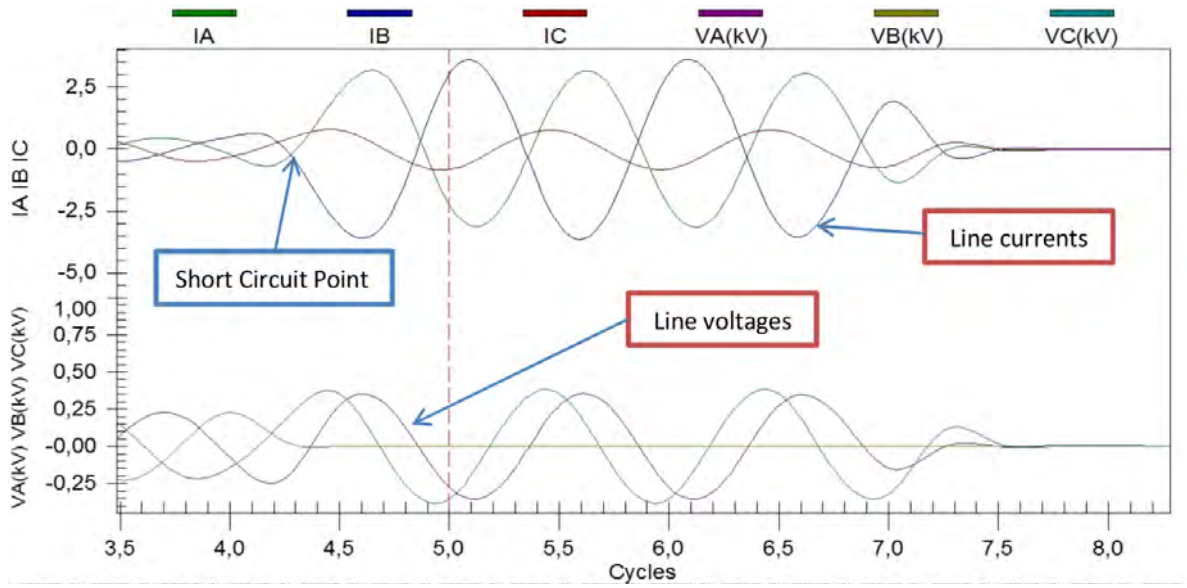
- Electrical supply: 380/415 V three-phase and neutral electrical supply with 100 mAmp Ground differential protection.

DIMENSIONS & WEIGHT

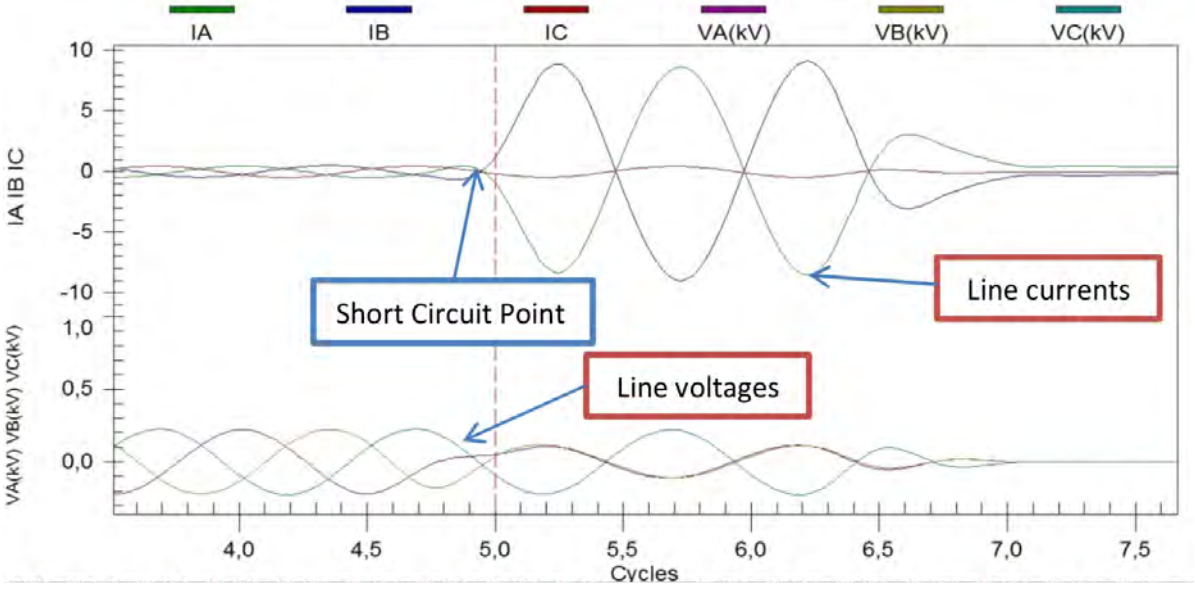
-Dimensions: 1250 x 800 x 2000 mm. approx.
(49.21 x 31.49 x 78.74 inches approx.).

-Weight: 400 Kg. approx.
(881.8 pounds approx.).

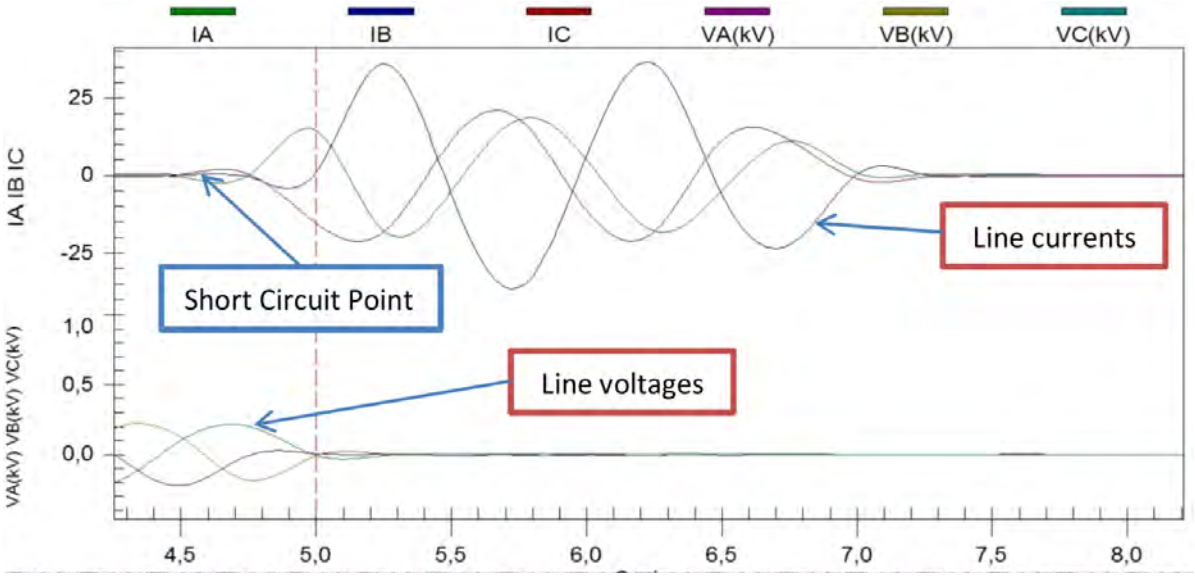
The following pictures show real short circuit test carried out in EDIBON with different protection relays modules and ERP-UB.
The current transients are visualized from the ACSelerator software which is provided with the protection relays modules.



Two-Pole Short Circuit with fault impedance screen

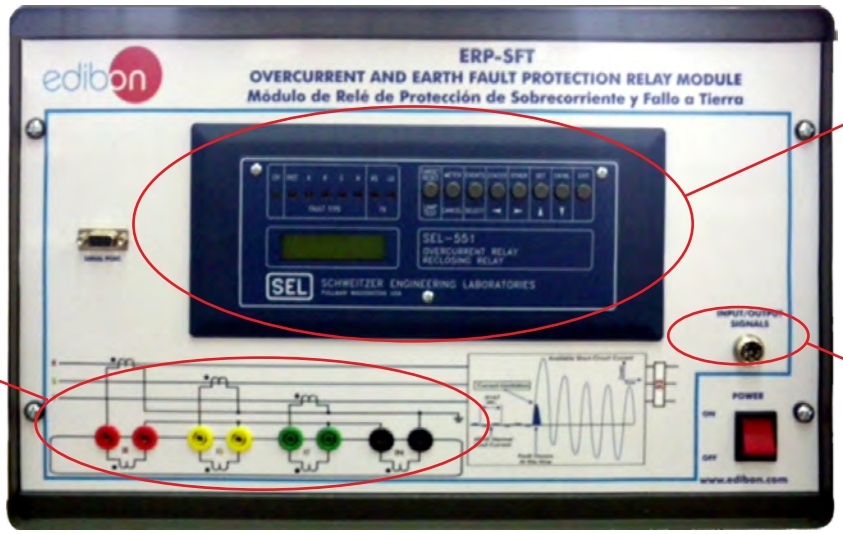


Two-Pole Short Circuit screen



Three-Pole Short Circuit screen

ERP-SFT. **Overcurrent and Earth Fault Protection Relay Module**



Protection device front panel indicators and controls

Electrical measurement input/output connectors

Inputs/Outputs signals 8 pins connector

GENERAL DESCRIPTION

For use with the Protection Relays Test Unit (ERP-UB), this relay enables investigations into protection and monitoring of transformers, transmission lines and distribution schemes.

The module mounts on the desk area of the Protection Relays Test Unit and by using a multi-core cable and safety leads connects to the test unit.

The relay is housed in a modern and robust enclosure (steel box) with carrying handles.

The relay module is based on the SEL-551/SEL-551C relay, enabling the students to set up different fault circuits on the Protection Relays Test Unit. Students will use the keypad and display on the relay module to programme it to the setting needed for the tests. They can also use the relay support software (supplied with the Protection Relays Test Unit) and computer (available separately, not included in the supply) to programme the relay module. The relay module is then connected to the fault circuits so test can be performed.

Facility to test two relay modules at the same time because there are enough connections on the Protection Relays Test Unit.

SPECIFICATIONS

ERP-SFT. Overcurrent and Earth Fault Protection Relay Module, for use with the Protection Relays Test Unit (ERP-UB), to enable investigations into protection and monitoring of transformers, transmission lines and distribution schemes.

It enables a wide range of test and investigations and it demonstrates the latest relay technology.

Modern and robust enclosure (steel box) with carrying handles.

Modern industrial application overcurrent and earth fault relay presented in an educational and teaching format.

The connections are via safety sockets.

The main functions:

- Phase Instantaneous Overcurrent (50P1-50P6).
- Phase Time-Overcurrent (51P1T, 51P2T).
- Single-phase Instantaneous Overcurrent (50A, 50B, 50C).
- Neutral Ground Instantaneous Overcurrent (50N1, 50N2).
- Neutral Ground Time-Overcurrent (51N1T).
- Residual Ground Instantaneous Overcurrent (50G1, 50G2).
- Residual Ground Time-Overcurrent (51G1T).
- Negative-Sequence Instantaneous Overcurrent (50Q1, 50Q2).
- Negative-Sequence Time-Overcurrent (51Q1T, 51Q2T).
- Setting Range, 5 A nominal, Instantaneous Overcurrent (OFF, 0.5-80.0 A).
- Setting Range, 5 A nominal, Time- Overcurrent (OFF, 0.5-16.0 A).
- One Auto-Reclosing Function 79.
- Selectable blocking.
- Circuit monitoring.
- Trend, fault and disturbance records.

Continue...

The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.

It allows an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.

Accuracy: +- 5%

Current: 5 A (A.C.)

Frequency: 50 or 60 Hz.

Operating time: typically 10 ms to 25 ms.

Cables and Accessories, for normal operation.

Manuals:

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, Practices and connection information.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Verification of Overcurrent Protection functionality.
2.- Verification of Phase Overcurrent Elements.
3.- Verification of Residual Ground Overcurrent Elements.
4.- Verification of Phase Instantaneous Overcurrent Protection.
5.- Verification of Phase Time-Overcurrent Protection.
6.- Verification of Neutral Ground Instantaneous Overcurrent Protection.
7.- Verification of Neutral Ground Time-Overcurrent Protection.
8.- Verification of Residual Ground Instantaneous Overcurrent Protection.
9.- Verification of Residual Ground Time-Overcurrent Protection.
10.- Verification of Current Transformer Measurement accuracy.
11.- Power Transformer Overcurrent Protection.
12.- Power Transmission Line Overcurrent Protection.
13.- Load Feeder Overcurrent Protection.
14.- Distribution System Overcurrent Protection.
15.- Power Transmission System Overcurrent Protection.

REQUIRED SERVICES

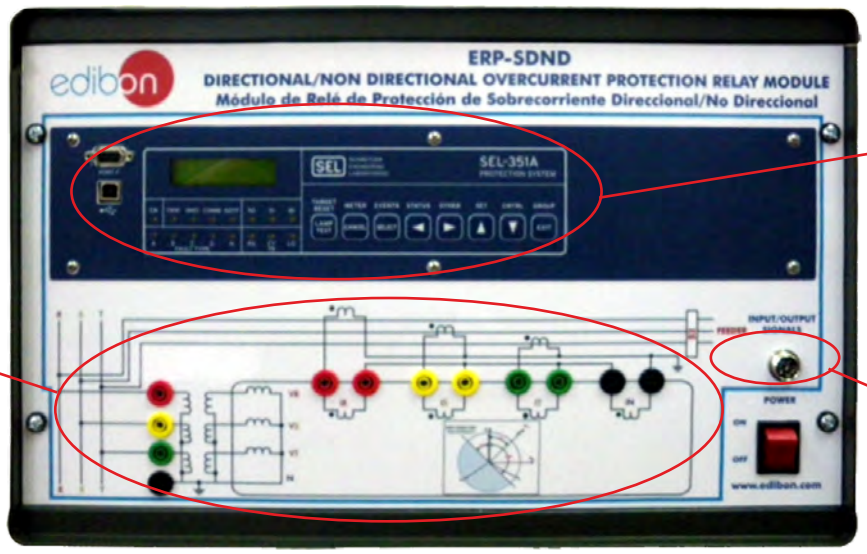
- Protection Relays Test Unit (ERP-UB).

DIMENSIONS & WEIGHT

-Dimensions: 490 x 330 x 310 mm. approx.
(19.29 x 12.99 x 12.20 inches approx.).

-Weight: 10 Kg. approx.
(22 pounds approx.).

ERP-SDND. **Directional/Non Directional Overcurrent Protection Relay Module**



GENERAL DESCRIPTION

A directional/non-directional overcurrent relay presented in an educational and teaching format.

For use with the Protection Relays Test Unit (ERP-UB), this relay enables investigations into protection and monitoring of generator and transformer schemes, overhead lines, underground cables and backup on high-voltage systems.

The module mounts on the desk area of the Protection Relays Test Unit and by using a multi/core cable and safety leads connects to the test unit.

The relay is housed in a modern and robust enclosure (steel box) with carrying handles.

The relay module is based on the SEL-351 industrial application relay, enabling the students to set up different fault circuits on the Protection Relays Test Unit. Students will use the keypad and display on the relay module to program it to the setting needed for the tests. They can also use the software (supplied with the Protection Relays Test Unit) and computer (available separately, not included in the supply) to program the relay module. The relay module is then connected to the fault circuits so test can be performed.

Tests are performed using single relay, but there is the facility to test two relay modules at the same time because there are enough connections on the Protection Relays Test Unit.

SPECIFICATIONS

ERP-SDND. Directional/Non Directional Overcurrent Protection Relay Module, for use with the Protection Relays Test Unit (ERP-UB), to enable investigations into protection and monitoring of generator and transformer schemes, overhead lines, underground cables and backup on high-voltage systems.

It enables a wide range of test and investigations and it demonstrates the latest relay technology.

Modern and robust enclosure (steel box) with carrying handles.

Modern industrial application directional/non directional overcurrent relay presented in an educational and teaching format.

The connections are via safety sockets.

The main functions:

The ERP-SDND Unit includes numerous phase, negative-sequence, residual-ground, and neutral overcurrent elements, as shown in the next table.

Overcurrent Element Operating Quantity	Number of Elements	Directional Control	Torque Control	Definite-Time Delay
Maximum phase current (IA, IB, or IC)	1 inverse-time (51P) 6 instantaneous (50P1-50P6)	Yes Yes, on first 4	Yes Yes, on first 4	NA Yes, on first 4
Maximum phase-phase current (IAB, IBC, or ICA)	4 instantaneous (50PP1-50PP4)	No	No	No
Independent phase current	3 inverse-time (51A, 51B, 51C)	Yes	Yes	NA
Residual-ground current (3I0)	2 inverse-time (51G1,51G2) 6 instantaneous (50G1-50G6)	Yes Yes, on first 4	Yes Yes, on first 4	NA Yes, on first 4
Negative-sequence current (3I2)	1 inverse-time (51Q) 6 instantaneous (50Q1-50Q6)	Yes Yes, on first 4	Yes Yes, on first 4	NA Yes, on first 4
Neutral current (IN)	1 inverse-time (51N) 6 instantaneous (50N1-50N6)	Yes Yes, on first 4	Yes Yes, on first 4	NA Yes, on first 4

Continue...

Inverse-time overcurrent element settings include a wide and continuous pickup current range, continuous time-dial setting range, and time-current curve choices from both US (IEEE) and IEC standard curves shown in the next table.

IEEE	IEC
Moderately Inverse (U1)	Standard Inverse (C1)
Inverse (U2)	Very Inverse (C2)
Very Inverse (U3)	Extremely Inverse (C3)
Extremely Inverse (U4)	Long-Time Inverse (C4)
Short-Time Inverse (U5)	Short-Time Inverse (C5)

Undervoltage Protection Element (27).

Phase Overvoltage Protection Element (59P).

Ground Overvoltage Protection Element (59G).

Negative Sequence Overvoltage Protection (59Q).

Creating fault and disturbance records.

Selectable blocking.

Selogic Control Equations.

Event Report.

Sequential Events Recorder (SER).

Breaker Wear Monitor.

Station Battery Monitor.

DNP3 Serial LAN/WAN Outstation (Slave).

Modbus RTU and TPC.

High-Accuracy Metering.

Remote and Local Control Switches.

Wye or Delta Voltage Connection.

Synchrophasor Measurements.

Fault Locator.

Fast SER Protocol.

Directional/Definite-Time Overcurrent Elements.

Two Residual-Ground Time-Overcurrent Elements.

Six Frequency Elements.

Sensitive Earth Fault Protection and Directional Protection for Various System Grounding Practices.

Load-Encroachment Logic.

Synchronism Check.

ACSELERATOR QuickSet Compatible.

The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.

It allows an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.

Accuracy: +- 10%.

Current: 5 A (A. C.).

Frequency: 50 or 60 Hz.

Operating time: typically 10 ms to 25 ms.

Cables and Accessories, for normal operation.

Manuals:

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, Practices and connection information.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Verification of Directional Protection functionality.

2.- Directional Protection with different measurement circuit conditions.

3.- Directional Protection application to Transmission Line under different load conditions.

4.- Forward Directional Protection.

5.- Reverse Directional Protection.

6.- Non-Directional Overcurrent Protection.

7.- Residual Ground Time-Overcurrent Protection.

8.- Residual Ground Instantaneous Overcurrent Protection.

9.- Verification of Cable Undervoltage Protection.

10.- Verification of Cable Overvoltage Protection.

11.- Verification of Current Transformers Measurements accuracy.

12.- Verification of Voltage Transformers Measurements accuracy.

13.- Distribution System Directional Protection.

REQUIRED SERVICES

- Protection Relays Test Unit (ERP-UB).

DIMENSIONS & WEIGHT

-Dimensions: 490 x 330 x 310 mm. approx.
(19.29 x 12.99 x 12.20 inches approx.).

-Weight: 10 Kg. approx.
(22 pounds approx.).

ERP-PDF. **Differential Protection Relay Module**

GENERAL DESCRIPTION

This ERP-PDF. Differential Protection Relay Module has to be used with the Protection Relays Test Unit (ERP-UB), and it enables investigations into protection of transformers, autotransformers, generators, Bus Bar and other apparatus with two windings.

A digital differential protection relay presented in an educational and teaching format.

The relay clearly demonstrates the characteristics of three-phase differential protection, and includes high stability during 'out-of-zone' faults, high-speed operation, zero-sequence current filtering for each winding, magnetising inrush restraint, amplitude and vector matching.

The module mounts on the desk area of the Protection Relays Test Unit and by using a multi-core cable and safety leads connects to the test unit.

The relay is housed in a modern and robust enclosure (steel box) with carrying handles.

The relay module is based on the SEL-587 industrial application relay, enabling the students to set up different fault circuits on the Protection Relay Test Unit. Students will use the keypad and display on the relay module to program it to the setting needed for the tests. They can also use the software (supplied with the Protection Relays Test Unit) and computer (available separately, not included in the supply) to program the relay module. The relay module is then connected to the fault circuits so test can be performed.

Most tests are performed using single relays. However, there are enough connections on the Protection Relays Test Unit to test two relay modules at the same time.

SPECIFICATIONS

ERP-PDF. Differential Protection Relay Module, for use with Protection Relays Test Unit (ERP-UB), to enable investigations into protection of transformers, autotransformers, generators, Bus Bar and other apparatus with two windings.

It enables a wide range of test and investigations and it demonstrates the latest relay technology.

It demonstrates the characteristics of three-phase differential protection.

Modern and robust enclosure (steel box) with carrying handles.

Modern industrial application differential protection relay presented in an educational and teaching format.

The connections are via safety sockets.

The main functions:

Eight Overcurrent Elements for Winding 1	**Instantaneous**	**Definite Time**	**Inverse Time**
Phase	50P1H	50P1	51P1
Negative Sequence		50Q1	51Q1
Residual	50N1H	50N1	51N1
Eight Overcurrent Elements for Winding 2	**Instantaneous**	**Definite Time**	**Inverse Time**
Phase	50P2H	50P2	51P2
Negative Sequence		50Q2	51Q2
Residual	50N2H	50N2	51N2
Setting Ranges, 5 A Model, (A secondary)	OFF, (0.5-80)	OFF, (0.5-80)	OFF, (0.5-16)

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Selogic Control Equations.

Event Reports.

ASCII. Binary, and Distributed Port Switch Communications.

Phase, Ground, Negative-Sequence, Differential and Harmonic Metering.

Restrained and Unrestrained Differential Elements.

Second- and Fourth Harmonic Restraint.

Fifth-Harmonic and DC Blocking.

CT and Transformer Connection Compensation.

Connection to the primary and secondary windings of the circuit experimental via current transformers with ratio to suit the inputs of the relay. This provides an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.

Accuracy: +- 5%.

Current: 5 A (A. C.)

Frequency: 50 or 60 Hz.

Operating time: typically 10 ms to 25 ms.

Cables and Accessories, for normal operation.

Manuals:

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, Practices and connection information.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Verification of Differential Protection functionality.
2.- Transformer Differential Protection with variable TAP's voltage regulation.
3.- Transformer Differential Protection with different transformer connection diagrams.
4.- Verification of Phase Instantaneous Overcurrent Protection for Winding 1.
5.- Verification of Phase Definite Time-Overcurrent Protection for Winding 1.
6.- Verification of Phase Inverse Time-Overcurrent Protection for Winding 1.
7.- Verification of Phase Instantaneous Overcurrent Protection for Winding 2.
8.- Verification of Phase Definite Time-Overcurrent Protection for Winding 2.
9.- Verification of Phase Inverse Time-Overcurrent Protection for Winding 2.
10.- Verification of Current Transformers Measurement accuracy.
11.- Power Transformer Overcurrent Protection.
12.- Distribution Substation Bus-Bar Differential Protection.
13.- Transmission Substation Bus-Bar Differential Protection.
14.- Analysis of Event Reports and Human Machine Interface.

REQUIRED SERVICES

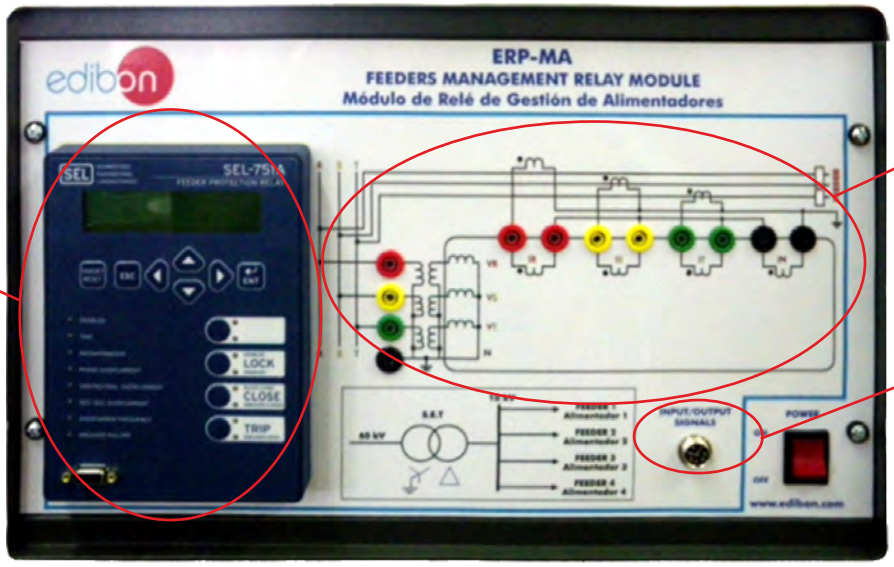
- Protection Relays Test Unit (ERP-UB).

DIMENSIONS & WEIGHT

-Dimensions: 490 x 330 x 310 mm. approx.
(19.29 x 12.99 x 12.20 inches approx.).

-Weight: 10 Kg. approx.
(22 pounds approx.).

ERP-MA. **Feeders Management Relay Module**



GENERAL DESCRIPTION

Feeders Management Relay Module for use with Protection Relays Test Unit (ERP-UB), which enables investigations into protection and monitoring of overhead lines, underground cables and feeders.

The module mounts on the desk area of the Protection Relays Test Unit and by using a multi-core cable and safety leads connects to the test unit.

The relay is housed in a modern and robust enclosure (steel box) with carrying handles.

The relay module is based on the SEL-751 industrial application relay, enabling the students to set up different fault circuits on the Protection Relays Test Unit. Students will use the keypad and display on the relay module to program it to the setting needed for the tests. They can also use the software (supplied with the Protection Relays Test Unit) and computer (available separately, not included in the supply) to program the relay module. The relay module is then connected to the fault circuits so test can be performed.

Tests are performed using single relay, but there is the facility to test two relay modules at the same time because there are enough connections on the Protection Relays Test Unit.

SPECIFICATIONS

ERP-MA. Feeders Management Relay Module, for use with the Protection Relays Test Unit (ERP-UB), to enable investigations into protection and monitoring of overhead lines, underground cables and feeders.

It enables a wide range of test and investigations and it demonstrates the latest relay technology.

Modern and robust enclosure (steel box) with carrying handles.

Modern industrial application feeder management relay presented in an educational and teaching format.

The connections are via safety sockets.

The main functions:

- Four levels of Phase Instantaneous Overcurrent Element (50P).
- Four levels of Negative-Sequence Overcurrent Element (50Q).
- Four levels of Residual Overcurrent Element (50G).
- Four levels of Neutral Overcurrent Element (50G).
- Two levels of Phase Time-Overcurrent Element (51P).
- Two levels of Residual Time-Overcurrent Element (51G).
- Two levels of Ground Time-Overcurrent Element (51G).
- One level of Negative-Sequence Time-Overcurrent Element (51Q).
- Phase to Ground Overvoltage (59G).
- Phase to Phase Overvoltage (59P).
- Negative-Sequence Overvoltage (59Q).
- Residual Overvoltage (59G).
- Phase to Ground Undervoltage (27G).
- Phase to Phase Undervoltage (27P).

Continue...

Six levels of Secure Overfrequency (81O).

Six levels of Secure Underfrequency (81U).

Two levels of Negative Power Flow with Definite Time Delay (32).

Two levels of Positive Power Flow with Definite Time Delay (32).

Station Battery Monitor.

Breaker Wear Monitoring.

Synchrophasor Protocol.

Peak Demand and Demand Metering.

Auto-Reclosing.

Creating fault and disturbance records.

The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.

It allows an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.

Accuracy: +- 10%.

Current: 5 A (A. C.)

Frequency: 50 or 60 Hz

Operating time: typically 10 ms to 25 ms.

Cables and Accessories, for normal operation.

Manuals:

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, Practices and connection information.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Verification of the Feeder Management Relay functionality.
2.- Phase Overcurrent Element of the Feeder Management Relay.
3.- Residual Ground Overcurrent Element of the Feeder Management Relay
4.- Overvoltage Element of the Feeder Management Relay
5.- Undervoltage Element of the Feeder Management Relay.
6.- Verification of Phase Instantaneous Overcurrent Protection.
7.- Verification of Phase Time-Overcurrent Protection.
8.- Verification of Residual Overcurrent Element.
9.- Verification of Residual Time-Overcurrent Element.
10.- Verification of Neutral Overcurrent Element.
11.- Verification of Overfrequency Protection Element.
12.- Verification of Underfrequency Protection Element.
13.- Verification of Positive (forward) Power Flow Protection Element.
14.- Verification of Negative (reverse) Power Flow Protection Element.
15.- Protection of Distribution Feeder Example.
16.- Protection of Overhead Transmission Line Example.

REQUIRED SERVICES

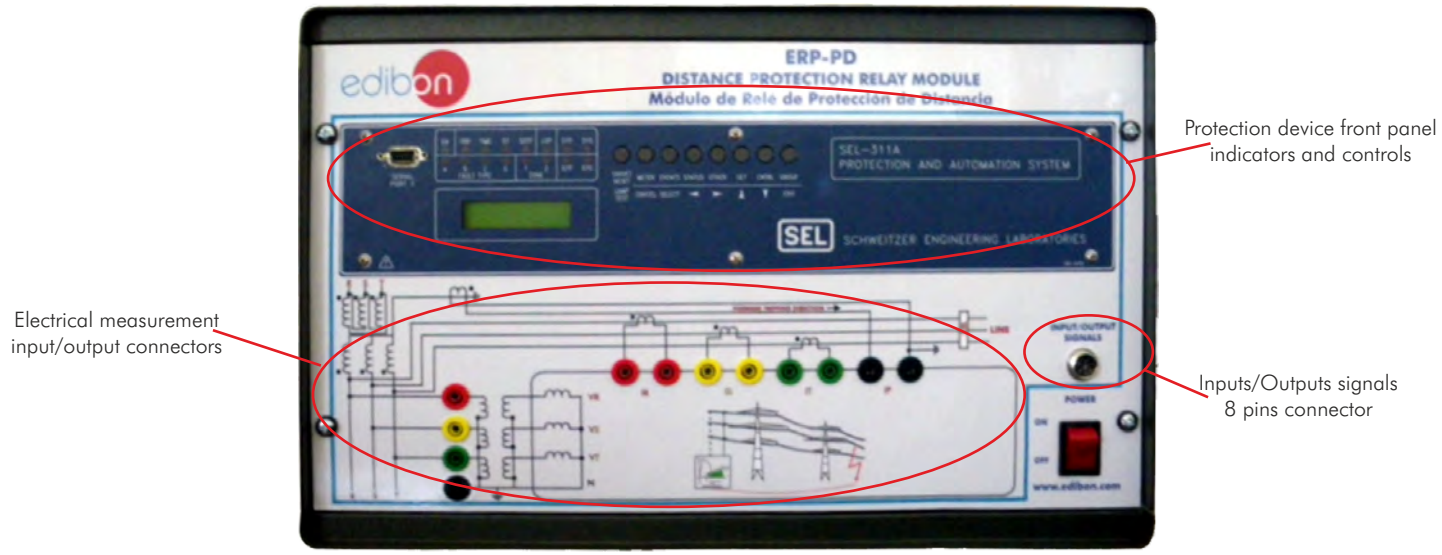
- Protection Relays Test Unit (ERP-UB).

DIMENSIONS & WEIGHT

-Dimensions: 490 x 330 x 310 mm. approx.
(19.29 x 12.99 x 12.20 inches approx.).

-Weight: 10 Kg. approx.
(22 pounds approx.).

ERP-PD. **Distance Protection Relay Module**



GENERAL DESCRIPTION

ERP-PD. Distance Protection Relay Module, for use with the Protection Relays Test Unit (ERP-UB), enables investigations into protection and monitoring of overhead transmission lines and underground cables.

The module mounts on the desk area of the Protection Relays Test Unit and by using a multi-core cable and safety leads connects to the test unit.

The relay is housed in a modern and robust enclosure (steel box) with carrying handles.

The relay module is based on the SEL-311 industrial application relay, enabling the students to set up different fault circuits on the Protection Relays Test Unit. Students will use the keypad and display on the relay module to programme it to the setting needed for the tests. They can also use the software (supplied with the Protection Relays Test Unit) and computer (available separately, not included in the supply) to programme the relay module. The relay module is then connected to the fault circuits so test can be performed.

Tests are performed using single relay, but there is the facility to test two relay modules at the same time because there are enough connections on the Protection Relays Test Unit.

SPECIFICATIONS

For use with the Protection Relays Test Unit (ERP-UB), to enable investigations into protection and monitoring of overhead transmission lines and underground cables.

It enables a wide range of test and investigations and it demonstrates the latest relay technology.

Modern and robust enclosure (steel box) with carrying handles.

Modern industrial application distance protection relay presented in an educational and teaching format.

The connections are via safety sockets.

The main functions:

- Two zones of Phase Mho Distance Protection Element (21P).
- Two zones of Ground Mho Distance Protection Element (21G).
- Directional Phase Overcurrent Protection Element (67P).
- Directional Ground Overcurrent Protection Element (67G).
- Phase Overcurrent Protection Element (50P).
- Ground Overcurrent Protection Element (50G).
- Phase Time-Overcurrent Protection Element (51P).
- Ground Time-Overcurrent Protection Element (51G).
- Event Reports.
- Breaker Wear Monitor.
- Fault Locator.
- Local Display.
- Synchronophasors.
- Load Encroachment.
- Metering and Monitoring Functions.

Continue...

Creating fault and disturbance records.

Blocking of any one protection element.

The connection to the experimental circuit is via current transformers with ratio to suit the inputs of the relay.

It allows an effective demonstration of the effect of current and voltage transformer ratio, connection and rating on protective relays.

Accuracy: +- 10%.

Current: 5 A (A. C.).

Frequency: 50 or 60 Hz.

Operating time: typically 10 ms to 25 ms.

Cables and Accessories, for normal operation.

Manuals:

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, Practices and connection information.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Verification of Line Distance Protection functionality.
2.- Line Distance Protection with different measurement circuit conditions.
3.- Line Distance Protection with different Line Loads conditions.
4.- Verification of Phase Instantaneous Overcurrent Element.
5.- Verification of Ground Instantaneous Overcurrent Element.
6.- Verification of Phase Time-Overcurrent Protection Element.
7.- Verification of Ground Time-Overcurrent Protection Element.
8.- Verification of Current Transformer Measurement accuracy.
9.- Verification of Current Transformers Connection Diagram.
10.- Verification of Voltage Transformers Measurement Accuracy and Connection Diagram for Distance Protection.
11.- Overhead Transmission Line Parameters Estimation for Distance Protection.
12.- Overhead Transmission Line Distance Protection.
13.- Distance Protection Event Reports Analysis.
14.- Distance Protection Relay Human Machine Interface.
15.- Distance Protection Relay Configuration.
16.- Distance Protection of Simple Power System Example.

REQUIRED SERVICES

- Protection Relays Test Unit (ERP-UB).

DIMENSIONS & WEIGHT

-Dimensions: 490 x 330 x 310 mm. approx.
(19.29 x 12.99 x 12.20 inches approx.).

-Weight: 10 Kg. approx.
(22 pounds approx.).

ERP-GMGPT. **Motor-Generator with protection relays and automatic regulation**

Enlarged image

GENERAL DESCRIPTION

It consists of a driving motor coupled to three-phase synchronous generator with independent excitation. This unit simulates a power plant with one turbine and one synchronous generator. Besides the ERP-GMGPT unit includes an advanced frequency and voltage controller used in real power plants.

With this controller the user has complete control over the turbine and the synchronous generator. The turbine-generator can work in automatic or manual control. On this way, in manual mode, the user will control the frequency of the turbine and the current excitation of the synchronous generator, taking decisions about how much active power give to the grid, what is the working frequency of the turbine, when is the adequate moment for synchronization with the grid, etc. On the other hand, the frequency and voltage controller can take the control, being previously set to work in automatic mode.

Besides, the frequency and voltage controller includes a management software that allows to configure different protections thresholds for the synchronous generator and the turbine such as unbalanced load protection, overcurrent protection, over/under voltage protection, over/under frequency protection, reverse power protection, etc.

SPECIFICATIONS

The ERP-GMGPT is a control unit for engine-generator simulator system.

The numerous inputs and outputs, along with a modular software structure, allow you to use the ERP-GMGPT for a wide range of applications with only a single part number. This includes stand-by, AMF (automatic mains failure), peak shaving, import-export or distributed generation, among others.

Also the ERP-GMGPT is compatible for island, island parallel, mains parallel and multiple unit mains parallel operations.

Each part of the ERP-GMGPT is correctly identified in order to facilitate the operation and fast identification.

All the adjustments are executed with the management software from a PC.

Elements of the ERP-GMGPT:

- Power input/output connectors.
- Multifunction control and protection device.
- Generator group control inputs and outputs connector.
- Generator rotor to ground protection Relay.
- Isolated operation connector (52GT state and 52G trip command).

Functions:

- Prime mover control.
- Engine, mains and generator protection.
- Engine data measurements.
- Generator and mains data measurement:
  - Voltage, current, power, kVar, kW, kWh, etc.
- Load/Var sharing for up to 32 participants.
- Load-dependent start/stop.
- Automatic, Manual, and Stop operating modes.
- Application modes:
  1. No CB (Circuit Breaker) operation.
  2. Open GCB (Generator Circuit Breaker).
  3. Open/close GCB.
  4. Open/close GCB/MCB (Generator CB/Main Circuit Breaker).

Continue...

Logics Manager for processing measured values, discrete inputs, and internal states.

Engine starter sequencing.

Alarm display with circuit breaker trip and engine shutdown.

AMF (automatic mains failure) standby genset control, with automatic engine start on mains failure detection and open transition breaker control.

Critical mode operation.

Synchronizing (phase matching and slip frequency) and mains parallel operation.

External frequency, voltage, power, and power factor set point control via analogue input or interface.

FIFO (First Input First Output) event history with 300 entries.

ECU data visualization via J1939.

CAN bus communication to engine controllers, plant management systems, expansion boards, and Toolkit configuration and visualization software.

RS-485 Modbus communication with plant management systems.

RS-232 Modbus communication with plant management systems.

Generator-Motor Group:

Generator-Motor Group mounted in aluminum structure with wheels.

Rated generator power: 4,5 KVA.

I rated stator: 6.5A.

I rated excitation: 4A.

RPM: 3000 rpm.

Rated motor power: 5 KVA.

I rated: 7.2A.

RPM: 3000 rpm.

Cables and Accessories, for normal operation.

Manuals:

This unit is supplied with the following manuals: Required Services, Assembly and Installation, Starting-up, Safety, Maintenance, Practices and connection information.

EXERCISES AND PRACTICAL POSSIBILITIES

1.- Working of motor protection switch.
2.- Motor protection relay.
3.- Thermistor protection.
4.- Investigation of time overcurrent protection.
5.- Unbalanced load protection.
6.- Reverse power protection.
7.- Overvoltage and undervoltage protection.
8.- Stator earth-fault protection.
9.- Generator differential protection (optional with ERP-PDF).
10.- Rotor earth-fault protection.
11.- Parallel operation of synchronous generator.
12.- Isolated operation of synchronous generator.

REQUIRED SERVICES

- Protection Relays Test Unit (ERP-UB).

DIMENSIONS & WEIGHTS

Generator-Motor Group:
-Dimensions: 1000 x 850 x 400 mm. approx.
(39.37 x 33.46 x 15.74 inches approx.).
-Weight: 85 Kg. approx.
(187 pounds approx.).

Module:
-Dimensions: 490 x 330 x 310 mm. approx.
(19.29 x 12.99 x 12.20 inches approx.).
-Weight: 10 Kg. approx.
(22 pounds approx.).

✱Specifications subject to change without previous notice, due to the convenience of improvements of the product.

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REPRESENTATIVE: