

PSS1

Power System Simulator

A self-contained unit that simulates all parts of electrical power systems and their protection, from generation to utilisation



- Completely self-contained teaching module for class and project work
- Simulates generation, transmission, transformation, distribution, utilisation and protection
- Fully controllable generator and prime mover mounted inside the cabinet for safety
- Twin distribution transformers with variable tapplings for parallel transformer and load flow tests
- Includes high-specification two-channel oscilloscope for studies of transient current waveforms
- Simulated power transmission lines and distance protection relay for realistic experiments
- 'Double bus' switched busbar with protection relays to connect the main systems together
- Can connect to TecEquipment's Power System Simulator SCADA (Supervisory Control and Data Acquisition) package to simulate 'real world' power system control and monitoring
- Range of industrial-standard digital protection relays
- Includes supplies, circuit protection, internal load banks, instruments and controls
- Synchroscope and three-lamp method for synchronising experiments

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- An ISO 9001 certified company

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Description

The Power System Simulator contains everything needed to teach students how electrical power systems work.

It is a self-contained unit (only needs electrical power) with full safety features. It includes all the main parts of an electrical power system, from supply (generation) to demand (utilisation). Each part includes dedicated industrial-standard protection relays that do specific jobs, from generator protection to distance protection on transmission lines, and distribution transformer protection.

Generator and grid supply

The PSS1 has a motor (prime mover) and generator set to simulate power generation. This set has characteristics similar to industrial turbine and generator sets for realistic experiments. The output of the generator passes through a generator transformer to a 'generator bus'. Protection relays and contact breakers monitor and switch the generator field and output.

The PSS1 includes a fully monitored and protected grid supply transformer. This transformer simulates the larger grid transformers used in national grid supply systems. The grid transformer reduces the incoming mains supply to give the correct distribution voltage at the 'grid bus'. It also allows students to correctly synchronise the generator output to the grid supply. For realistic tests, students can use the grid supply or the generator as a power source for their experiments.

Transmission lines

A set of reactances simulate transmission lines of different lengths to simulate overhead or underground power cables. Each line includes test points to monitor the conditions along the lines. The user can simulate faults at different places along the transmission lines and discover the effects. A dedicated distance protection relay protects the lines and can indicate how far along the line the fault has occurred.

Transformation, distribution and utilisation

As well as the grid supply and generator transformers, the Power System Simulator has two identical distribution transformers to simulate the distribution transformers fitted near to factories or houses. These transformers have variable tapplings and feed a 'utilisation bus'. Dedicated relays protect the transformers and can work in different ways, determined by student experiments. The utilisation bus simulates electrical consumers (houses and factories). It includes variable resistive, capacitive and inductive loads, with an induction motor (dynamic) load.

A switched busbar section includes a main bus and a standby or 'reserve bus'. These simulate a real bus-switching system in a power plant or power distribution station. Protection relays and contact breakers monitor and switch the incoming and outgoing feeders of the busbar. One feeder of the busbar has a 'point-on-wave' circuit-breaker for studies of switching transients.

Test points, transducers and fault switches

All the important circuits have test points connected to a set of test sockets. The students can link out these sockets or connect them to other test equipment. A set of transducers allows students to connect the test sockets to an oscilloscope (supplied) for transient measurements.

There are two fault switches to apply faults to different parts of the Power System Simulator. One fault switch is a standard three-phase switch; the other is a timed circuit breaker with a digital timer to set a precise fault duration.

Protection relays and instruments

All parts of the PSS1 include industrial-standard protection relays. The relays show students how actual power systems are protected and the different ways that they are protected. The students can set the relays from their control panels. The more complex relays also include sockets to link them to a suitable computer (computer not included) for more detailed programming, if needed. The relays operate the circuit-breakers around the PSS1. The circuit-breakers also include hand-operated switches, and lamps. The lamps show whether the circuit-breaker is open or closed.

Multi-function digital meters connect to all the important circuits to show the conditions of all three phases. A phase-angle meter shows the phase difference between any two voltages connected to it.

Moving coil meters show the prime mover voltage, current and power.

Standard Features

- Supplied with comprehensive user guide
- Two-year warranty
- Made in accordance with the latest European Union directives

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Experiments

Transmission, distribution and utilisation:

- Load flow
- Symmetrical faults
- Unbalanced faults
- Unsymmetrical faults
- Circuit interruption

Generator:

- Synchronisation
- Characteristics and performance
- Voltage variation and control
- Voltage regulation
- Stability studies

Transformer:

- Unequal taps
- Unequal impedances
- Unbalanced loads

Overcurrent protection:

- Relay grading
- Auto-reclose
- High-set instantaneous
- Back-tripping
- Directional control

General protection:

- Phase faults
- Earth faults
- Distance protection
- Differential protection of transformers
- Differential protection of generators
- Busbar protection
- Generator protection

Recommended Ancillaries

- Power System Simulator SCADA Package (PSS2) (*SCADA = Supervisory Control and Data Acquisition)
This is a computer, a printer and communications hardware, with industrial-standard software that communicates with the relays and other instruments of the Power System Simulator. It allows students to remotely monitor and control the different parts of the PSS1.
- Second Generator (PSS3)
This is a console that contains a duplicate of the prime mover and generator fitted in the PSS1, but includes added features and protection relays for extra experiments in embedded and central generation.
Note: the Second Generator is only for use with the Power System Simulator. It does not work as a stand-alone product.

Essential Services

Electrical supply:

Three-phase 10 kW, 50 or 60 Hz (specify on order)

Floor space needed:

Approximately 6 m x 3 m of solid, level floor

Operating Conditions

Operating environment:

Laboratory environment

Storage temperature range:

-25°C to +55°C (when packed for transport)

Operating temperature range:

+5°C to +40°C

Operating relative humidity range:

80% at temperatures < 31°C decreasing linearly to 50% at 40°C

Sound Levels

Less than 70 dB(A)

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Specification

Nett dimensions:

5100 mm long (plus an additional 500 mm to the right of the cabinet for power connections).

1500 mm front to back (plus an additional 1.5 m at the back when the access doors are open)

2000 mm high

2860 kg nett weight

Packed volume and weight:

21.74 m³ and 3530 kg

Simulator voltages:

- Distribution: 220 V three-phase line to line
- Utilisation: 110 V three-phase line to line

Grid transformer:

- 5 kVA delta to star (Dy11)

Primary is matched to the incoming three-phase supply to give the 220 V three-phase line-to-line secondary distribution voltage. Includes earth link for the secondary star point and a selectable tapping earth resistor for restricted earth fault protection tests.

Generator and prime mover:

- 6 kVA maximum (operated at a nominal 2 kVA), four-pole salient pole a.c generator
Brushless, with automatic and manual excitation.
- 7 kVA maximum induction motor with shaft encoder and electronic four-quadrant a.c vector-drive control, with a four-position drive inertia switch

Generator transformer:

- 1:1 ratio delta-to-star (Dy11) impedance matching with adjustable secondary tapping

Transmission lines:

Line reactances simulate 'per unit' (pu) values of impedance:

- Line 1: 0.10 pu
- Lines 2 and 3: 0.15 pu
- Lines 4 and 5: 0.25 pu
- Line 6: 5 x 0.1 pu length with four test points and

dedicated three-zone distance protection

- Line 7: 4 x 0.01 pu (cable)

Capacitors are provided adjacent to the lines. Each capacitor has selectable values and may be inserted in circuit to give π or T-line configurations for studies of losses.

Distribution transformers:

- Two identical 2 kVA transformers, 220 V to 110 V Star-to-delta Yd1
Adjustable primary tapings and matched impedances

Switched busbar:

- Six bi-directional feeders, each with circuit-breakers – one circuit breaker is a 'point-on-wave' device
- Two circuit-breakers to break each half of each bus
- Twelve bus isolators, six on each half of the bus
- Two circuit-breakers that break the coupling between the main and reserve bus

Protection relays:

- Grid transformer protection
- Grid bus protection
- Generator protection
- Generator bus protection
- Distance protection
- 2 x double bus protection
- 4 x distribution transformer protection

Loads:

- Two separate 220 V (distribution) loads, each with delta-connected variable resistors and inductors; one load is near to the generator and the other near to the distribution bus.
- Two sets of 110 V (utilisation) loads at the utilisation bus; each has delta-connected variable resistors, inductors and capacitor banks.
- One dynamic load – an induction motor at the utilisation bus