Overview

- This Power Systems Trainer is a self-contained, SCADA-supervised laboratory system that simulates the complete operation of an electrical power system — from generation to transmission, transformation, distribution, utilization, and protection.
- Developed in strict compliance with the latest European Union Directives (CE, EMC, LVD, RoHS), the incorporates industrial-grade European-brand relays, breakers, and analyzers, offering students, researchers, and professionals a real-world experience in power system operation and protection.
- The system is fully integrated with ASCDA (Advanced SCADA Software Suite), providing real-time monitoring, data logging,switching, event recording, and protection relay configuration through an intuitive graphical interface.

Key Features

- Complete power system simulation: generation, grid supply, transmission, transformation, distribution, utilization.
- Industrial-standard protection relays from ABB, Siemens, and Schneider Electric.
- SCADA-supervised operation with single-line diagram (SLD) interface, relay configuration, fault logging, and event playback.
- Real-time data acquisition: voltage, current, frequency, power factor, harmonic distortion, breaker status, relay trip/alarm status.
- Integrated fault creation: single-line, double-line, three-phase, and earth faults with programmable duration.
- Synchronization studies: generator-to-grid, phase angle, frequency, and voltage matching.
- Load banks: resistive, inductive, capacitive, and dynamic (motor) loads.
- Inbuilt safety system: emergency stop, interlocks, and fault alarms.

System Specifications

Generation & Grid Supply

- Prime Mover: 7 kVA induction motor with four-quadrant vector drive and shaft encoder.
- Generator: 6 kVA synchronous generator, 4-pole, brushless, with manual/automatic excitation.
- Generator Transformer: Delta-Star (Dy11), 1:1 ratio, impedance matched, with adjustable taps.
- Grid Transformer: 5 kVA, Delta-Star (Dy11), primary matched to mains, secondary 220V 3-phase.

Note: Specifications are subject to change, Photos shown above are Indicative, Actual Product can Vary.

- Synchronization Unit: Synchroscope and Siemens 7VE61 synchronization relay.

Transmission Lines

- Seven simulated line sections (per-unit impedances 0.1–0.25 pu, cable & overhead models).
- Fault switches (manual and timed) for applying line-to-line, line-to-ground, and three-phase faults.
- Test sockets for oscilloscope/SCADA measurement at multiple points.
- Capacitor banks for long-line and Ferranti effect studies.

Distribution & Utilization

- Twin 2 kVA distribution transformers with adjustable taps, Star–Delta (Yd1).
- Switched Busbar:
- Main and reserve bus, six bi-directional feeders with motorized circuit breakers.
- One feeder equipped with point-on-wave switching (via SCADA timing).
- Inter-bus coupler breaker for double-bus operation.
- Utilization Bus:
- Variable resistive, inductive, capacitive loads (delta-connected).
- Dynamic load: 1.5 kW squirrel-cage induction motor.
- Protection Devices (All relays and breakers are industrial-standard, EU-certified, from leading European brands.)
- Generator Protection
- ABB REG670
- Functions: Overcurrent, Differential, Over/Undervoltage, Over/Underfrequency, Loss of Excitation, Reverse Power, Rotor Earth Fault.
- Grid Transformer Protection
- Schneider Micom P642
- Functions: Restricted Earth Fault (REF), Differential, Overcurrent Backup.
- Transmission Line Protection
- Siemens 7SA82
- Functions: 3-Zone Distance, Overcurrent, Power Swing Blocking, Fault Locator.
- Distribution Feeder Protection (Six Feeders)
- Siemens 7SJ64
- Functions: Numerical Overcurrent & Earth Fault Protection, Directional Control, Breaker Failure Protection.
- Circuit Breakers & Switchgear
- Motorized Circuit Breakers:
- Siemens 3WL Air Circuit Breakers
- ABB VD4 Vacuum Circuit Breakers (selected feeders).
- Isolators/Disconnectors: ABB OT Series with mechanical interlock.
- Auxiliary Protection: Schneider Acti9 MCBs.
- Other Protection & Measurement Devices
- Siemens 7VE61 Synchroscope & Synchronization Relay.
- Siemens 7RW80 Under/Overvoltage & Frequency Protection Relay.
- Schneider ION9000 Power Quality Analyzer (integrated with ASCDA).
- Siemens DIGSI / SICAM Fault Recording & Event Logger (integrated with SCADA).

PC Configuration for SCADA Workstation

- Processor (CPU): Intel Core i7-11700 or i7-11700K (8 cores / 16 threads, up to 5.0 GHz Turbo)
- Motherboard / Chipset: Intel 500-series (e.g., B560, H570) or 400-series (Z490, B460) with LGA 1200 socket; supports PCIe 4.0 (if available), multiple PCIe slots, M.2 NVMe slot, and dual LAN
- RAM (Memory): 32 GB DDR4-3200 (2 × 16 GB modules, dual channel), expandable up to 64 GB
- Storage: 1 TB NVMe PCIe SSD (dedicated for SCADA software, database, logs, and

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replay files)
- Monitor: 27" IPS monitor, Full HD (1920 × 1080) or higher resolution, wide-viewing angle; recommended dual-monitor setup for SCADA mimic diagrams and event logging

SCADA Integration (ASCDA Software Suite)
- This comes with a dedicated SCADA software package offering:
- Single-Line Diagram (SLD) GUI with live status of CBs, isolators, relays, and buses.
- Relay Communication via IEC 61850, Modbus TCP/IP, and IEC 60870-5-104.
- Event & Fault Recorder with timeline playback (relay trips, breaker operations).
- Trending & Analysis: Real-time plots of V, I, f, PF, THD, harmonic analysis.
- Fault Simulation: Trigger line, bus, transformer, or generator faults directly from SCADA.
- Protection Relay Configuration: Set thresholds, curves, time delays, and observe relay response.
- Power Quality Monitoring: Voltage dips, swells, flicker, harmonics (via Schneider ION9000).
- User Management: Role-based access for students, instructors, and administrators.
- Data Logging: Export to CSV, Excel, or SQL database for research.

Learning Outcomes
- Operation and synchronization of synchronous generator with grid.
- Transmission line behavior under normal and fault conditions.
- Distance protection, fault location, and power swing blocking.
- Transformer differential and earth fault protection.
- Bus switching and feeder protection schemes.
- Load flow analysis, voltage regulation, and stability studies.
- Real-time SCADA monitoring and control of protection systems.
- Fault recording and analysis for post-fault diagnosis.
- Power quality monitoring and harmonic analysis.

Standard Features
- Modular, compact console design with EU safety compliance.
- Supplied with comprehensive experimental manual
- Equipped with emergency stop, interlocks, and audible alarms.
- Mounted on heavy-duty wheels for mobility.
- Fully compliant with CE / EMC / LVD / RoHS Directives.

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