Protection, Monitoring, and Control System for Distribution Substations

Data Sheet

GENERAL DESCRIPTION

This pre-engineered system provides protection, monitoring, and control for typical distribution substations. This simple and affordable system uses SEL digital relays and communications processors along with a Human-Machine Interface (HMI) implemented with off-the-shelf, industry-recognized HMI software to provide full-featured protection and basic automation functions. Communications to a remote HMI or Supervisory Control and Data Acquisition (SCADA) system and dial-in/dial-out capability (manual or automatic) are also supported.
**DESIGN CONCEPT**

SEL has created standard designs for the protection scheme, relay settings, communications processor application, metering and monitoring functions, control functions, and HMI. These designs take advantage of the protection, monitoring, metering, and control capabilities built into SEL relays. By using proven designs, the individual system design effort and documentation costs are reduced. The designs can be scaled up or down, and tailored to meet specific substation and customer requirements. Contact SEL for solutions tailored to your requirements.

**FUNCTIONAL SUMMARY**

- **Protection**
  
The system includes fast bus tripping to clear distribution bus faults in cycles, complete backup relaying, and breaker failure protection in addition to transformer differential protection and feeder overcurrent protection. Lockout functions are implemented for breaker failure, bus faults, and transformer faults. Relay logic detects uncommanded changes, e.g., changes in circuit breaker position not initiated through the HMI or relay front-panel control.

- **Monitoring and Metering**
  
  Monitoring and metering are provided through the digital relays. The SEL-351 Relay meters bus voltage, real and reactive transformer power, and substation DC voltage, and collects discrete alarm indications.

- **Control**
  
  Control is implemented through the relays, with the local HMI providing the operator interface in the substation. HMI or SCADA systems can provide control from remote locations. Control switches can be placed in the substation as a means of manual control. Programmable logic controllers and RTUs are not required.

- **Self-Checking**
  
  The relays and communications processors continuously perform self-checks. If a problem is detected, an alarm will appear on the HMI. In addition, the health of each communications channel within the substation is continuously checked by the communications processor and reported to the HMI.

- **Local and Remote Human-Machine Interface**
  
  The local HMI is implemented on a personal computer with off-the-shelf, industry-recognized HMI software. Protection functions are not dependent on the availability of the PC. The local HMI continuously reports substation status and provides a control interface to the substation equipment. During maintenance periods, two levels of safety tagging are provided. Screens to aid the operator are built in. These include a protection one-line diagram, communications system screen, relay target emulation screen, and customizable help screens that can include customer documents.

  A remote HMI can also be provided. The remote HMI is similar to the local HMI but at a location remote from the substation.
• **SCADA Interface**

  The system communicates with a SCADA system through a port on the SEL-2030 Communications Processor using Modbus RTU, Modbus Plus™, or DNP 3.0 Level 2 protocols. SEL will work with you or your SCADA vendor to implement the communications interface. Please contact SEL if other protocols are involved.

• **Event Reporting and Oscillography**

  The operator can view an oscillographic display of the currents and, if available, voltages from any relay. The relays automatically collect and store the data whenever a fault occurs. The SEL-5601 Analytic Assistant Software displays the data on the substation PC.

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**Figure 1: One-Line Diagram – Example System**
Protection
- Two-Winding Transformer:
  - Primary protection – harmonically restrained percentage current differential and high-set unrestrained current differential
  - Backup protection – phase and ground non-directional time overcurrent in SEL-551 Relay
  - Backup protection – phase and ground non-directional time overcurrent in SEL-587 Relay
- Distribution Bus:
  - Primary protection - Fast Bus Tripping
  - Backup protection - phase and ground non-directional time overcurrent in SEL-587 Relay
  - Backup protection - phase and ground non-directional time overcurrent in SEL-351 Relay
  - Breaker failure detection that trips the high-side circuit breaker for a main circuit breaker failure
- Distribution Feeders:
  - Primary protection - phase and ground non-directional time overcurrent
  - Backup protection - phase and ground non-directional time overcurrent in SEL-351 Relay
  - Automatic reclosing
  - Breaker failure detection that trips the main circuit breaker for feeder circuit breaker failure

Control
- Circuit Breaker (Trip/Close)
- Lockout for:
  - Transformer faults
  - Bus faults
  - Breaker failure trips
  - Uncommanded change of circuit breaker position (momentary change detection)
- Feeder Reclosing (On/Off)
- Feeder Ground Relaying (On/Off)
- Local/Remote Control Selection
- Relay Target Reset
- Caution Tag (Reclosing Off)
- Clearance Tag (Control Disabled)

Human-Machine Interface
- Desktop Substation PC with Microsoft® Windows® NT™ Workstation 4.0 Operating System
- Wonderware InTouch™ Software License
- Four Levels of Password Security
- Screens:
  - System One-Line Diagram
  - Relay Targets
  - Alarm History
  - System Communications
  - On-Line Documentation (Including Customer Provided Documents)
  - Simplified Protection One-Line Diagram
  - Circuit Breaker Control (one per circuit breaker)
  - Caution Tag (one per circuit breaker)
  - Clearance Tag (one per circuit breaker)
- SEL-5010 Relay Assistant Software
- SEL-5020 Settings Assistant Software for SEL Communications Processor
- SEL-5601 Analytic Assistant Software
- HyperTerminal Software (comes with Microsoft Windows NT Workstation 4.0 Operating System, for transparent connections to relays)

Metering and Monitoring
- Transformer Currents (high side and low side)
- Real and Reactive Transformer Power
- Feeder Currents
- Distribution Bus Voltages
- Transformer Alarms (discrete points)
- Substation Alarms (discrete points)
- Substation DC Voltage
- Relay Front-Panel Targets

Major Equipment (Example System):
- Five SEL-551 Relays
- One SEL-587 Relay
- One SEL-351 Relay
- One SEL-2030 Communications Processor
- One Desktop Substation PC

Services and Documentation
- Application of Customer Provided Relay Settings Using SEL Standard Relay Setting Templates
• SEL-2030 Communications Processor
  Settings
• Telephone Support During Installation and
  Commissioning
• System Documentation Consisting of:
  ▪ Operator training manual
  ▪ Maintenance and troubleshooting manual
  ▪ System overview
  ▪ System installation and startup notes
  ▪ Written description of protection system
    operation
  ▪ Simplified substation one-line diagram
    including relays, communications
    processors, communications channels,
    and local HMI
  ▪ Simplified AC and DC schematic
    diagrams for the protection scheme
  ▪ Relay settings specification sheets
  ▪ Detailed communications block diagram
  ▪ HMI operating instructions
  ▪ Equipment instruction manuals
  ▪ HMI application on CD-ROM as installed
    on substation PC
  ▪ Relay settings in SEL-5010 files on CD-
    ROM, and in paper copy, as installed on
    substation PC
  ▪ Communications processor settings in
    SEL-5020 files on CD-ROM, and in paper
    copy, as installed on substation PC
  ▪ Bill of material
  ▪ Software licenses
  ▪ Software manuals
  ▪ Non-SEL equipment warranties

Optional Features and Services
• Enhanced Distribution Bus Protection,
  Monitoring, and Control:
  ▪ Directional overcurrent relaying
  ▪ Over- and undervoltage relaying
  ▪ Over- and underfrequency relaying
  ▪ Voltage sag/swell monitoring
  ▪ Load shedding and restoration
• Enhanced Feeder Protection, Metering,
  Monitoring, and Control:
  ▪ Directional overcurrent relaying
  ▪ Over- and undervoltage relaying
  ▪ Over- and underfrequency relaying
  ▪ Voltage sag/swell monitoring
  ▪ Real and reactive power metering
  ▪ Demand metering
  ▪ Load shedding and restoration
• Three-Winding Transformer Protection
• Transmission Line Protection
• Pre-Wired Racks
• Pre-Fabricated Control Houses
• Fault Studies, Protection Design, and Relay
  Settings
• Remote Human Machine Interface
• Interface with SCADA via Modbus, Modbus
  Plus, or DNP 3.0 Level 2 Protocols
• SEL-351S Breaker Control Systems or
  SEL-351R Recloser Control Systems with
  Large Pushbutton Operator Interface

FOR ADDITIONAL INFORMATION

This system is one example of SEL’s approach to providing practical, capable, and cost effective
protection and automation. SEL would be pleased to tailor a Protection and Automation System
to fit your needs. To discuss your particular application, including any additional or special
features, please contact us through your local SEL representative, field application engineer, or
the SEL Customer Service Representative.

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We are interested in any questions you may have about this or other SEL products and systems. We
appreciate receiving any comments and suggestions about new products, product
improvements, or system features that would help us make your job easier.