

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Visit our website - *Click HERE*

SEL Application Guide Volume I AG97-04

Using the SEL-321 Relay and SEL-221G Relay as Primary and Backup Transmission Protection

Joe B. Mooney and John J. Kumm

INTRODUCTION

Some regional coordination councils recommend or require that primary and backup protective relays used at the bulk transmission level be of differing construction and operating principles. Some even suggest that protective relays from different vendors be used. This requirement is intended to reduce the possibility that a common flaw in the two protection systems would result in an undetected fault.

We propose that two SEL relays, the SEL-221G Relay and SEL-321 Relay, offer a complementary protection set with enough difference in design, construction, and operating principle to fully satisfy the recommendations described above.

THE SEL-221G RELAY

The SEL-221G Relay is an updated-hardware version of the SEL-121G Relay, which was introduced in 1987. The SEL-200 series hardware platform was released in 1992 to reduce the size and cost of the older SEL-100 series relays. The SEL-221G Relay is a three-zone phase distance, ground directional overcurrent relay, with three-shot reclosing, out-of-step blocking, and support for various communications-aided protection schemes.

The SEL-221G Relay uses the Motorola 6809 microprocessor and a 12-bit analog-to-digital converter.

THE SEL-321 RELAY

The SEL-321 Relay is a high-performance protective relay that provides up to four zones of phase mho and ground mho or quadrilateral distance protection, along with directional phase, ground, and negative-sequence overcurrent elements. Included are logic blocks that support communications-aided protection, switch-onto-fault tripping, loss-of-potential detection, and SELOGIC® Control Equations. The SEL-321 Relay has been used to protect power lines around the globe since 1993.

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court • Pullman, WA • 99163-5603 • USA
Phone: (509) 332-1890 • Fax: (509) 332-7990
E-mail: info@selinc.com • Internet: www.selinc.com

ISO 9001 CERTIFIED

The SEL-321 relay is based on the Motorola MC68332 32-bit microprocessor and a 16-bit analog-to-digital converter.

Everything that SEL learned by designing, manufacturing, and supporting the SEL-100 and -200 series relays for nearly ten years went into making the SEL-321 Relay a far more accurate and robust relay than any relay previously built by SEL. To illustrate this, listed below are some areas where the SEL-321 Relay has improved over earlier SEL relays.

Operating Temperature Range

The SEL-321 Relay is designed for operation in the temperature range -40° to +85°C. Earlier relays can be applied to +70°C. This increase in the top end temperature means an expected longer relay life under normal conditions of 25° to 30°C.

Decreased Critical Component Count

The SEL-321 Relay analog data acquisition system design uses fewer components than the data acquisition systems of earlier 200-series distance relays. Fewer components yield fewer opportunities for failure, hence, higher overall reliability.

More Secure Output Control Logic

The SEL-321 Relay uses a specially designed security logic to control the relay output contacts. Each contact must receive a specific Arm - Fire command sequence within a specific time frame in order to close. This does not affect the relay operating speed because the commands occur within the same processing interval. The logic does improve the output contact operating security.

There are other differences between the SEL-321 Relay hardware and older SEL relay designs. All of these differences result in performance improvements or enhanced features for the customer.

32-Bit Microprocessor

The Motorola MC68332 microprocessor has roughly 20 times the processing capability of the venerable Motorola 6809. This additional capability is used to provide innovative protection functions not available in any other protective relay. Four independent zones of phase and ground mho plus ground quadrilateral distance elements; a unique, impedance-based negative-sequence directional element; secure fault identification logic; and an extremely accurate fault locating algorithm are a few examples of the functions made possible by the powerful computer used in the SEL-321 Relay.

16-Bit Analog-to-Digital Converter

The SEL-321 Relay uses a 16-bit analog-to-digital converter rather than the older 12-bit converter used by the SEL-100 and -200 series relays. The 16-bit converter simultaneously provides higher measuring accuracy and a broader dynamic measuring range. We used these capabilities to make the relay measuring elements more accurate than ever before and to provide extremely broad current, voltage, and impedance setting ranges.

Front-Panel Interface

The SEL-321 Relay offers a front-panel LCD interface that you can use to review/change relay settings, view meter data, verify relay self-test health, and examine fault data.

A More Detailed Comparison

SEL proposes the SEL-321 Relay as primary protection and the SEL-221G Relay as the backup relay system. These relays meet the requirements for two diverse transmission line relays in many ways. The following table highlights the main differences between the SEL-321 Relay and the SEL-221G Relay.

Item	SEL-321 Relay	SEL-221G Relay
In-Service Experience	Released to production in 1992. The first units went into service in January of 1993.	Released to production in 1987 (SEL-121G Relay). First units in service that same year. Changed over to 200-series hardware package in 1992.
Microprocessor	Motorola 68332 32-bit processor.	Motorola 6809 8-bit processor.
A/D Converter	16-bit A/D converter.	12-bit A/D converter.
Analog Filtering	Low-pass filter with -3 db point at 540 Hz.	Low-pass filter with -3 db point at 85 Hz.
Waveform Sampling	16 samples per power system cycle.	4 samples per power system cycle.
Digital Filtering	Full-cycle cosine filter rejects all harmonics of the fundamental frequency.	CAL filter rejects even harmonics of the fundamental frequency.
Processing Interval	Eight times per power system cycle.	Four times per power system cycle.
Hardware Configuration	Two printed circuit boards on draw-out trays in a single chassis with power supply on a separate PCB. One printed circuit board contains the processing modules (i.e., the analog signal processing, digital signal processing, communications, microprocessor, etc.). The second board contains all of the logic input and output contact circuitry.	Single printed circuit board on a draw-out tray in a single chassis with the power supply on a separate PCB. All signal processing, logic input, and output contact circuitry is contained on the single board.
Power Supply	Switchmode power supply, loaded at 33% less than maximum rated loading to improve expected life.	Switchmode power supply, loaded at less than maximum rated loading, to improve expected life.

Item	SEL-321 Relay	SEL-221G Relay
Communications Ports	Three independent EIA-232 ports. Two ports located on the rear of the relay. One port located on the front of the relay.	Two EIA-232 ports. Two ports located on the rear of the relay. One port is shared with a serial port mounted on the front of the relay.
IRIG-B Time Synch Input	Provided on rear of relay.	Provided on rear of relay.
Inputs/Outputs	Up to 16 inputs. Up to 32 outputs. Both inputs and outputs are fully programmable. Electromechanical output relay.	Six inputs (fixed function). Eight output contacts. Four of the output contacts are programmable. Electromechanical output relay.
Front-Panel Interface (MMI)	Included as standard feature.	No front-panel interface provided.
Distance Elements	Four zones of phase and ground distance. All zones selectable for forward or reverse reach.	Three zones phase distance only. One zone may be set in the reverse direction.
Distance Element Algorithms	Phase-pair mho elements for phase fault detection. Single-phase mho and quadrilateral elements for ground fault detection. The mho elements use positive-sequence memory polarization. The quadrilateral reactance elements use zero-sequence current polarization for improved load rejection.	Polyphase (compensator distance) element for phase fault detection.
Directional Overcurrents	Four levels each of residual and negative-sequence overcurrent.	Three levels of residual overcurrent.
Time Overcurrent	Phase, negative-sequence, and residual overcurrent.	Residual overcurrent.
Directional Elements	New element uses negative-sequence impedance characteristic.	Traditional directional element torque calculation. Selectable for negative-sequence currents and voltages, zero-sequence voltages and currents, and zero-sequence current.
Pilot Schemes	All pilot tripping schemes supported (POTT, DCB, DTT, DCUB, PUTT, DUTT).	Logic for pilot scheme tripping is included. However, special versions of the SEL-221G Relay are required to address some pilot scheme requirements.

Item	SEL-321 Relay	SEL-221G Relay
Programmability	SELOGIC® Control Equations.	Programmable mask logic.

SOME BENEFICIAL FEATURES IN COMMON TO BOTH RELAYS

SEL relays have a field-proven Mean Time Between Failure (MTBF) of over 150 years. This MTBF is the best in the industry.

Both relays use a self-testing routine that has a field-proven record of detecting 80% of all failures.

All SEL relays are supported by the very best warranty, technical staff, and customer service staff in the industry.

Both relays use field-proven fault locating algorithms. These algorithms reduce the impact of load flow and fault resistance on the calculated fault location. The SEL-221G Relay fault locator has been used successfully in the field for over ten years.

The event reports provided in the SEL-321 Relay and the SEL-221G Relay use similar formats. The SEL-321 Relay can provide a more detailed report format for special analysis. The event reports provide information on relay response, operating time, breaker trip times, communication channel performance, and system fault data. Using common formats allows you to very easily cross check the relays performance using the event data.

SEL relays use a simple, easy to understand ASCII format. This simplifies integration and communication with the relays. Since the SEL-221G and SEL-321 Relays are nearly identical with respect to communications format, the substation integration task is simpler and more economical. In addition, both relays integrate fully with the SEL-2020 Communications Processor.

CONCLUSION

The application of SEL-321 and SEL-221G Relays as primary and backup line protection provides two complementary sets of protection elements in hardware packages having differing microprocessors and data acquisition systems. Those relay features that are in common provide many application advantages and cost savings, including similarities of command sets, communication capabilities, and reporting functions.

FACTORY ASSISTANCE

The employee-owners of Schweitzer Engineering Laboratories, Inc. are dedicated to making electric power safer, more reliable, and more economical.

We appreciate your interest in SEL products, and we are committed to making sure you are satisfied. If you have any questions, please contact us at:

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA USA 99163-5603
Tel: (509) 332-1890
Fax: (509) 332-7990

We guarantee prompt, courteous, and professional service.

We appreciate receiving any comments and suggestions about new products or product improvements that would help us make your job easier.

All brand or product names appearing in this document are the trademark or registered trademark of their respective holders.

Schweitzer Engineering Laboratories, Inc., SEL, and SELOGIC are registered trademarks of Schweitzer Engineering Laboratories, Inc.

Copyright © SEL 1997 (All rights reserved) Printed in USA.

Using the SEL-321 Relay and SEL-221G Relay
as Primary and Backup Transmission Protection SEL Application Guide 97-04 970204

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP