

SEL-T4287

Traveling-Wave Test System



Simple, compact, and economical secondary pulse injection test set for testing traveling-wave fault locators and line protective relays

- Specify the line parameters, fault type, and location, and let the test set calculate and apply the traveling-wave secondary test signals.
- Verify the security and dependability of traveling-wave protection elements and schemes by applying internal or external fault test conditions.
- Test the accuracy of traveling-wave fault locators by applying secondary traveling-wave pulses with nanosecond precision.
- Perform end-to-end testing of traveling-wave protection schemes and multi-ended fault locators with multiple test sets synchronized to a common satellite-based time reference.
- Use this portable test set for both laboratory and field testing, taking advantage of its rugged and compact housing and the carrying handle.





Key Features

Secondary Traveling-Wave Injection

Traveling-wave fault locators and protection elements and schemes measure sharp changes in their input currents and voltages with rise times as fast as 1 microsecond. These fault locators and relays respond to relative polarities and the relative timing of these sharp signal changes. The SEL-T4287 Traveling-Wave Test System is a secondary pulse injection test set that generates output current signals with a short rise time, adequately slow decay, and nanosecond precision necessary for testing traveling-wave protective relays, standalone traveling-wave fault locators, and traveling-wave fault locators embedded in line protective relays.

Versatile Applications

The SEL-T4287 generates two 3-phase sets of secondary traveling-wave currents. An included voltage module accessory (containing low-inductance resistors) allows you to convert one current output set into one voltage output set to simulate traveling-wave voltage signals. Test current- or voltage-based fault locators or protection elements and schemes, including single- and multi-ended fault locators, traveling-wave directional elements, and traveling-wave differential schemes. Time-synchronize or cross-trigger multiple SEL-T4287 test sets to generate more than two 3-phase traveling-wave signal sets with desired timing patterns, as needed by the device under test (DUT).

Simple Test Parameter Configuration

Specify line and fault parameters, and let the SEL-T4287 calculate and apply the traveling-wave test signals. The simple and intuitive SEL-T4287 HMI allows you to specify test parameters and offers full control of tests without the need for a PC and software.

End-to-End Testing

Perform end-to-end testing of traveling-wave protection schemes and multi-ended fault locators with multiple SEL-T4287 test sets synchronized to substation satellite clocks via IRIG-B inputs. Preconfigure each test set, schedule a test time, and let the multiple SEL-T4287 test sets apply the right test signals at all terminals of the line. Test multi-ended traveling-wave fault locators for lines with more than two terminals. End-to-end testing is a standard feature included in the base product and can be used with any IEEE C37.118-compliant satellite clock with IRIG-B output.

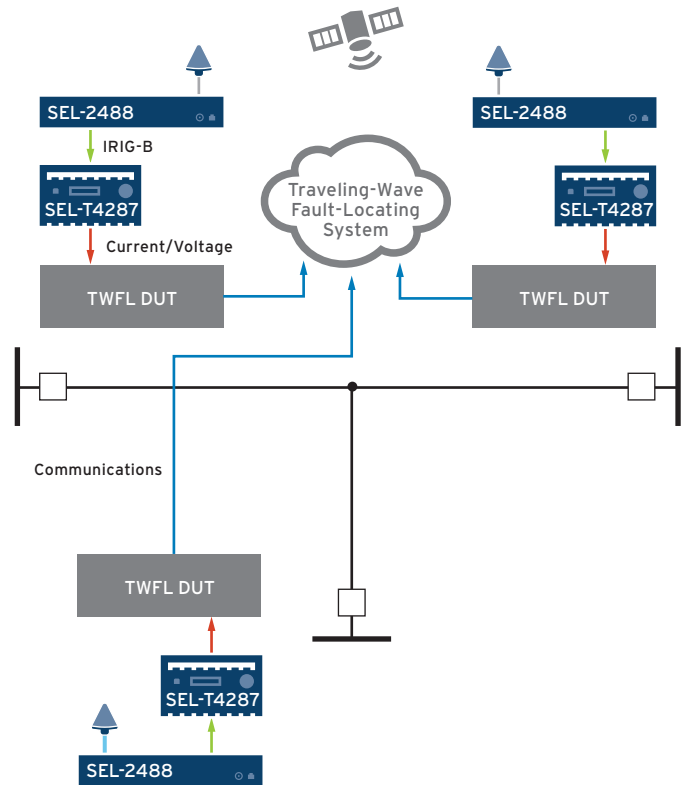
Applications

The SEL-T4287 is suitable for testing traveling-wave protection elements and schemes in SEL products, such as the SEL-T400L Time-Domain Line Protection, as well as traveling-wave fault locators embedded in SEL protective relays, such as the SEL-411L Advanced Line Differential Protection, Automation, and Control System. The SEL-T4287 may also be used to test other manufacturers' traveling-wave fault locators.

Testing Multi-Ended Traveling-Wave Fault Locators

Apply the SEL-T4287 to test multi-ended traveling-wave fault locators. Use multiple SEL-T4287 test sets synchronized to a common satellite time via standard IRIG-B inputs. Inject traveling-wave current to the DUT. Obtain voltage traveling-wave signals using the provided voltage module, if required. Configure each SEL-T4287 to provide the first traveling-wave pulse as per the desired fault location for any given line length and configuration, and schedule the test time.

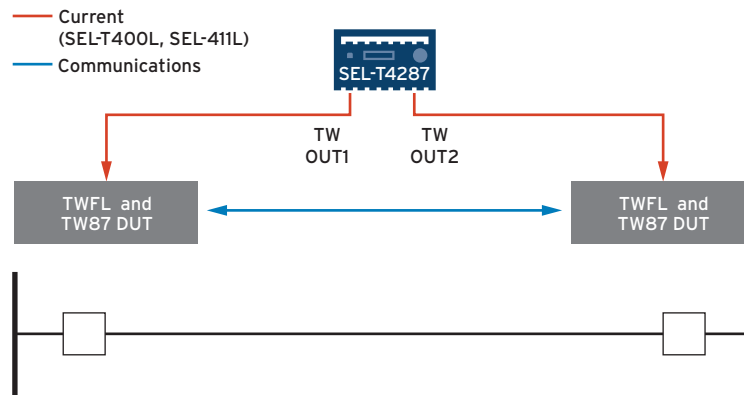
The SEL-T4287 test sets trigger automatically at the scheduled test time and provide the correct test stimulus to the multi-ended fault-locating system under test. Use substation satellite clocks when testing in the field. In a laboratory setup, connect all SEL-T4287 test sets to the same clock. Use this method for end-to-end testing of the SEL-T400L and SEL-411L double-ended traveling-wave fault locators.



End-to-end testing of a multi-ended fault-locating system.

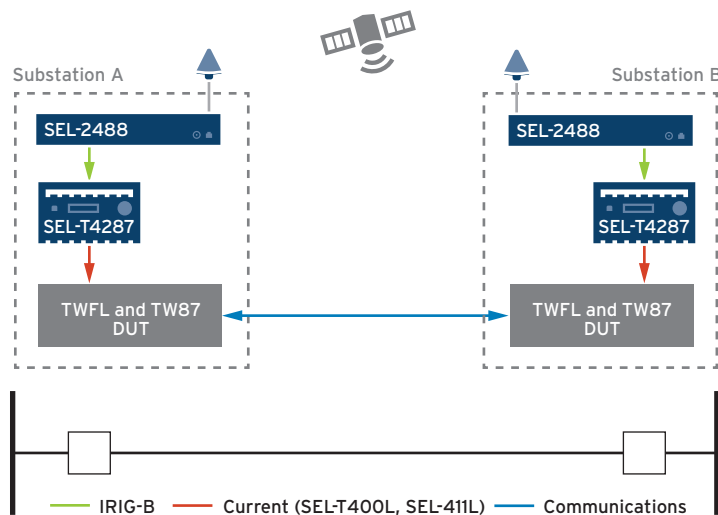
Testing Traveling-Wave Differential Protection Scheme and Double-Ended Fault Locators

Apply a single SEL-T4287 in a laboratory setup to test double-ended fault locators embedded in line protective relays, such as the SEL-T400L and SEL-411L, and to test the traveling-wave differential scheme that is available in the SEL-T400L. Configure the test set for double-ended testing, with the two test set outputs providing the local and remote currents accordingly.



Laboratory testing of double-ended traveling-wave fault locators embedded in protective relays and a traveling-wave differential protection scheme.

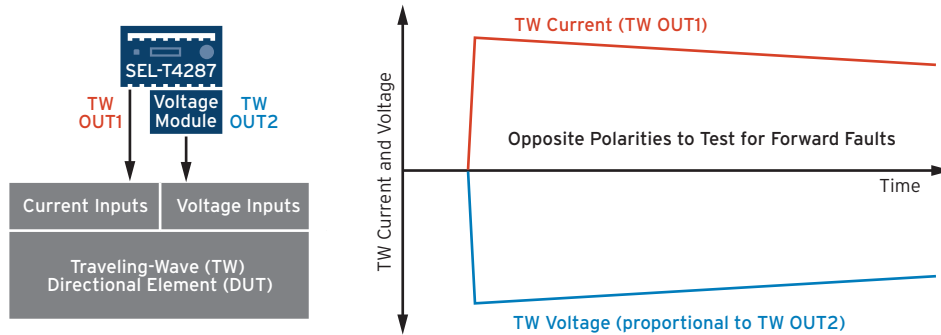
Use two satellite time-synchronized SEL-T4287 test sets for end-to-end testing in the field. Configure each test set for double-ended testing, with the two test set outputs providing the local or remote currents accordingly. Connect the relay in each substation to the corresponding output of the test set, schedule the test time, and let the two SEL-T4287 test sets trigger automatically to provide the test stimulus to the scheme.



End-to-end testing of double-ended traveling-wave fault locators embedded in protective relays and a traveling-wave differential protection scheme.

Testing Traveling-Wave Directional Elements

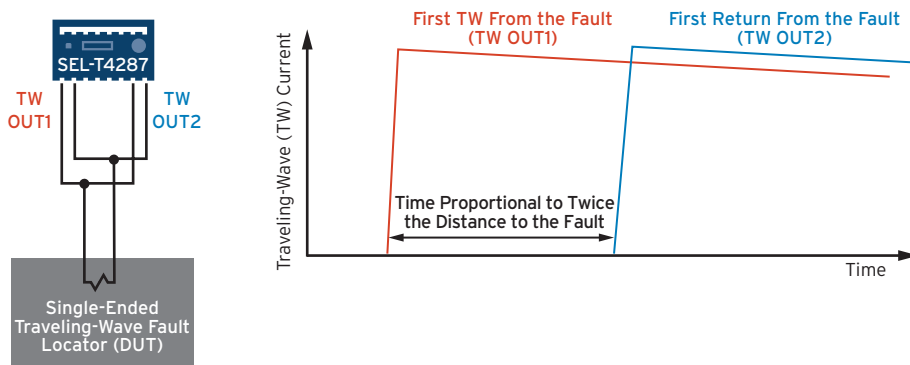
Connect the provided voltage module to one of the two traveling-wave current output sets to simulate traveling-wave voltages. Configure the test set for single-ended testing, and generate simultaneous traveling-wave current and voltage signals. Switch the wiring to apply the voltage and current traveling waves of the matching or opposite polarities to test for reverse and forward fault conditions, respectively.



Apply current and voltage signals for testing traveling-wave directional elements.

Testing Single-Ended Traveling-Wave Fault Locators

Configure the SEL-T4287 for single-ended testing. Based on the line parameters, fault type, and location, the test set calculates and applies two traveling waves, which is adequate for testing single-ended fault locators. The first test set output represents the initial traveling wave originating from the fault and arriving at the line terminal. The second test set output represents the first return from the fault location; i.e., the wave reflected from the local terminal that traveled to the fault location and back to the local terminal. Configure the DUT and SEL-T4287 to apply both pulses to the same input of the fault locator. Use additional time-synchronized or cross-triggered SEL-T4287 test sets to generate more traveling-wave pulses if your DUT requires more pulses than the initial wave and the first return from the fault.



Testing single-ended traveling-wave fault locators.

Product Overview

USB port for firmware upgrades.

View the selected test trigger source.

Arm and initiate a test manually.

Change the menu selection, and dial in new values of line and test parameters.

View line and test parameters.

Navigate to line and test parameters.



Traveling-wave current outputs.

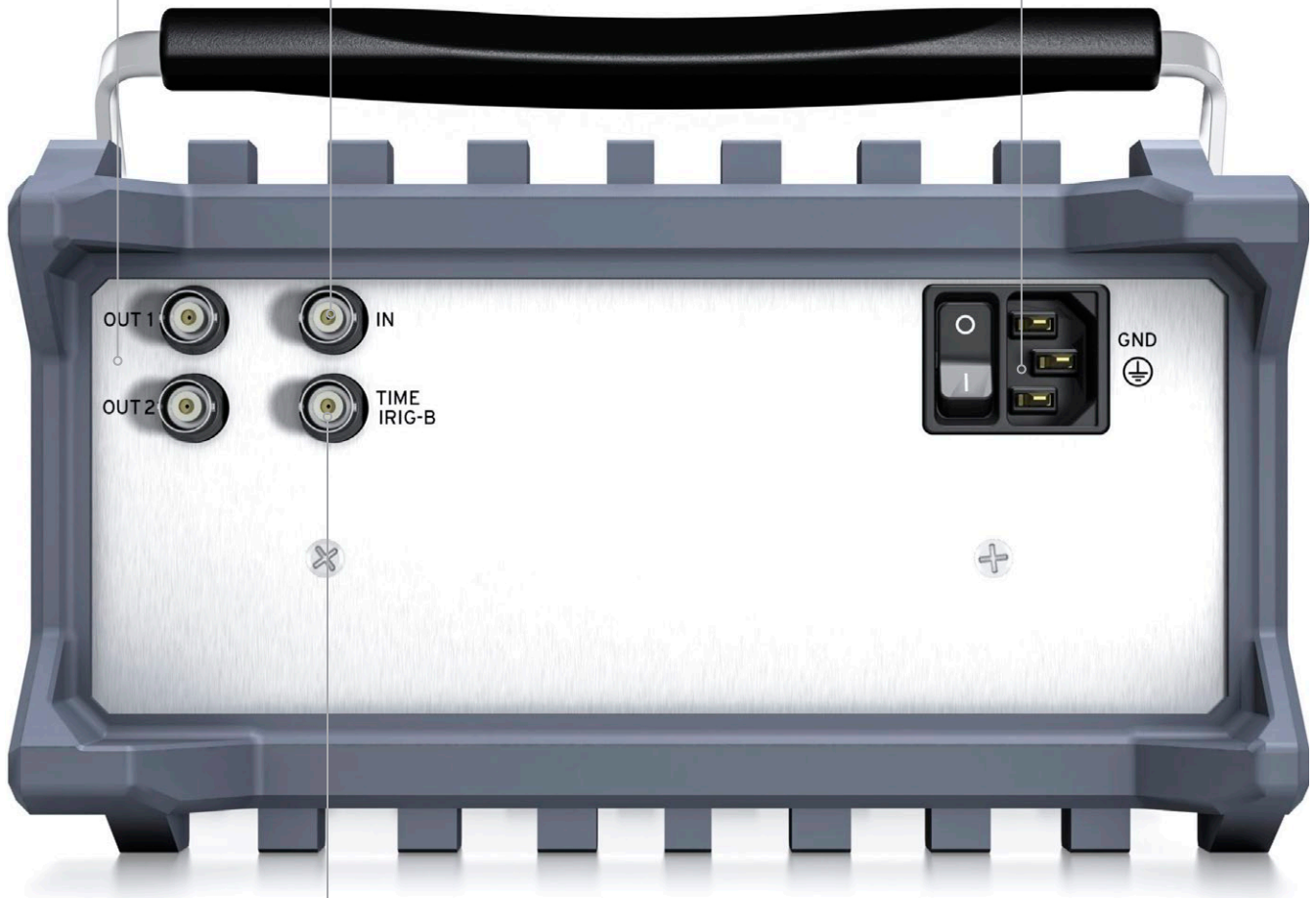
Confirm new values of line and test parameters.

Initiate a test using a 48 V binary input trigger.

Transistor-transistor logic (TTL) cross-trigger outputs to other test sets.

Power supply: 110–240 Vac.

TTL cross-trigger input from other test sets.



IRIG-B input from a satellite clock for synchronized testing.

Specifications

General

Current Outputs	Traveling-wave current magnitude: +5 A, +2.5 A, -2.5 A, and -5 A nonadjustable and based on the selected fault type Traveling-wave pulse rise time: <1 μ s* Traveling-wave pulse half-way decay time: 389 μ s \pm 20%* 631 μ s \pm 20%** Traveling-wave timing accuracy: <16 ns
Line Parameters	Length: 0.01–500.00 units in steps of 0.01 Traveling-wave propagation time: 10.00–1,700.00 μ s in steps of 0.01 μ s
Fault Parameters	Location: 0.00 to line length in steps of 0.01 of line length units Type: Phase-to-ground internal and external
Test Mode	One-terminal (single-ended) or two-terminal (double-ended)
Triggering Source	Manual: Test is initiated when the RUN pushbutton is pressed. Time: Test is initiated at the top of a second using the scheduled test time based on the satellite-synchronized clock connected to the rear-panel IRIG-B input. Loop: Once manually initiated, a specified test is automatically repeated at the top of a second every five minutes to facilitate testing for consistency and spread of results (no IRIG-B signal required). Binary input: Test is initiated on the rising edge of the 48 V front-panel binary input voltage. TTL input: Test is initiated on the rising edge of the 5 V rear-panel TTL input voltage.
Cross-Triggering Output	Two 5 V rear-panel TTL outputs
Power Supply	Rated voltage: 110–240 Vac Rated frequency: 50/60 Hz Burden <50 VA
Firmware Upgrade	USB front-panel port

*With output connection short-circuited

**With only the voltage module attached

Accessories

- SEL-2401 Satellite-Synchronized Clock
- SEL-2407® Satellite-Synchronized Clock
- SEL-2488 Satellite-Synchronized Network Clock
- Voltage Module for SEL-T4287 (part number 915900503)

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