

APPLICATION NOTE

Testing SEL-T400L Relays with Doble Protection Testing Solutions

Introduction

The comprehensive line of Doble protection testing solutions allow you to efficiently design and perform simulations of electrical conditions that challenge any protection and control system. Power with flexibility describes Doble Protection Suite and Doble RTS™ (RTS) software applications as well as Doble F-Series power system simulators and Manta MTS-5100 relay test systems. Each solution accommodates your company's unique testing program and compliance stance.

The automated protection testing solutions from Doble include methods for verifying innovations in time-domain line protection including ultra-high-speed functions based on traveling wave principles. Traveling waves occur during faults and can be analyzed by polarity, time and distance traveled. Relays that can detect traveling waves reveal fault location information within milliseconds while offering other critical line protection and control advantages like high-speed tripping and communications that increase reliability and security.

Problem: Generating traveling waves during tests

Algorithms used by the relay detect traveling wave currents that propagate in microseconds at nominal frequency. Tests must apply traveling wave simulations synchronized to current injections at nominal frequency in microsecond intervals and sample relay communication signals in megahertz resolution.

Presently, no digital or conventional relay test set on the market offers this performance stand-alone, so a traveling wave generating instrument must be introduced into the test process. The traveling wave generator and the relay test set must be precisely GPS time synchronized for successful test executions with realistic traveling waves during fault simulations.

Solution: Using Doble protection test instruments and software with SEL-T4287 Traveling Wave Test System

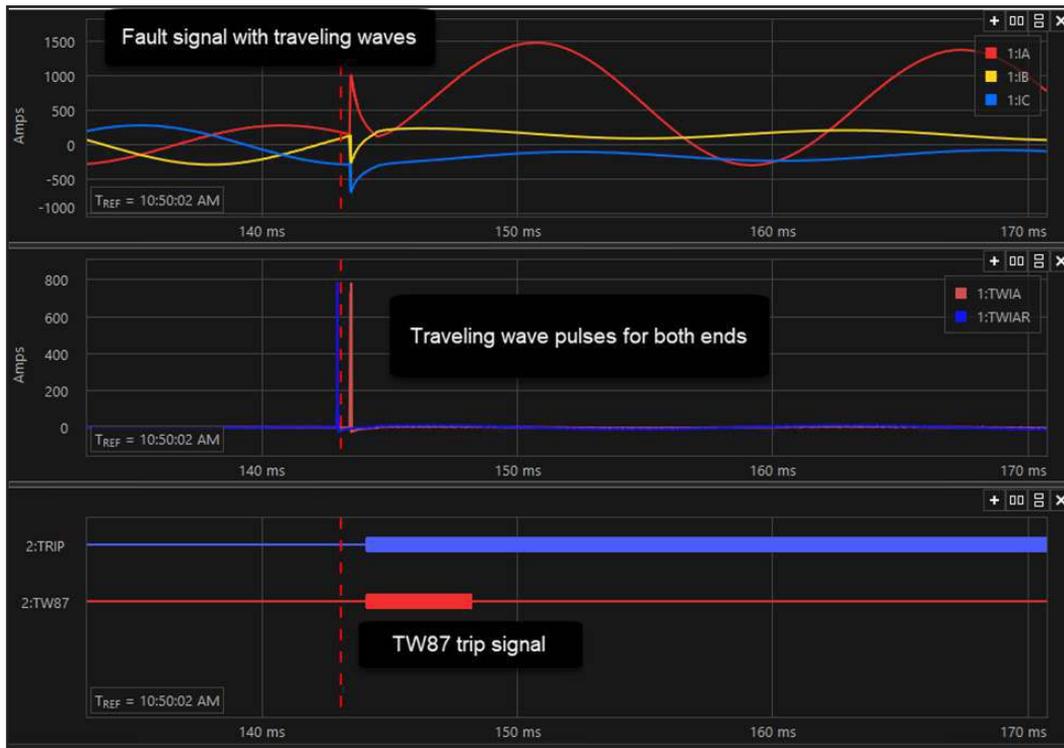
Doble offers three platforms that provide the necessary tools for testing SEL-T400L* relays:

1. F6150e or F6150sv Power System Simulators controlled by Protection Suite or RTS software
2. Manta MTS-5100 Relay Test Systems stand-alone or controlled by RTS software
3. Third-party relay test sets controlled by RTS software

Each of the three platforms Doble provides can be used with the SEL-T4287 Traveling Wave Test System* that generates traveling wave signals during the testing of line differential/traveling wave differential elements.

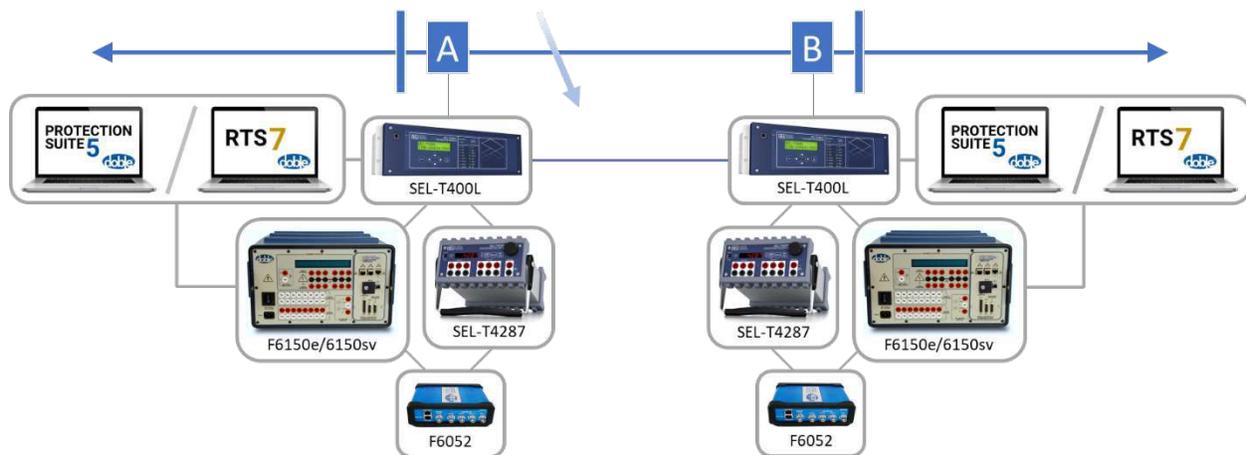
**Instruments are manufactured by Schweitzer Engineering Laboratories.*

Traveling Wave Trip Signal



Doble F6150sv/F6150e with Protection Suite or RTS software

The F6150e or F6150sv Power System Simulator is GPS time-synchronized with the SEL-T4287 by means of the F6052 Universal Time Synchronizer that supports both IRIG-B and PTP. The PC running Protection Suite or RTS software* and the power system simulator, are connected to the network via Ethernet switch.



*Requires matched Protection Suite-to-Protection Suite or RTS-to-RTS test executions.



Protection Suite

Protection Suite software provides a power system model that creates all the calculations required for both ends of the line differential. Here, an internal Ph-G fault at 10% of the line from Relay A is shown:

The screenshot displays the Protection Suite software interface. The top menu bar includes: State Details, Sources, Worksheet, Inputs, Timers, Outputs, Power System Model (active), Signals, Notes, Recording, and Formula References. The main window is divided into several sections:

- Power System Impedance Model:** A table showing sequence impedances for Line 1, S1, and S2.
- Source Voltages:** A table showing voltage magnitudes and angles for S1 and S2.
- PSM Control:** Includes a 'Place States' button and a checkbox for 'Live Sync PSM States'.
- Model Configuration:** Set to 'Single Line'. A diagram shows a line between Relays A and B, with sources S1 and S2 connected to the line.
- Display:** Shows 'Coordinates' (Polar, Pri/Sec) and 'Fault Model' (Fault Type: Ph-G, Rfg: 0.010 Ω, Rf: 0.005 Ω).
- Fault Location:** Shows 'Line 1' and '10.00 %'.

Create these calculations once and share the file with the Protection Suite user at the Relay B location.

Testing impedance and line differential protection has never been easier than now in Protection Suite with the release of version 5. Users can solve equations involving complex numbers with new built-in functions, test multiple zones and faults under one step with the Impedance Characteristic test, and quickly configure fault distance or line differential testing with the power system model built into state simulation tests.

RTS

The F6150e or F61 Line fault configurations in RTS are designed using the FasFault interface, which is an interactive, visual power system modeling tool. Here, an internal Ph-G fault at 10% of the line from Relay A is shown:

The screenshot shows the FasFault interface. The left pane displays a tree view of 'LIBRARY TESTS' with 'A TERMINAL: AG @ 10% TEST' selected. The main window shows a diagram of a line between Relays A and B, with a fault point marked at 10% distance from Relay A. The 'New / Selected Fault' dialog is open, showing the following configuration:

- Fault Number: 1
- Fault Type: AG
- Line Location (%): 10.00
- Max Fault Duration (s): FAULT_TIME
- Options: Evaluate Pass/Fail, Verify OP, Verify NDDP, Verify Time
- Expected Op Time: 0
- Tolerance Min %: 0.00, Max %: 0.00
- Tolerance Min +/-: 0.00, Max +/-: 0.00
- Tolerance Evaluation: Off

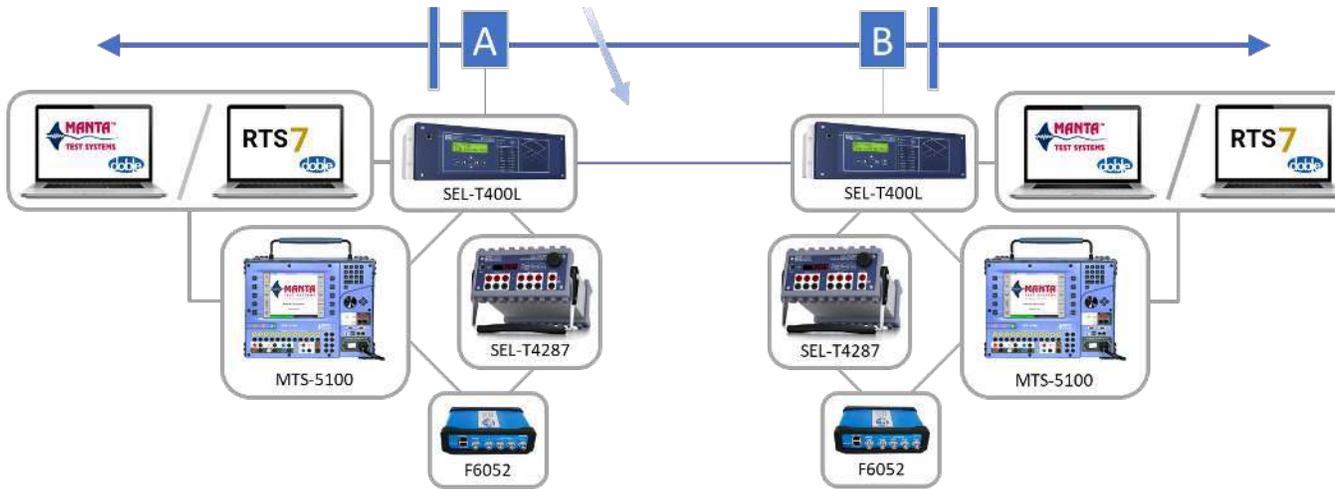
The 'Fault Values' table is also visible:

Va	Vb	Vc	Ia	Ib	Ic
12.24 @ 0.00	77.00 @ 234.56	82.01 @ 132.04	7.37 @ 260.00	0 @ 0	0 @ 0

Enter source impedance and other line parameters and the FasFault interface auto-calculates test quantities for each fault location placed on the line model. RTS software has FasFault and other user-friendly test creation tools which are showcased in the RTS T400L automated test routine that is available to customers.

Manta MTS-5100 stand-alone or with RTS software

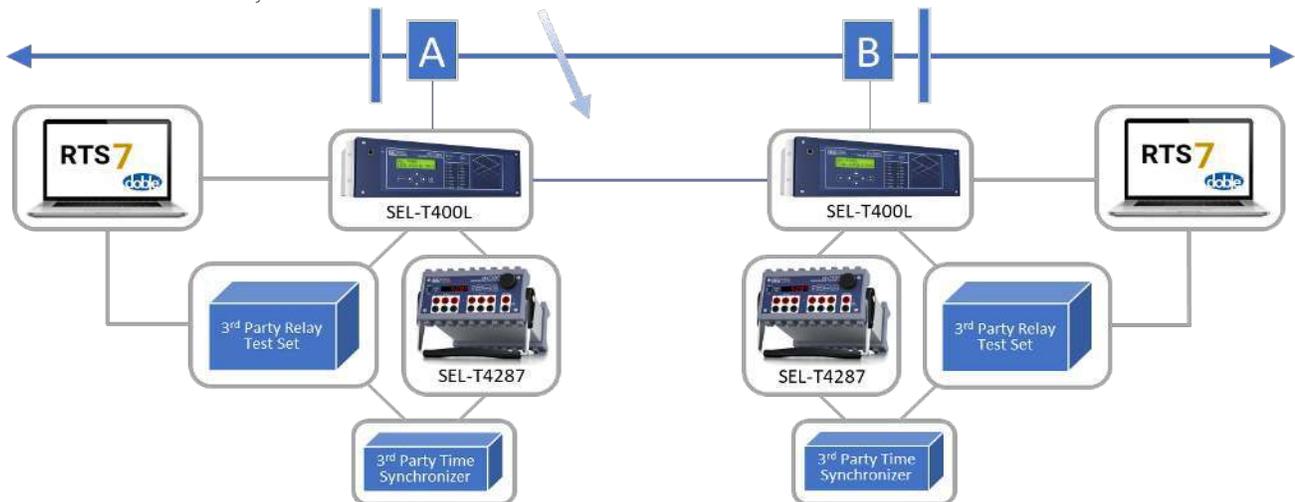
With its embedded computer and RapidTest™ software, the MTS-5100 will test traveling wave relays stand-alone or controlled from a PC running either RapidTest remotely or Doble RTS*. The MTS-5100 is connected to the network via Ethernet switch and synchronized to the T4287 with the F6052 Universal Time Synchronizer.



**Requires matched RapidTest-to-RapidTest or RTS-to-RTS test executions.*

RTS software with third-party protection test sets

Companies having a variety of relay test sets in their fleet can use RTS to standardize their protection system maintenance programs. The RTS test routine for the SEL-T400L relay can be used with test sets from other manufacturers seamlessly.



Technical presentations and papers given at Doble Protection Seminars offer more detail on testing the SEL-T400L relay. Contact Doble for more information on how the protection testing solutions Doble improve your processes and allow you more time to focus on the critical nature of your work.



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 PUBLISHED: February 2021