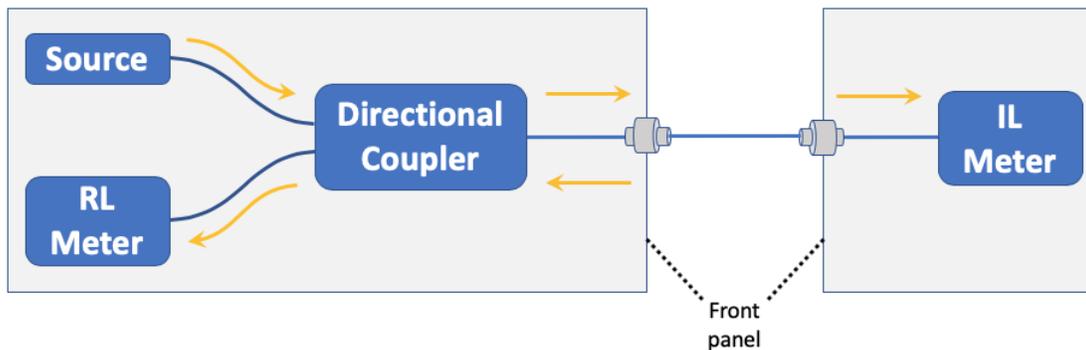


# CW RL Testing vs. Pulsed (OTDR) RL Testing

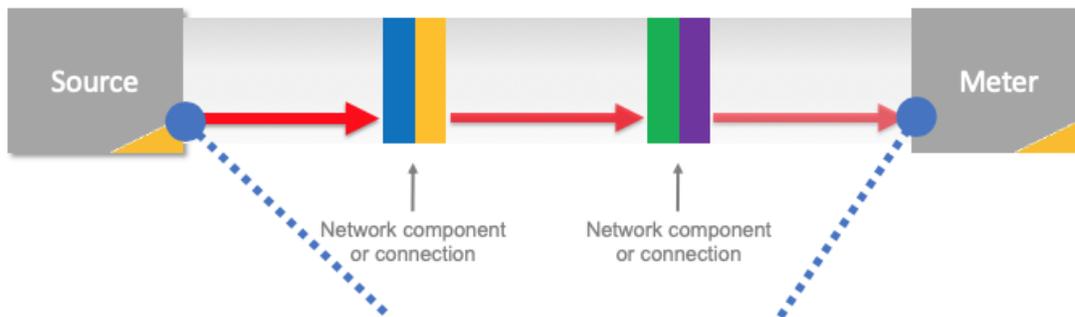
This is the new [OptoTest OP925 Insertion Loss \(IL\) & Return Loss \(RL\) benchtop meter](#). It is based on the use of a CW (continuous wave) source.

The OP925 will measure insertion loss, return loss and optical power. Power measurements can be made in absolute (dBm) or relative (dB) modes. It supports single and dual wavelength sources. It has a high dynamic range and has a simple user interface.

This is the block diagram of a typical benchtop IL/RL meter. A source sends a signal through a directional coupler out the front panel. Reflections travel back through the directional coupler and into the RL meter. A separate optical power meter (OPM) is also found on the front panel, is used for IL measurements.



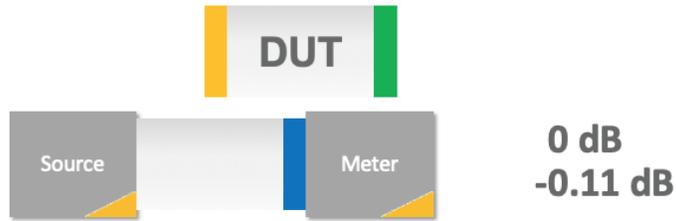
Insertion loss measurements are quite straight forward. Here we see an assembly consisting of three fibers. The signal, shown here as the red arrows, leaves the source and travels through the fibers and is then terminated in the IL power meter. Each length of fiber and interface introduces losses. The total insertion loss is calculated as the ratio of the source and received signal strengths expressed in dB.



$$IL = 10 \text{ Log (transmit power / receive power)}$$

Next, we'll look at how one can measure the insertion loss of just one cable.

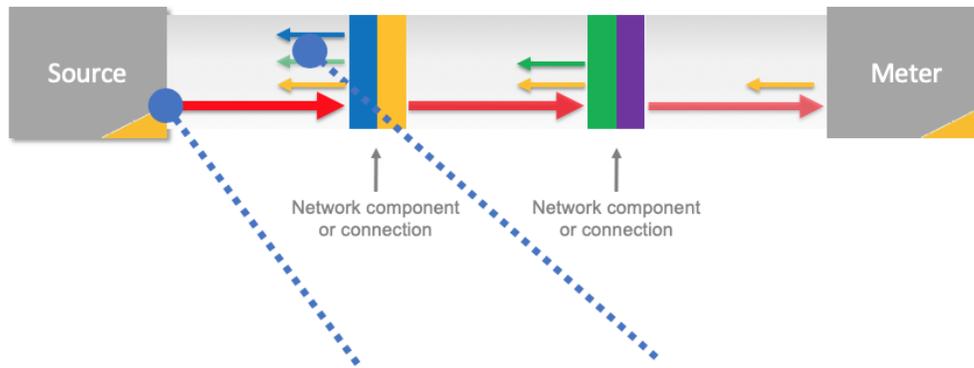
Many set ups include the use of a reference cable attached to the source. To measure the loss of just one length of fiber, one needs to compensate for the loss of the reference cable. This is done by attaching the meter directly to the end of the reference cable and setting the 0 dB reference point. Next the DUT cable is inserted and the IL meter reads the loss directly.



1. Set Reference
2. Add DUT
3. Measure loss

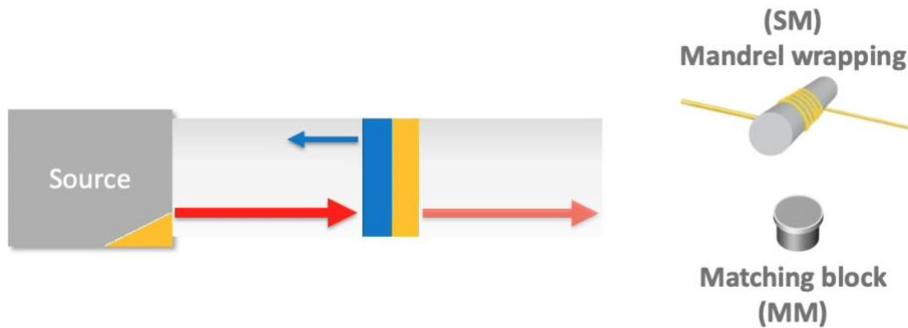


Return loss is measured with the internal power meter attached to the direction coupler. Here we see a multi-fiber assembly. The red arrows show the signal transmitted from the source. Each interface in the assembly reflects a small amount of power back to the source. These reflections are shown by the small blue, green and yellow arrows. Backscatter caused by Rayleigh scattering inherent to the fiber itself is also part of the reflected power. The source power is compared to the total reflected power and the ratio is expressed in dB.

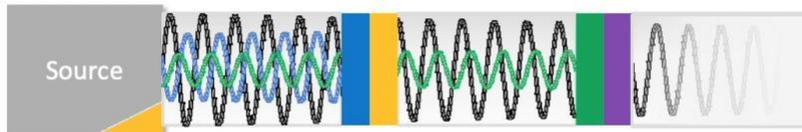


$$RL = 10 \text{ Log (Source power / Reflected power)}$$

The end reflection of a cable or assembly will prevent accurate measurement of its first connector. One can eliminate this reflection by using a mandrel wrap on single-mode fiber or a matching block with single mode fiber (including the bend-insensitive types) and multi-mode fiber. The cable can then be reversed to measure the return loss from the other connector.



Here we see the mechanics of a CW RL test. The black wave represents the signal from the source. The blue and green waves represent the reflections from each interface. The end reflection is not shown because it has been terminated as shown in the previous slide. The return loss includes the sum of both the blue and green reflections and they cannot be separated from each other. The magnitude of the blue reflection thus limits the measurement accuracy of the green reflection. This is why extra cables and switches should be avoided between the source and the DUT but if necessary, should be of extremely low return loss such as with the OptoTest reference and SAVER cables.



$$RL = 10 \text{ Log (source / (reflection + reflection))}$$

Cannot separate reflection from reflection

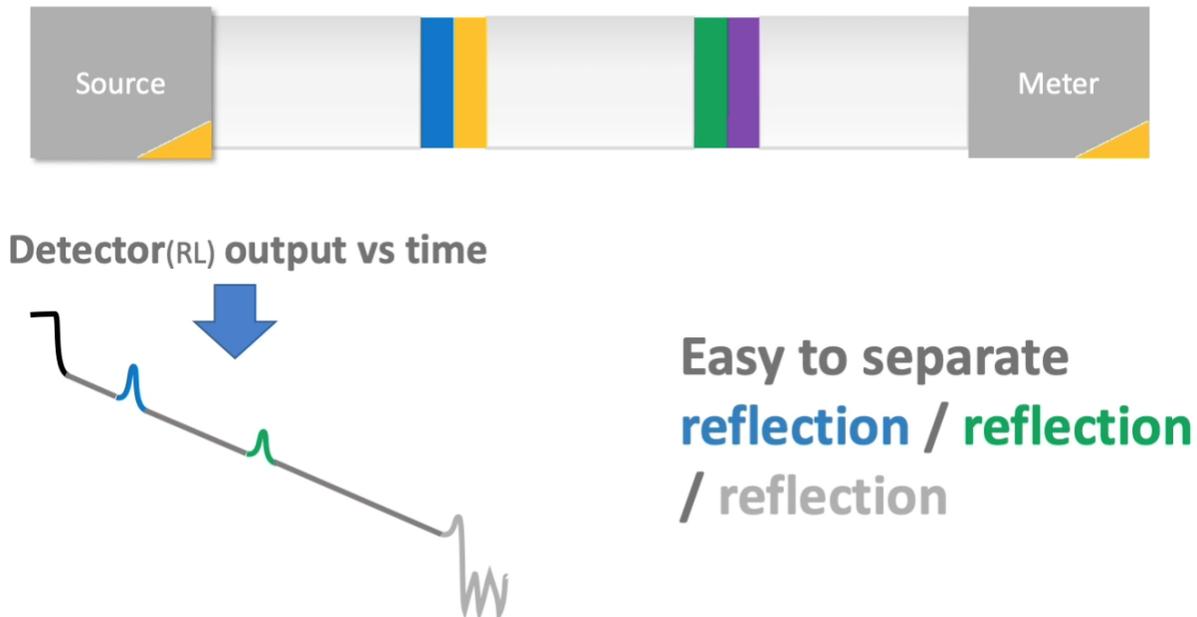
Minimize this reflection for accuracy

The benefits of the CW system are several. The test equipment itself is simple and straightforward. You get a total RL measurement that includes the Rayleigh scattering. The OPM is of high accuracy and the overall cost of the meter is relatively low.

There are some limitations to the CW measurement method. Any lossy components such as switches placed between the meter and the DUT can decrease the accuracy of the measurement. If you need to measure the contributions from each reflection point in an assembly several extra steps would be required. These may be difficult to perform and produce user-dependent variations in the results. Finally, one needs to terminate the end cable during RL measurements. This is difficult to do with short or stiff SM cables that can't be mandrel wrapped.

The [OptoTest OP940](#) uses a pulse technique instead of a CW technique for measuring IL and RL. Pulsed measurements are sometimes referred to as the OTDR (optical time-domain reflectometer) approach. This model is available in single and multi-channel versions. The pulse method provides a scanning function that is quite handy when diagnosing problems.

This animation shows how a pulsed system operates. As the pulse leaves the source, it will generate reflected pulses at each interface along the way. These reflections show up as peaks in the output of the return loss detector inside the unit. Since each reflection arrives at the detector at a different moment in time, it is easy to measure the reflection of interest independently of the others.



Pulsed testing benefits include the ability to measure reflections independently. This also means you can measure both IL and RL without separately terminating the cable for the RL test. The result is faster overall testing. Switches can also be introduced after the source without degrading measurement accuracy. The OP940 is available in versions with built-in switches that support up to 24 output channels.

The OP925 and OP940 share many similarities. They both have a very simple front-panel control interface. They are both software controllable via USB connection. They offer the same choice of high dynamic range detectors. And those detectors can be front panel or remotely mounted. They are also identical in size.

There are several key differences between the OP925 and OP940. The primary difference is in the RL test method. The CW source of the OP925 provides the total RL of an assembly whereas the pulsed source of the OP940 lets one analyze the different reflections within the assembly. The pulsed source in the OP940 also enables the handy diagnostic scan function. The color display on the OP940 is particularly helpful for Pass/Fail indication with easy to read green and red readouts. While the OP925 supports dual wavelength SM and MM testing, the OP940 optionally adds support for quad wavelength FTTX testing. The OP940 is also available with multichannel switched outputs. And while both units support remote control via USB, the software for the OP925 is still pending completion as of April 2020.

OptoTest provides a robust selection of IL/RL test solutions that fit your measurement methodology, test speed requirements, channel count needs, automation goals and your budget.