ACCEPTANCE TESTING OF FIBER OPTIC CABLE USING AN OTDR

By Larry Johnson

Fiber optic acceptance testing ensures that any new cable matches the optical and physical requirements of the planned application. This testing should be performed upon delivery of the cable, prior to its installation.

It is important that the operator knows the specifications in order to properly test against them. These specifications include the cable’s length, its fiber count, the acceptable loss in dB per kilometer, the total loss, the operating wavelength, and the fiber type and manufacturer. This process also provides an opportunity to obtain and store OTDR waveforms in the system documentation for future maintenance or restorations.

Always carefully examine the cable reel for physical signs of shipping damage. Look for evidence that indicates the cable has been subject to unacceptable amounts of stress.

The reel will include some form of cable documentation. A copy of this information should be attached to the acceptance test form. These documents generally contain traceability information, as well as optical test data difficult to acquire in the field. For example, a multimode fiber reel’s documentation would include information on the fiber’s bandwidth, while a single-mode fiber reel would provide test data related to the various types of optical dispersion.

This documentation form also lists the fiber’s index of refraction, as documented by the fiber’s manufacturer. This number should be not be used for the index of refraction in the OTDR because it does not include the cable’s helix factor, which is a measure of the difference in fiber versus cable sheath length. The technician must compensate for the extra fiber slack by adjusting the OTDR’s refractive index setting so that OTDR distance readings match the sequential markings on the cable jacket. The acceptance test is the best opportunity to make these adjustments prior to cable installation.

One important consideration in testing is to ensure a good launch condition that couples the maximum amount of light from the OTDR into the fiber. Poor launch conditions result in greatly reduced distance-measurement capability and possible measurement errors. Before any tests can be made with the OTDR, it must be properly terminated to the fiber to be tested.
For installed spans, linking the OTDR to the span under test requires a hybrid patch cord. Most OTDRs have an internal ultra physical contact (UPC) spherical polish, but some reflection-sensitive systems use the angled physical contact (APC) polish. The hybrid patch cord addresses both connector type and connector polish issues. Always clean the end face of the plug prior to mating to the OTDR.

There are two methods of terminating a fiber. The first method uses a bare-fiber adapter, which consists of a plug body that grips the fiber to be tested. The design of the bare-fiber adapter is such that the fiber can pass completely through the adapter body and damage the optical port. Because of this, the bare-fiber adapter must never be connected directly to the OTDR. Instead, the adapter should be used with a short patch cord and mating adapter sleeve to isolate damage from the OTDR’s port.

The second method uses a pigtail with a reusable mechanical splice, which allows easy mating of the fibers to be tested with the OTDR. The Norland reusable mechanical splice has been used for decades for testing bare fibers. It features a glass body that internally holds and aligns two fibers. The splice is filled with a refractive index matching fluid to reduce reflections. To make the connection, strip and cleave both of the fibers to be tested, then insert and center both into the mechanical splice to complete the termination.

For the cable to be tested, prepare the end of the cable by stripping away the outer jackets, armor (if present), and buffer tubes to a distance of approximately one meter. Clean all of the fibers and organize them based on the industry standard color code. Strip, clean, and cleave the first test fiber and insert it into the other end of the mechanical splice so it lightly butts against the pigtail fiber.
We will use the manual method of OTDR operation. Start the OTDR and select the correct wavelength and refractive index for the test. Set the OTDR’s measurement mode to “Two Point Attenuation”. In this mode, the OTDR allows you to set markers at any two points on the backscatter trace and display the attenuation of the region between the markers in either dB or dB per kilometer.

For an acceptance test, set the first marker at the beginning of the trace after the initial tail of the dead-zone and the second marker at the end of the trace. The results will display as dB/km at a specific wavelength being tested. Set the OTDR to “Real-time Mode” and adjust its range, pulse width, and zoom settings so that the entire fiber span is visible on the screen. If no trace displays, there may be too much loss in the pigtail splice. In this case, adjust the fibers in the temporary mechanical splice. Be sure that the cleave length is correct and that the fibers are centered in the splice.

In real-time mode, the trace may appear noisy. Start the OTDR’s averaging mode to reduce noise and clean up the trace. After averaging is complete, the event table will show reflective events at the OTDR port and at the end of the fiber. The trace should appear linear with no abrupt interruptions that would indicate a break or other fault in the fiber. After the dead zone, the straight line will have a very gentle slope indicating the attenuation of the fiber span.

![An OTDR trace showing a linear attenuation slope.](image)

Marker placement is extremely important when making any OTDR measurement. Select the “A” marker and use the arrow keys to place it immediately following the dead zone at the OTDR’s connector. The tail of the dead zone is shaped somewhat like a ski slope. The exact point where this slope becomes a straight line is the point where the marker will be placed.

The far end of the fiber could be represented by a spike, or less commonly, by a roll-off. In either case, the “B” marker must be placed at the exact point where the backscatter trace ceases to be a straight line. To correctly place the second marker, use the zoom controls on the OTDR for increased resolution.
The OTDR will display the distance from the OTDR connector to the end of the fiber as well as the total loss of the span in dB or the loss per kilometer. Use the data storage features of the OTDR to save the trace using a unique file name. If using a dead-zone box, the length must be subtracted from the length measurement.

When measuring the other fibers in the cable, the end reflection should be located at the roughly same point. The presence of shorter fibers implies that the fiber is damaged or stressed within the cable structure and will require further investigation. It could also be caused by cable structures with inner and outer rows of buffer tubes. The inner buffer tubes would have a shorter fiber length than those in the outer rows. In this case, an index of refraction adjustment must be made for both inner and outer rows and the adjustment documented.

For each fiber, make a note of the total length and dB per kilometer for each test wavelength on the acceptance test form. It is also important to test each fiber at the wavelengths designed for the fiber type. For multimode fiber, this is 850 and 1300 nanometers, and for single-mode fibers, both 1310 and 1550 nanometers. Refer to the testing specifications and note if they pass or fail. In addition, make note of the sequential markings at both ends of the cable, as well as the adjusted value of refractive index.

After each fiber has been tested, trim back 50 percent of the exposed length. This indicates that it has been tested, but allows re-testing if necessary. After all the fibers have been tested, count your fiber traces in the OTDR’s memory to ensure that all fibers have been documented. Then, cut back the remaining lengths of exposed fiber and properly reseal the cable ends.

This article reviewed how to perform an acceptance test and how to place OTDR markers manually for accurate results. However, most users will rely on the OTDR’s automatic measurement functions, which quickly display length, losses, and reflection values for the fiber span. In the case of an acceptance test, the key points to document are the total length of the fiber, the total loss of the fiber in dB, and the loss of the span for each test wavelength in dB per kilometer.

This article is based on the “Acceptance Testing” chapter from The Light Brigade’s OTDR Theory and Operation DVD (W-6D-121), which is available from the Light Brigade at www.lightbrigade.com.

About The Author

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