OTDR Dead Zones and Dead Zone Boxes

WHITE PAPER

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One of the key concepts to understand when evaluating, comparing, or using an Optical Time Domain Reflectometer (OTDR) is the concept of a “dead zone”.

During OTDR measurements, dead zones are a limiting factor so it is important to minimize the effects of dead zones wherever possible.

This white paper will attempt to explain what a dead zone is, the effects of dead zones on an OTDR measurement, as well as “dead zone boxes” used to counter the effects of an OTDR’s dead zone on the OTDR measurement.

DEAD ZONES DEFINED

In regards to OTDR testing, a dead zone can be loosely defined as a portion of optical fiber beyond an event – usually a reflective event – where subsequent events cannot be detected.

Confusing the issue is the fact that there are different types of dead zones. Generally speaking, dead zones can be separated into two categories: optical fiber related dead zones, and OTDR related dead zones.

OPTICAL FIBER RELATED DEAD ZONES

Event dead zone defines the distance at which the OTDR can detect the presence of one or more events that closely follows a previous event.

Attenuation dead zone defines the distance where the OTDR can measure the attenuation, or loss, of two or more closely spaced events.

Event dead zone and attenuation dead zone specifications are typically listed on manufacturer’s OTDR datasheets.

OTDR RELATED DEAD ZONE

Another type of dead zone is related to the time it takes for the OTDR’s avalanche photodetector (APD) to recover from the bright reflection received from the OTDR test port.

Due to this “blindness”, also known as saturation, the OTDR is unable to “see” events that closely follow the near-end patch panel in the link under test.

In addition, the length of the dead zone is directly proportional to the pulse width (PW) used for the test. In other words, a longer pulse width means a longer dead zone.

PURPOSE OF A DEAD ZONE BOX
To counter the effect of OTDR-related dead zones, a long spool of optical fiber can be inserted between the OTDR and the link under test.

This spool of fiber is typically called a *dead zone box*, but is also referred to as a *pulse suppressor box*, *fiber ring*, or simply *launch cable* in the fiber optics industry.

If no dead zone box is used, the OTDR dead zone occurs at the beginning of the link under test, effectively covering up possible events that closely follow the near-end patch panel.

If a dead zone box is used, the dead zone occurs in the dead zone box, so that near-end events are more readily detectable.

In addition, a dead zone box must be used in order to measure the attenuation (loss) of the near-end connector. To measure the attenuation of the far-end connector, a second dead zone box must be attached to the end of the fiber.

GENERAL RULE OF THUMB
At a minimum, the dead zone box must be longer than the pulse width setting used for the current OTDR test.

Ideally, however, the dead zone box should be longer than the OTDRs longest pulse width setting to cover all possible pulse widths. Most multimode dead zone boxes are at least 150 meters long, while singlemode dead zone boxes are often over 1 kilometer long.

IMPORTANT POINTS TO CONSIDER
There are two main issues to consider when working with a dead zone box: durability and expense.

DURABILITY ISSUES
A dead zone box is like any other fiber optic cable, such as patch cables, in that they wear out over time.

If handled properly, normal wear and tear will limit a dead zone box connector to around 500-1000 insertions due to the Zirconium ferrule shaving off over time.

However, if the dead zone box is not handled properly, mishandling of the cable could break the fragile optical fiber, and poor cleaning procedure could cause endface damage such as scratches or pits.

COST ISSUES

Due to the extreme length, dead zone boxes have a high initial purchase cost, usually costing several hundred dollars each.

A second cost issue relates to connector configuration. As with standard patch cables, the dead zone box needs to have the correct connectors on each end to allow for connection to the OTDR port and the near-end port of the link under test. This can get extremely expensive since technicians would need one dead zone box for every possible connector combination they encounter.

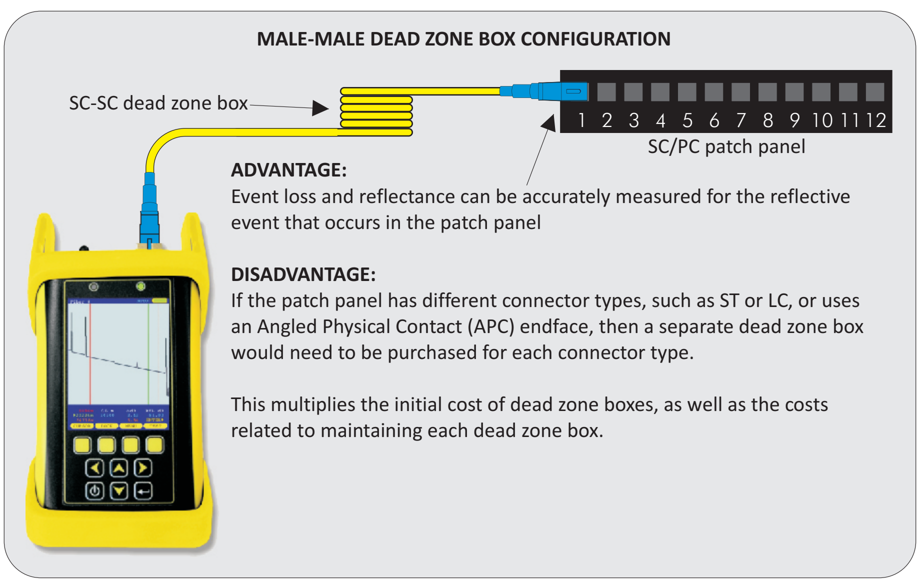
Finally, when the dead zone box does eventually wear out, the dead zone box will need to either be sent back to the manufacturer to be repaired, or replaced outright.

Dead zone box repair may not be very expensive, but the technician will be without the dead zone box for a time, which means they will be unable to perform OTDR measurements until the dead zone box is returned. In addition, the dead zone box can only be repaired so many times before it can no longer be repaired, and must be replaced.

DEAD ZONE BOX CONFIGURATIONS

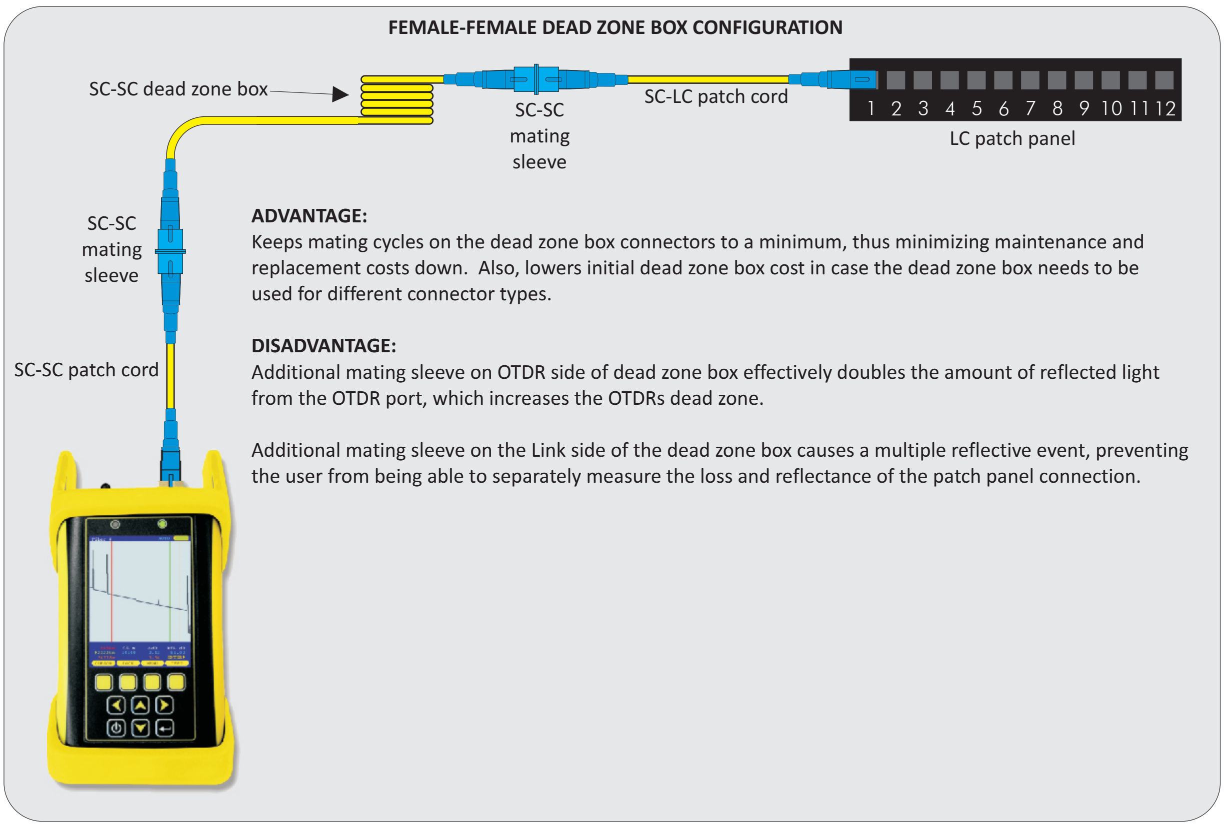
There are three different dead zone box configurations, each with its own set of advantages and disadvantages. It should be noted that all three different configurations have roughly the same initial purchase cost.

Male-male. The most common configuration has male-tip connectors on both ends of the dead zone box. While this method has the highest cost to purchase and maintain, it is also the best configuration to use for the measurement of event attenuation and event reflectance because the dead zone box only causes one event at the beginning of the link under test.



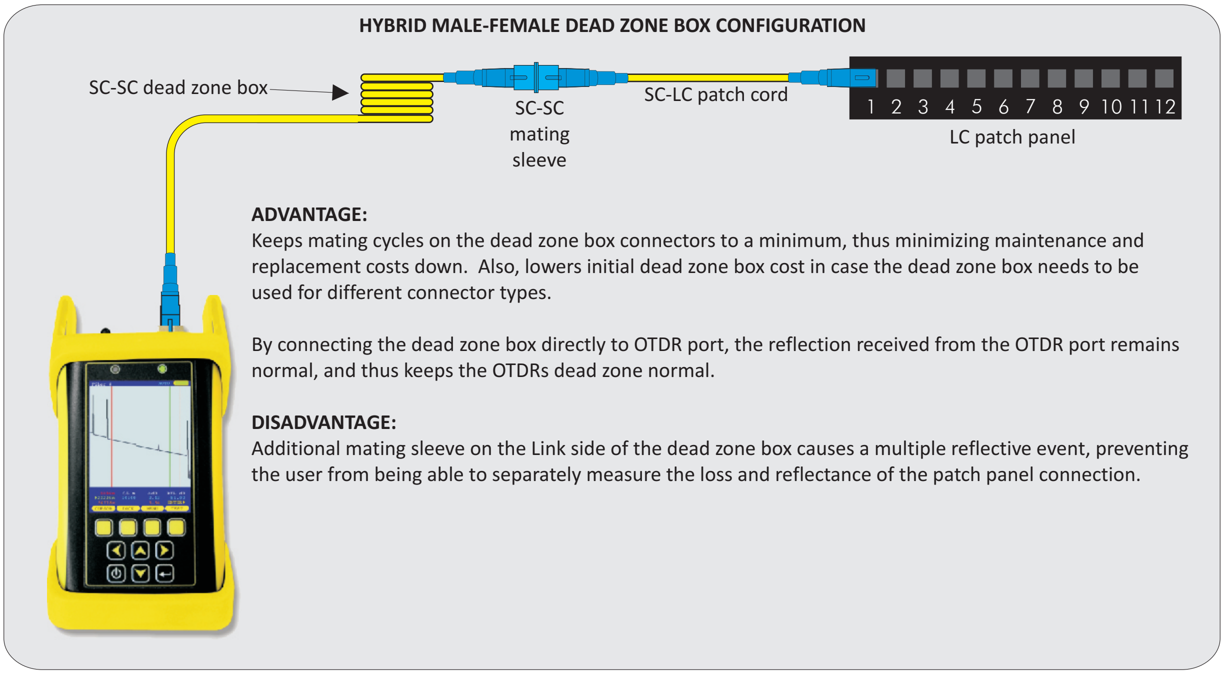
Female-female. The next configuration takes a standard male-male dead zone box, and adds mating sleeves onto the end of each connector, resulting in a female-female configuration. The obvious advantage here is that only one dead zone box needs to be purchased initially. Short patch cables are used to adapt to whatever connector types are needed, and the patch cables are cheaper to replace when they wear out.

The disadvantage to this configuration is that the mating sleeves become another event to the OTDR. In fact, if the patch cable is too short, two events may be too close together and add upon one another. This results in event attenuation that is roughly double what it should be, and the reflectance of both of the two events is added together (there is no way to separate the two reflective events being reported).



Hybrid male-female. This configuration places a mating sleeve only on one end of the male-male dead zone box. The thought process here assumes that the male end of the dead zone box will mate with the OTDR port, which should only occur once or twice a day.

The advantages and disadvantages of this method are roughly the same as the female-female configuration, although by eliminating the mating sleeve and patch cable from the OTDR side of the dead zone box, the attenuation through the mating sleeve is eliminated, and the OTDR APD will recover from saturation somewhat quicker, thus shortening the OTDRs dead zone.



ADVANTAGE:
Keeps mating cycles on the dead zone box connectors to a minimum, thus minimizing maintenance and replacement costs down. Also, lowers initial dead zone box cost in case the dead zone box needs to be used for different connector types.

By connecting the dead zone box directly to OTDR port, the reflection received from the OTDR port remains normal, and thus keeps the OTDRs dead zone normal.

DISADVANTAGE:
Additional mating sleeve on the Link side of the dead zone box causes a multiple reflective event, preventing the user from being able to separately measure the loss and reflectance of the patch panel connection.

CONCLUSION

The dead zone of an OTDR prevents the OTDR from detecting near-end events unless a long spool of fiber called a dead zone box is used. Dead zone boxes have the same cable and connector maintenance issues as standard patch cords, but due to their extreme length, are very expensive to purchase and maintain.

The optimal dead zone box configuration for taking OTDR measurements is a male-male configuration, although this method is also the most expensive from a maintenance standpoint. Other configurations are less expensive, but are less optimal for measuring the loss and reflectance of near-end events.

It is up to the OTDR technician to understand the issues surrounding dead zone boxes in order to determine which connection method they wish to use.