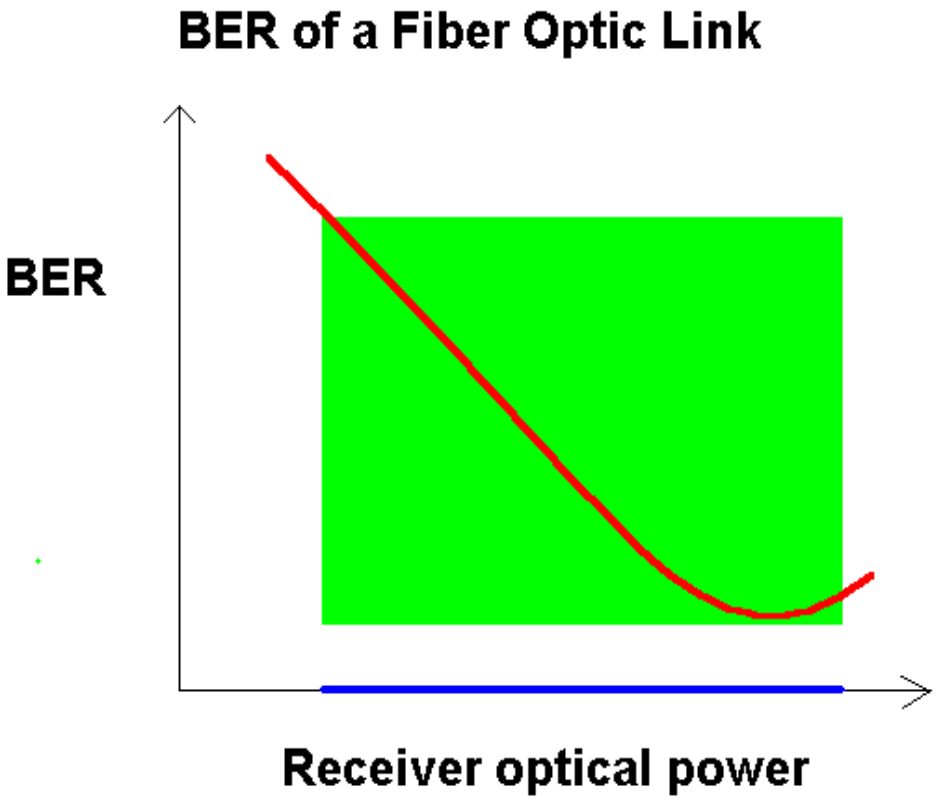
FiberFin®

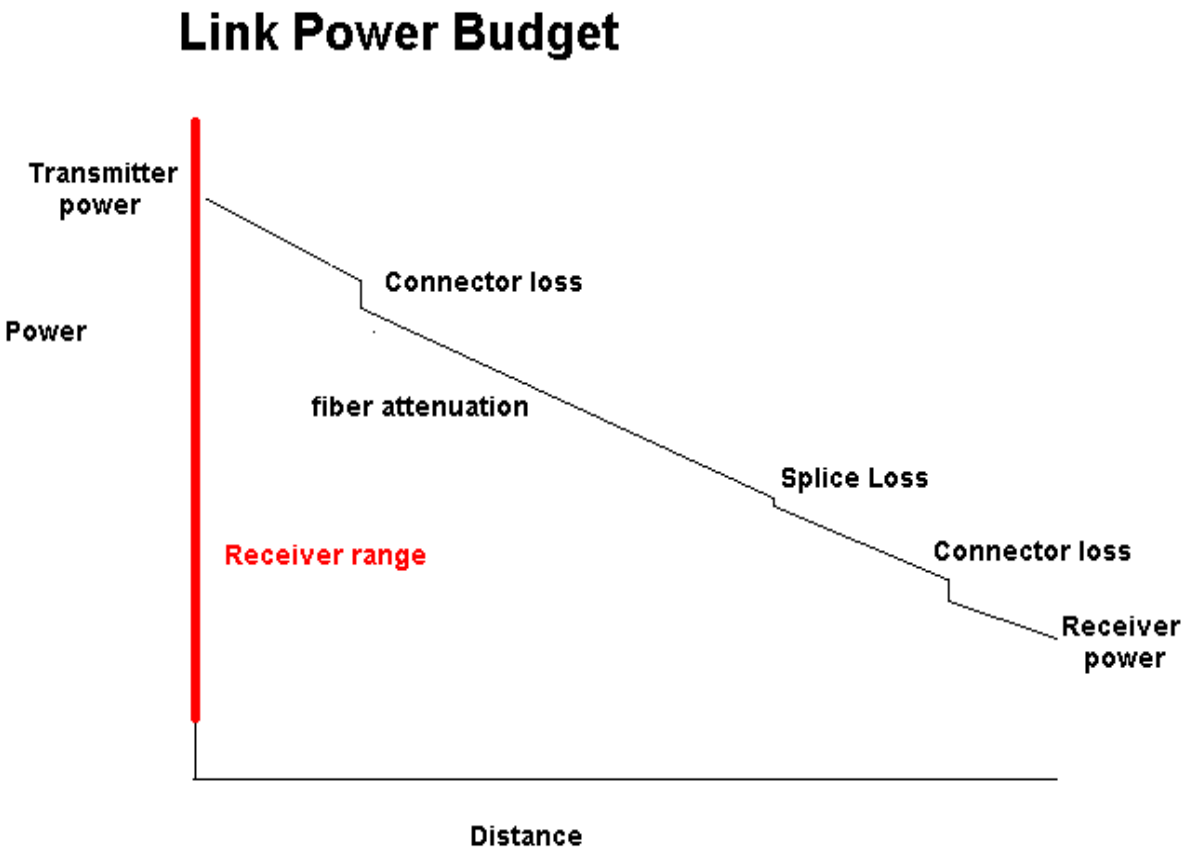
Recommendations for Testing db Loss in Plastic Fiber optic cable

Network Performance – BER
(Bit Error Rate)



Cable Performance

Power Budget

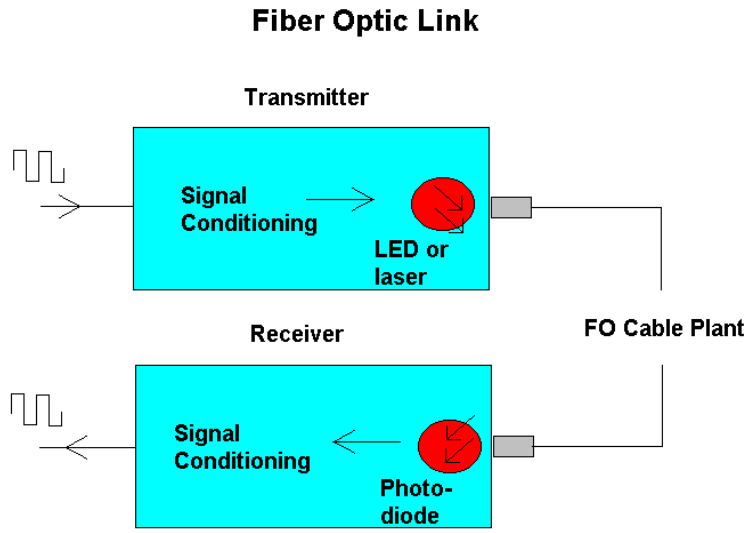


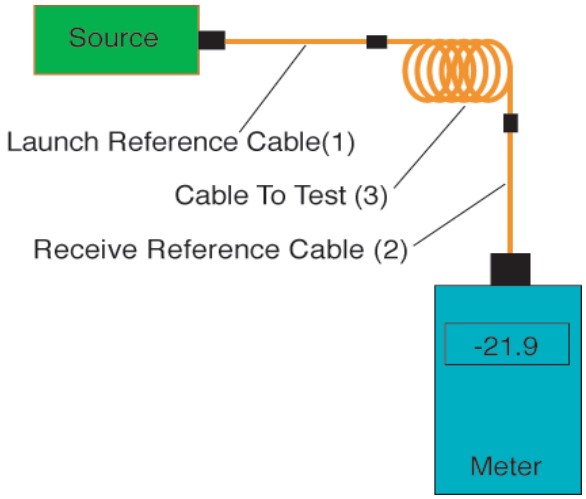
Insertion loss testing

- Insertion loss testing simulates the way the cable will be used by the systems operating over it. A source, similar to the system source is used for inserting light into the cable under test. A meter is used to measure the source output and the loss when the cable under test is added. Known-good reference cables are used to mate with the cable under test to insert light into the cable and allow testing loss of the connectors on the cable. A double-ended test like this measures the loss of the fiber and connectors on both ends, plus anything in the middle.
- The test equipment for insertion loss testing includes a test source and a meter, sometimes available as separate instruments and sometimes integrated into one instrument, called an OLTS (optical loss test set.) The source, similar to the system source, is used for inserting light into the cable under test. The meter is a specialized light meter used to measure the source output and the loss when a cable under test is added. A double-ended test like this measures the loss of the fiber and connectors on both ends, plus anything in the middle.

Insertion Loss Testing

- Simulates actual system operation





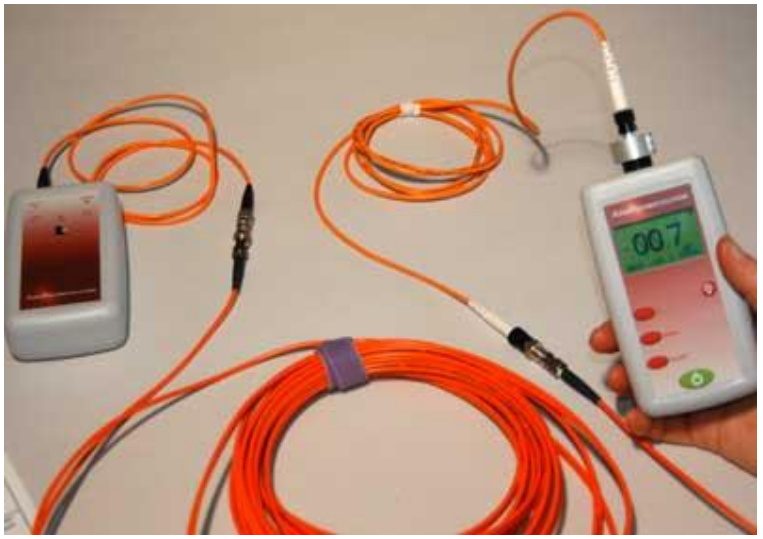
Loss is a function of both wavelength

- Loss is a function of both wavelength (lower loss at higher wavelength) and source type (or more accurately, the mode fill typical or the source type, since LEDs launch light with a wider bean angle (higher mode fill) than a laser.)
- The source should match the system source in type (LED or laser) and wavelength (650 nm for LEDs and lasers) to accurately reproduce system loss. Systems using VCSELs at 850 nm may require testing with those sources.
- The source requires a launch reference cable to mate the the cable under test. The launch cable is used as a the calibration point for source power (the “ 0 dB reference”) and reference connector to mate to the cable under test if the connectors are matable types. Otherwise a cable substitution test is used.

Insertion Loss Test Equipment

Test Sources

- Source should match transmitter type and wavelength
  - 650 nm LEDs
  - 650 nm laser
  - 850 nm VCSEL
  - Connects to “launch” reference cable to connect to cable under test



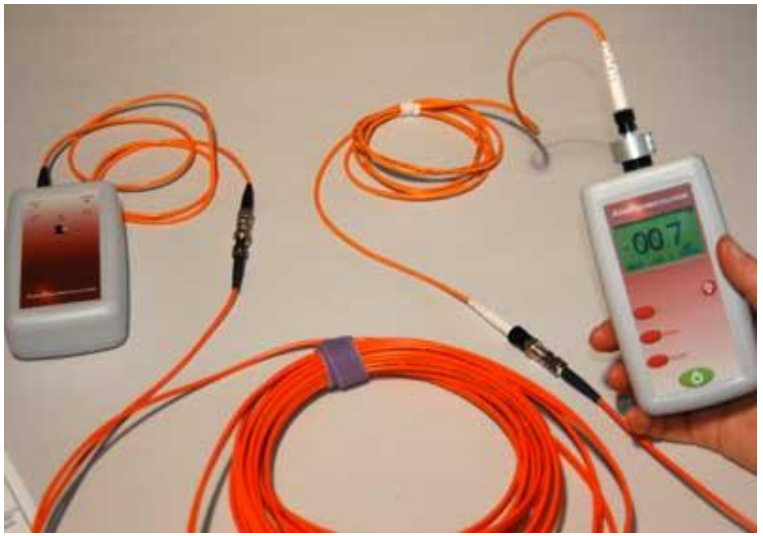
The power meter is a specialized light meter

- The power meter is a specialized light meter with adapters to allow connection to the fiber optic connectors on the cables and calibration at the wavelengths used in fiber optic systems.
- The power meter needs to be calibrated to NIST (standards US national standards labs) and be able to measure at appropriate wavelengths (650, 780 or 850 nm.)
- Most meters have measurement ranges for “dBm” for measuring absolute power and “dB” or relative power for measuring loss. If it has a dB scale, it will be able to set a “0 dB reference” for simplifying loss measurements. Some meters may have a linear range - usually milliwatts - used for measuring absolute power.
- Meters should offer adapters to most popular fiber optic connectors (ST, SC, LC, etc.) to make it easier to measure power and loss in cable plants with various types of connectors.
- The meter has a light detector, usually a germanium semiconductor with thin glass window, chosen to allow use at all the wavelengths of interest. The detector may also be made of silicon for plastic fiber systems operating at 650 nm or InGaAs (Indium-gallium-arsenide) which is more expensive that germanium but has the ability to measure lower power levels.
- It is mandatory that the detector be large enough to capture all the light from the fiber, which in most meters means at least 2 mm diameter, to allow proper calibration with any fiber type.

Insertion Loss Test Equipment

Fiber Optic Power Meters

- Specialized light meter
- Adapts to FO connectors
- Calibrated at proper wavelengths
  - 650/780/850 nm
- Measurement ranges
  - dBm/dB



dB is a measure of optical power

- dB is a measure of optical power on a log scale, simplifying measurements over a wide dynamic range. Fiber optics uses power levels from +20 to -40 dBm, a range of 1,000,000 to 1! But that translates to 60 dB, an easier number to deal with.
- Absolute power is measured in dBm or dB referenced to 1 mw. Positive dBm means the power is greater than 1 mw, while negative numbers mean the power level is less than 1 mw.
- A nice thing about dB is that loss is easily measured by subtracting the reference level for “0” dB from the measured value of the loss. That is, if you measure -20 dBm from the end of the reference cable, then -22 dBm when testing cables, the cable loss is 2 dB.

Insertion Loss Test Equipment

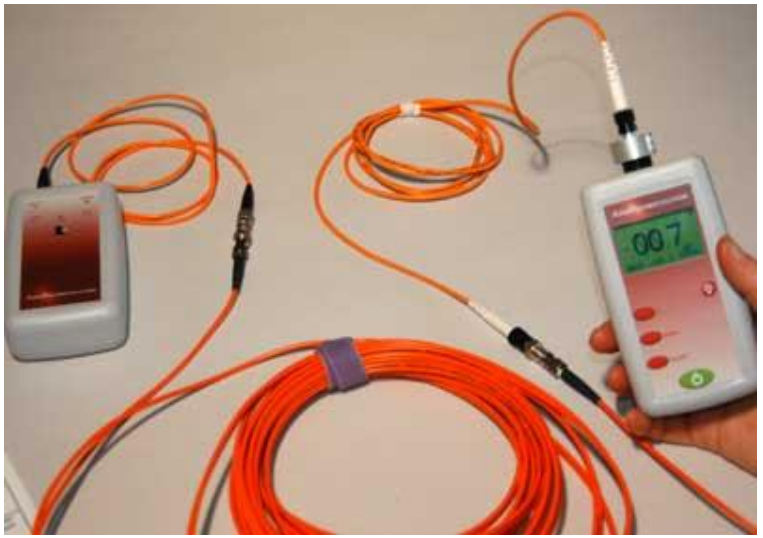
Fiber Optic Power Meters measure dB

- Loss is measured in “dB”
- dB means decibel
- Log scale: dB=10 log (power ratio)
  - 10 dB= 10X
  - 0 dB = 1X
  - 3 dB = 2X
  - -10dB = 0.1X
- dBm is dB referenced to 1 mw
  - 0 dBm = 1 mw
  - -10 dBm = 0.1 mw = 100μw

Insertion Loss Test Equipment

Reference Cables

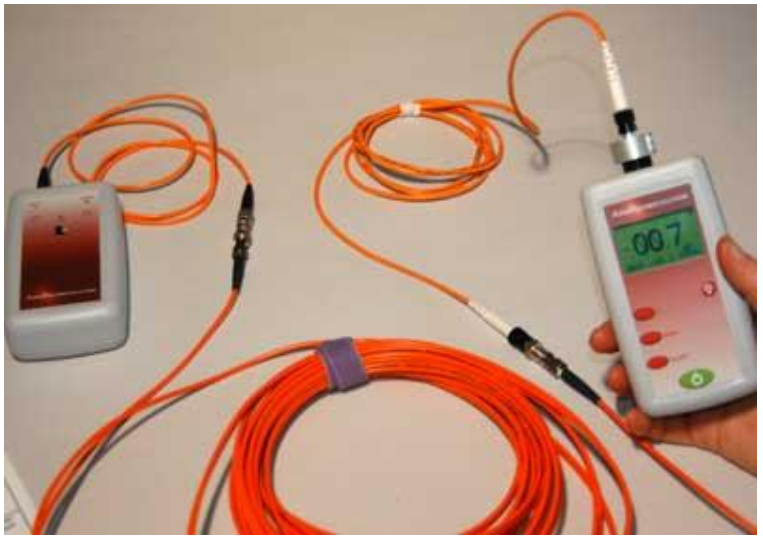
- Reference cables attach to cable under test to:
- Launch light from test source into cable under test
- Mate with connectors to test loss
- May need one or two reference cables



Insertion Loss Test Equipment

Reference Cables

- The quality of the reference cables is very important as it will affect the loss measured!
  - Setting reference levels
  - Testing loss mated to cable under test

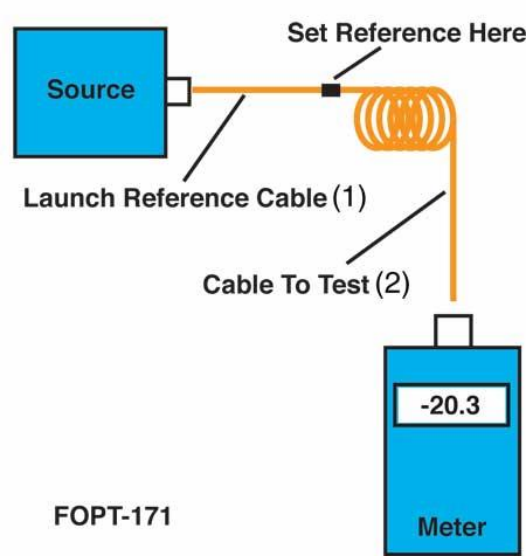


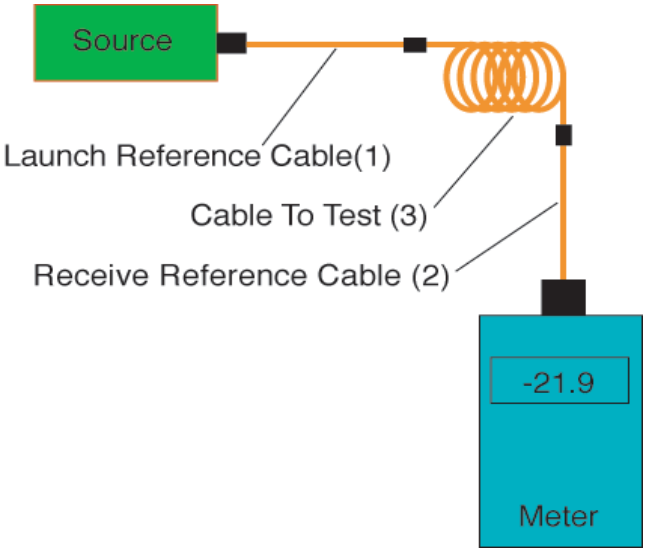
Reference cables

- It is very important to understand that the quality of reference cables is going to determine the loss of the cable plant being tested!
- The connectors must be good condition and they must be kept free of scratches and contamination by grease or dirt. Bad connectors on a reference cable will insure that all cables tested with them will test bad!
- Regularly clean the connectors on your reference cables and test them with other reference cables to make sure they are OK. Re-polish them when scratched with 3um film / re-terminate them or replace them.

Insertion Loss Testing

- FOTP-171 vs OFSTP-14/OFSTP-7





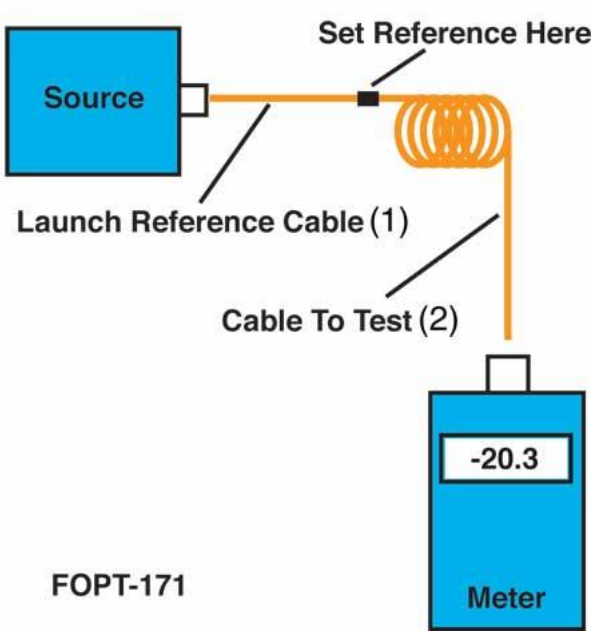
OFSTP

optical fiber standard test procedure

- So far we have talked about testing installed and terminated cable plants, where we want to test the connectors on each end and everything in between. So we use a meter and source with two reference cables - one on each end. This test is defined by a standard OFSTP-14 (OFSTP = optical fiber standard test procedure) for multimode and OFSTP-7 for singlemode.
- Another test, FOTP-171, uses only a launch reference cable and the cable under test. This method allows testing a single cable from each end to find out if either connector is bad.

Insertion Loss Testing
FOTP-171

- Uses one launch reference cable (1) only
- Measures loss of connector mated to the launch cable plus any loss in the fiber itself
- Allows testing each connector separately to diagnose connector faults
- Use for troubleshooting cable plant connector problems.

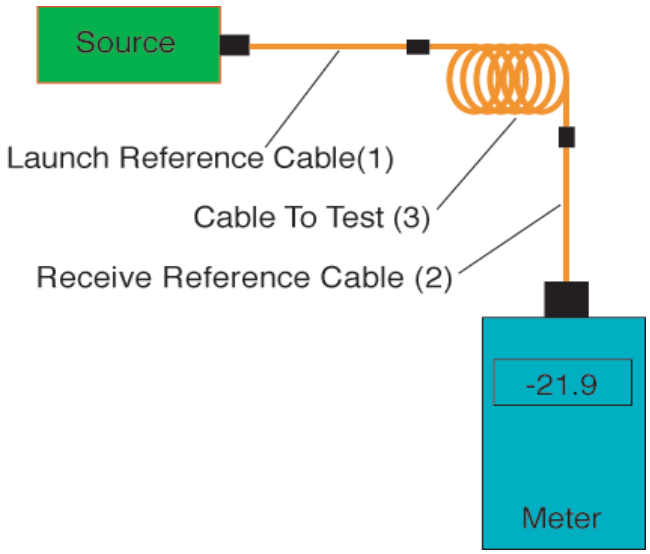


FOTP-171 test

- A FOTP-171 test uses only a single launch reference cable to test the cable. This method allows testing a single cable from either end to find out if one connector is bad. It’s main use is testing patchcords to insure both connectors are good, but it can also be used to troubleshoot installed cables where one connector is suspected of being bad.
- The 0 dB loss reference is made by connecting the power meter to the output of the launch cable and measuring the power output. The cable under test is connected to the launch cable and the meter. The loss measured is only the loss of the mated connectors and any loss of the fiber in the cable, usually very small when testing patchcords this way.
- The fact that the connector on the launch cable and the cable under test are mated directly to the meter, with it’s large detector, means that the connection loss to the meter is calibrated out of the loss test, allowing testing of only the connector mated to the launch cable.

Insertion Loss Testing
OFSTP-14 (MM) & OFSTP-7(SM)

- OFSTP-14/OFSTP-7 are "double ended" tests for testing installed cable plants
- Measures loss of connectors on both ends plus anything in between
- Requires two reference cables
- How do you set reference?



OFSTP-14/OFSTP-7

- OFSTP-14/OFSTP-7 are used for testing installed and terminated cable plants, where we want to test the connectors on each end and everything in between. So we use a meter and source with two reference cables - one on each end.
- The big issue with this test method is how one sets the 0 dB reference.

OFSTP-14/OFSTP-7

- OFSTP-14/OFSTP-7 offers three options on how one sets the 0 dB reference.

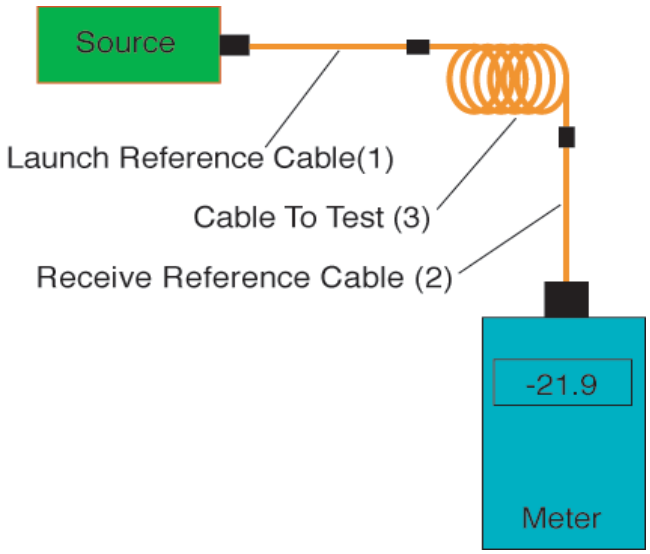
- Method A: with two cables (launch and receive cables)

- Method B: with one reference cable (the launch cable) is the method with the least measurement uncertainty. The reference is set

- Method C: with three cables (launch, receive and a “golden” reference cables)

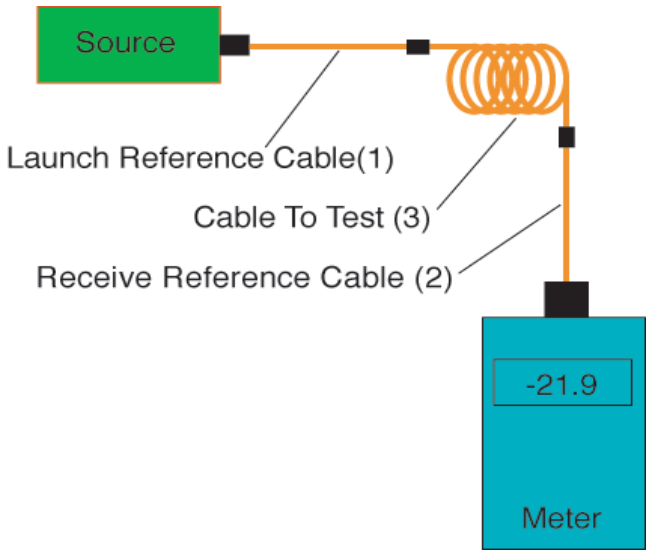
Insertion Loss Testing
OFSTP-14 (MM) & OFSTP-7(SM)

- How do you set reference?
- Method B: with one reference cable (the launch cable)
- Method A: with two cables (launch and receive cables)
- Method C: with three cables (launch, receive and a “golden” reference cables)



Insertion Loss Testing
OFSTP-14 (MM) & OFSTP-7(SM)

- When/why do you use each method?
- Method B: test equipment matches cable plant connectors
- Method A: test equipment not compatible, male connectors
- Method C: test equipment not compatible, male/female connectors



Insertion Loss Testing

What If Connectors Are Not Mateable?

- Some connectors do not mate with other connectors, just attach to transmitters and receivers
- Use a “cable substitution test”
- Attach known good cable (reference) between meter and source, measure = “0 dB ref”
- Remove and attach cable to test, measure difference