Qualified Partner Programme QPP
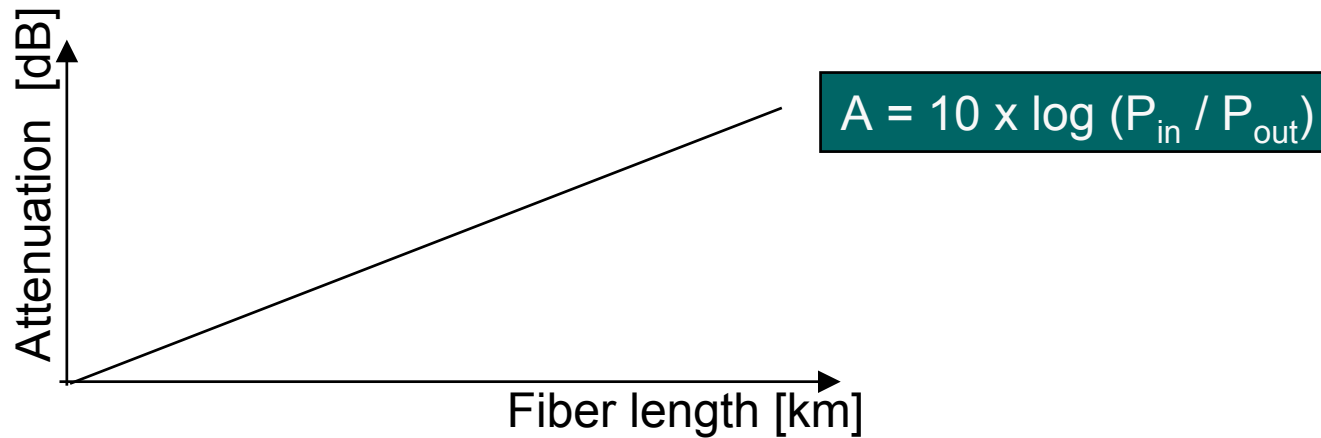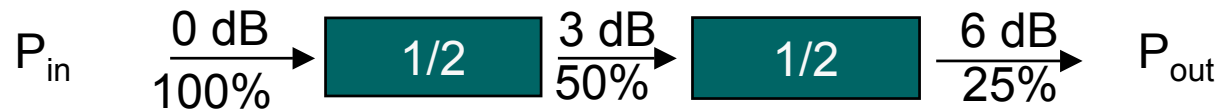
FO Measurement Technique

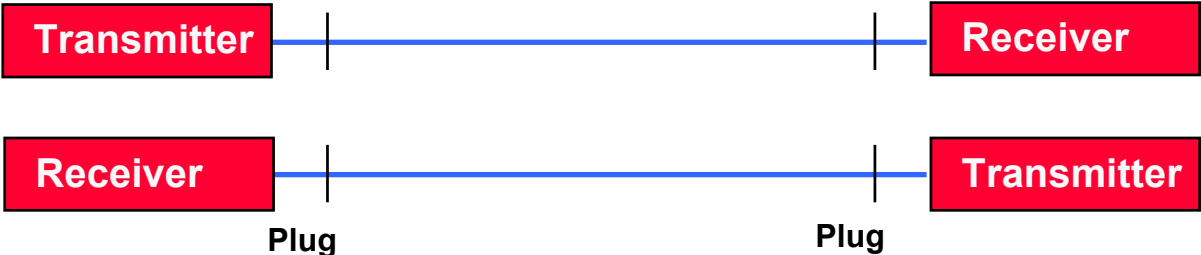## Felice Guarna

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dB (decibel)

P_{in} $\xrightarrow[100\%]{0\ dB}$ | 1/2 | $\xrightarrow[50\%]{3\ dB}$ | 1/2 | $\xrightarrow[25\%]{6\ dB}$ P_{out}

Attenuation [dB] vs. Fiber length [km]

$$A = 10 \times \log (P_{in} / P_{out})$$

Attenuation measurement / measuring principles

Power measuring

| Transmitter | Receiver |

Plug   Plug

| Receiver | Transmitter |

Backscatter measuring (OTDR)

OTDR

Plug   Plug

OTDR

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When to employ which method

Power meter:

- always with terminated cable ends
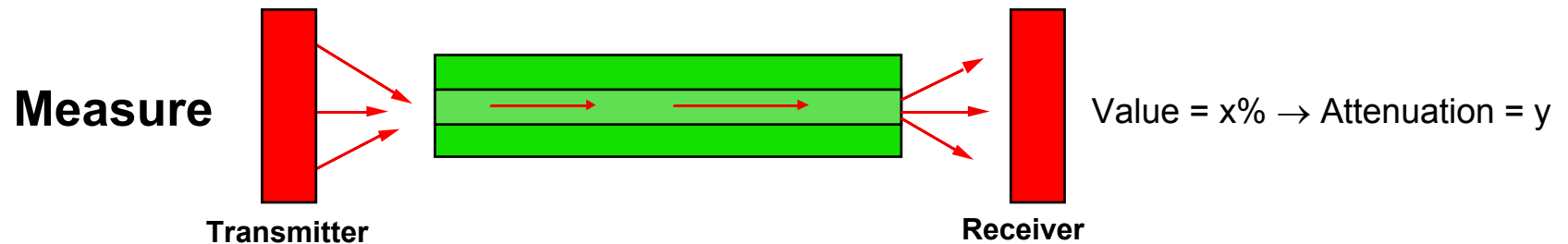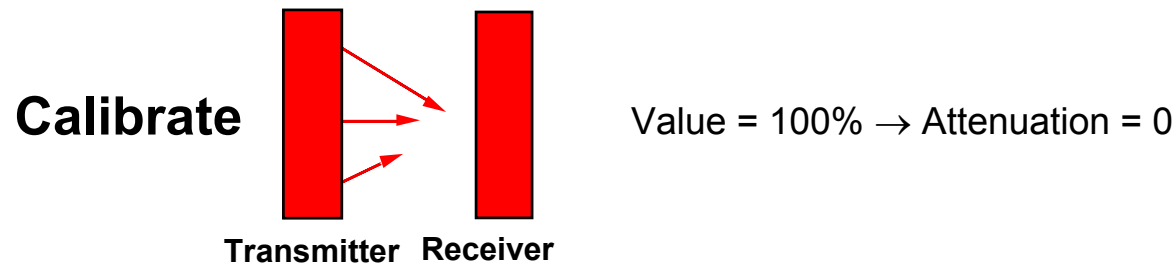
- to measure the actual link loss

Backscatter measuring:

- when there is a closure

- on cables of over 200 m

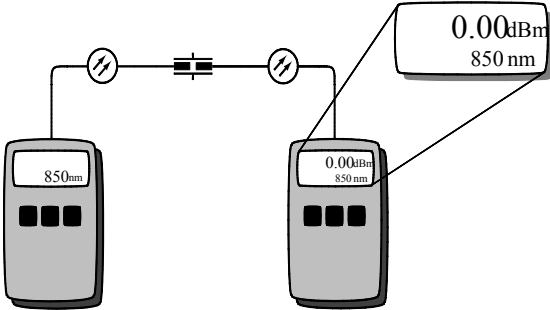- in difficult tracks

- for fault tracking

PMD measuring:

- on singlemode links with very high transmission rates (>2 km)

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The principle of level measuring / power measuring

Calibrate

Value = 100% → Attenuation = 0

Transmitter **Receiver**

Measure

Value = x% → Attenuation = y

Transmitter

Receiver

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Level measuring / power measuring

1. Reference measuring

Transmitter

Receiver

Test cable 1   Test cable 2

0.00 dBm
850 nm

850 nm

0.00 dBm
850 nm
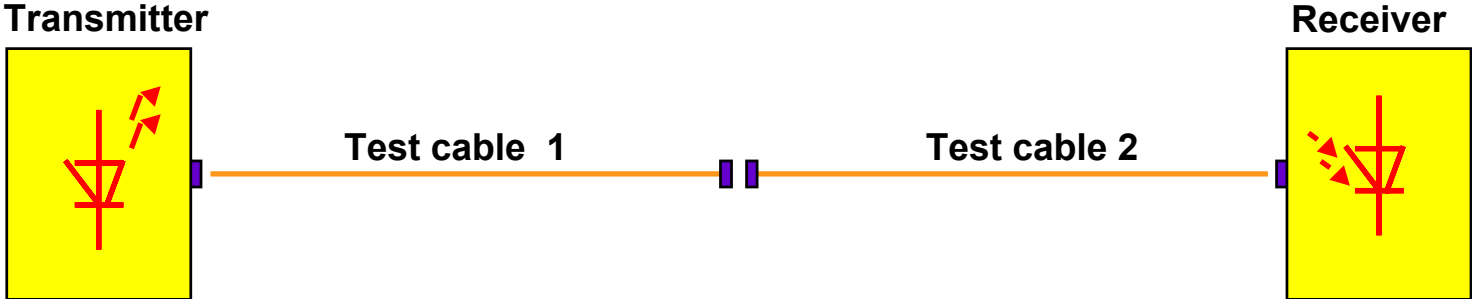
Adjust:
attenuation = 0 dB

Level measuring / power measuring

2. Measuring the system's attenuation

Transmitter

Receiver

FO System

Total attenuation [dB]

Ð 0.74 dBm
850nm

850nm

Ð 0.74 dBm
850nm

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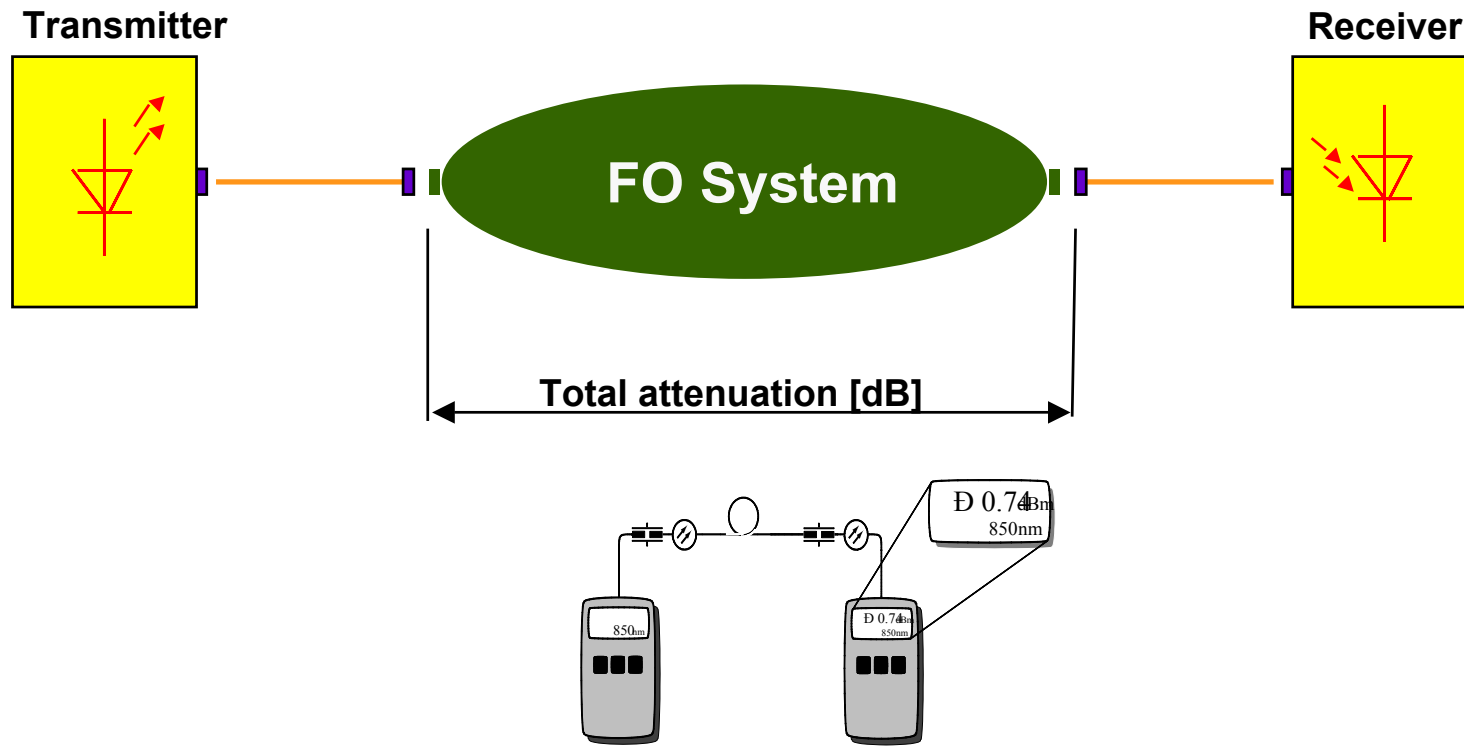
Power measuring characteristics

- Very accurate measurement

- Simple (economical) test equipment

- Very suitable for the testing of an installation

- Does not detect the cause of attenuation

Light sources to measure the parameters

(power source)

- Weight   field-capable

- Battery lifespan / type   customary batteries

- Battery display

- Wavelength   850/1300 or 1310/1550 nm

- Light source (laser / LED)   laser only for SM and
                                     long distances

- Output (dB)   max. link loss

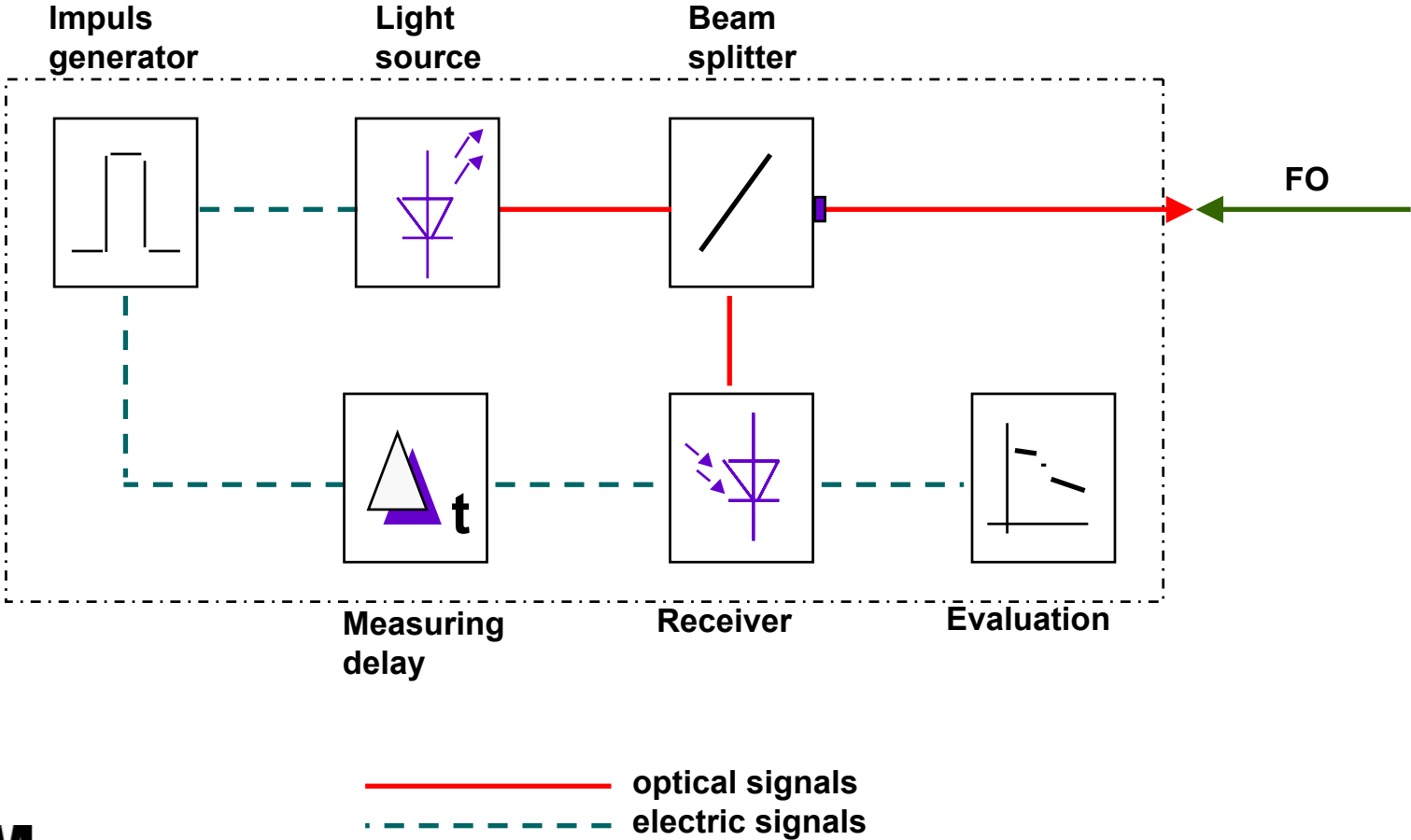- Stability   measuring accuracy

- Connector   adapters (ST / SC / MT-RJ...)

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Optical fiber transmission links

Application	Light source	Wavelength	Transmitter (dBm)	Receiver (dBm)	Dynamic ratio (dB)
Telecom	Laser/SM	1310 nm 1550 nm	+3...-6 0...-10	-40...-45 -40...-45	34...48 40...45
Data transmission	LED/MM	850 nm 1300 nm	-10...-20 -10...-20	-30...-35 -30...-35	10...25 10...25
CATV	Laser/SM	1300 nm 1550 nm	+10...0	0...-10	10...20

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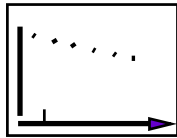
Powermeter parameters

- Weight   field-capable

- Battery lifespan / type   customary batteries

- Battery display

- Wavelength   840 ....1650 nm

- Measuring range   high dynamic ratio

- Measuring accuracy

- Measuring units   dBm, dB (mW, µW)

- Connector   adapters (ST / SC / MT-RJ...)

- Storage   yes / no
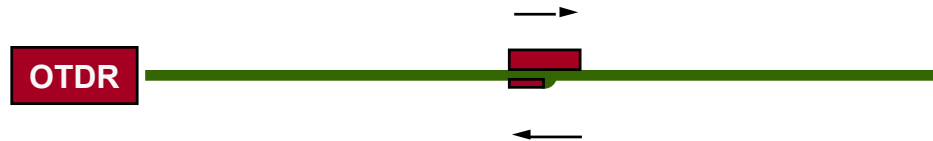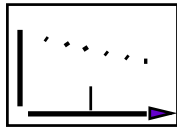
Optical time domain reflectometer OTDR

Impuls generator

Light source

Beam splitter

FO

Measuring delay

Receiver

Evaluation

optical signals

electric signals

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OTDR measuring procedure

A light pulse propagates in an optical waveguide.

OTDR

The light pulse is partly reflected by an interfering effect.

OTDR

The reflected light pulse is detected by the OTDR.

OTDR

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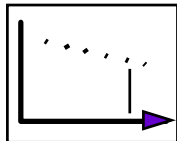
Typical and standardised attenuation values

Fusion splice
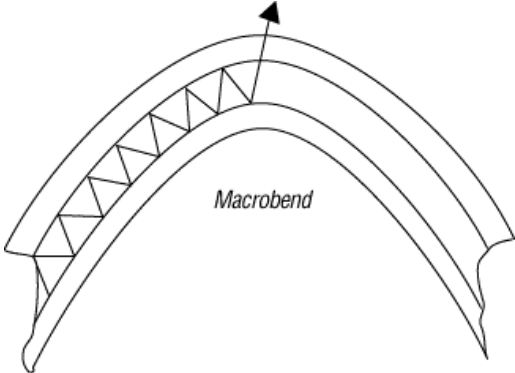
- Typical:
    - MM: approx. 0.05 dB
    - SM: approx. 0.10 dB
- According to standard (EN 50173 (draft 2001):
    - MM: 0.3 dB
    - SM: ditto MM

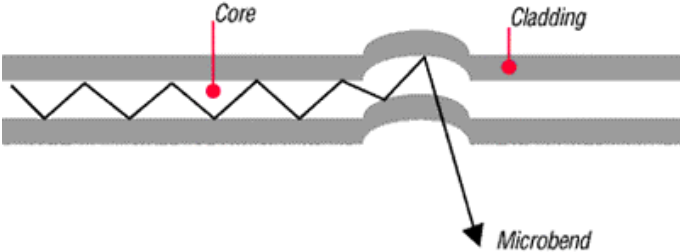**Connector (IL / RL)**

- Typical:
    - MM: RL: 30 dB   IL: approx. 0.3 dB
    - SM   RL: 45 dB   IL: approx. 0.1 - 0.2 dB
- According to standard (EN 50173 (draft 2001):
    - MM: RL: 20 dB   IL: 0.50 dB for 95% of the plugged connections
                                             0.75 dB for 100% of the plugged connections
    - SM: RL: 35 dB   IL: not specified / dito MM

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Further causes of attenuation

Macrobending:

Macrobend

Mikrobending:

Core   Cladding

Microbend

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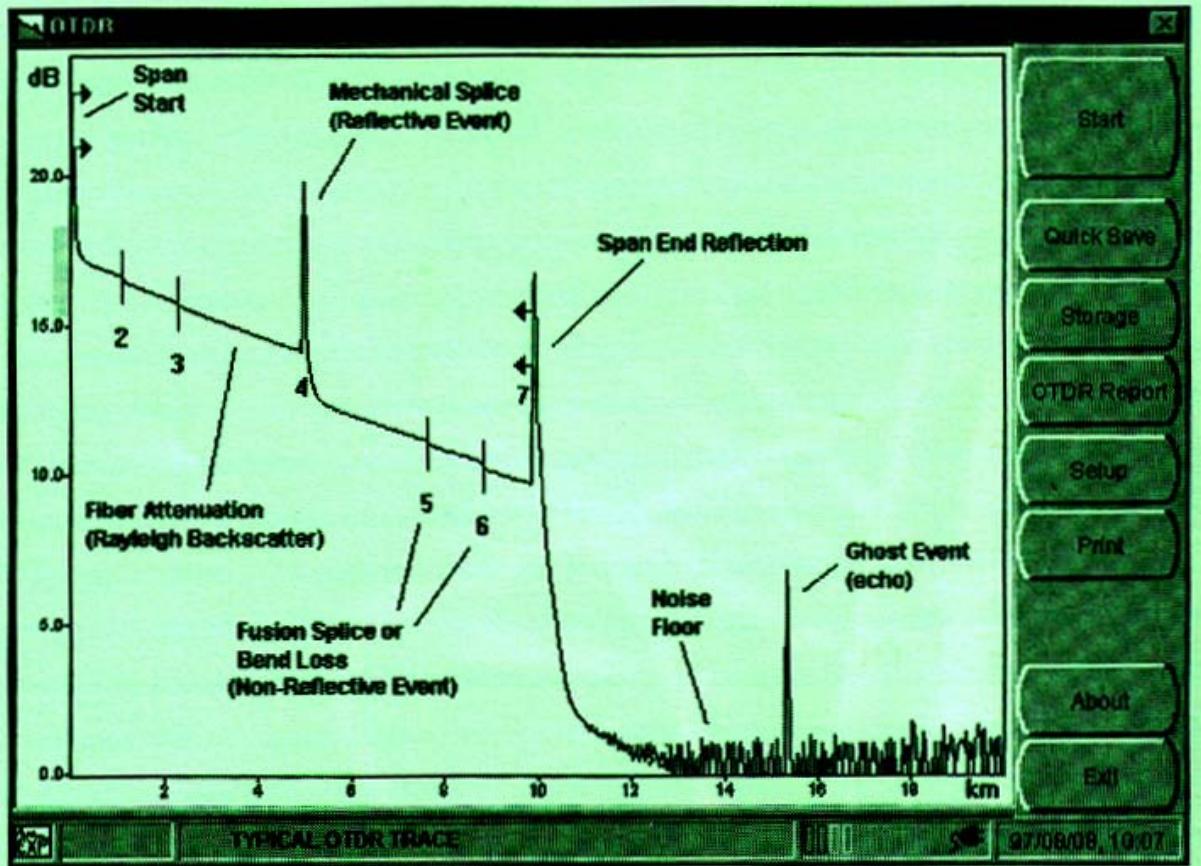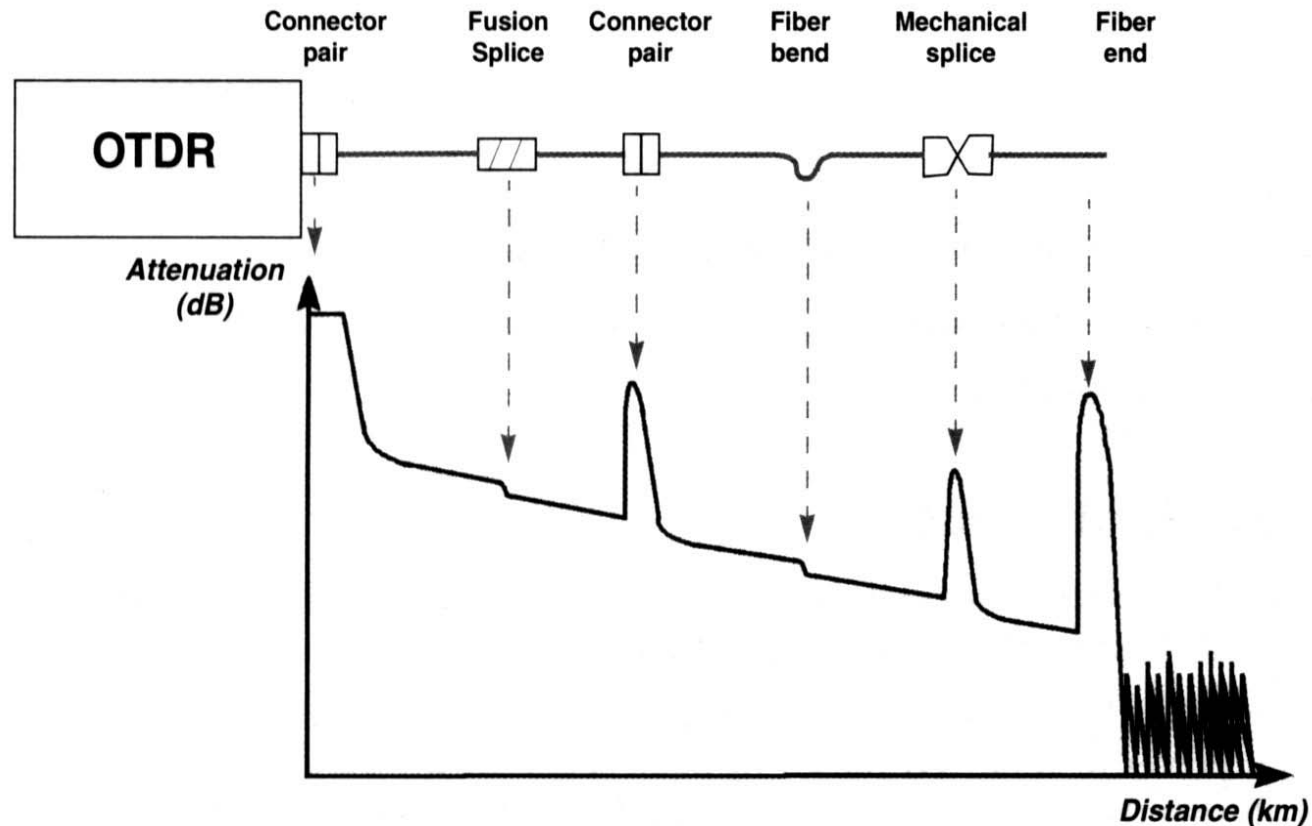
An example of an OTDR waveform

Figure 3.1 A typical OTDR waveform

An example of an OTDR waveform

Typical OTDR trace

OTDR characteristics

- Very accurate measurement

- Local resolution partly less than 1 meter

- Very suitably for measuring an installation

- Allows fault diagnosis and fault localization

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OTDR parameters

- Weight   field-capable
- Battery lifespan   approx. 6 h
- Display (TFT, b/w)   contrast <--> price
- Wavelength   850/1300 or 1310/1550 nm
- Dynamic ratio (dB)   max. link losses
- Pulse width (ns)   localisation accuracy
- Event dead zone   resolution
- Initial dead zone   launch / resolution
- Sampling points   measuring accuracy
- Connector   adaption
- Storage   storage capacity
- Interfaces   printer, etc.
- Software   user-friendliness

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Dynamic ratio in an OTDR
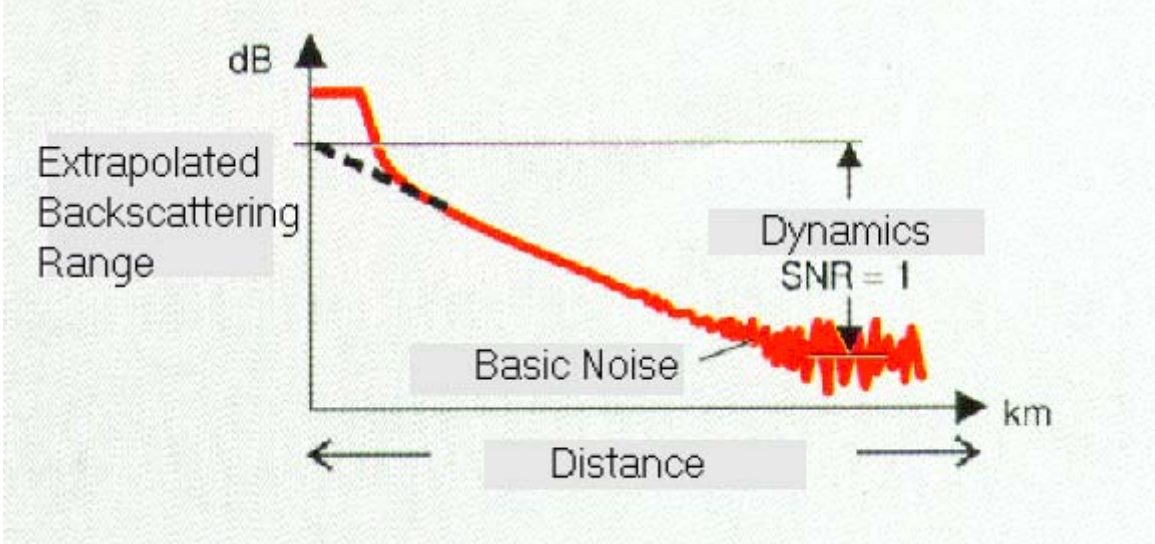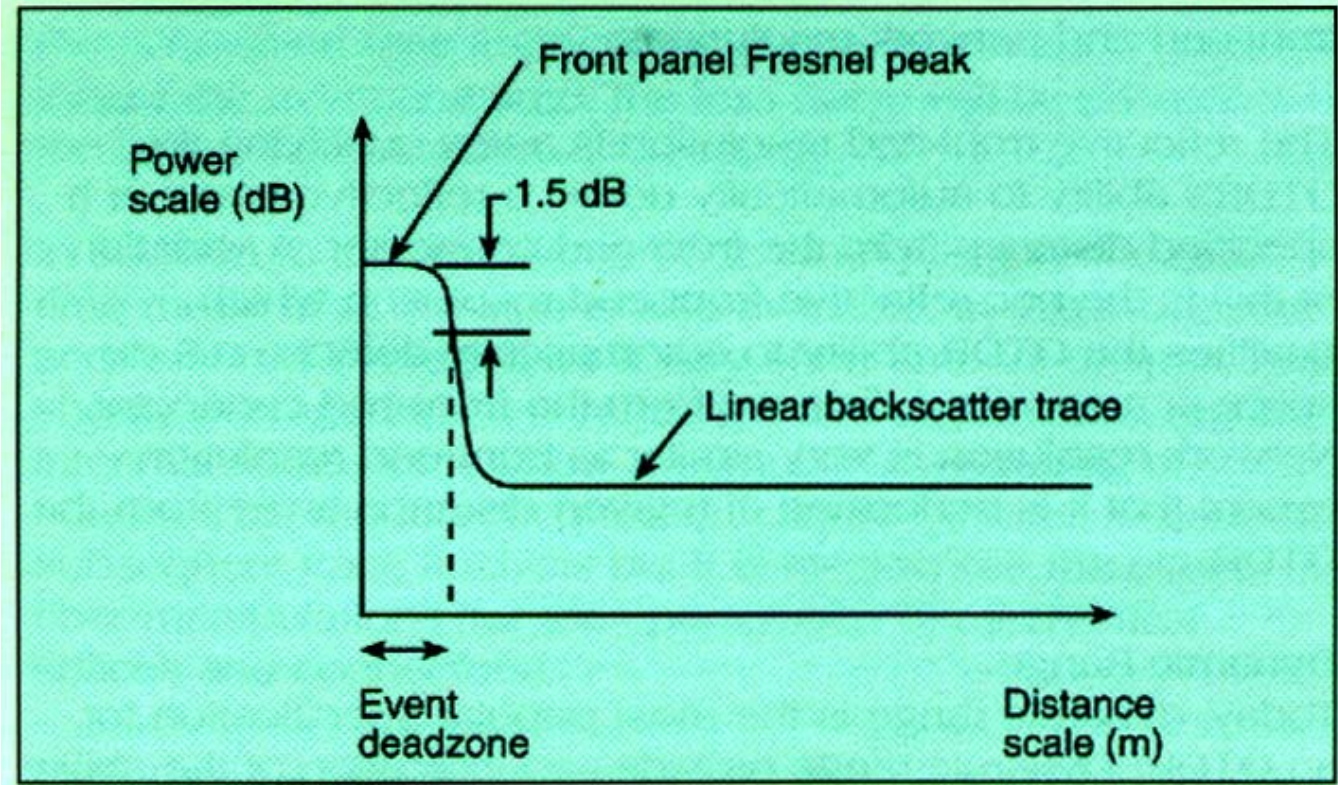
Event dead zone in an OTDR

Figure 3.3 Event dead zone
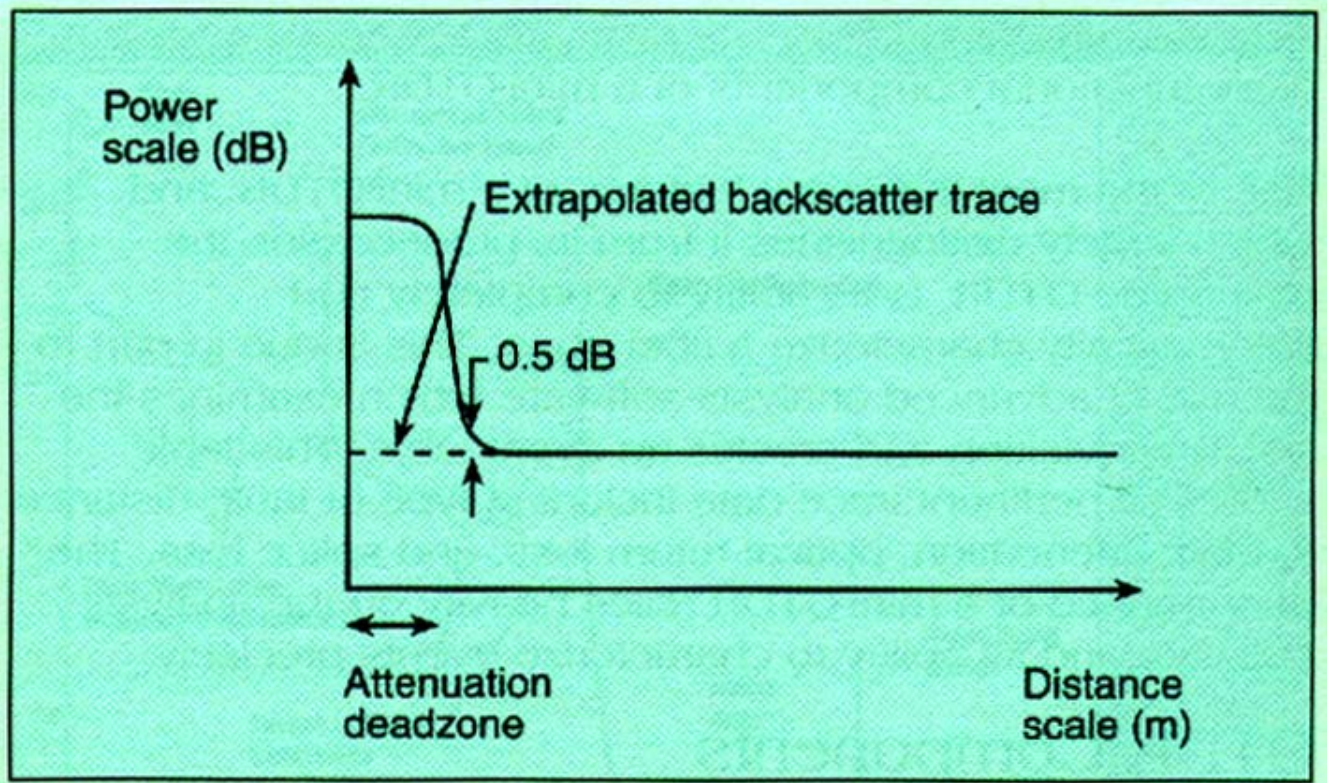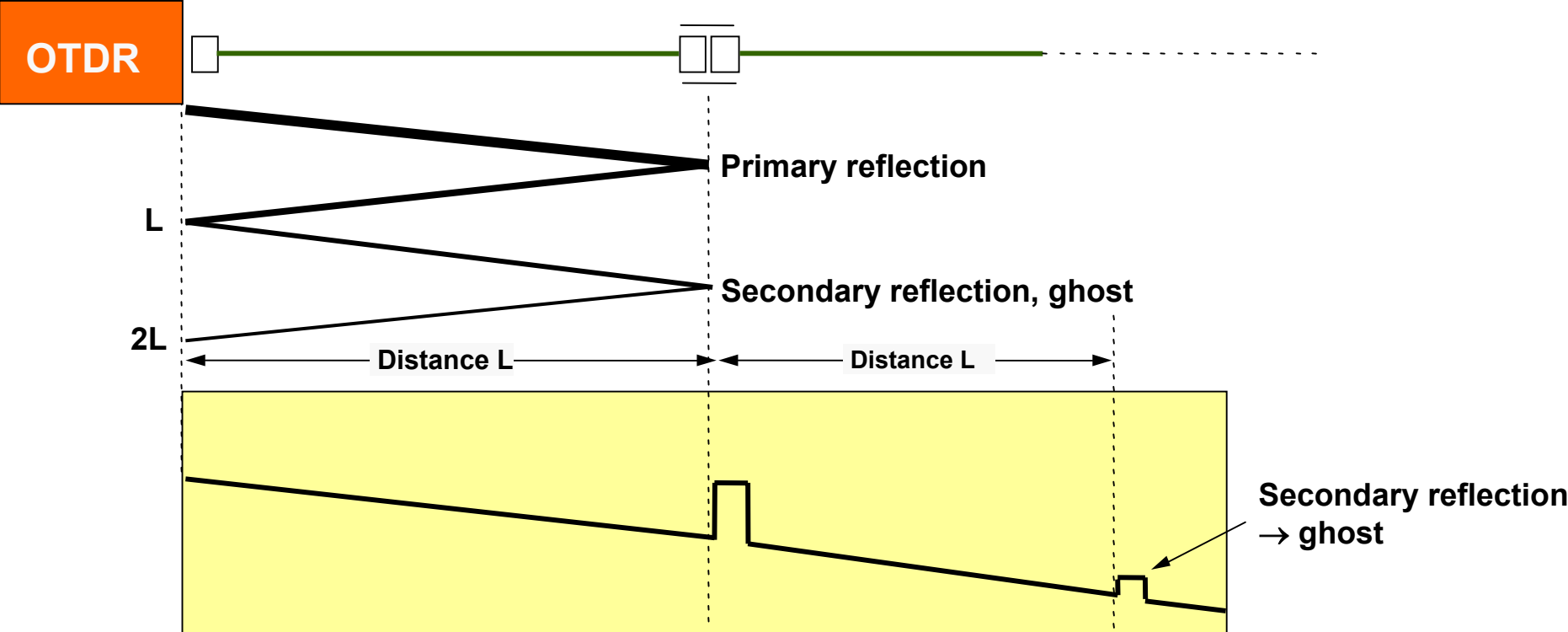
Attenuation dead zone in an OTDR

Figure 3.4 Attenuation dead zone

Ghosts and OTDR?

Secondary reflection ("Ghost")

OTDR

Primary reflection

L

Secondary reflection, ghost

2L

Distance L

Distance L

Secondary reflection → ghost

WHY ?

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