Dimensioning of F.O. Transmission Systems

For reliable operation of a F.O. data transmission system it is essential that the transmitted optical signals arrive at the receiver with sufficient amplitude. The incident power should at least exceed twice (+ 3 dB) the value of the minimum sensitivity of the receiver. Otherwise, the inherent noise of the system may result in increasing randomly distributed transmission errors in the data transfer. Therefore, in system design the power budget of the optical path has to be checked. The following aspects have to be considered:

- Optical power output of the transmitter
  The optical power generated by the LED does mainly depend on the applied forward current.Typical power levels coupled into the core are:

  for glass-fibre (λ = 850 nm):

50/ 125 µm GI fibre:	80 µW
200/ 230 µm SI fibre:	250 µW

  for Polymer fibre (λ = 660 nm):

980/1000 µm:	600 µW

- Specific attenuation-coefficient of the fibre
  The specific attenuation of optical fibres depends on the wavelength applied and is specified in dB/km.
  Typical values are:

  for glass-fibres (λ = 850 nm):

50/ 125 µm GI fibre:	---3 dB/km
200/ 230 µm HCS:	---5 dB/km

  for polymer fibre (λ = 660 nm):

980/1000 µm (PMMA):	---0.2 dB/m

  The fibre loss usually contributes to the highest amount to the overall transmission index of the optical link.

- Additional interconnections in the cable system
  Interconnections in the optical link create some further attenuation for the travelling optical signals.
  Typical insertion loss is
  - for a spliced connection ≤ 0.3 dB
  - for a connector-set 0.8 dB … 0.5 dB

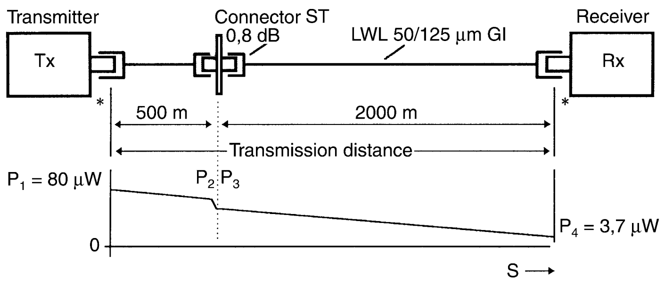
  depending on the type of fibre and the connectors applied.

- Sensitivity of the optical receiver DC-coupled optical receivers, commonly used, with SI-diodes as receiving elements show typical minimum sensitivities of
  ≤ 3 µW @ 850 nm (glass fibre systems)
  ≤ 5 µW @ 660 nm (polymer fibre systems)

- Temperature dependence and ageing of LED, thermal influence on cable loss
  These items should be taken into account with an amount of 2 dB. Thus, in total a system reserve of 5 dB has to be considered in the link power budget.

Examples

a) Glass fibre system (λ = 850 nm)



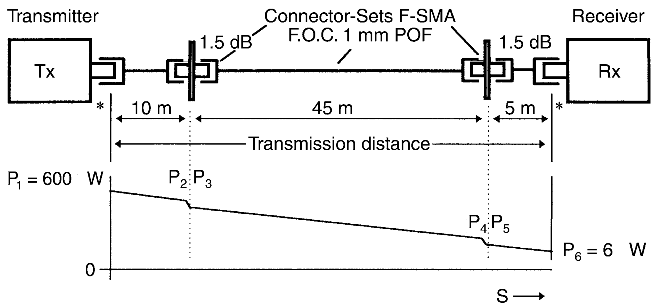
Link budget analysis:
Transmitter:
P1 = 80 µW = -11 dBm
power coupled into fibre core

Cable Loss: 2.5 km x 3 dB/km	= 7.5 dB
Loss per connector set ST	= 0.8 dB
System reserves (3 dB + 2 dB)	= 5.0 dB
Total system losses:	**13.3 dB**

Incident power at receiver: P4 = - 24.3 dBm = 3.7 µW
This satisfies the required minimum-conditions ≥ 3 µW

* The injection- and decoupling-loss at the transmitter- and receiver-ends of the fibre has not additionally to be taken into account as they are alraedy included in the given power ratings of these elements.

b) Polymer fibre system (λ = 660 nm)

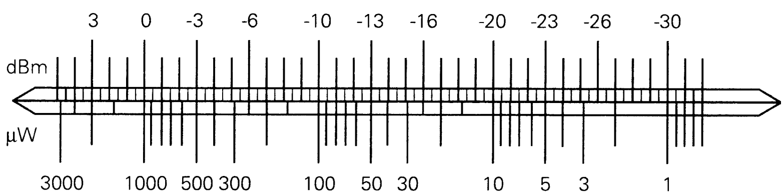


Link budget analysis:
Transmitter:
P1 = 600 µW = -2.2 dBm
power coupled into fibre core

Cable loss: 60 m x 0.2 dB/m	= 12 dB
2 connector-sets F-SMA (2 x 1.5 dB)	= 3.0 dB
System reserves (3 dB + 2 dB)	= 5.0 dB
Total system losses:	**20.0 dB**

Incident power at receiver:
P6 = - 22.2 dBm = 6.0 µW
This satisfies the required minimum-conditions ≥ 5 µW
Omitting the additional interconnections in the cable (here e.g. the 2 F-SMA connector sets) results in larger maximum transmission distances.

Conversion Diagram



Fibre optic cords