POF Optical Interface
- Update -

Bernd Horrmeyer

Current work at POFAC

- **POF-Conference 2013:**

S. Werzinger, C.-A. Bunge, S. Loquai, O. Ziemann, "Application and Evaluation of an Analytic Connector Loss Model for SI-POF", in proc. of 22nd ICPOF, pp. 193-198, Búzios, Brasil, 2013. (Winner Best Poster Award POF2013)

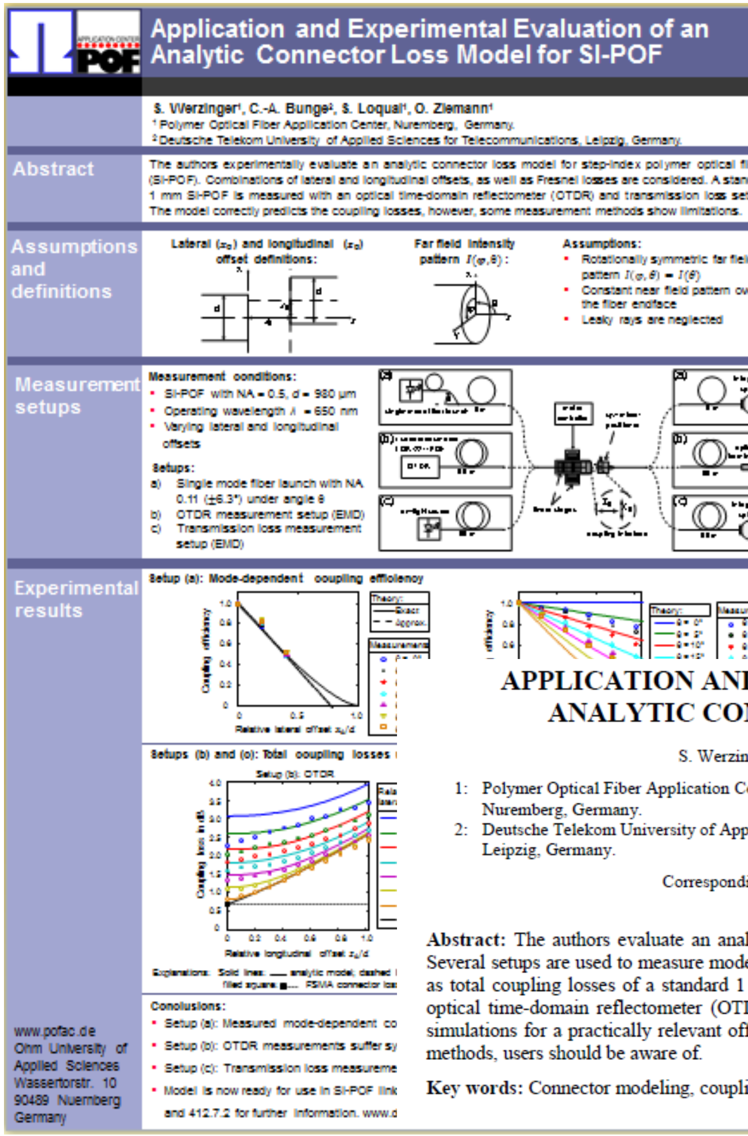
- **Masterthesis:**

S. Werzinger, "Modeling, Simulation and Measurement of Step-Index Polymer Optical Fiber Connector Losses", Master thesis, POF-Application Center, University of Applied Sciences "Georg Simon Ohm", Nuremberg, Germany, 2013.

- **Applied Research Conferences:**

S. Werzinger, C.-A. Bunge, S. Loquai, O. Ziemann, “Measurement, Simulation and Analytic Modeling of Polymer Optical Fiber Connector Losses“, in proc. of 3rd Applied Research Conference, pp. 254-257, Deggendorf, Germany, 2013.

Overview



Loss effect		UMD	EMD
Fresnel reflections	n_{co} | n_0	$\eta_r \approx \left[1-\left(\frac{n_{co}-n_0}{n_{co}+n_0}\right)^2\right]^2$	
Core diameter mismatch ($d_1 > d_2$)	d_1 | d_2	$\eta_\delta \approx \left(\frac{d_2}{d_1}\right)^2$	
NA mismatch ($NA_1 > NA_2$)	NA_1 | NA_2	$\eta_{NA} \approx \left(\frac{NA_2}{NA_1}\right)^2$,	$\eta_{NA} \approx 1-3\left(\frac{NA_2}{NA_1}-1\right)^2$
Mean acceptance angle (in rad)		$\overline{\Theta}_c = \frac{\Theta_{c1}+\Theta_{c2}}{2}$	
Lateral offset	x_0	$\eta_{x_0} \approx 1-\frac{4}{\pi}\frac{x_0}{d}$	
Longitudinal off			
Longitudinal an			
Combined offse			

Measurement, Simulation and Analytic Modeling of Step-Index Polymer Optical Connector Losses

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rsity of Applied Sciences for Telecommunications in Leipzig, Leipzig, Germany.

Applied Research Conference
October 17 – 18, 2013
Deggendorf / Germany

APPLICATION AND EXPERIMENTAL EVALUATION OF AN ANALYTIC CONNECTOR LOSS MODEL FOR SI-POF

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2: Deutsche Telekom University of Applied Sciences for Telecommunications in Leipzig, Gustav-Freytag-Str. 43-45, 04277 Leipzig, Germany.

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Abstract: The authors evaluate an analytic connector loss model for step-index polymer optical fibers (SI-POF). Several setups are used to measure mode-dependent coupling efficiencies for lateral and longitudinal offsets, as well as total coupling losses of a standard 1 mm SI-POF under EMD conditions. Transmission loss measurements and optical time-domain reflectometer (OTDR) measurements are in good agreement with the model and ray-tracing simulations for a practically relevant offset range. The investigations also reveal limits of the applied measurement methods, users should be aware of.

Key words: Connector modeling, coupling loss, step-index polymer optical fibers, OTDR.

PHOENIX CONTACT
INSPIRING INNOVATIONS

Poster, part 1

Application and Experimental Evaluation of an Analytic Connector Loss Model for SI-POF

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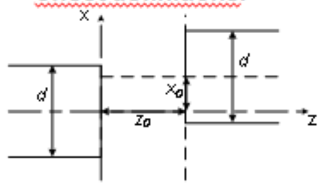
[2] Deutsche Telekom University of Applied Sciences for Telecommunications, Leipzig, Germany.

Abstract

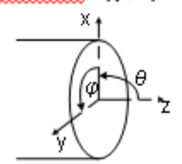
The authors experimentally evaluate an analytic connector loss model for step-index polymer optical fibers (SI-POF). Combinations of lateral and longitudinal offsets, as well as Fresnel losses are considered. A standard 1 mm SI-POF is measured with an optical time-domain reflectometer (OTDR) and transmission loss setups. The model correctly predicts the coupling losses, however, some measurement methods show limitations.

Assumptions and definitions

Lateral (x_0) and longitudinal (z_0) offset definitions:



Far field intensity pattern $I(\varphi, \theta)$:



Assumptions:

- Rotationally symmetric far field pattern $I(\varphi,\theta) = I(\theta)$
- Constant near field pattern over the fiber endface
- Leaky rays are neglected

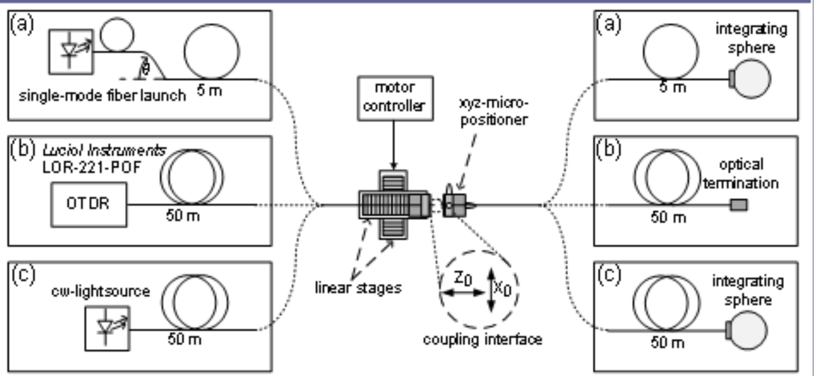
Measurement setups

Measurement conditions:

- SI-POF with NA = 0.5, d = 980 µm
- Operating wavelength λ = 650 nm
- Varying lateral and longitudinal offsets

Setups:

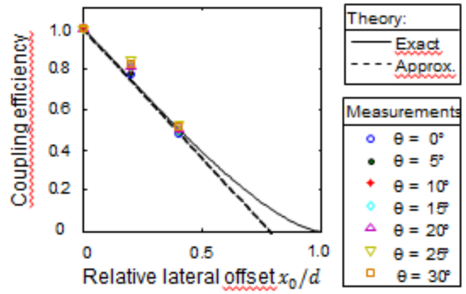
a) Single mode fiber launch with NA 0.11 (±6.3°) under angle θ
b) OTDR measurement setup (EMD)
c) Transmission loss measurement setup (EMD)

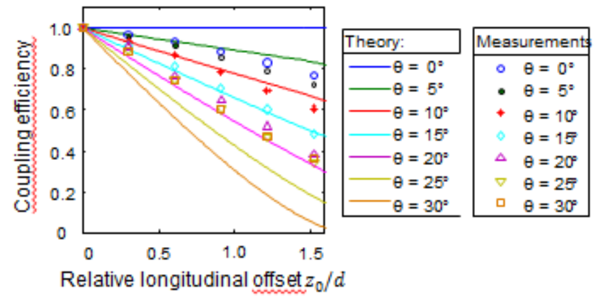


Poster, part 2

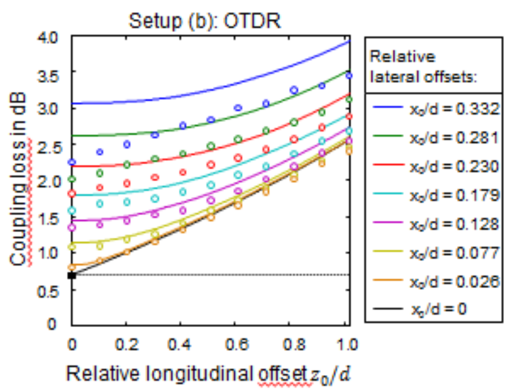
Experimental results

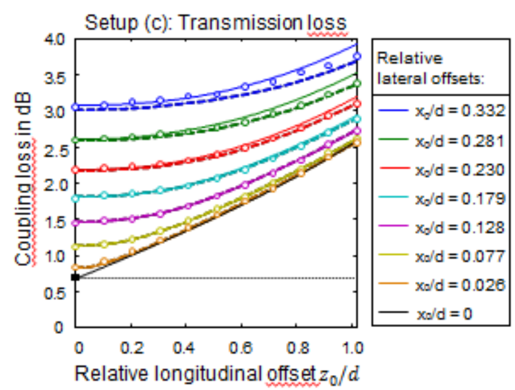
Setup (a): Mode-dependent coupling efficiency





Setups (b) and (c): Total coupling losses under EMD conditions





Explanations: Solid lines: — analytic model; dashed lines: – – ray-tracing simulation (setup (c) only); circles: ○ measurement data; filled square: ■··· FSMA connector loss as reference (measured with OTDR).

Conclusions:

- Setup (a): Measured mode-dependent coupling efficiencies agree with theory for angles of 5° to 20°.
- Setup (b): OTDR measurements suffer systematic errors of up to 0.7 dB for (only) large lateral offsets.
- Setup (c): Transmission loss measurements fully agree with analytic model and ray-tracing simulations.
- Model is now ready for use in SI-POF links and application standards. See DKE working groups 412.7.1 and 412.7.2 for further information. www.dke.de/ak412-7-1

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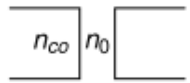
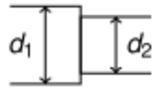
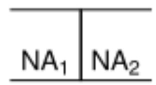
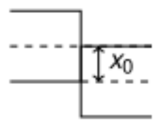
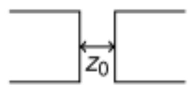
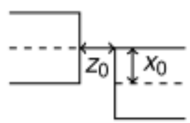
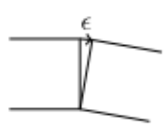
Masterthesis, Equations

Loss effect		UMD	EMD
Fresnel reflections		$\eta_r \approx \left[1 - \left(\frac{n_{co}-n_0}{n_{co}+n_0}\right)^2\right]^2$	
Core diameter mismatch ($d_1 > d_2$)		$\eta_\delta \approx \left(\frac{d_2}{d_1}\right)^2$	
NA mismatch ($NA_1 > NA_2$)		$\eta_{NA} \approx \left(\frac{NA_2}{NA_1}\right)^2$,	$\eta_{NA} \approx 1 - 3\left(\frac{NA_2}{NA_1} - 1\right)^2$
Mean acceptance angle (in rad)		$\overline{\Theta}_c = \frac{\Theta_{c1}+\Theta_{c2}}{2}$	
Lateral offset		$\eta_{x_0} \approx 1 - \frac{4}{\pi}\frac{x_0}{d}$	
Longitudinal offset		$\eta_{z_0} \approx 1 - \frac{8}{3\pi}\frac{z_0}{d}\overline{\Theta}_c\left(\frac{\overline{\Theta}_c^2}{5} + 1\right)$,	$\eta_{z_0} \approx 1 - \frac{1}{\pi}\frac{z_0}{d}\overline{\Theta}_c\left(\frac{\overline{\Theta}_c^2}{4} + 2\right)$
Longitudinal and lateral offset		$\eta_{x_0,z_0} \approx 1 - \frac{4}{\pi}\frac{\Delta_0}{d}$	
Combined offset parameter Δ_0 ($n = 2.3$)		$\Delta_0 = \left[x_0^n + z_0^n\left(\frac{2\overline{\Theta}_c^3}{15} + \frac{2\overline{\Theta}_c}{3}\right)^n\right]^{\frac{1}{n}}$,	$\Delta_0 = \left[x_0^n + z_0^n\left(\frac{\overline{\Theta}_c^3}{16} + \frac{\overline{\Theta}_c}{2}\right)^n\right]^{\frac{1}{n}}$
Angular offset (in rad)		$\eta_\epsilon \approx 1 - \frac{2}{\pi}\frac{\epsilon}{\overline{\Theta}_c}$,	$\eta_\epsilon \approx 1 - 0.7\left(\frac{\epsilon}{\overline{\Theta}_c}\right)^2$

Outlook

- Comparison of theoretical and practical results

  ↳ POFAC, DKE, IEC?

- Drafting of an optical interface-document

  ↳ DKE, IEC?

What`s next?

Thank you for your attention !

Bernd Horrmeyer

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INSPIRING INNOVATIONS

Standardelemente

Navigationselemente

i — Weitere PowerPoint Datei
mit vertiefender Information aufrufen.

Sprung/Abspielen eines Inhalts
innerhalb der Datei

Präsentation beenden
(Sprung auf letzte Folie)

neu
new

Kennzeichnung von neuen Produkten

Blockpfeile

Hervorgehobener Text

Standardvariante für hervorgehobenen Text

Hervorgehobener Text

Hervorgehobener Text: Nur für Kernaussagen, wichtige Zusammenfassungen, strategische Statements

Legende