Pin Gap Investigations for the 1.85mm Coaxial Connector

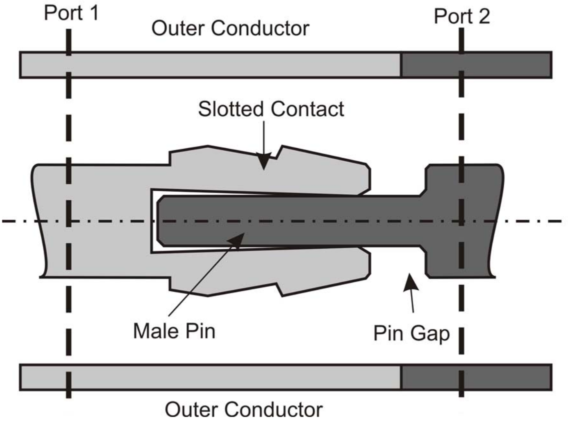
Johannes Hoffmann, Pascal Leuchtmann, Rüdiger Vahldieck

IFH ETH Zürich

6.3.2008

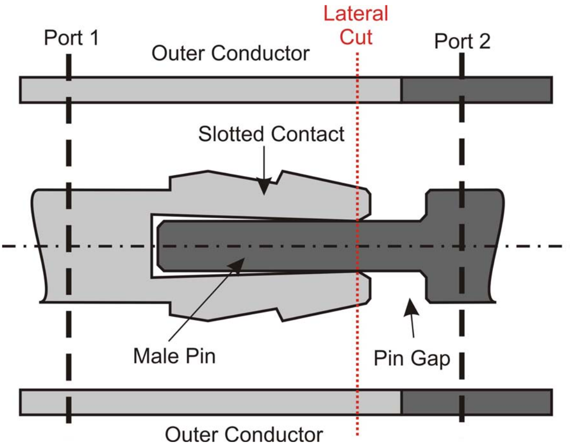
Outline

Longitudinal Cut



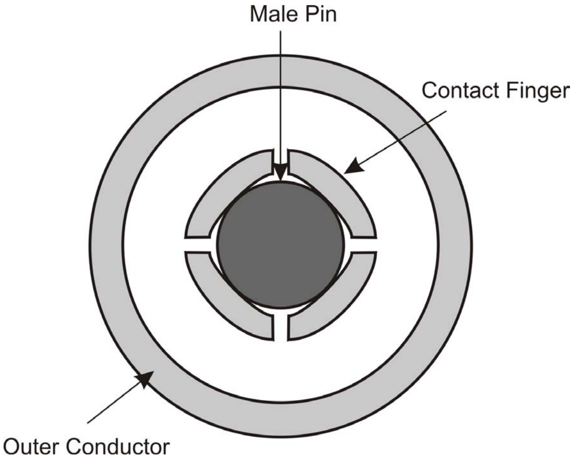
Geometry of female part exaggerated

Longitudinal Cut



Geometry of female part exaggerated

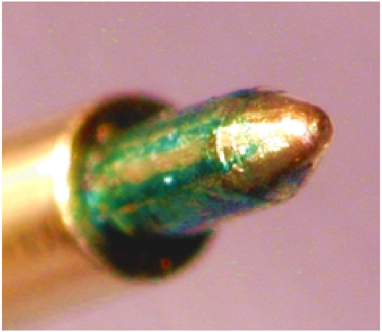
Lateral Cut



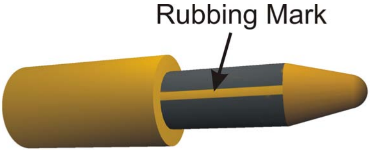
Light Gray=Female Part, Dark Gray=Male Part

Contact Width

The rubbing mark on the male pin is a result of repeated connections. Contact Width approx. 80μm

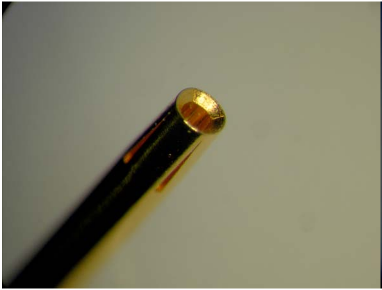


Male pin with rubbing mark (Photo)

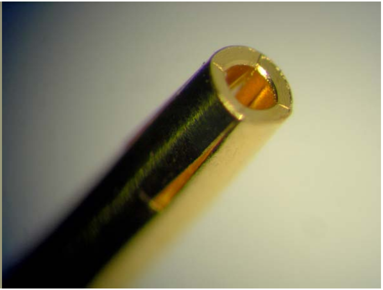


Drawing

Photo of Female Part

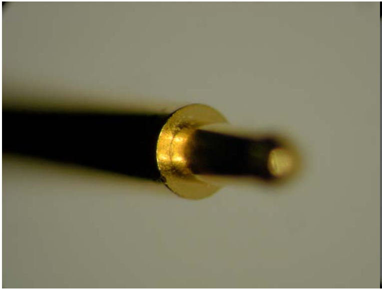


Big inner female chamfer

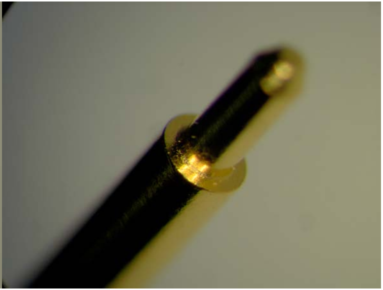


Small inner female chamfer

Photo of Male Part

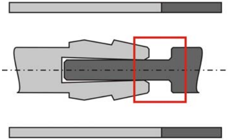


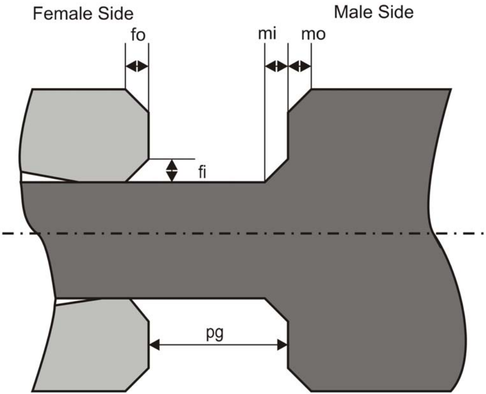
Small inner male chamfer



Big inner male chamfer

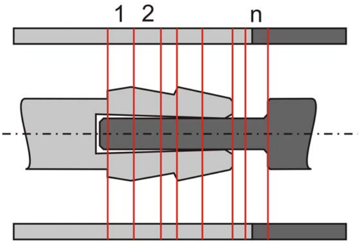
Pin Gap Details





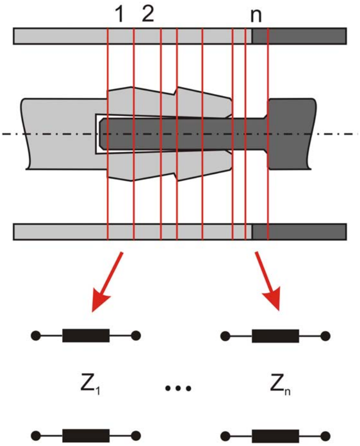
Light Gray=Female Part, Dark Gray=Male Part

State of the Art I



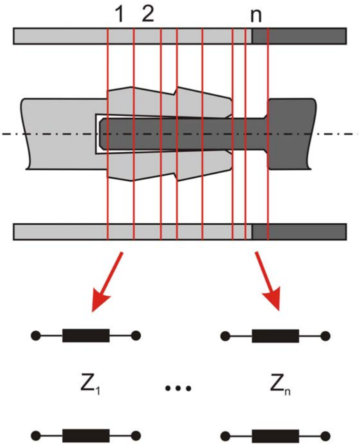
- Connector is sliced into *n* sections.

State of the Art I



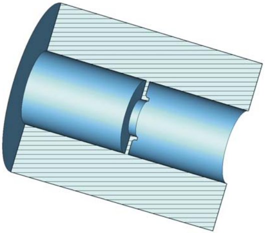
- Connector is sliced into n sections.
- Sections' characteristic impedance Z_i is computed and sections are cascaded.

State of the Art I



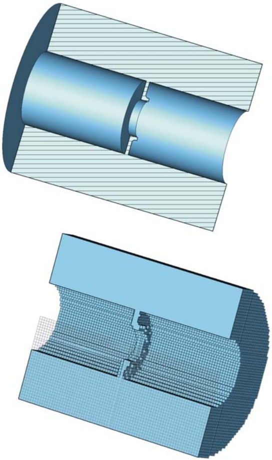
- Connector is sliced into n sections.
- Sections' characteristic impedance Z_i is computed and sections are cascaded.
- Neglects transition slotless-slotted.

State of the Art II



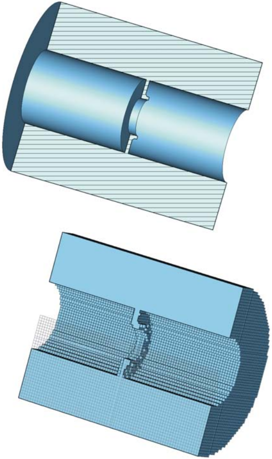
- Connector is modeled cylindrically symmetric.

State of the Art II



- Connector is modeled cylindrically symmetric.
- FDTD or FEFD methods for S-parameter computation.

State of the Art II



- Connector is modeled cylindrically symmetric.
- FDTD or FEFD methods for S-parameter computation.
- Neglects slots in female part.

Methods

Finite Element Frequency Domain (Ansoft)

- Frequency Domain Method.
- Unstructured mesh.
- Unsensitive to small pin gaps, can incorporate losses.
- Meshing requires expert knowledge.

Finite Difference Time Domain (CST)

- Time Domain Method.
- Structured mesh.
- Sensitive to small pin gaps, lossy model very inaccurate.
- Automatic meshing works fine.

Validation

3 Criteria for Validation

- Convergence with finer mesh.
- Plausibility of S-parameters, e.g. bigger chamfers have similar effect as bigger pin gap.
- FEFD results agree with FDTD results $|S_{11FEFD} - S_{11FDTD}| < 0.001$.

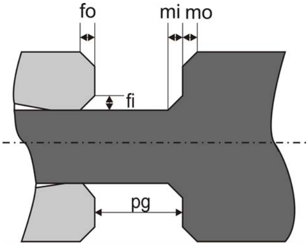
Losses

Lossy FDTD simulations are inaccurate due to convolution integral evaluation.

→ Use lossless simulation and introduce losses afterwards.

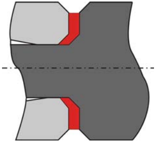
$$S_{11Lossy} = S_{11};\ S_{22Lossy} = S_{22}$$
$$S_{12Lossy} = S_{21Lossy} = \sqrt{1 - |S_{11}|}e^{-\gamma l}$$

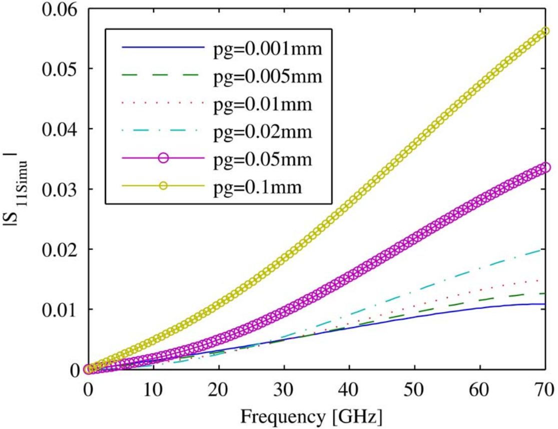
Parameter Range



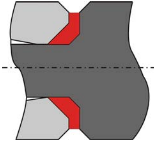
Parameter	Range	Full name
fo	$5 \ldots 30\,\mu$m	Female Outer Chamfer
fi	$10 \ldots 110\,\mu$m	Female Inner Chamfer
pg	$1 \ldots 100\,\mu$m	Pin Gap
mi	$9 \ldots 50\,\mu$m	Male Inner Chamfer
mo	$5 \ldots 30\,\mu$m	Male Outer Chamfer
f	$0 \ldots 71$ GHz	Frequency

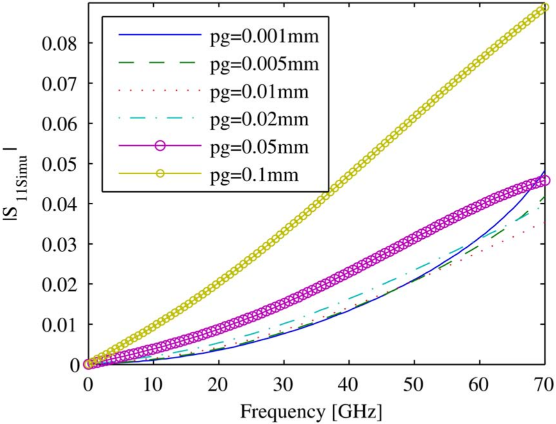
S_{11} with small Female Chamfer



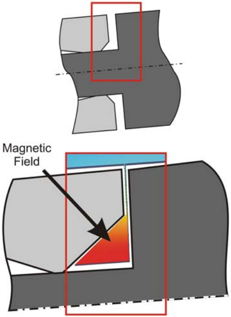


S_{11} with big Female Chamfer



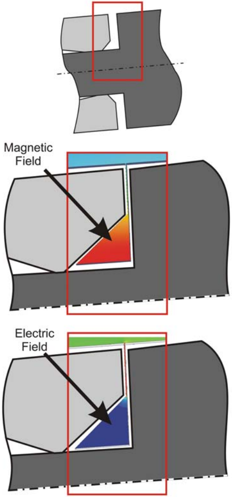


Resonant Circuit



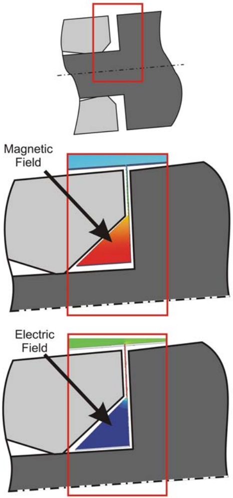
- Currents produce strong magnetic field.

Resonant Circuit



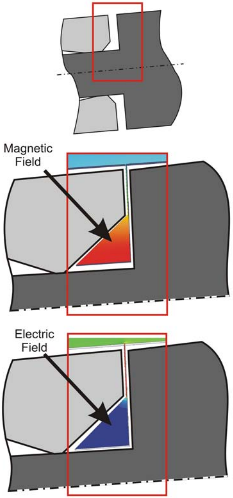
- Currents produce strong magnetic field.
- Strong electric field in gap.

Resonant Circuit



- Currents produce strong magnetic field.
- Strong electric field in gap.
- Resonant circuit as a result.

Resonant Circuit



- Currents produce strong magnetic field.
- Strong electric field in gap.
- Resonant circuit as a result.
- Using approximate formulae:
  $C = 1.9\,\mathrm{pF}$ $L = 3.3\,\mathrm{pH}$
  $f_R = 64\,\mathrm{GHz}$.

Conclusion

- Non-cylinder symmetric Connectors are simulated.
- Simulations are validated by diverse simulation methods and meshing convergence.
- Drastic effects of very small pin gaps are revealed.

COMO70

The Connector Modeling up to 70 GHz (COMO70) partners:

- Huber+Suhner
- Agilent
- Federal Office of Metrology METAS, Switzerland
- ETH Zürich

See as well: http://people.ee.ethz.ch/~tcm70