Horrmeyer_3dg_01_11162022

Willkommen

APL Measurements

NEXT / RL 100 MHz

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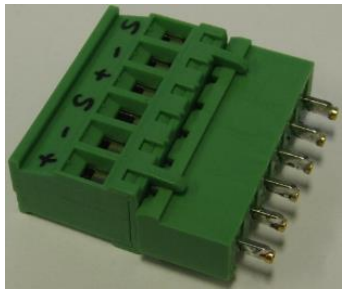
Background

- During the development of cg, signal integrity studies were performed on terminal blocks (pluggable and fixed).
- The measurements are based on the information in APL document draft 0.8.
- The measurements up to 20MHz were extended to 100MHz

APL Coupling Measurements

Description of the test samples

PCB connectors



MVSTBR 2,5/ 6-ST-5,08
Art.-Nr.: 1792281
&
MSTBVA 2,5/ 6-G-5,08
Art.-Nr.: 1755778

Number of test samples: 3 pairs

Feed-through terminal block

UT 2,5
Art.-Nr.: 3044076

Number of test samples: 1

Feed-through terminal block

ST 2,5
Art.-Nr.: 3031212

Number of test samples: 1

Feed-through terminal block

PT 1,5/S BU
Art.-Nr.: 3208126

Number of test samples: 1

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Articles in detail https://www.phoenixcontact.com

PCB connector

MVSTBR 2,5/ 6-ST-5,08 - 1792281

PCB connector, nominal cross section: 2.5 mm^2, color: green, nominal current: 12 A, rated voltage (III/2): 320 V, contact surface: Tin, type of contact: Female connector, number of potentials: 6, number of rows: 1, number of positions: 6, number of connections: 6, prod…

PCB header

MSTBVA 2,5/ 6-G-5,08 - 1755778

PCB headers, nominal cross section: 2.5 mm^2, color: green, nominal current: 12 A, rated voltage (III/2): 320 V, contact surface: Tin, type of contact: Male connector, number of potentials: 6, number of rows: 1, number of positions: 6, number of connections: 6, prod…

Feed-through terminal block - UT 2,5

3044076

Feed-through terminal block, nom. voltage: 1000 V, nominal current: 24 A, connection method: Screw connection, Rated cross section: 2.5 mm^2, cross section: 0.14 mm^2 - 4 mm^2, mounting type: NS 35/7,5, NS 35/15, color: gray

Feed-through terminal block - ST 2,5

3031212

Feed-through terminal block, nom. voltage: 800 V, nominal current: 24 A, connection method: Spring-cage connection, Rated cross section: 2.5 mm^2, cross section: 0.08 mm^2 - 4 mm^2, mounting type: NS 35/7,5, NS 35/15, color: gray

Feed-through terminal block - PT 1,5/S BU

3208126

Feed-through terminal block, nom. voltage: 500 V, nominal current: 17.5 A, connection method: Push-in connection, 1 level, Rated cross section: 1.5 mm^2, cross section: 0.14 mm^2 - 1.5 mm^2, mounting type: NS 35/7,5, NS 35/15, color: blue

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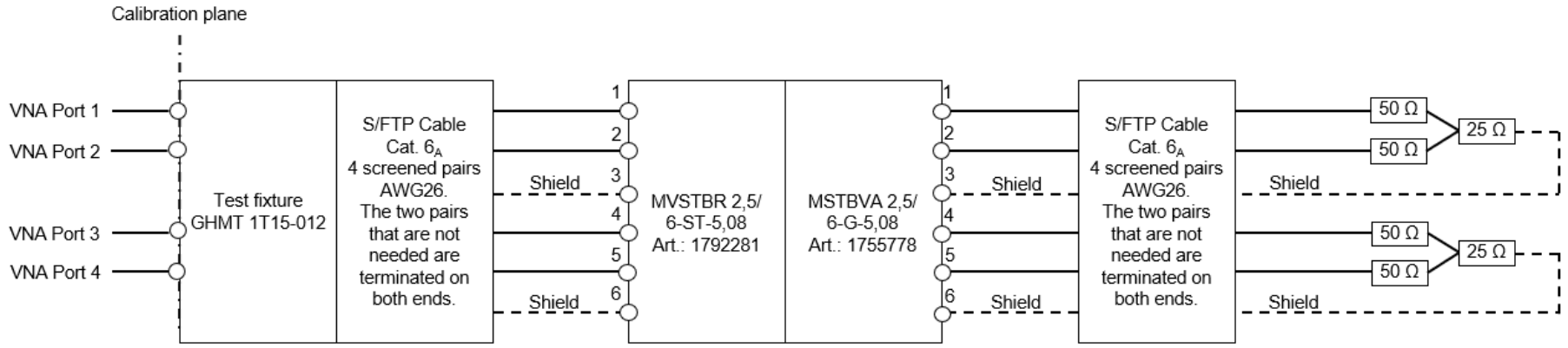
APL Coupling Measurements

Measuring principle

- Balunless measurement with a four-port vectorial network analyzer (VNA)



$$Crosstalk_{\mathrm{DUT}1,2-4,5} = -20 \cdot \log\left|\underline{S}_{\mathrm{dd}\ 1,2-4,5}\right| - 20 \cdot \log\left|\frac{\underline{S}_{14} - \underline{S}_{15} - \underline{S}_{24} + \underline{S}_{25}}{2}\right|$$

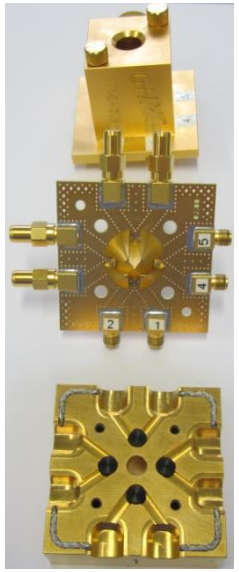
$$Crosstalk_{\mathrm{VNA}1,2-3,4} = -20 \cdot \log\left|\underline{S}_{\mathrm{dd}\ 1,2-3,4}\right| - 20 \cdot \log\left|\frac{\underline{S}_{13} - \underline{S}_{14} - \underline{S}_{23} + \underline{S}_{24}}{2}\right|$$

Fig. 1: Crosstalk measuring principle based on the example of the PCB connectors MVSTBR and MSTBVA. The measurement is carried out with a four-port VNA. The termination is made by a differential mode plus common mode resistor termination network according to IEC 60512-27-100. A Cat. 6_A cable with four shielded twisted pairs is used for the interconnection of the connectors under test with the test fixture and the termination networks. Non used twisted pairs of the cables are terminated with chip resistors.

General preparation

Test fixture and termination

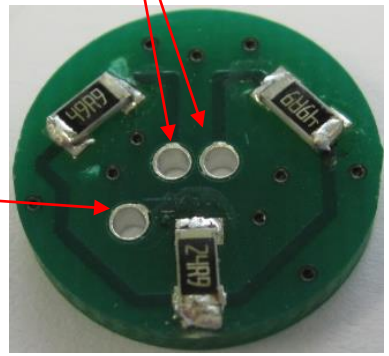
Test fixture GHMT 1T15-012



Differential mode plus common mode resistor termination network according to IEC 60512-27-100

Differential pair
1,2 or 4,5

Shield



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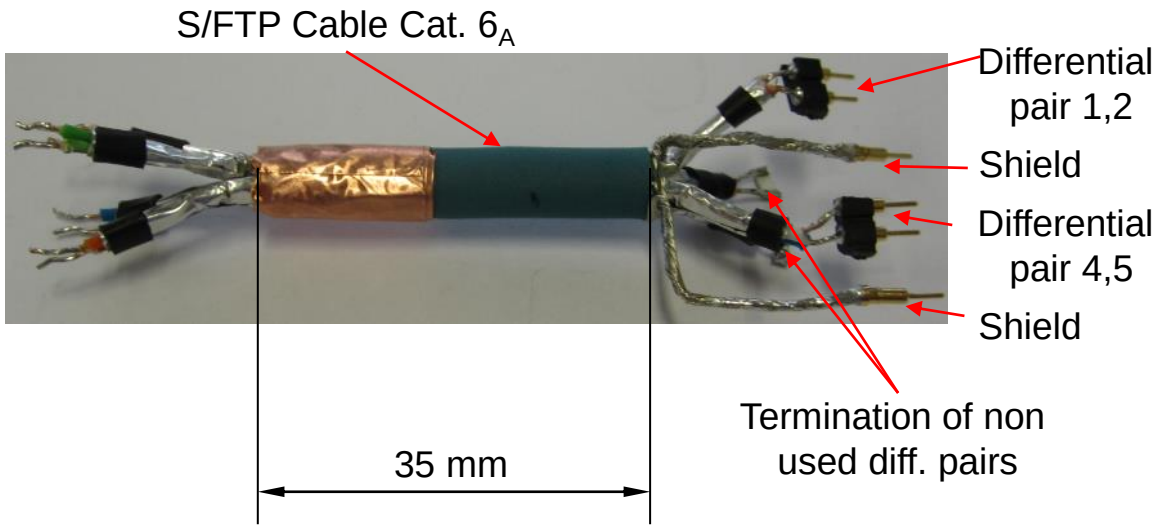
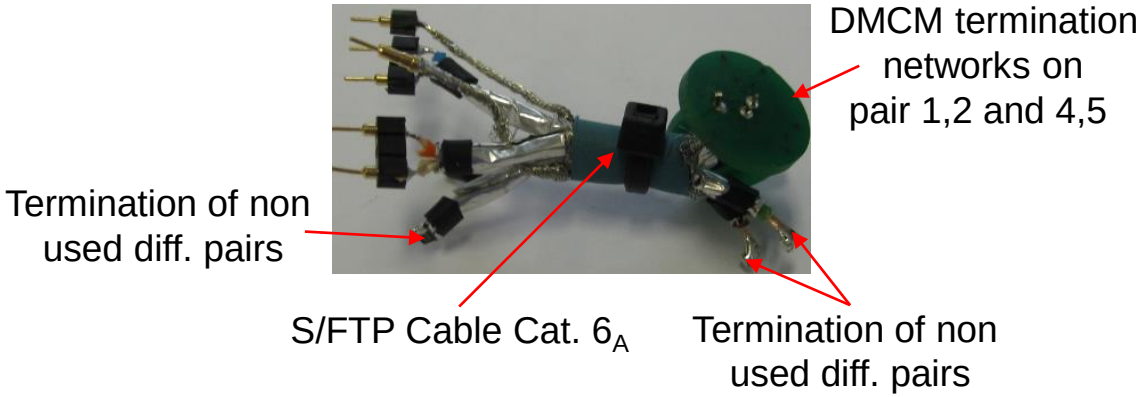
General preparation

Interconnections

Interconnection between test sample and test fixture GHMT 1T15-012

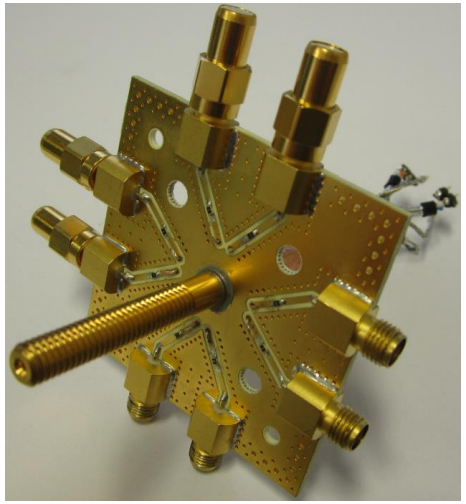


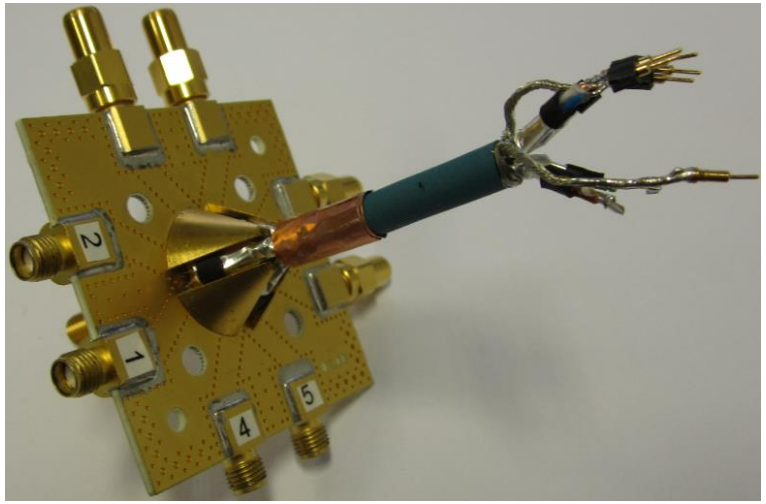
Interconnection between test sample and termination network

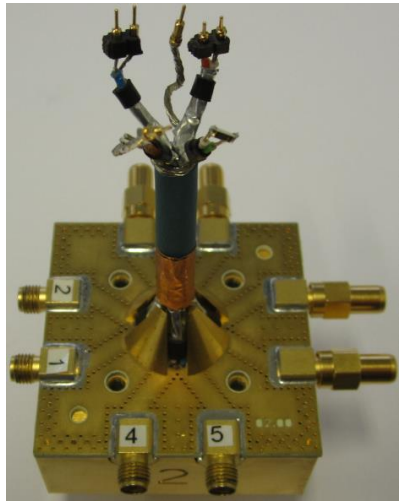


General preparation

Test fixture and interconnection







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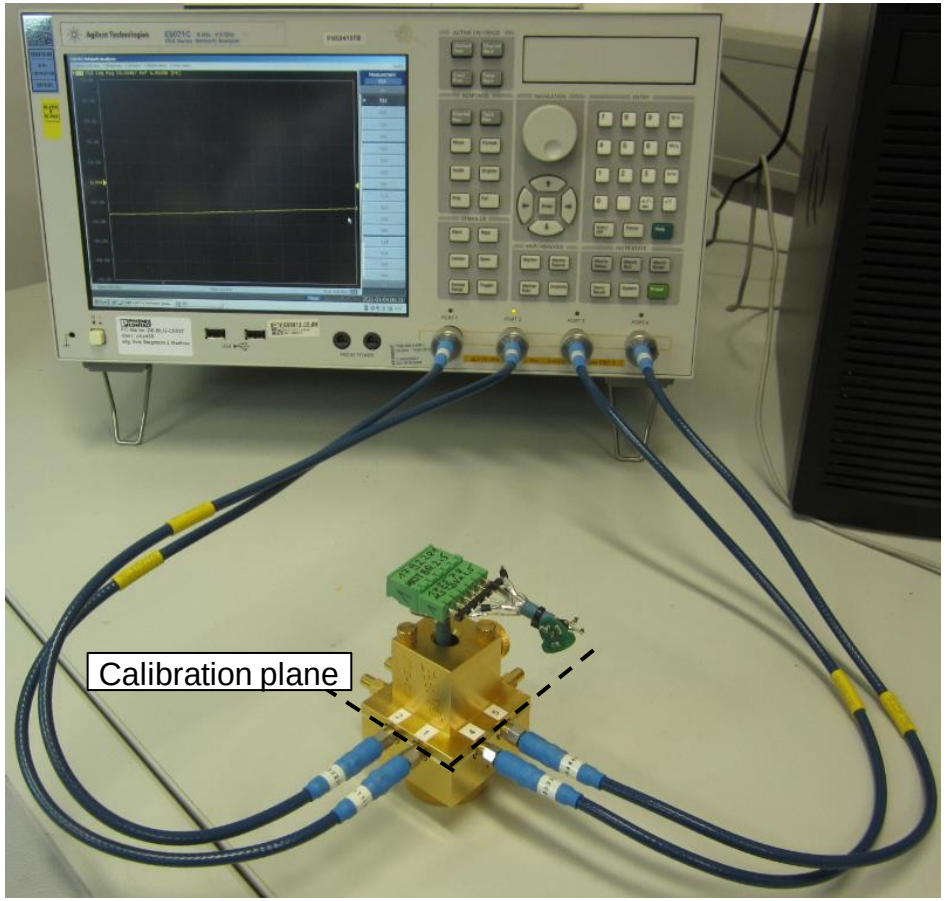
Experimental procedure

Test setup

- Parameters and requirements
  - Start-frequency: 0,1 MHz
  - Stop-frequency: 100 MHz
  - Number of measuring points: 1601
  - IF-Bandwith: 100 Hz
  - Calibration: 4-Port-Calibraition with an E-Cal at the SMA-connectors
  - Requirements: APL Port Profile Specification Draft 0.8 Table A.2 – Electrical requirements terminal / block connector

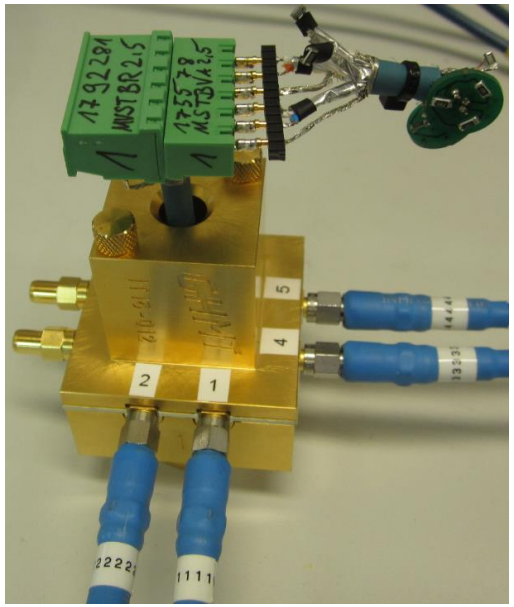


Experimental procedure

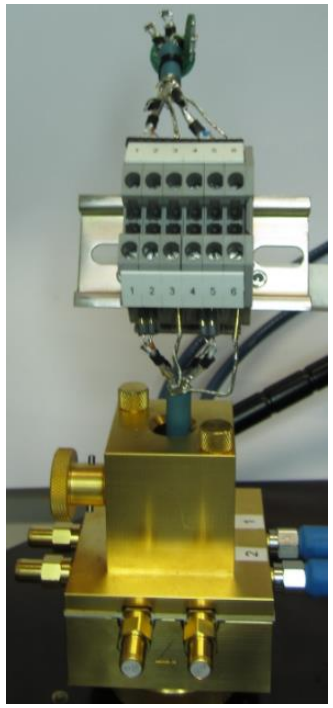
Test setup

- Test setup with different test samples

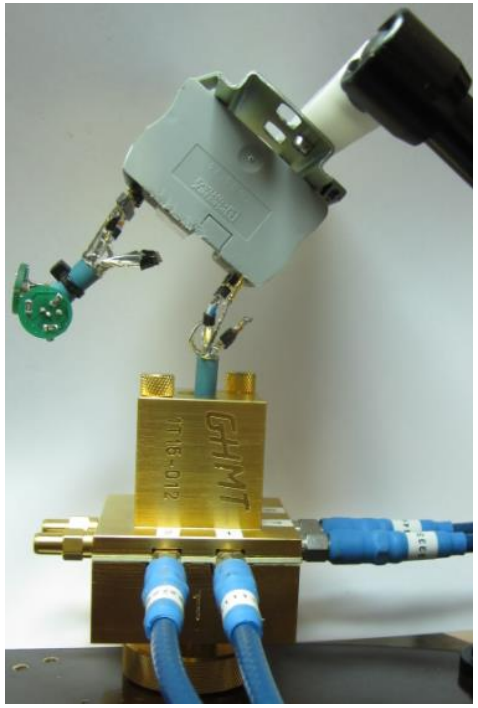
Art.-Nr.: 1792281 & 1755778



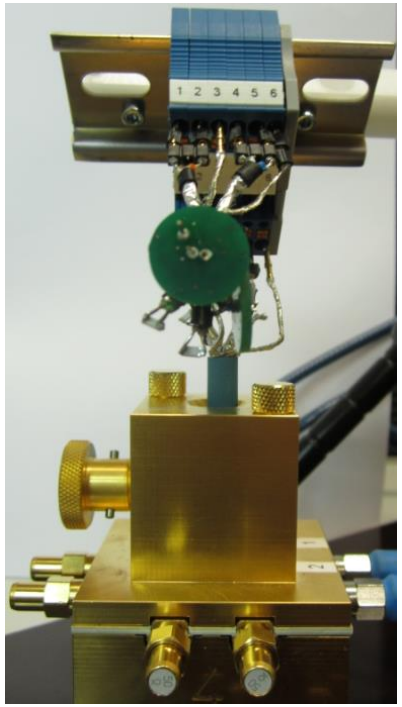
Art.-Nr.: 3044076 (UT 2,5)



Art.-Nr.: 3031212 (ST 2,5)



Art.-Nr.: 3208126 (PT 1,5/S BU)



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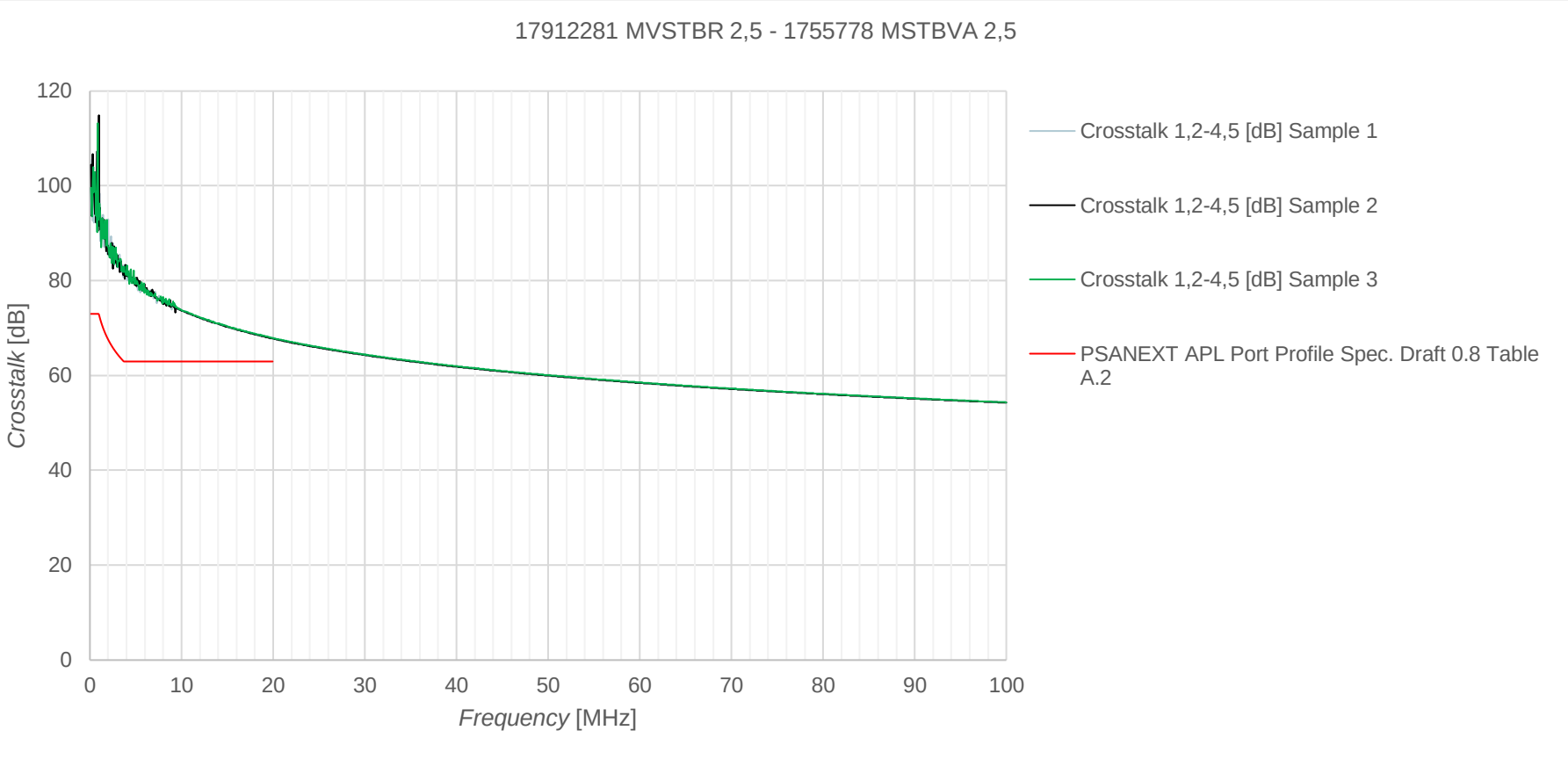
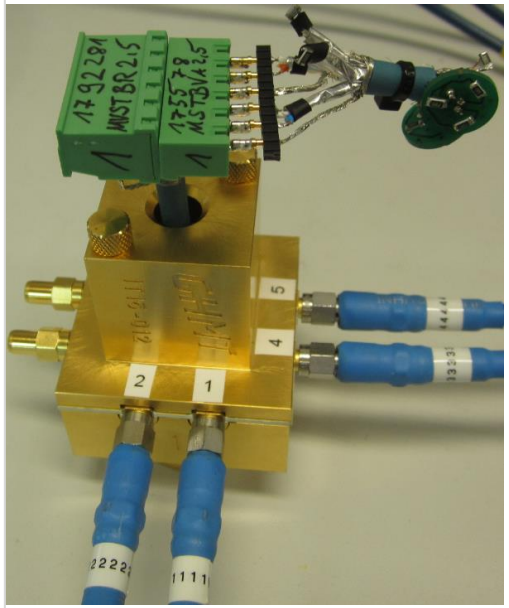
Results

Art.-Nr.: 1792281 & 1755778 (MSTB)





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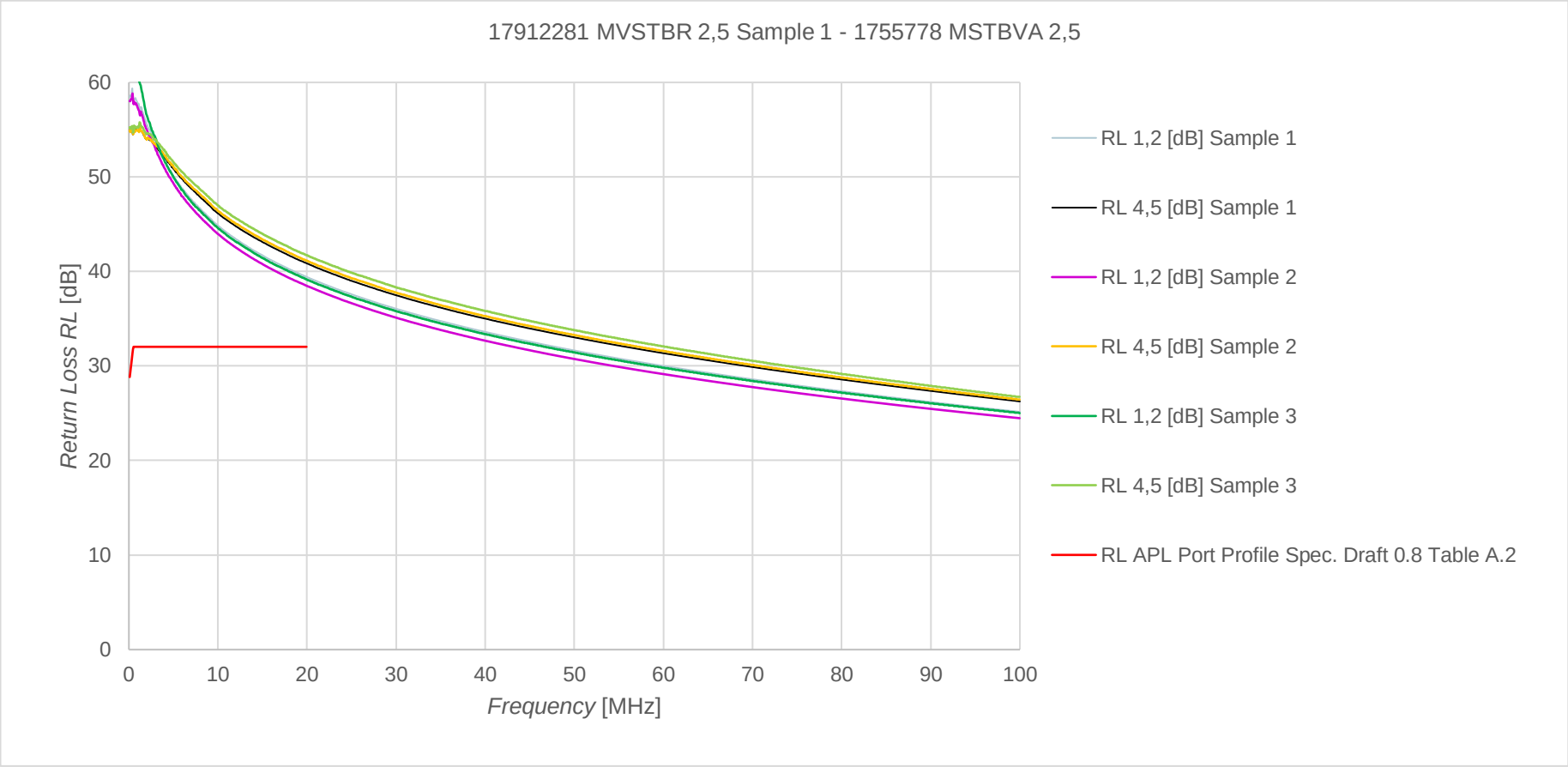
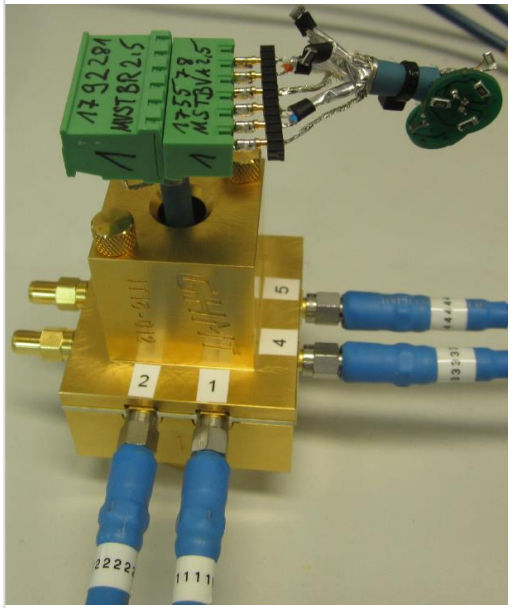
Results

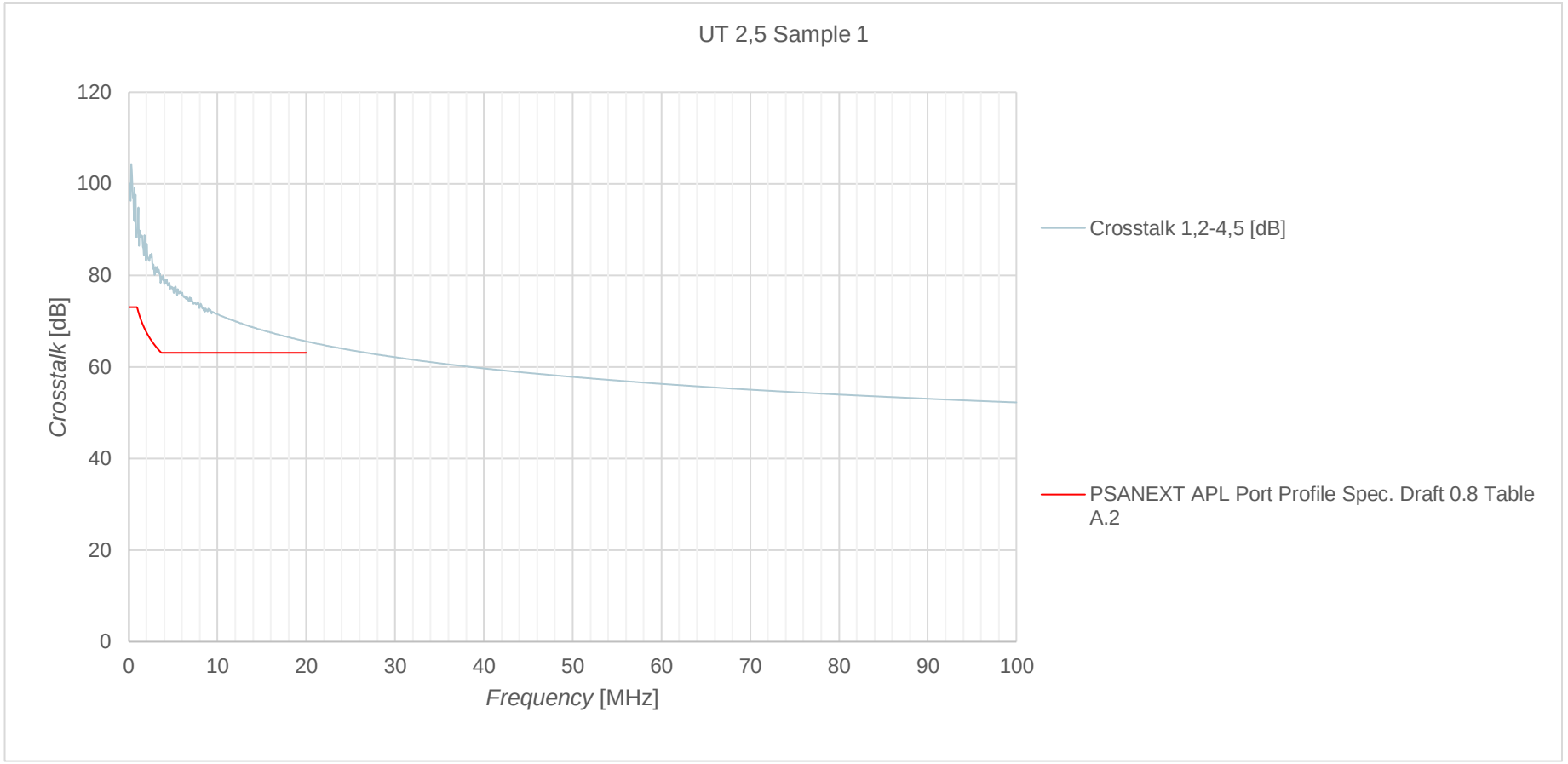
Art.-Nr.: 1792281 & 1755778 (MSTB)

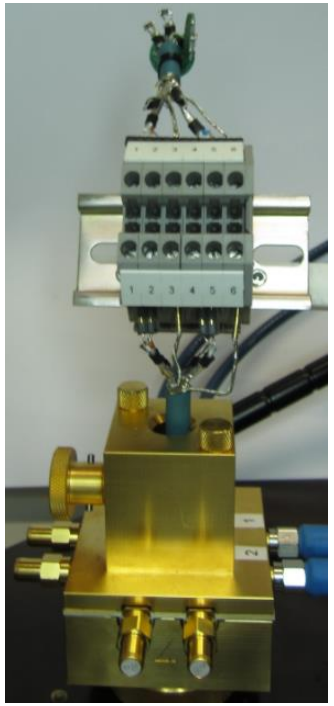




Results

Art.-Nr.: 3044076 (UT 2,5)





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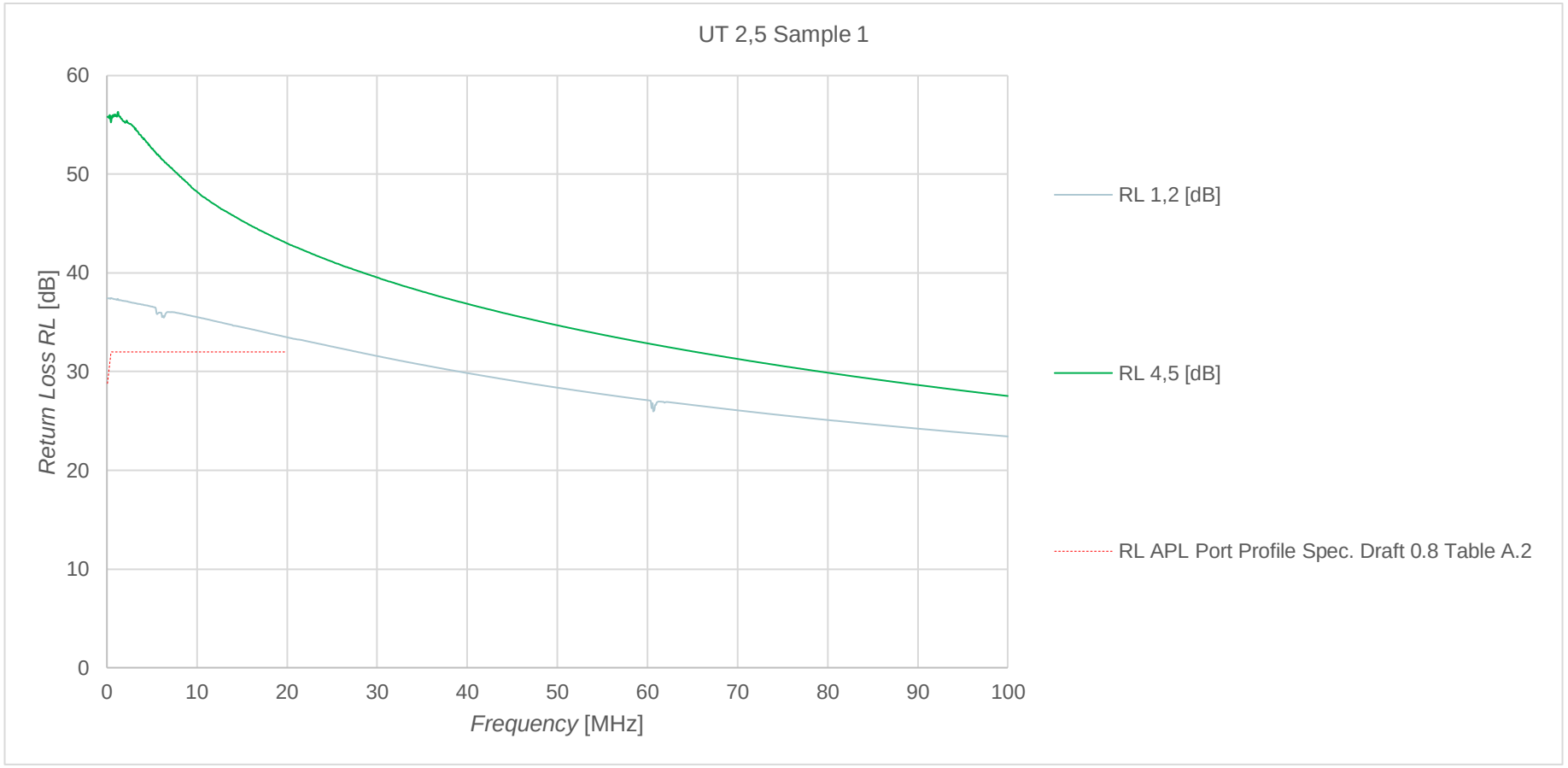
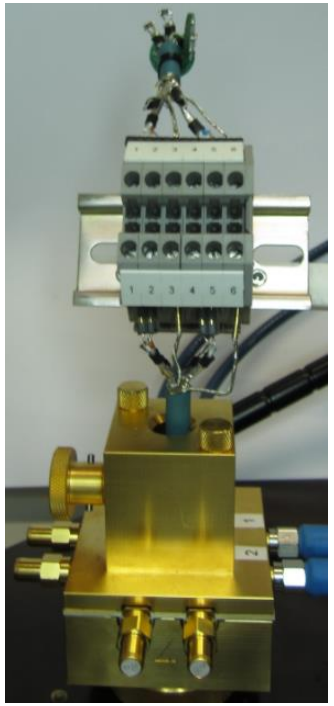
Results

Art.-Nr.: 3044076 (UT 2,5)





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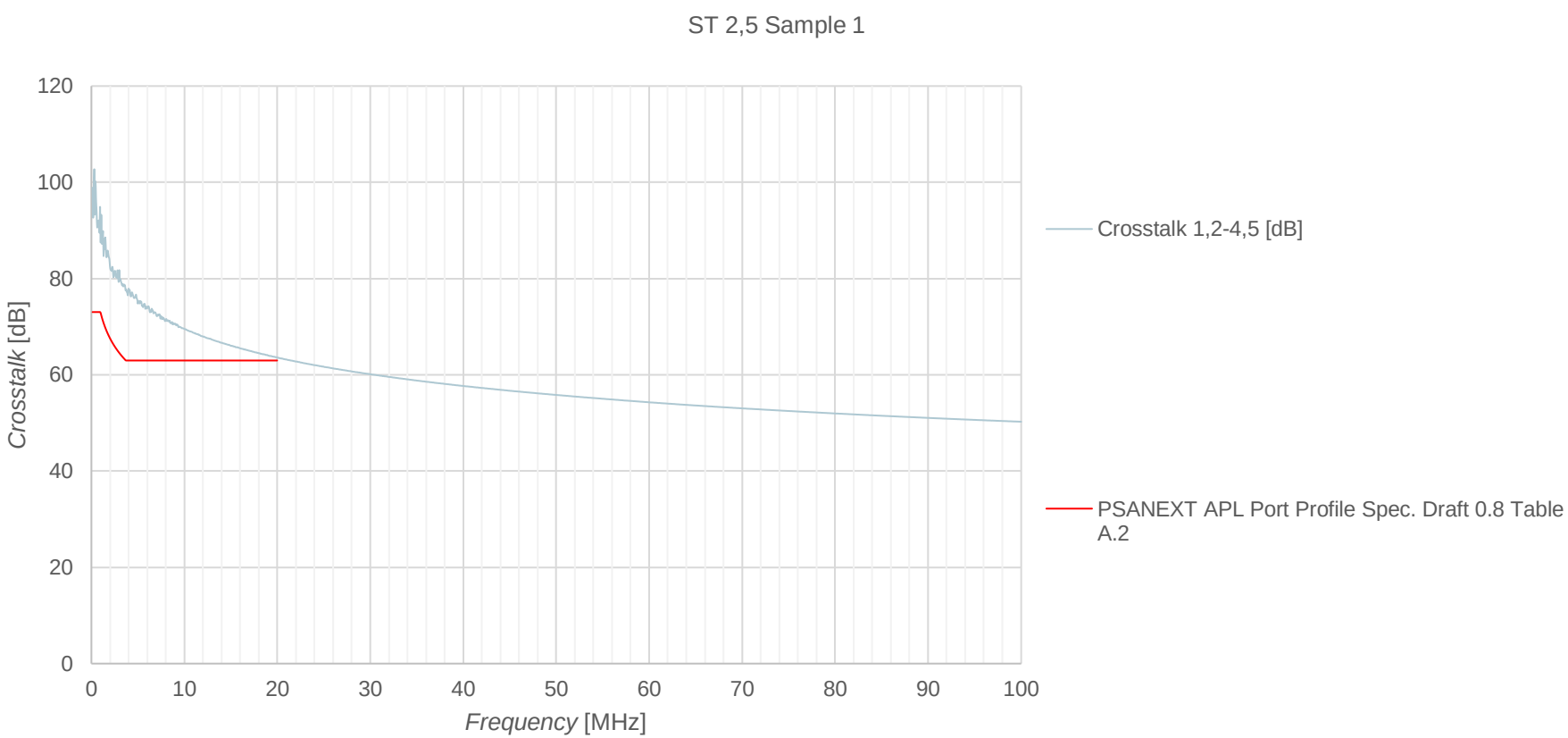
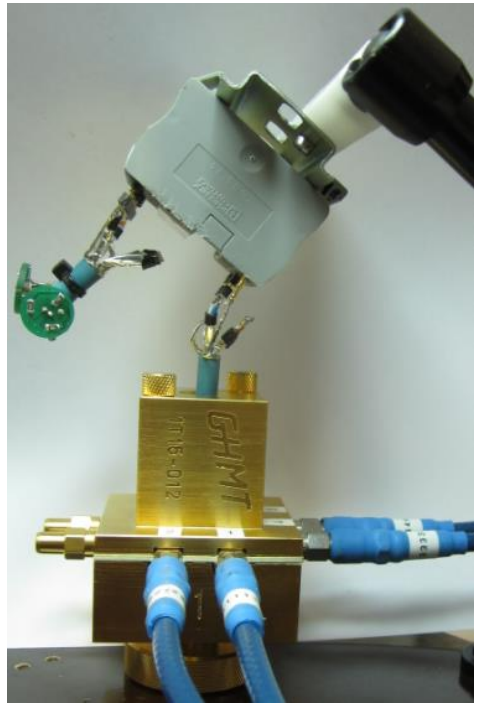
Results

Art.-Nr.: 3031212 (ST 2,5)





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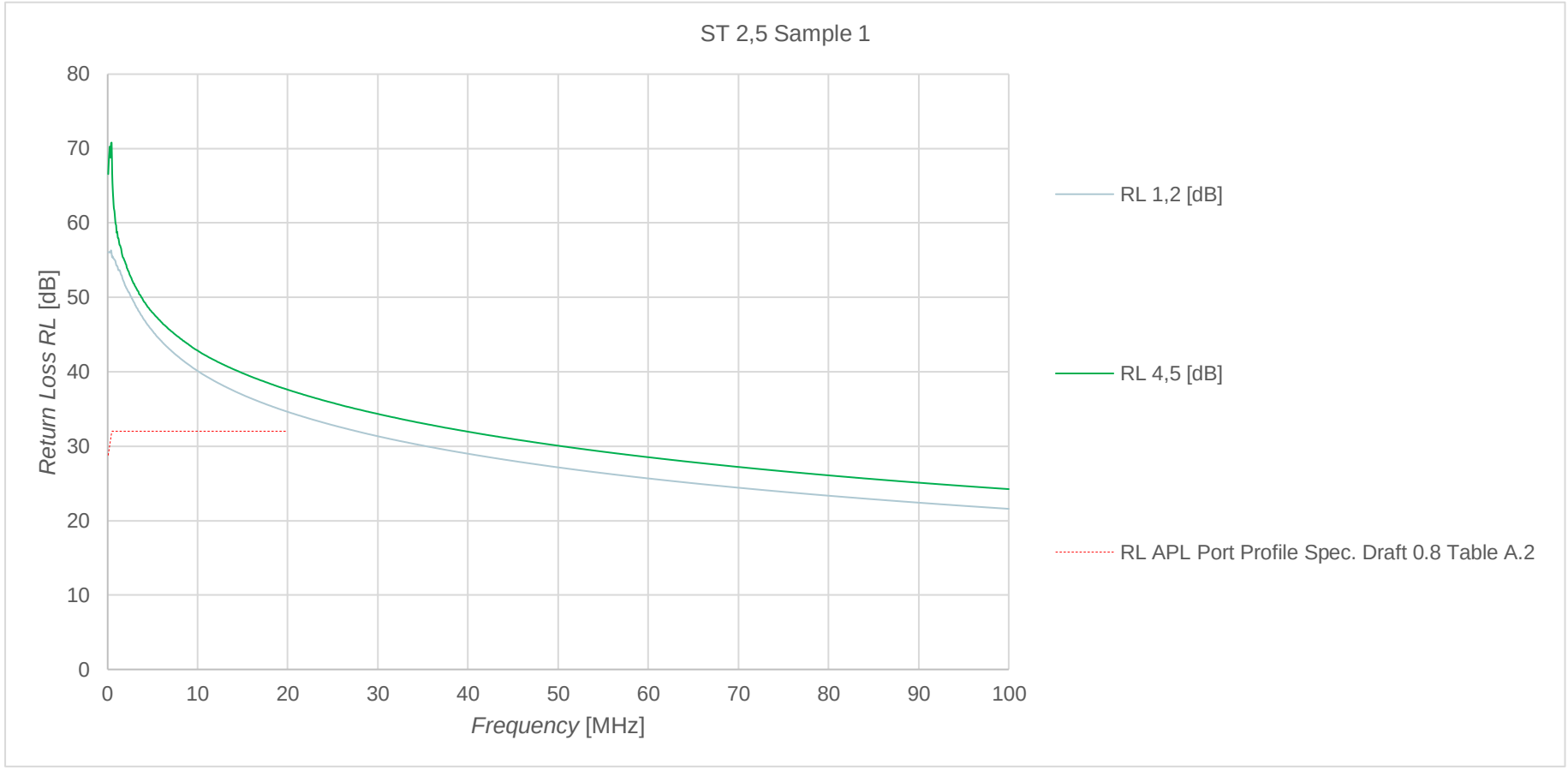
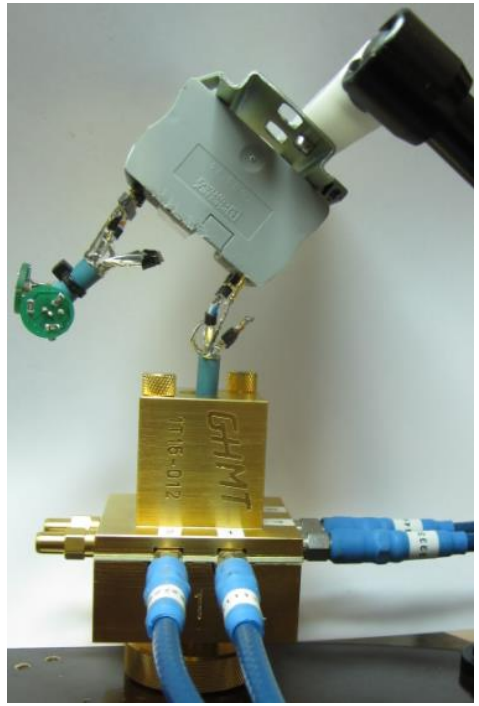
Results

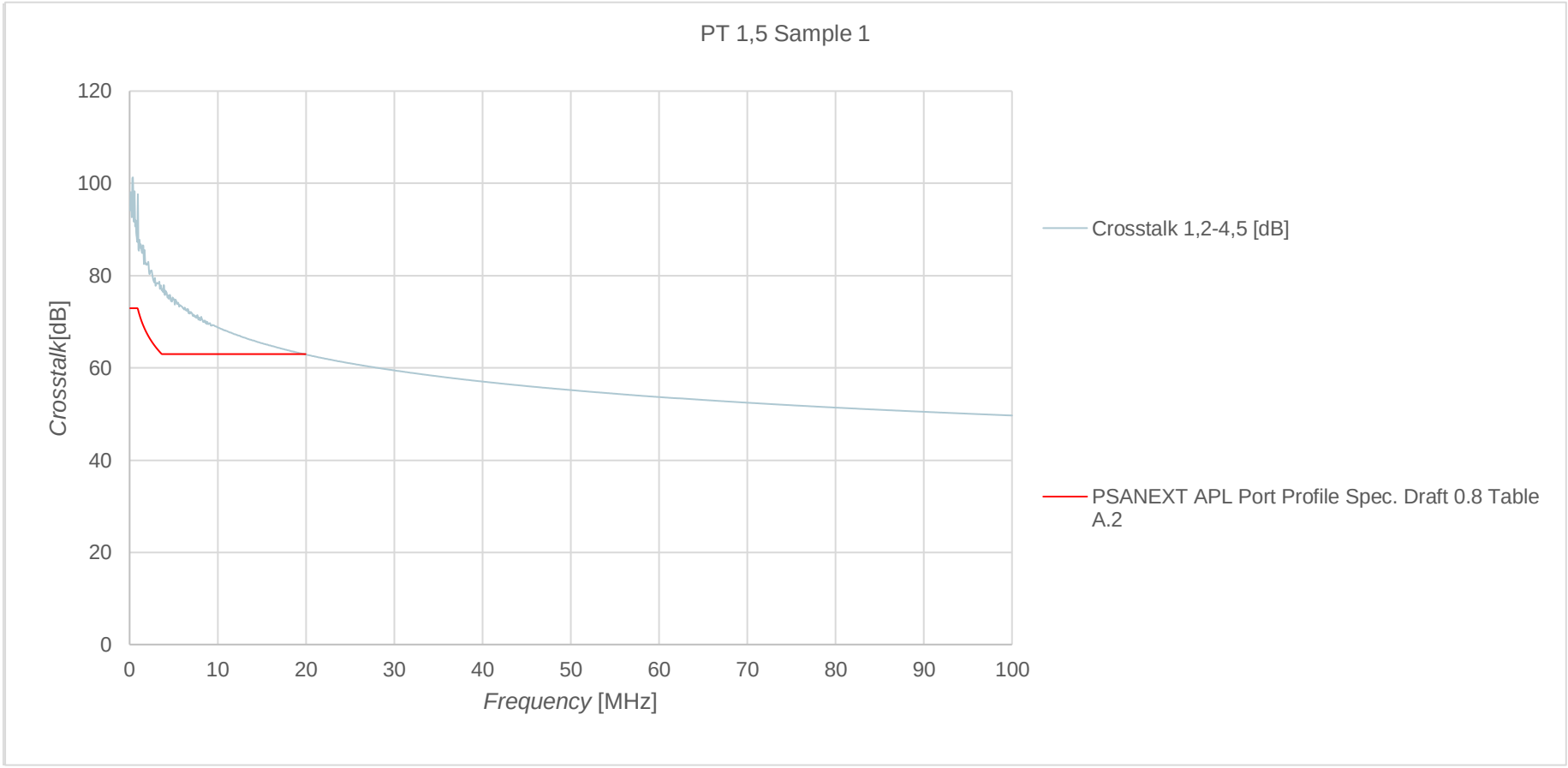
Art.-Nr.: 3031212 (ST 2,5)

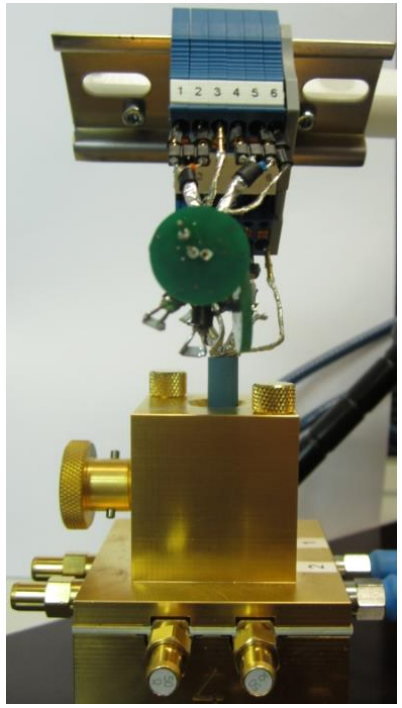




Results

Art.-Nr.: 3208126 (PT 1,5/S BU)





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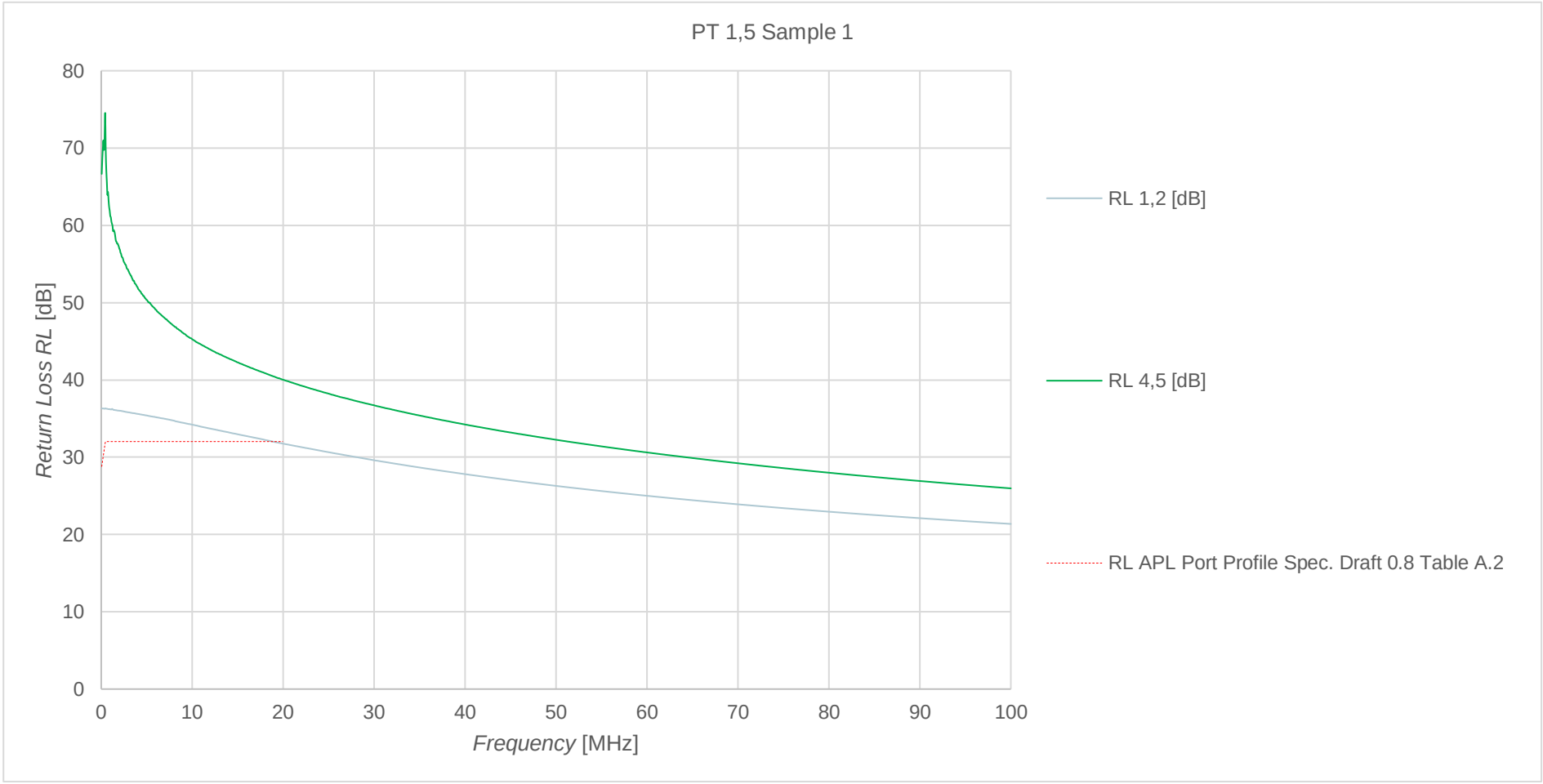
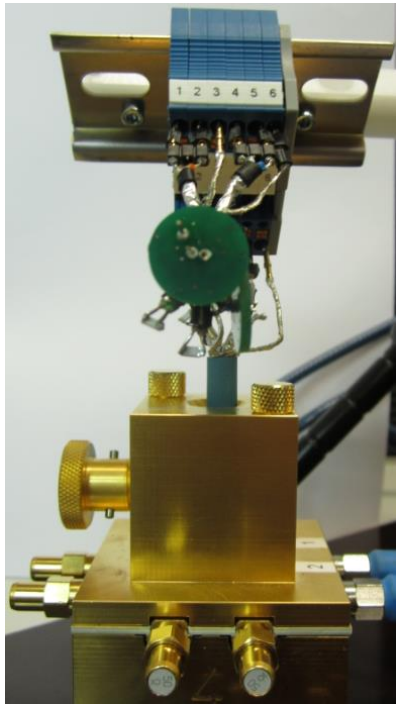
Results

Art.-Nr.: 3208126 (PT 1,5/S BU)





Resumee

- All products comply with the limits up to 20MHz
- For higher frequencies the limits shall be adjusted
- In general, a lower edge steepness and thus harmonic frequency is advantageous
- Higher codings are rather uncritical because of the measures taken to limit crosstalk
- For further investigations, agreed measurement setups and limit values are necessary