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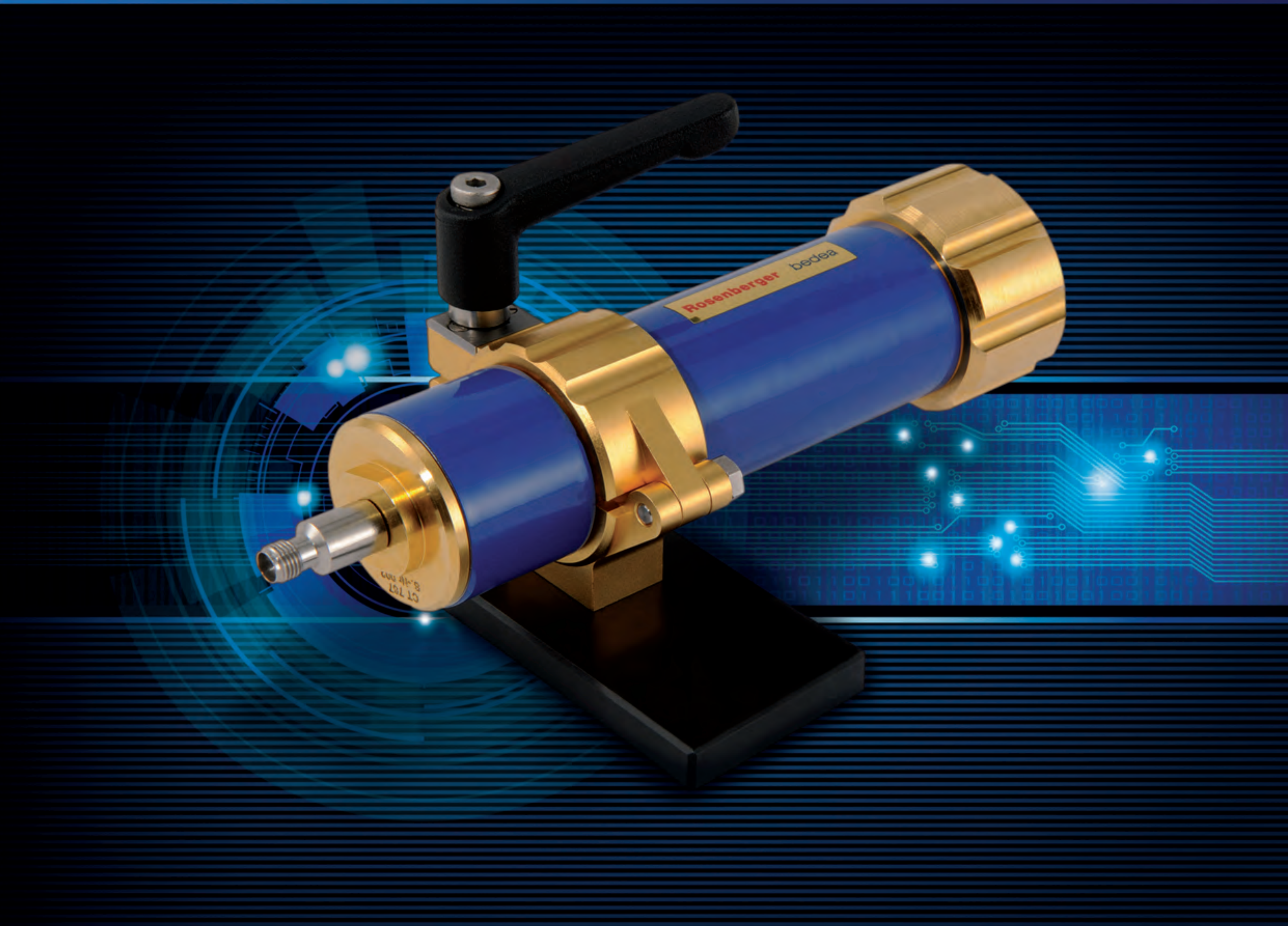
Guidant Test Measurement

Brief information CoMeT



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The measuring system CoMeT

In the context of increasing of any kind of electromagnetic interference, investigation of electromagnetic compatibility (EMC) of electrical and electronic systems is of growing importance.

The CoMeT system measures in accordance to the proven and international standardized triaxial test method. The test method is not sensitive to external electromagnetic interference and fast and well reproducible. The measuring range is from DC to 12 (18) GHz. There is no emission of electromagnetic interference. Transfer impedance and Screening attenuation of communication cables and cable assemblies can be measured with one test set-up. By the Triaxial cell, special attention is paid to the shielding effectiveness of HV-cables for electric vehicles.

Rosenberger and *bedea* are world-class companies. Combined with these names are trend setting high frequency technologies, standard custom solutions as well as cable connections for highest user demands.

With the different types CoMeT 40, CoMeT 90, CoMeT K and the different sizes of Triaxial cells, a family of products for the measurement of EMC performance of almost all components is available.

CoMeT accessories

For the CoMeT-System a huge array of accessories is available. CoMeT accessories are described under: http://www.bedea.com/html_d/mt-comet.html

Content

The test system CoMeT is a modular system for measuring EMC respectively Transfer impedance and Screening- or Coupling attenuation of screened cables, connectors or components with the triaxial test procedure according to IEC 62153-4-x

Table 1 – IEC 62153-4-x, Metallic communication cable test methods – Test procedures with triaxial test set-up

IEC 62153-4-X	Metallic Communication Cable test methods - Electromagnetic compatibility (EMC)
IEC/TR 62153-4-1Ed.2	Introduction to electromagnetic (EMC) screening measurements
IEC 62153-4-3Ed.2	Surface Transfer impedance - Triaxial method
IEC 62153-4-4Ed.2	Shielded screening attenuation, test method for measuring of the screening attenuation a_S up to and above 3 GHz
IEC 62153-4-7	Shielded screening attenuation test method for measuring the Transfer impedance Z_T and the screening attenuation a_S or the coupling attenuation a_C of RF-Connectors and assemblies up to and above 3 GHz, Tube in tube method
IEC 62153-4-9	Electromagnetic Compatibility (EMC) – Coupling attenuation, triaxial method
IEC 62153-4-10	Shielded screening attenuation test method for measuring the Screening Effectiveness of Feedtroughs and Electromagnetic Gaskets
IEC 62153-4-15	Test method for measuring transfer impedance and screening attenuation - or coupling attenuation with Triaxial Cell
IEC 62153-4-16	Technical report on the relationship between transfer impedance and screening attenuation (under consideration)
EN 50289-1-6	Surface transfer impedance - Triaxial method and screening attenuation - Triaxial method

Derived of these standards are numerous regional and national standards and standards of other organizations

Transfer impedance and Screening attenuation, IEC 62153-4-3 und IEC 62153-4-4

Evaluation of screening effectiveness

The measure of the screening behaviour of the screens of coaxial and symmetrical cable screens is the Transfer impedance Z_T in the lower frequency range up about to 100 MHz as well as the Screening attenuation a_S in the upper frequency range from 30 MHz upwards.

The Screening attenuation a_S is defined as the logarithmic ratio of the input power P_1 to the radiated power P_2.

Screening attenuation: $a_S = 10 \log |P_1/P_2|$

The transfer impedance Z_T [mΩ/m] is defined as quotient of the longitudinal voltage U_1 induced to the inner circuit by the current I_2 fed into the outer circuit or vice versa, (see EN 50289-1-6 respectively IEC 62153-4-3).

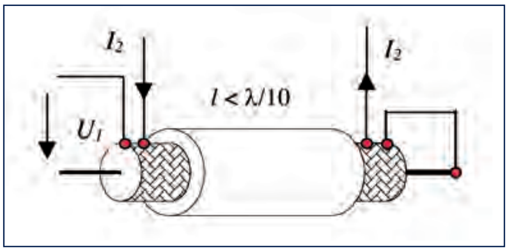


Figure 1: Definition of Z_T

The value Z_T of an electrically short screen is expressed in ohms [Ω] or decibels in relation to 1Ω.

$$Z_T = \frac{U_1}{I_2} \qquad\qquad Z_T\ \mathrm{dB}(\Omega) = +20 \cdot \log_{10}\left(\frac{|R_K|}{1\Omega}\right)$$

Coupling transfer function

The Coupling transfer function $T_{n,f}$ gives the relation between the Screening attenuation a_S and the Transfer impedance Z_T of a screened element like a coaxial cable or a coaxial connector (n = near end, f = far end). In the lower frequency range, where the samples are electrically short, the Transfer impedance Z_T can be measured up to the cut-off frequencies $f_{cn,f}$. Above these cut off frequencies $f_{cn,f}$ in the range of wave propagation, the Screening attenuation a_S is the measure of screening effectiveness. In case of cables, the cut-off frequencies $f_{cn,f}$ may be moved towards higher or lower frequencies by variation of the length of the cable under test.

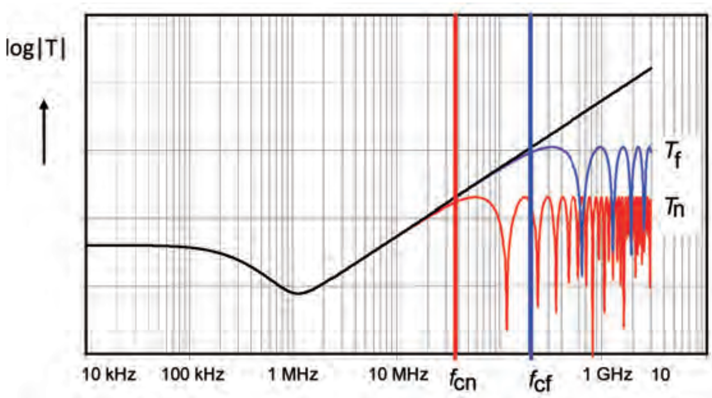


Figure 2: Calculated Coupling transfer function $T_{n,f}$ of a braided screen

The measurement of the Transfer impedance, the Screening attenuation and the Coupling attenuation of communication cables is described in IEC 62153-4 respectively in EN 50289-1-6, triaxial test method.

Up to now, to measure Transfer impedance and Screening attenuation two different test set-ups were necessary, e.g. triaxial tube and absorbing clamps.

With the new measuring tube CoMeT both, the Transfer impedance Z_T in the lower frequency range up to about 100 MHz as well as the Screening attenuation a_S in the higher frequency range up to and above 3 GHz (12 GHz) can be measured. Furthermore, measurements of the Coupling attenuation a_C of screened balanced cables can be made. The Coupling attenuation a_C is the sum of the unbalance attenuation of the pairs and the Screening attenuation of the screen.

Measure Transfer impedance and Screening attenuation

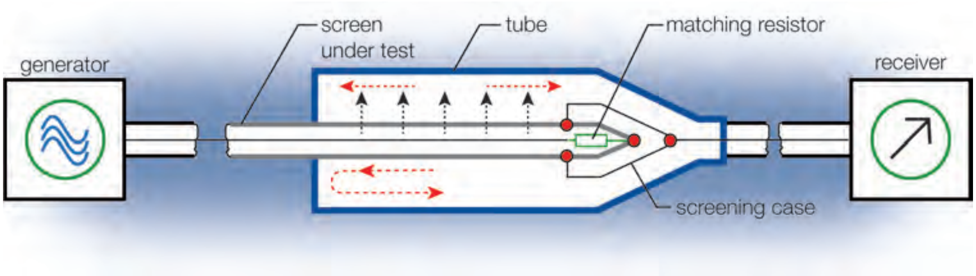


Figure 3: Principle test set-up to measure Transfer impedance and Screening attenuation

Coupling attenuation

Measuring of Coupling attenuation of balanced cables and connectors in the tube is in principle the same as measuring of the Screening attenuation, but the device under test shall be fed with a differential signal.

Up to frequencies of about 1 GHz, the device under test may be fed with a balun, but baluns are commercial available up to 1.2 GHz only. At frequencies above 1 GHz, the use of a multiport network analyser is recommended. The DUT is fed by two generators, where the signal of the 2nd generator has a phase shift of 180°.

At the far end, the DUT is matched with a symmetric/asymmetric load. In that way, both, the common mode as well as the balanced mode are matched.

Measuring of Coupling attenuation

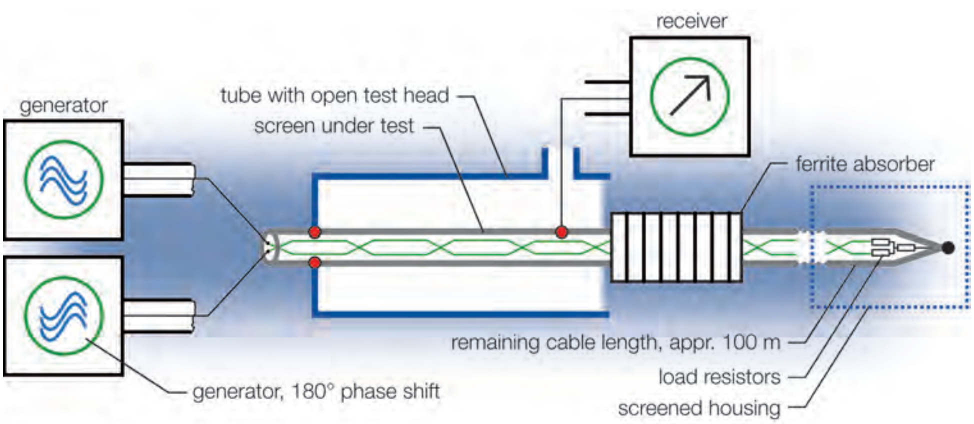


Figure 4: Principle test set-up to measure coupling attenuation

Advantages of the system

Advantages of the CoMeT System:

- insensitive against electromagnetic disturbances from outside,
- no radiation of electromagnetic power,
- high dynamic range > 125 dB, (depending on the sensitivity of the NWA only),
- high reproducibility,
- simple and easy set-up,
- fast preparing of the sample under test,
- only one measurement required,
- measure of the screening attenuation a_S and the transfer impedance Z_T with one test fixture,
- large frequency range from DC up to 12 GHz.

Cut off frequencies:

The upper cut off frequency results from the definition of the wave propagation of transversal electromagnetic waves (TEM-waves) which is given by:

$$f_g = \frac{2 \cdot c_0}{\pi \cdot \sqrt{\varepsilon_{r2}} \cdot (D_2 + d_1)}$$

where d_1 is the outer diameter of the braid of the CUT, D_2 is the inner diameter of the measuring tube and ε_{r2} is the resulting dielectric permittivity of the outer system.

With an inner diameter of 40 mm of the tube and an outer diameter of about 3,5 mm of the braid, the cut off frequency of the system is about 4,2 GHz.

The influence of higher modes may be neglected in case of symmetric set-up, (DUT is centred proper in the middle of the tube). With the high precision test head 40/3, one can measure up to 12 GHz.

The lower cut off frequency to measure the screening attenuation a_S (electrical long cables) and the upper frequency limit to measure the transfer impedance Z_T (electrical short cables) are given by the definition of electrically long and electrically short by:

Electrical lengths

electrically long:

$$\lambda_o / L \leq 2 \cdot \left| \sqrt{\varepsilon_{r1}} - \sqrt{\varepsilon_{r2}} \right| \quad \text{or} \quad f > \frac{c_o}{2 \cdot L \cdot \left| \sqrt{\varepsilon_{r1}} - \sqrt{\varepsilon_{r2}} \right|}$$

resp. electrically short:

$$\lambda_o / L > 10 \cdot \sqrt{\varepsilon_{r1}} \quad \text{or} \quad f < \frac{c_o}{10 \cdot L \cdot \sqrt{\varepsilon_{r1}}}$$

where

L	is the coupling length in the tube
λ_0	is the wave length of free space
ε_{r1}	is the dielectric permittivity of the CUT
ε_{r2}	is the dielectric permittivity of the outer system
f	is the frequency in Hz

Due to the variable length of the tube, the frequency limits may be varied in a wide range.

Mechanical construction CoMeT 40

The test set-up CoMeT 40 consists of a tube of 0,5 m and of 3 tubes of 1 m, which may be coupled together RF-tight by tube clamps as well as of a test head and a screening cap.

Simple and easy sample preparation

Integrated combined with the measuring head is a screening cap to keep the matching resistor of the cable under test and to connect the cables screen to the tube. The special designed test head takes the screening cap and matches the tube to the 50 Ohm input resistance of the receiver.

Except of soldering the terminating resistor between inner and outer conductor of the cable under test there is no need for further soldering during the preparing of the sample.

Only the cables sheath has to be removed in the connecting area.

On the generator side, the screen is connected to the tube with contact slices.

The required accessories for connecting cable screens in the diameter range from 2,3 mm up to 9,8 mm are attached to the test fixture.

With this equipment, cable screens up to 9,8 mm diameter can easily be mounted.

All parts of the equipment are fixed in a robust case which allows shipment by any means of transportation.

Figure 5: CoMeT 40-components

Scope of supply CoMeT 40

- Matched test head with screening cap for matching resistor,
- suitable for cable screens from Ø 2,3 mm to Ø 9,8 mm,
- contact slices for the connection of the cable screens at the near end from 2,3 mm to 9,8 mm,
- set consisting of one tube of 0,5 m length and 3 tubes of 1,0 m length, including quick releasefastener,
- robust transportation case

large selection of accessories

Figure 6a: Test set-up CoMeT 40, Scope of supply, level 1

Figure 6b: Test set-up CoMeT 40, Scope of supply, level 2

Mechanical construction CoMeT 90

For cables with larger diameters, e.g. screened power cables, a larger test set is available. Following the same mechanical and electrical principles of the CoMeT 40, cables with screen diameters from 7,8 mm up to 22 mm can be tested. The tube length of 0,45 m (0,3 m active length) allows measurements of transfer impedance up to approx. 100 MHz.

Scope of supply of the CoMeT 90-System

Figure 7a: Test set-up CoMeT 90, supply schedule, box 1

Figure 7b: Test set-up CoMeT 90, supply schedule, box 2

Construction of the CoMeT 90-System

The test set-up CoMeT 90 is configured modular and allows measurements on cable length of 0,3 m 0,5 m and 1 m.

The screening cap is used to accommodate the terminating resistor of the DUT and for contacting of the shield of the DUT within the tube. The specially designed test head is used to receive the shielding sleeve and to adjust the tube to the 50 Ohm input impedance of the receiver.

Besides the soldering of the matching resistor between the inner conductor and screen of the specimen, no further soldering is required for preparation of the DUT. Only the sheath of the cable under test is to be removed at the near end to make the contact (the short circuit) to the tube.

The short circuit at the near end between the screen and the tube is achieved with contact slices.

The required accessories for connection of cable shields in the diameter range from 7,8 mm to 22,0 mm are included in appropriate increments.

Tube in tube, IEC 62153-4-7

The „tube in tube“-procedure is an extension of the procedures to measure Transfer impedance and Screening attenuation according to IEC 62153-4-3 und IEC 62153-4-4.

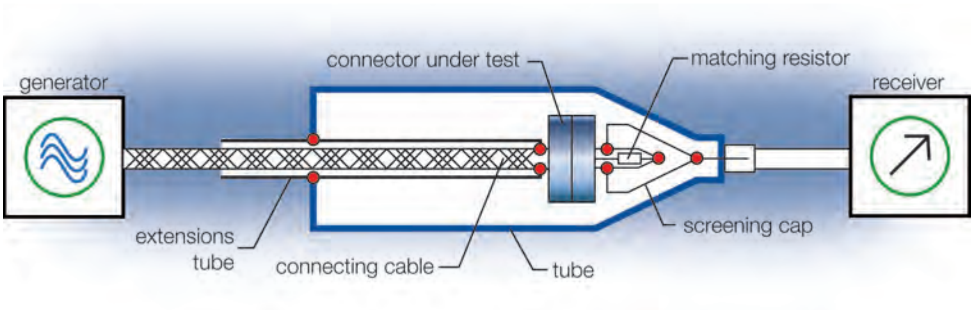


Figure 8: Transfer impedance and Screening attenuation with „tube in tube“-procedure according to IEC 62153-4-7

test sample enlarging

With an RF-tight extension tube the electrical short connector is extended and the cut off frequency of the transition from Transfer impedance to Screening attenuation is shifted towards lower frequencies.

Figure 9: Accessories „tube in tube“

Triaxial Cell, IEC 62153-4-15

Larger connectors and assemblies do not fit into the basic tubes of the CoMeT-System.

EMC of CATV-components and of HV-connectors

The Triaxial Cell was designed to test larger connectors and assemblies.
The principles of the triaxial test procedures according to the IEC 62153-4-x series can be transferred to rectangular housings. Tubes and rectangular housings can be operated in combination in one test set-up.

The screening effectiveness of connectors, assemblies or other devices can be measured in the tube as well as in the Triaxial Cell. Test results of measurements with tube and cell correspond well.

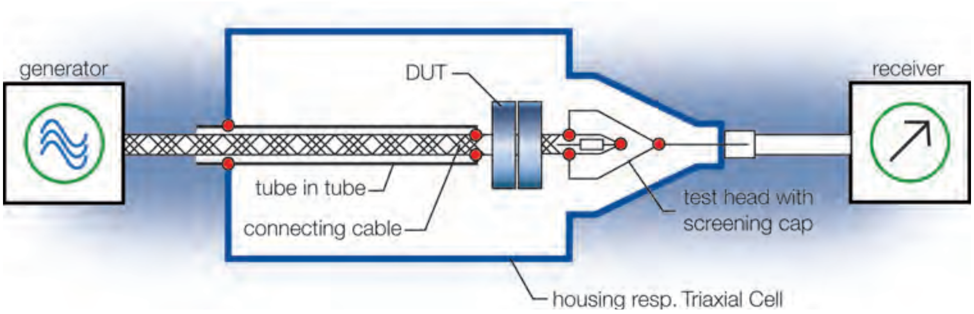


Figure 10: Triaxial Cell, principle

The housing respectively the triaxial cell is in principle a cavity resonator which shows different resonance frequencies, depending on its dimensions.
For a rectangular cavity resonator, the resonance frequencies can be calculated according to the following equation:

$$f_{MNP} = \frac{c_0}{2}\sqrt{\left(\frac{M}{a}\right)^2 + \left(\frac{N}{b}\right)^2 + \left(\frac{P}{c}\right)^2}$$

where

M, N, P	number of modes (even, 2 of 3 > 0)
a, b, c	dimensions of cavity [m]
c_0	velocity of light in free space

Conductive or electrically parts located inside the cell may detune or attenuate cavity resonances.

For the 1000/150 cell, the first resonance frequency is 1,41 GHz.

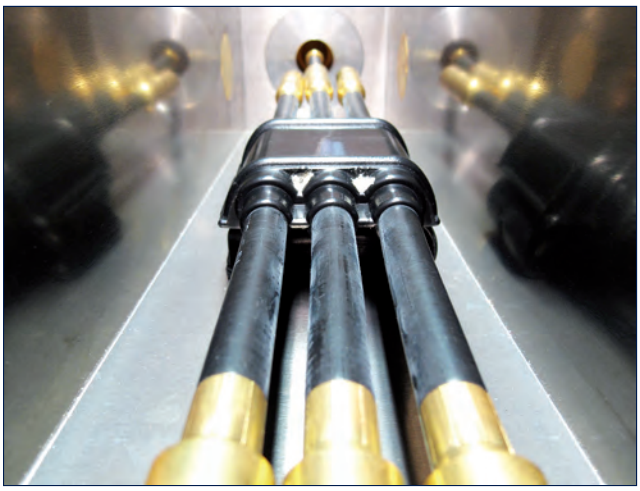


*Figure 11:
CATV tap-off in Triaxial cell*

Figure 11: Different designs of Triaxial Cells of the CoMeT System

The Triaxial cell may be operated with the components of the CoMeT 40 or with the components of the CoMeT 90 depending on the diameter of the connecting cable.

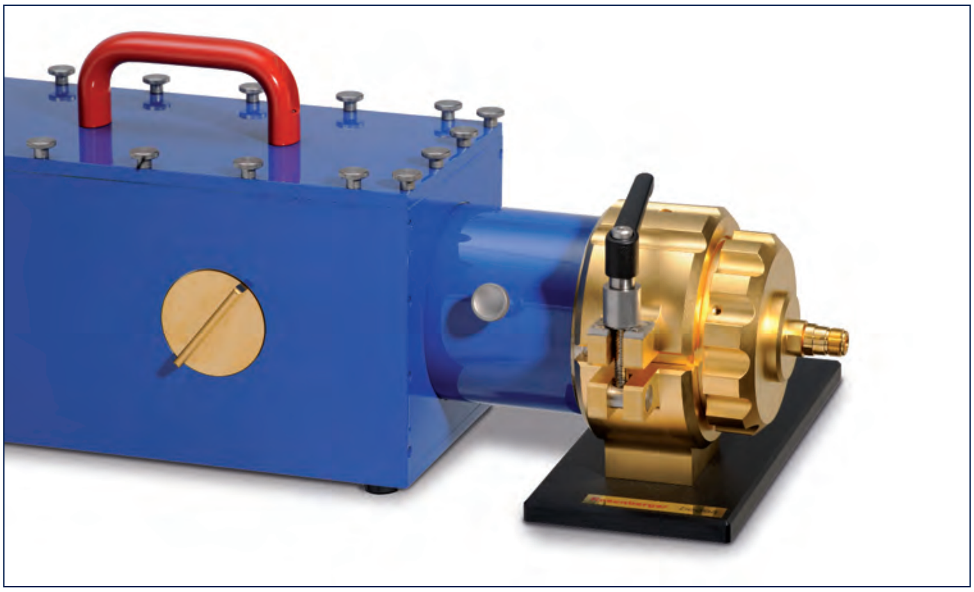


Figure 12: Triaxial cell with test head

CoMeT K – IEC 62153-4-10 –

Measuring of EMC gaskets and feedthroughs

With the test system CoMeT-K, one can measure Transfer impedance and Screening attenuation of EMC gaskets and feedthroughs accurately and reliably.

The test set-up consists of two RF-tight coaxial systems, (double coaxial) which are separated by a metallic shielded wall. This screened wall serves to accommodate the implementation of the EMC gaskets or feedthroughs under test.

EMC of feedthroughs and EMC gaskets

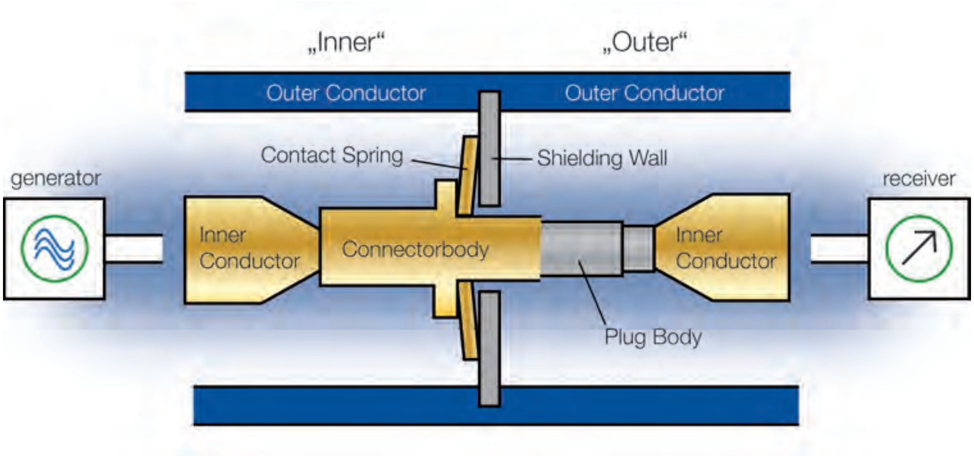


Figure 13: Measuring of EMC gaskets and feedthroughs, principle

High dynamik range without screened room

Advantage of the method is the closed test setup which receives no interference from outside noise power or emits noise to the outside. Thus, a high dynamic range of over 100 dB is possible without measuring cabin.

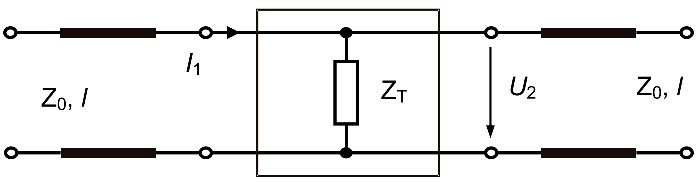


Figure 14: Measuring of EMC gaskets and feedthroughs, equivalent circuit

Using a network analyser (NWA) a high-frequency signal is transmitted to the one side of the specimen and the signal coupled through to the other side is measured. The frequency range extends from a few kHz up to 4 GHz and above.

Figure 15: CoMeT K - Measuring of EMC gaskets and feedthroughs

Control- and evaluation software WinCoMeT

The control- and evaluation software WinCoMeT is a comprehensive tool for measuring all parameters of the Triaxile test procedure. The analysis of the measurements is based on the IEC 62153 series and constantly kept up to date.

Supported test procedures as part of the CoMeT-System:
Measuring, calculation and representation of:
- transfer impedance,
- screening attenuation,
- coupling attenuation,
- coupling transfer function

Controlling of the network analyzer and evaluation of the measurements according to IEC 62153

Additionally the general test procedures on communication cables optionally are supported:
- transmission,
- attenuation,
- attenuation, (open/short procedure),
- return loss including time domain and gating,
- characteristic wave impedance (open/short procedure),
- phase, velocity, electrical length.

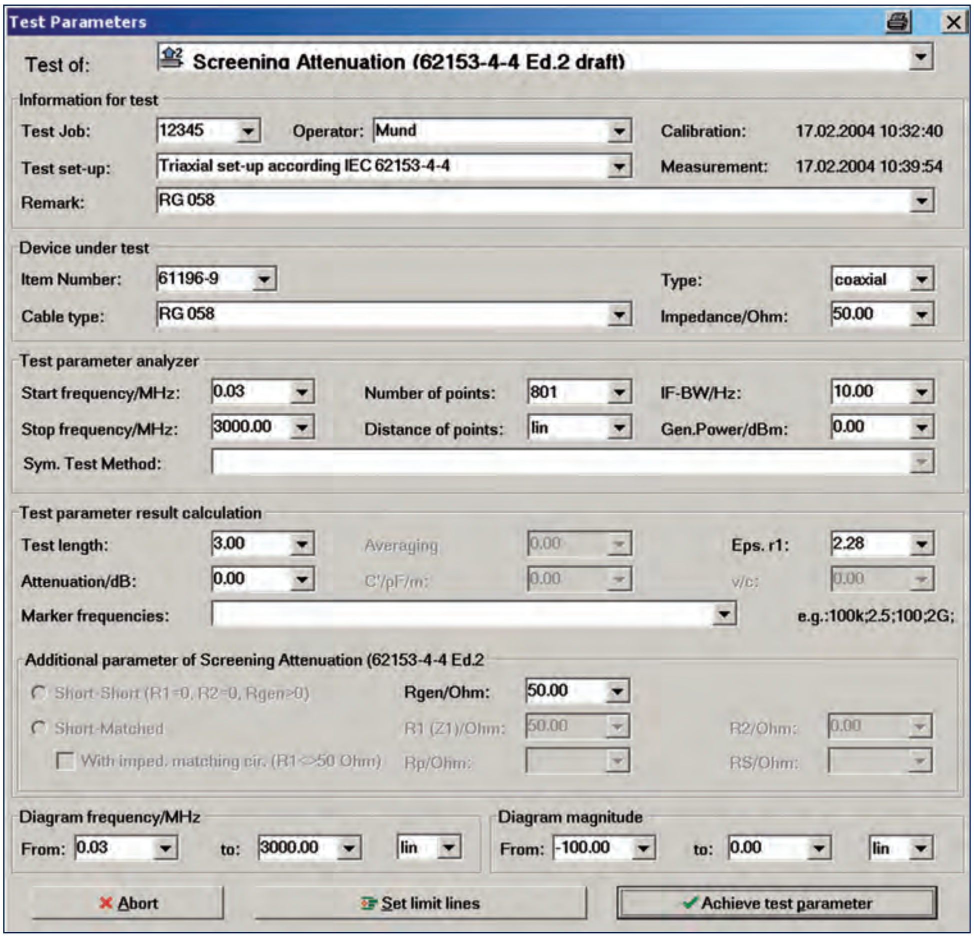
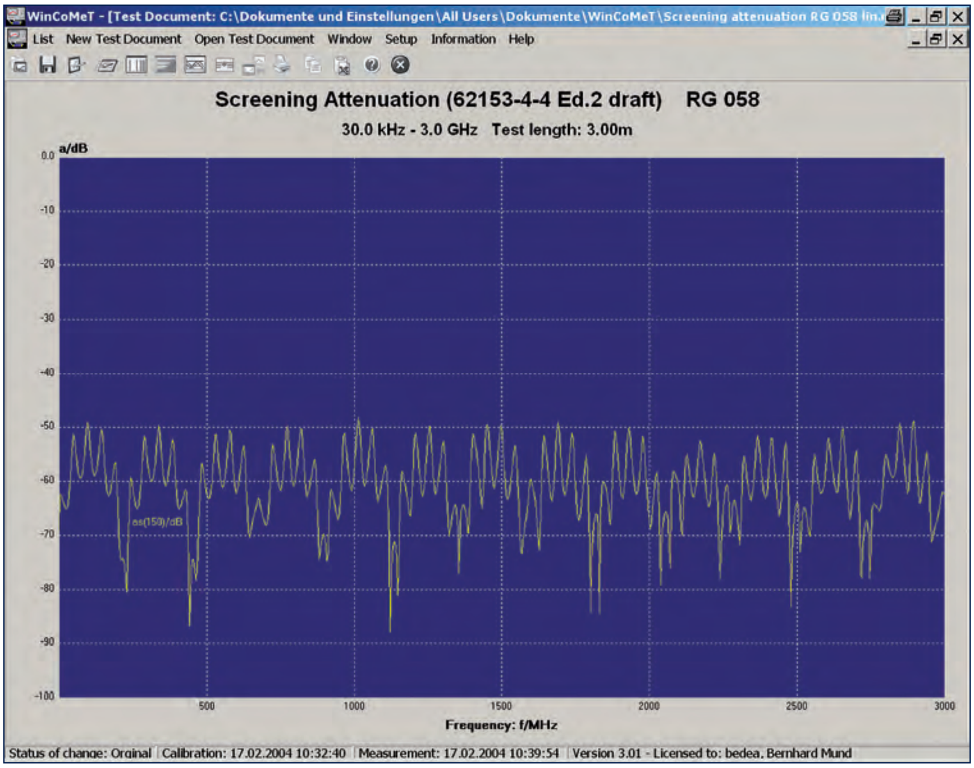


Figure 16: Entry form of test parameters

Functions of the software:
- performing the measurement using a network analyzer,
- storage of test parameters, measurement results including calibration,
- representation of the test results with zoom function in logarithmic or linear display (different measurements can be displayed in simultaneous),
- printing of a test protocol,
- export the graph to the clipboard,
- marker function,
- user-definable limit curves (including MS-Excel import),
- export of all measurement data to MS-Excel,
- Printing of measurement protocols on all installed printers (MS Windows compatible printers and PDF).

Scope of supply:
- software in German and / or English language,
- manual in German and / or English,
- free telephone and e-mails support for 12 months after delivery.

System Requirements:
- PC with MS Windows operating system, (XP/Windows 7 / Windows 8),
- National Instruments GPIB-card (NI488.2) or installed NI-VISA-interface,
- Network analysers from Rohde & Schwarz und Hewlett Packard resp. Agilent, others on request,
- MS-Windows compatible printer (PDF-printer to print test reports in PDF),
- MS-Excel for export of the measurement data and results.



graphical representation of test results

Figure 17: Main screen for displaying the test results

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