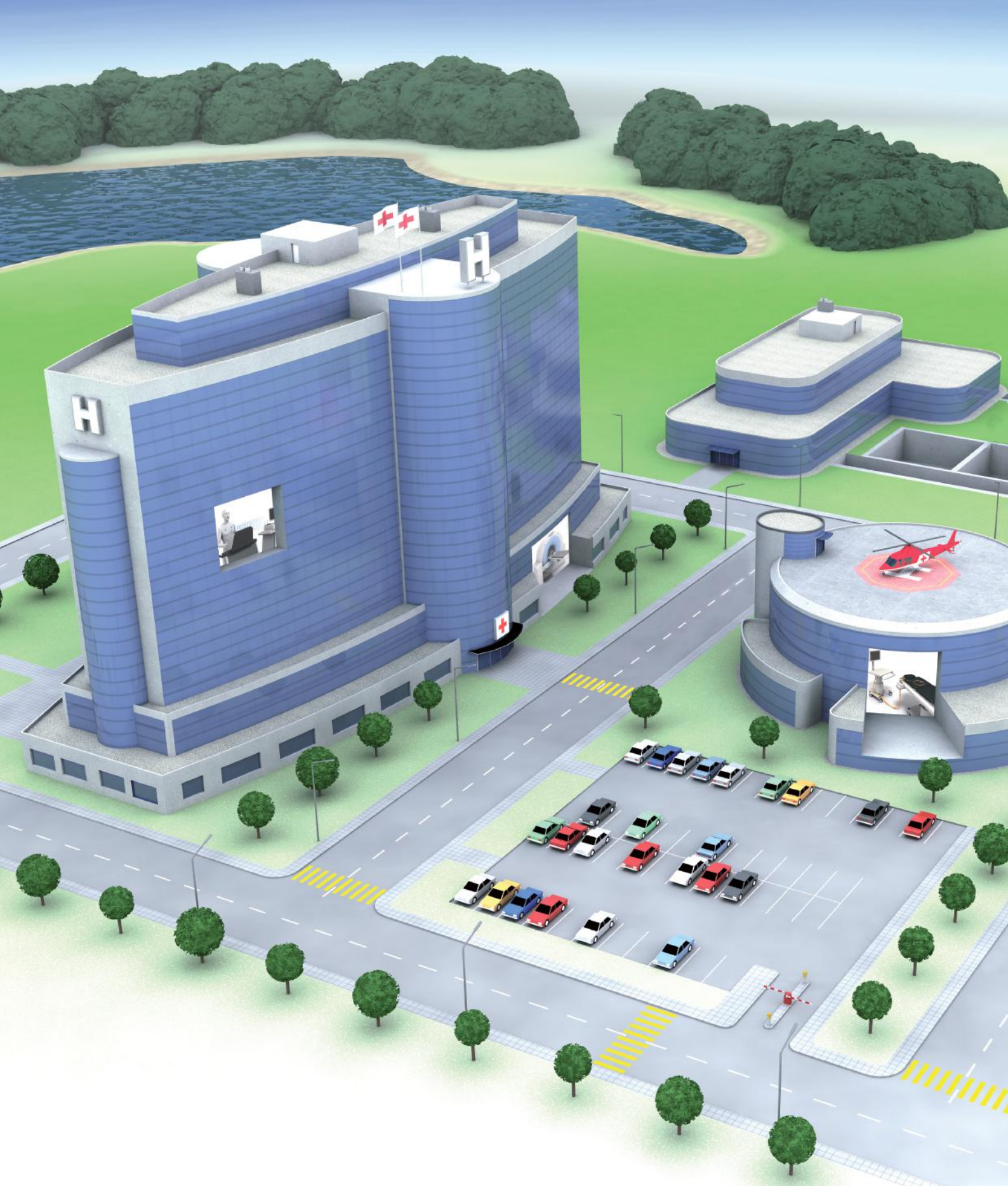


Microwave ablation Endoscopy

Edition 2016



Supplier to the medical market





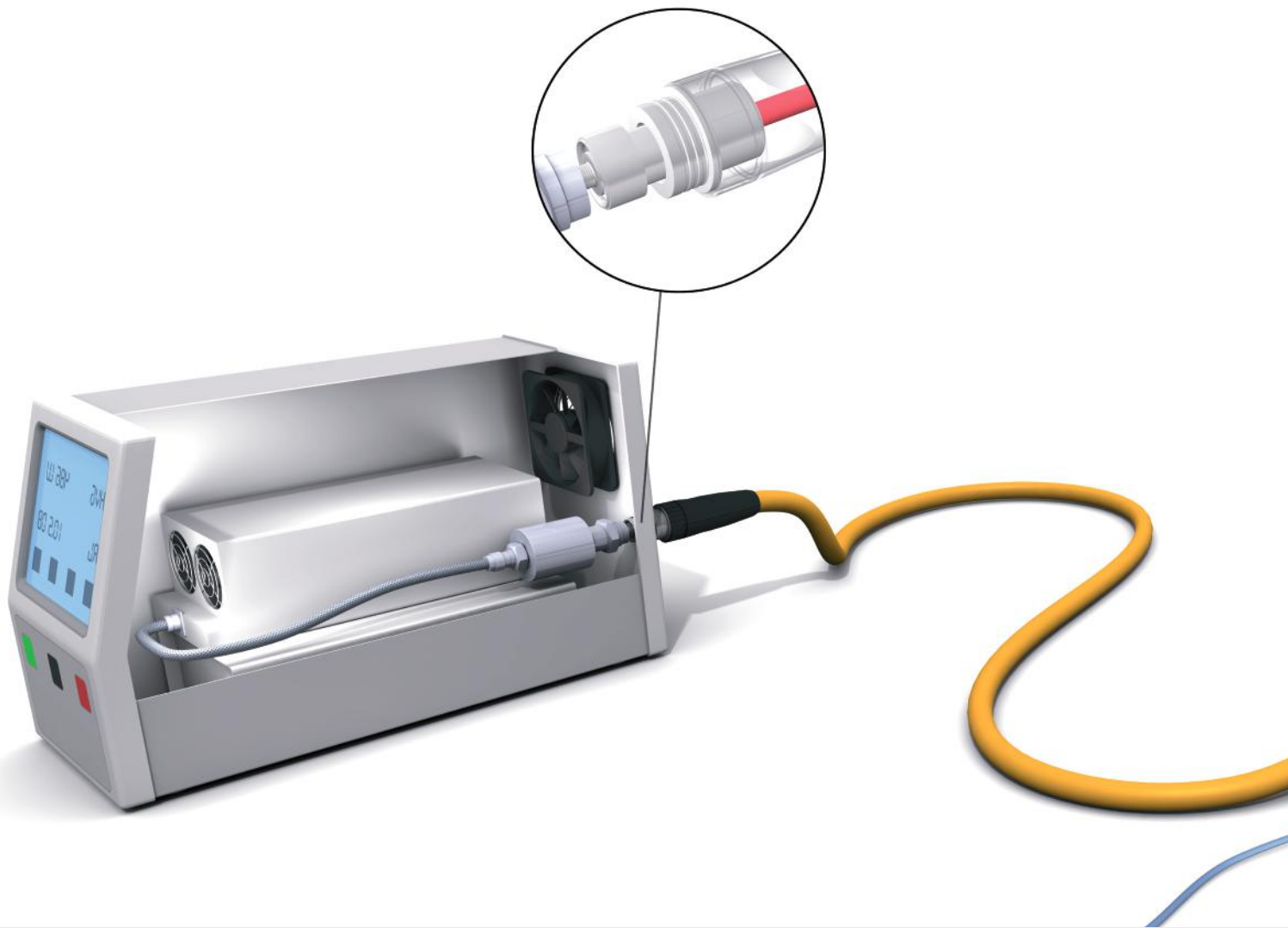
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Your partner for reliable connections

The HUBER+SUHNER Group is a leading international manufacturer and supplier of components and systems for electrical and optical connectivity. The company unites technical expertise in radio frequency technology, fiber optics and cable and polymer technology under one roof.

HUBER+SUHNER has worked in the medical market for many years with a wide range of leading manufacturers of medical devices. Within this wide market, HUBER+SUHNER concentrates on the development and production of innovative, passive connection solutions in the following fields:

- Microwave ablation
- Diagnostics
- Radiation therapy
- Radio frequency applications

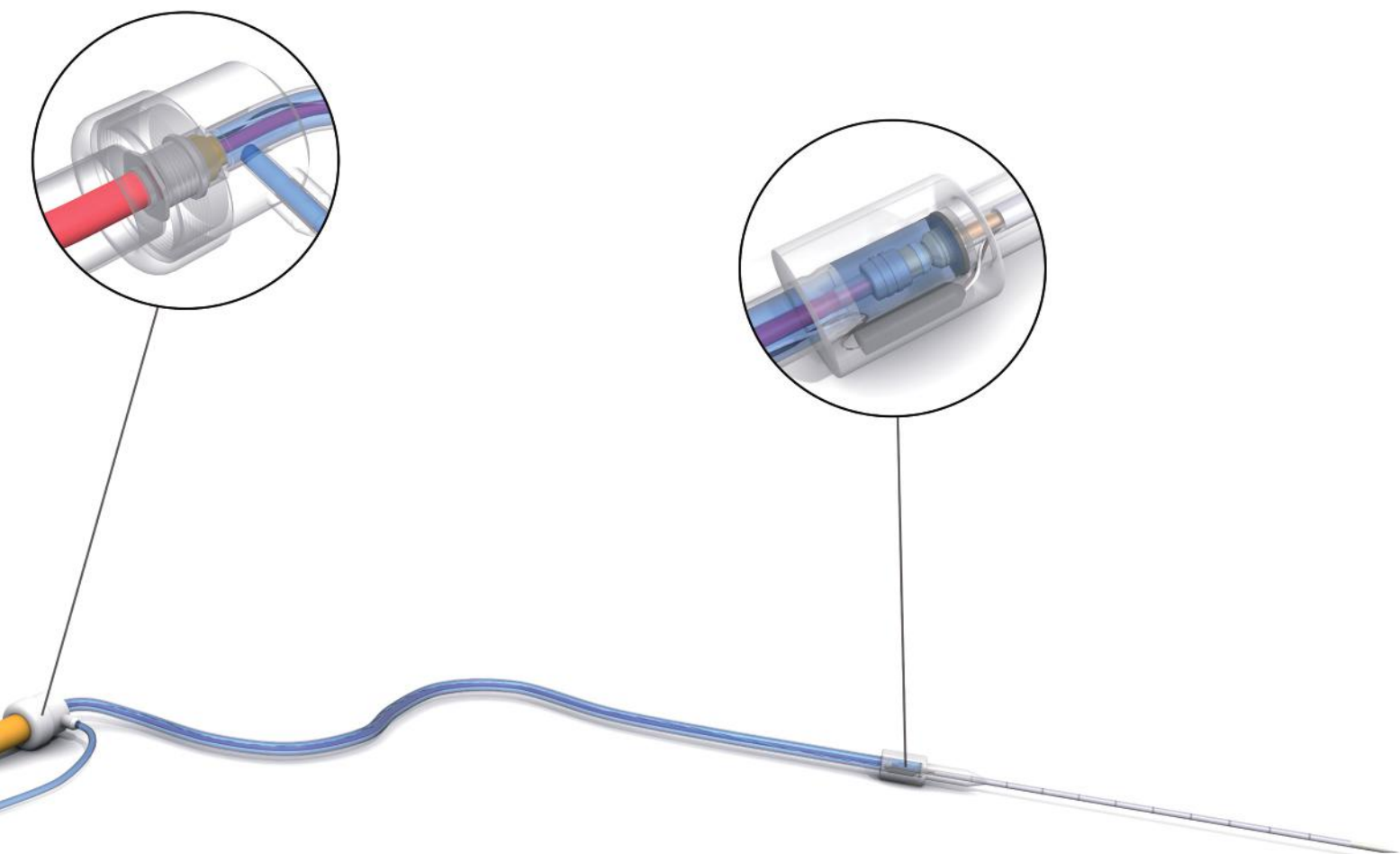


Microwave ablation

One promising new method for treating cancer tumours and metastases is microwave (MW) or radio frequency (RF) ablation. These minimally or non-invasive procedures enable work to be carried out in areas which are difficult to access, where treatment with conventional methods is only possible with serious side-effects. The savings resulting from shorter recovery times are resulting in rising acceptance of these treatment methods in healthcare circles.

Generator

The generator supplies the microwave energy. An integral controller allows the power, treatment time and temperature to be controlled. The device is used in the vicinity of the patient and must therefore meet the high safety requirements that apply in human medicine. An integral DC/DC block provides protection from high voltage. At the same time, sensors monitor the temperature and radio frequency power level. The robust radio frequency connectors on the device are designed for frequent connection cycles and ensure that the generator has a long service life.



Transmission cable

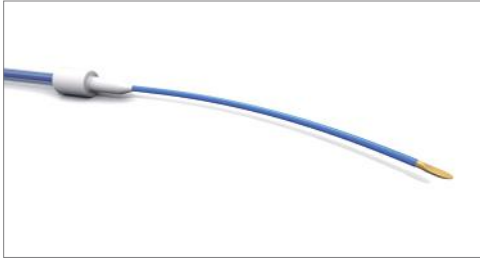
The transmission cable must be robust and mobile and is therefore strengthened with specially developed reinforcements. At the same time, the microwaves must be transferred from the generator to the antenna in the applicator with minimal energy losses. The cables are therefore strengthened with special reinforcements to make them crush-resistant. The materials used in the cable are also selected to meet the requirements for medical use, above all for sterilisation. Properties such as coolability and the diameter of the transmission cable likewise play a major role in the cable selection process.

Applicator

HUBER+SUHNER develops all equipment together with the customer or supplies individual components for the applicator (also known as the probe or disposable element). Thanks to its long experience in microwave technology, HUBER+SUHNER is capable of manufacturing thin cables which result in extremely low losses while also allowing cooling in or around the cable using a variety of media. The use of special connectivity solutions can also satisfy the demand for flexibility while maintaining the form stability of the supply cable to the antenna. This makes the applicator simple and highly ergonomic to handle.

Endoscopic probe cable solutions

HUBER+SUHNER works with customers to develop the applicator or supply individual components. Thanks to its long experience in microwave technology, HUBER+SUHNER is capable of manufacturing space-saving cables which result in extremely low losses whilst also promoting cooling in or around the cable using a variety of media. The use of special cables and connectors can also satisfy the demand for flexibility whilst maintaining the form stability of the supply cable to the antenna.



A flexible cable on this applicator leads to the integral microwave antenna tip which allows the antenna to be inserted through a catheter to the required area of the body. In addition to a small diameter and the correct balance between flexibility and rigidity, excellent cooling is also required. The disposable is designed for single use.

In a nutshell, the function of a Microwave-Ablation System can be described as follows: A probe is guided to the target tissue, where it emits microwaves. This makes the water molecules vibrate. Consequently the target tissue heats up and dies.

An efficient system should be able to deliver as much energy as possible. This requires coaxial cables with very low losses. An appropriate choice of cable materials and increasing the cable diameter are then necessary. The allowed diameter is however constrained by opposing requirements on flexibility - for handling and steerability reasons- and the internal diameter of catheters - in which the coaxial cable is guided to the target tissue.

The optimal cable is achieved by minimizing its losses given the additional (often opposing) constraints. The next section presents some cables with diameter under 2 millimeters from HUBER+SUHNER's portfolio. Based on our long experience in the development/production of coaxial cables we can also offer customer specific solutions.

Low-loss cables with diameter under 2 mm

Cable description	Loss at 2.45 GHz dB	Loss at 6 GHz dB	Diameter mm
Sucoform_47_FEP	1.87	3.01	1.30
Sucoform_43_FEP	1.91	3.10	1.09
Multiflex_53	1.78	2.86	1.74
Multiflex_47_CT*	TBD*	TBD*	≤1.38*
32085*	1.24*	1.95*	1.60*

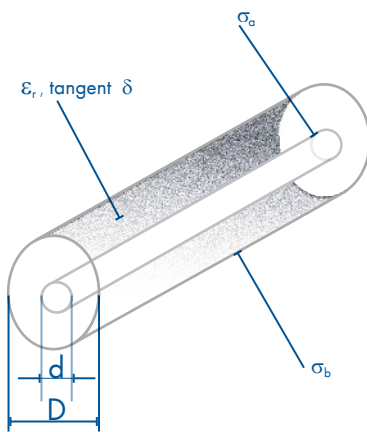
*preliminary data

Attenuation in coaxial structures

The transmission loss (attenuation) indicates how much lower the outgoing power is in comparison with the incoming power in a cable. In equation (1), this value is negative. To avoid confusion, however, attenuation is often stated as a positive figure.

$$\text{Attenuation loss} = \alpha = 10 \log \frac{\text{Power}_{\text{out}}}{\text{Power}_{\text{in}}} \text{ [dB]} \quad (1)$$

Attenuation rates of conductor and dielectric



σ_a = conductivity of the inner conductor
 σ_b = conductivity of the outer conductor
 ϵ_r = dielectric constant
 Tangent δ = characteristic of insulator material

Total transmission loss is:

$$\alpha_{\text{total}} = \alpha_{\text{conductors}} + \alpha_{\text{dielectric}}$$

Figure 1, Attenuation loss components

The cable attenuation loss is the sum of the conductor losses (e.g. copper losses) and the dielectric losses.

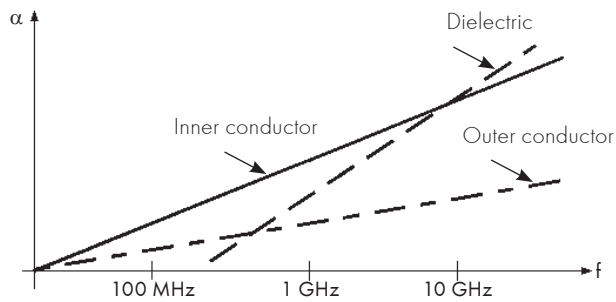
$$\alpha_{\text{Conductor}} = \alpha_c = \frac{11.39}{Z} \times \sqrt{f} \times \left| \frac{\sqrt{\rho_{rd}}}{d} + \frac{\sqrt{\rho_{rD}}}{D} \right| \text{ [dB/m]} \quad (2)$$

$$\alpha_{\text{Dielectric}} = \alpha_d = 90.96 \times f \times \sqrt{\epsilon_r} \times \tan \delta \text{ [dB/m]} \quad (3)$$

The constants are calculated with f in [GHz] and the diameter d and D in [mm].
 f = frequency

Attenuation in coaxial structures

Z is the characteristic impedance in Ohms [Ω], ρ_{rD} and ρ_{rI} represent the material resistivities of the conductor in comparison to copper. That is: $\rho_{rD} = 1$ for a copper inner conductor and $\rho_{rI} \approx 10$ for a steel outer conductor, because the conductivity of copper is approximately ten times higher than that of steel. δ is the loss angle of the insulating material.



Conductor losses dominate at low frequencies and dielectric losses in higher frequency ranges.

Figure 2, Attenuation loss as a function of the three cable components

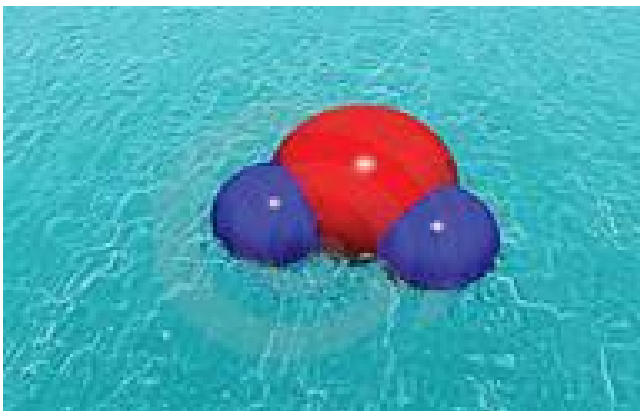
A lower attenuation loss can be achieved by the following:

- Large cable diameter
- High conductivity of the materials
- Low dielectric constant
- Small loss angle

Because the conductor losses increase proportionally to \sqrt{f} , whereas the dielectric losses increase directly proportionally to f , the losses from the polymer structures used in applications such as RF ablation are considerable (formulae (2)+(3)). The two parameters that need to be influenced are ϵ_r and $\tan\delta$.

Both values are directly linked physically to the presence of material and assume minimum values in a vacuum ($\epsilon_r = 1$ and $\tan\delta = 0$).

Furthermore, the employed plastics must provide excellent stability in terms of mechanical and thermal loading, dielectric strength and, most importantly, process capability.



Attenuation in coaxial structures

Material	ϵ_r	$\tan\delta$	Glass temperature [°C]	Operating temperature [°C]	Density [g/m ³]	Dielectric strength [kV/mm]
Air	1.0	<10 ⁻⁵	...	...	0.0013	<1.0
PE	≥2.28	0.0003	<-125	-40...+85	0.91...0.97	>28
SPE	1.25...2.05	<0.0003	....	-40...+80	0.21...0.75	...
XLPE	>2.28	>0.0003	....	-20...+10	0.91...0.97	>25
FEP	2,1	<0.0007	-100	-100...+200	2.15	>50
PFA	2.06	0.0001	<-80	-200...+250	2.14	>50
PTFE _{sat}	<2.05	<0.0001	-100	-200...+250	2.2	25...50
PTFE _{unsat}	1.4...1.7	<0.0001	...	-200...+250	0.8...1.5	...
PP	2.25	<0.0005	-20	-10...+100	0.9	>25
PEEK	3.2	0.003	143	-250...+250	1.32	20

Reference table

HUBER+SUHNER has been developing and manufacturing coaxial cables and connectors for over 50 years. Today, hundreds of different cables and thousands of connector types are used in a wide variety of applications. These are manufactured using state-of-the-art resources such as robot soldering cells, material-specific extrusion techniques developed in-house, forward-looking stripping equipment, the company's own fully-automated electroplating plant and much more besides.

As a result, the products benefit from the following characteristics among others:

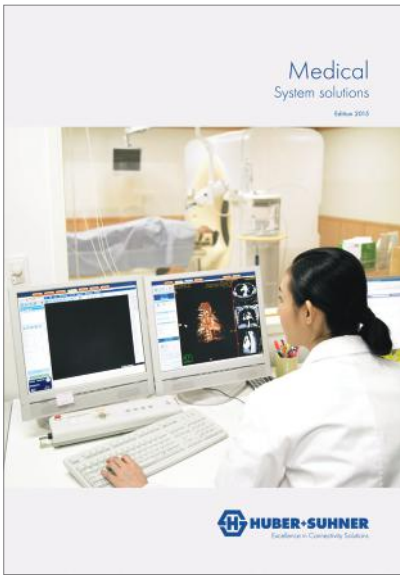
- Process control for volume production of even the tiniest components.
Example: Coaxial cables with outer conductor dimensions of <0.4 mm
- The industry's lowest electric losses for flexible microwave cables
- Interface optimisation for microwave connectors for >5000 connection cycles
- Customer-specific product surfaces

Further catalogues

All our catalogues are updated regularly. They are available in electronic format and can be accessed from our main HUBER+SUHNER homepage.

Simply go to the "Downloads" section and select "Radio frequency" and "Catalogues" to filter down your search.

<http://hubersuhner.com/en/Service-Contact/Downloads>



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