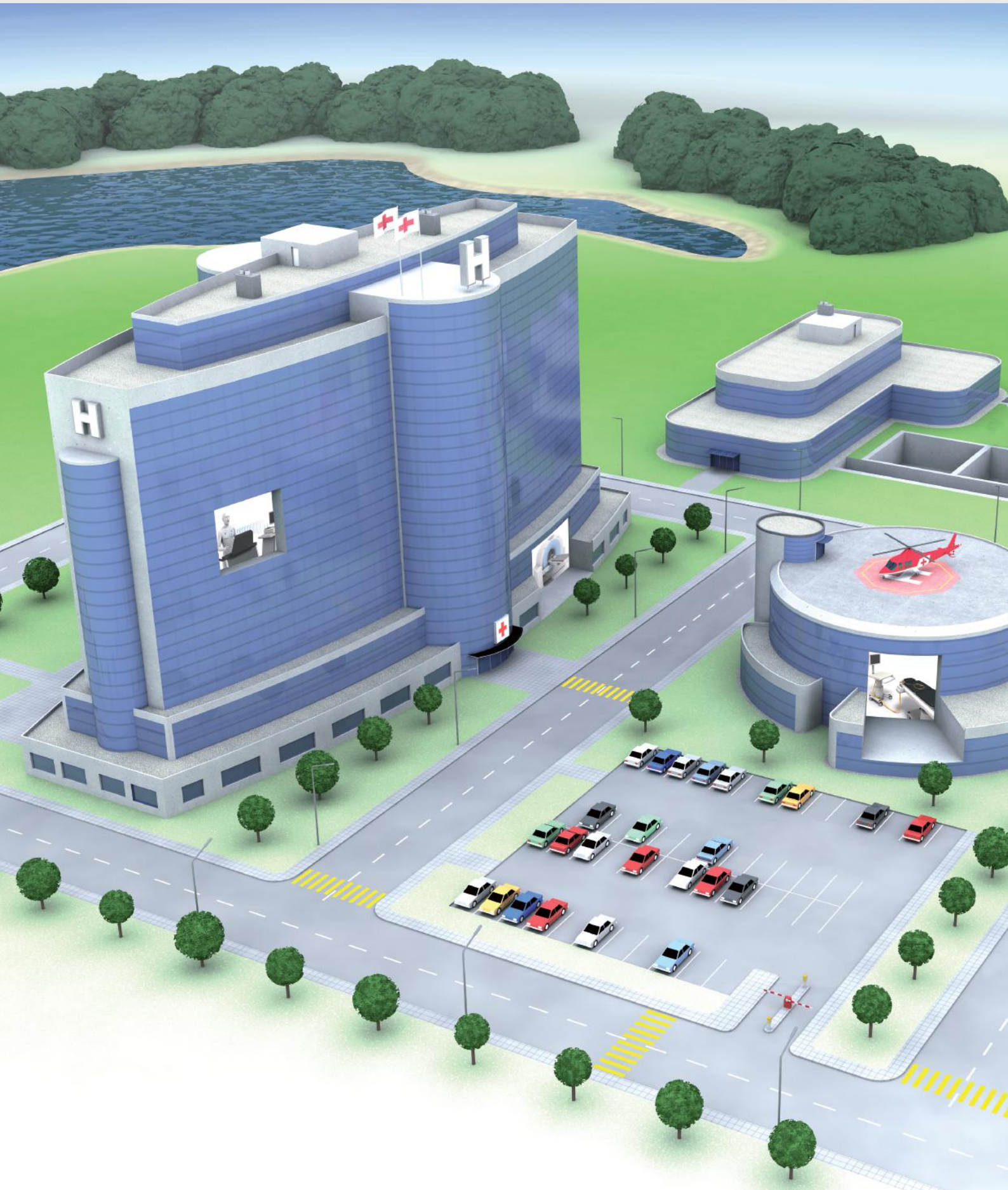
Microwave ablation

Edition 2016

HUBER+SUHNER

Excellence in Connectivity Solutions

Supplier to the medical market



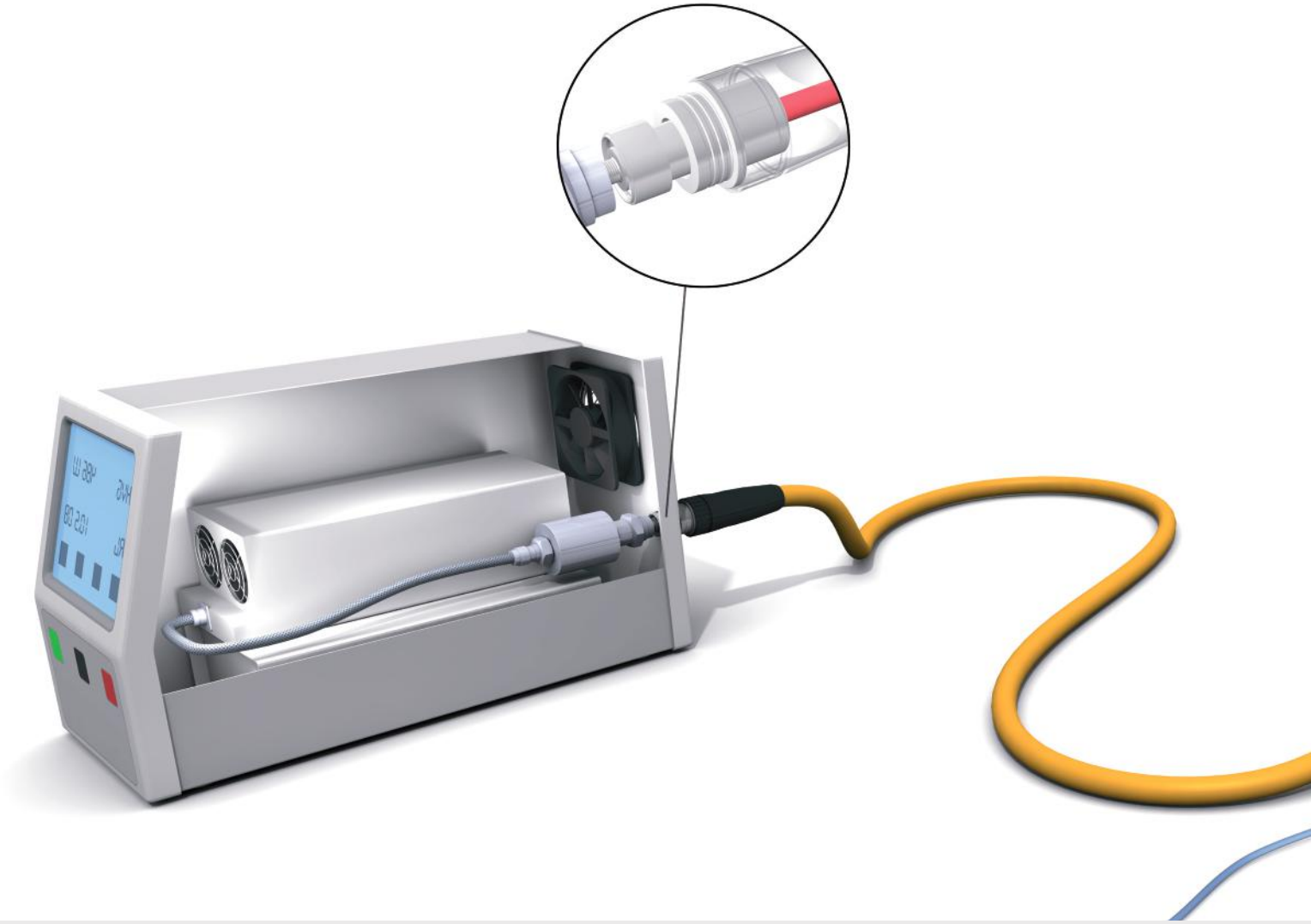
Your partner for reliable connections

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

HUBER+SUHNER
Excellence in Connectivity Solutions

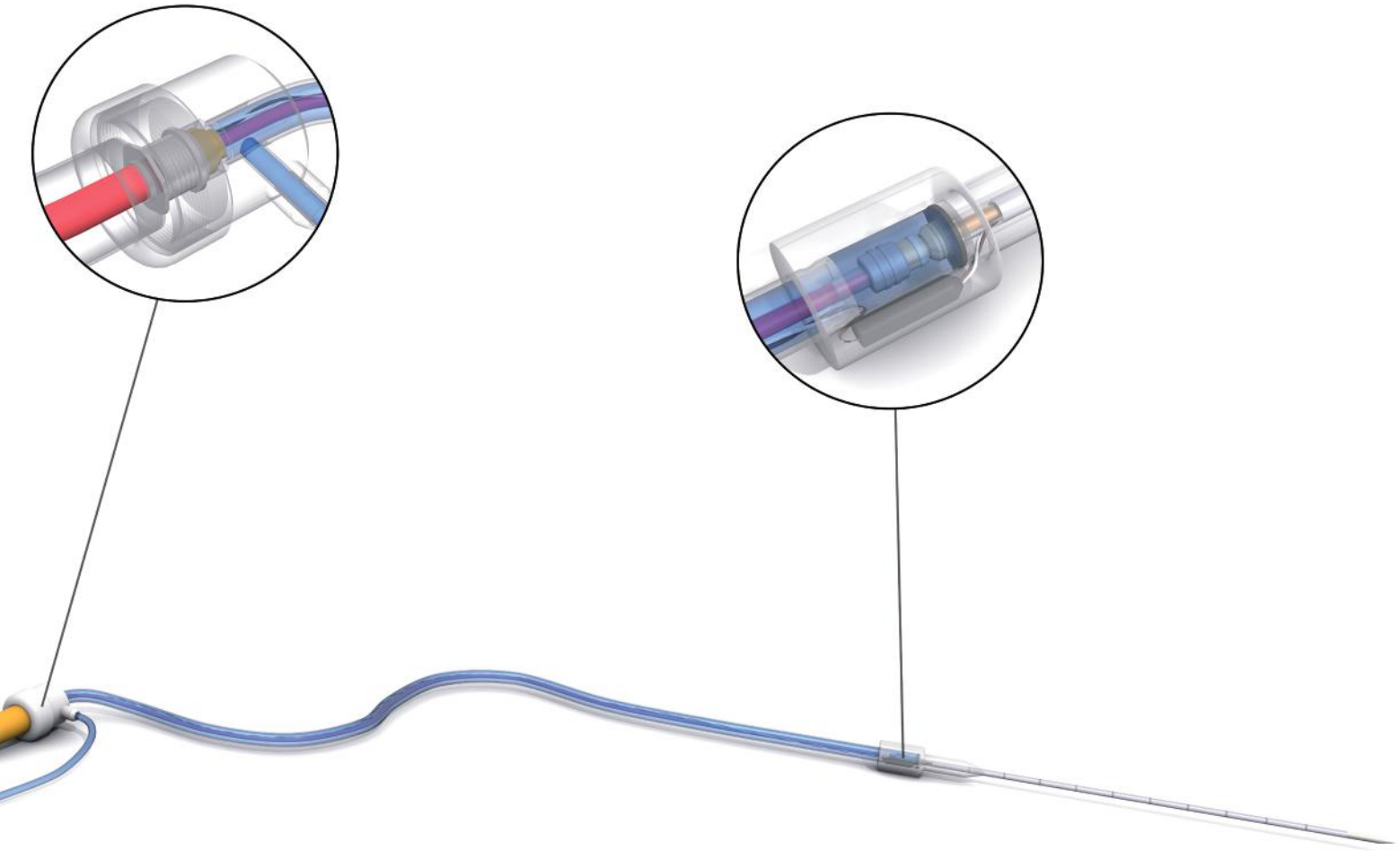


Microwave ablation

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

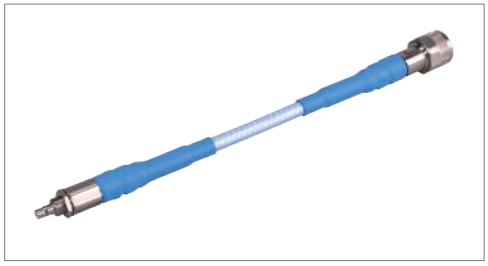
The transmission cable must be robust and mobile and is therefore strengthened with specially developed reinforcements. At the same time, the microwaves must be transferred from the generator to the antenna in the applicator with minimal energy losses. The cables are therefore strengthened with special 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.

Generator

The generator supplies the microwave energy and the power, treatment time and temperature of the application are regulated using an integral controller. Since the generator is used in the close vicinity of the patient, it must meet the safety requirements for use in human medicine.
At the same time, properties such as electrical attenuation, frequent connection cycles with simple connector mechanisms, safe function and reliability are also important.



Low-attenuation microwave cables

This cable assembly has been tuned for minimal losses, high power and combines the microwave source with the output connector. Flexibility, relatively tight bending radii and the easy installation of the snap-lock connectors help with the miniaturisation of the generator and ensure efficient assembly. In addition, shielding properties are an important criterion to ensure that all EMC requirements can be satisfied.

Housing connection

The radio frequency connector on the generator output must ensure that the power can be transferred and must also be designed to withstand the high number of connection cycles of the transmission cable. The connector must be easy to use while also ensuring a high level of connection reliability. At the request of the customer, it is also possible to manufacture and use modified radio frequency connectors for this application.

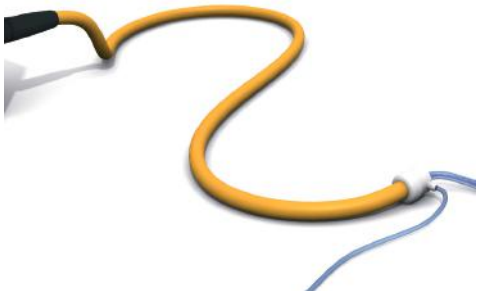
Amplifier output

The high-performance connector is installed directly on the microwave amplifier housing and connects the power output directly to the printed circuit board inside. Quick-lock connectors, such as QN connectors are often used to make the connections easier.

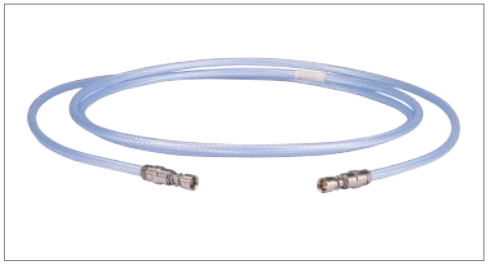
DC/DC block

The use of a DC/DC block to insulate the generator from the applicator on the internal and external conductors of the coaxial cable creates a galvanic separation from the generator. This protects the patient and the medical staff in the event of an electrical fault.

Transmission cable



The energy is fed through the transmission cable from the generator to the applicator with minimal energy losses. Specially developed reinforcements make the cable robust and crush-resistant.
The materials used for the cable meet the requirements for a medical environment, particularly for sterilisation. In addition these cables can be finished to satisfy special requirements such as coolability and coding.



Low-attenuation microwave cables

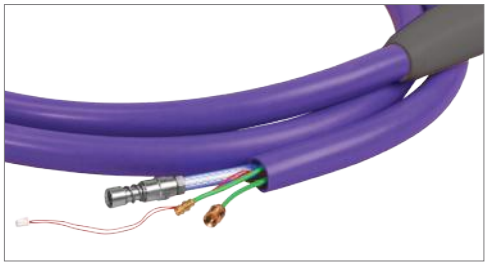
A low-loss microwave cable is the key component in a transmission cable. In addition to minimal losses in the cable, flexibility, haptics and weight are other important factors. Since the cables also come into contact with the patient, they should also not become hot if possible. HUBER+SUHNER Sucoflex cables are used for this application.

Cable connectors

The connection of the transmission cable to the generator must ensure that power can be transmitted while also withstanding a high number of connection cycles with the generator. The connector must be easy to use while also ensuring a high level of connection reliability.

Interface connectors

The connection between the transmission cable and applicator is often located in a special unit mounted on the operating table.
Easy, fast handling, even when using the applicator with medical gloves, is a central requirement for the ergonomic properties of this radio frequency connector, in addition to its electrical properties.



Hybrid cable assemblies

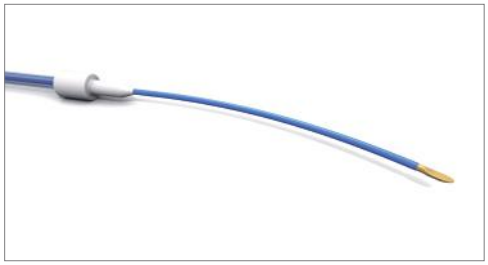
In addition to microwave transmission, other connections may be integrated in the transmission cable, such as signal cables for a wide range of sensors. HUBER+SUHNER works with customers to develop complete cable assemblies with hybrid connectors which are both compact and can also withstand high mechanical forces .

Applicator

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.

Rigid probe

This probe consists of a rigid needle with integral microwave antenna which is inserted into the the body up to the diseased tissue. The critical requirements for the design of this applicator are a small diameter, mechanical strength and excellent cooling.



Flexible probe

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.

Applicator for the body surface

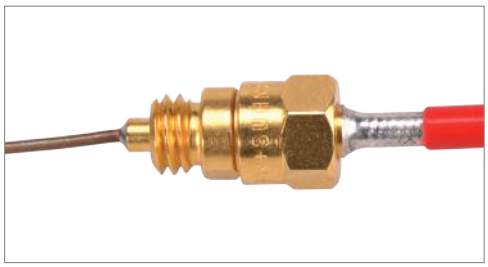
These applicators are used for medical treatments on the surface of the body (for example for treating hyperhidrosis). Each applicator is used multiple times and includes an antenna which is connected directly to the generator using flexible, low-attenuation cables.

Semi-rigid cables

Low-attenuation semi-rigid cables are used inside the steel needle of a rigid probe. In addition to the production of these cables, HUBER+SUHNER can also deliver the required assembly techniques used to produce these probes, such as laser cutting and welding.

Flexible probe cables

A flexible, low-attenuation cable ends in the antenna tip. HUBER+SUHNER produces these assemblies including the assembly of the antenna tip itself. Their high power consumption means that additional cooling may be required. HUBER+SUHNER integrates cooling systems with liquids or gases without noticeably reducing flexibility.

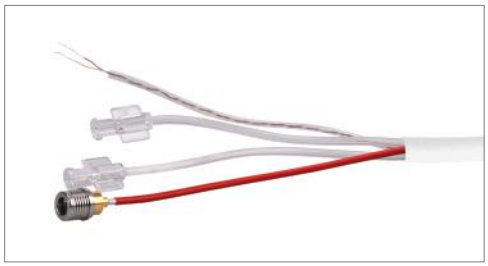


Connector between flexible and rigid parts

Special connector solutions are required for the transitions between the flexible and the rigid part of the applicator. MCX connectors and modified versions of these connectors are ideal for this purpose. They can be used as straight or right-angled connectors within the handle of the probe.

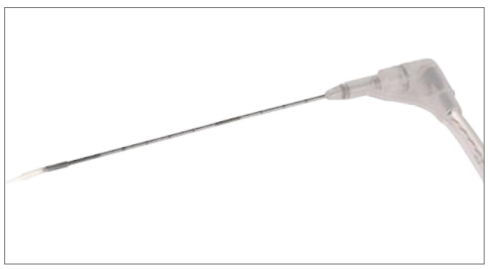
Antenna tip

The antenna tip is a key component for a stationary or mobile probe. It emits microwave energy to destroy the diseased tissue. HUBER+SUHNER assembles antenna tips using precision assembly processes.



Hybrid cables

In its hybrid cables, HUBER+SUHNER combines flexible microwave cables with various data and cooling cables. These solutions are generally designed and enhanced for specific customer applications.



Probes assembly

In addition to producing the various components, HUBER+SUHNER has the expertise required to manufacture the entire applicator and can provide the customer with support in the development process from the prototype phase to mass production.

Customer statement

"HUBER+SUHNER has proven to be a terrific partner in our development and production launch activities. Their people are truly an extension to our team."

Eric Clyse, Vice President of Operations
NeuWave Medical, USA

NeuWave Medical, Inc. is a spin-off company from the University of Wisconsin and arose as the result of an academic collaboration of engineers and physicians who wished to improve treatment of cancer. NeuWave buys several passive RF interconnection products like low loss cables, specially developed assemblies, smallest size Semi Rigid cabling and connectors from HUBER+SUHNER. The products are integrated into "Certus 140", a 2.45GHz soft tissue ablation system used in the treatment of cancer. The cables need to transmit very high levels of microwave energy to the tip of a very small probe while minimizing losses.

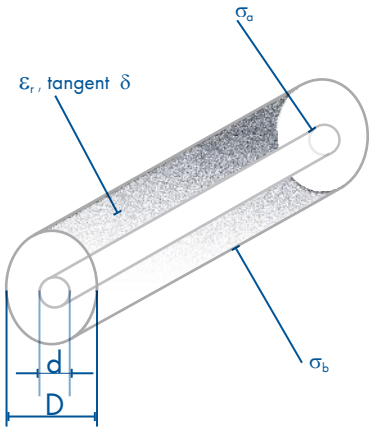
"We chose HUBER+SUHNER because of their engineering capabilities and their commitment to hit the difficult design requirements in time. They delivered as promised, including a late design requirement change", says Eric Clyse. "HUBER+SUHNER has enabled NeuWave Medical to deliver a world-class medical product to the market in a very efficient and cost effective manner."

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.

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

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:

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

Figure 1, Attenuation loss components

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

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

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

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], ρrd and ρrD represent the material resistivities of the conductor in comparison to copper. That is: ρrd = 1 for a copper inner conductor and ρrD ≈ 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.

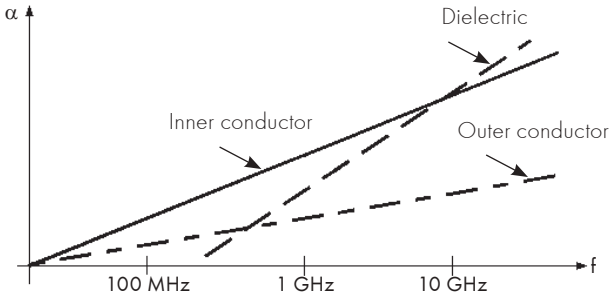


Figure 2, Attenuation loss as a function of the three cable components

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

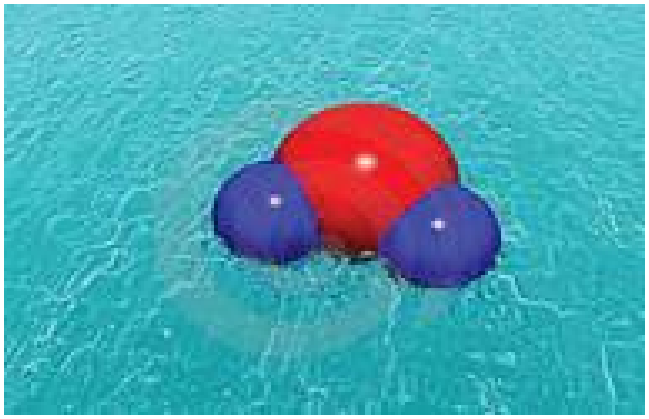
A lower attenuation loss can be achieved by the following:

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

Because the conductor losses increase proportionally to √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 tanδ.

Both values are directly linked physically to the presence of material and assume minimum values in a vacuum ($\varepsilon_r = 1$ and tanδ = 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	tanδ	Glass temperature [°C]	Operating temperature [°C]	Density [g/m³]	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:

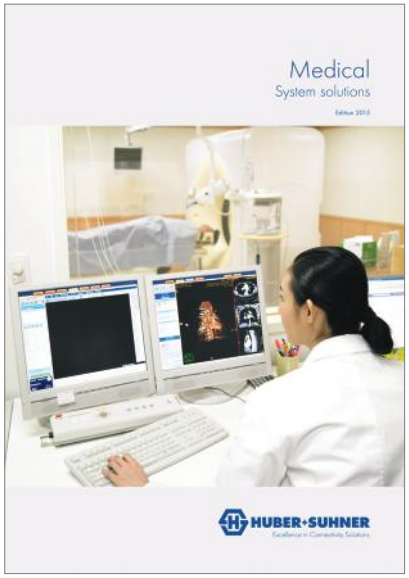
- Process control for volume production of even the tiniest components.
  Example: Coaxial cables with outer conductor dimensions of <0.4 mm
- The industry's lowest electric losses for flexible microwave cables
- Interface optimisation for microwave connectors for >5000 connection cycles
- Customer-specific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

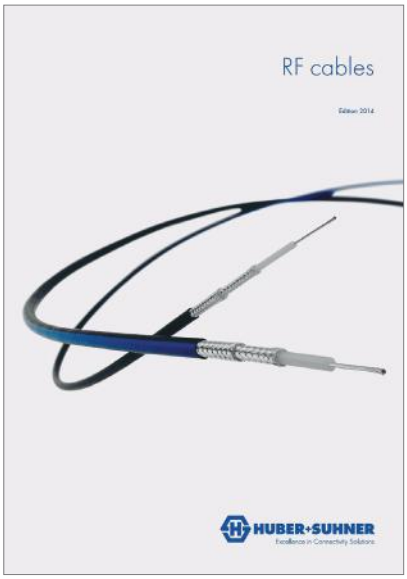
Further catalogues

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





HUBER+SUHNER AG
Degersheimerstrasse 14
9100 Herisau
Switzerland
Phone +41 71 353 4111
Fax +41 71 353 4444
hubersuhner.com

4346/02.2016

HUBER+SUHNER is certified in accordance with EN 9100, ISO 9001, ISO 14001, ISO/TS 16949 and IRIS.