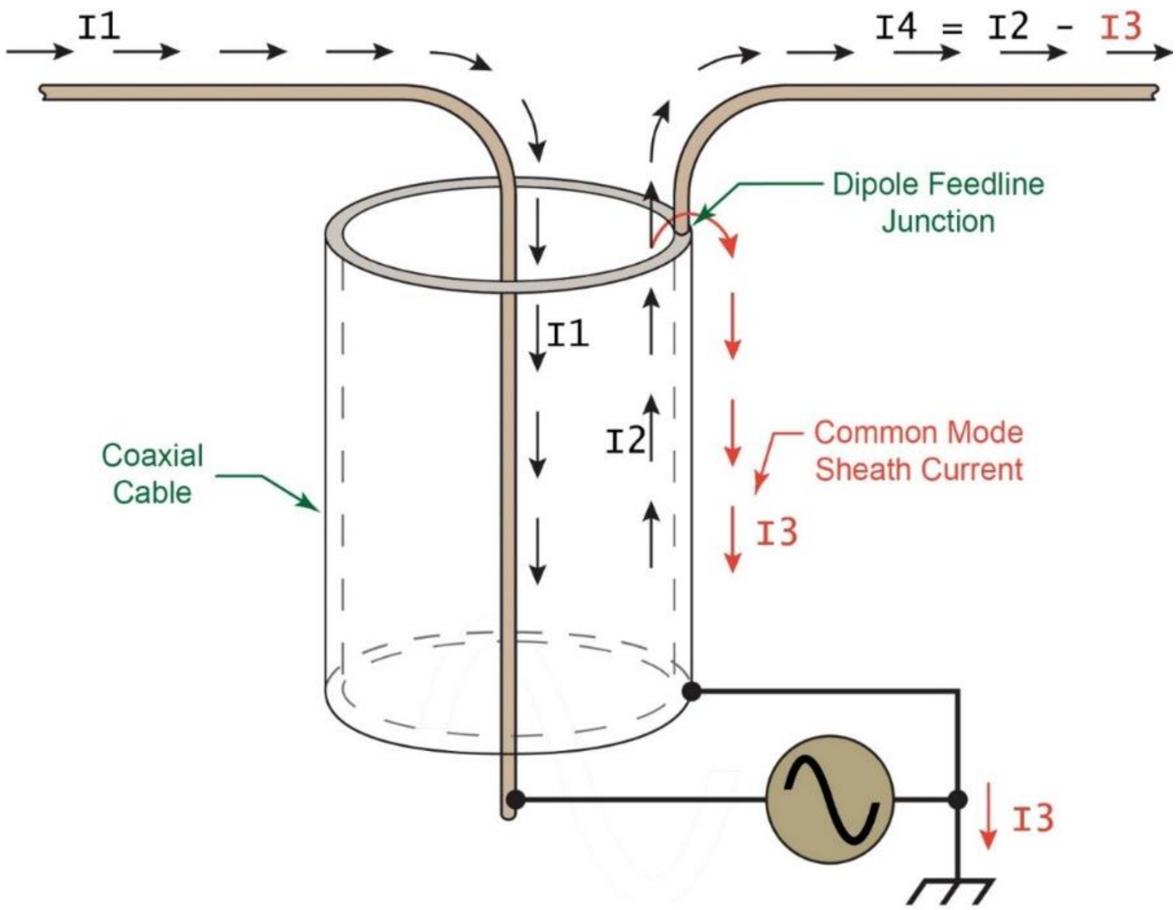
Application Note: Sheath Wave Blocking

1. Generation and effect of sheath waves



Sheath waves occur when the feed to the antenna is not fully or partially balanced. The picture shows a dipole antenna which is connected directly (without balancing) to a coaxial cable. The transmission energy leads from the first arm of the dipole antenna as current I1 into the inner conductor of the coaxial cable and current I2 on the inside of the shielding of the cable back to the second arm of the dipole antenna. In the ideal case (with optimum balancing) I1 and I2 are identical and no current flows on the outside of the cable shield as I3 back to the transmitting amplifier or to system ground.

In the scheme shown here, no balun is used and the current I2 is divided into I4 and I3, where the latter is diverted to ground. The shielding of the coaxial cable acts like a piece of grounded antenna wire that is conductively connected to the second arm of the dipole antenna at the feeding point. The current I3 thus represents the unwanted sheath wave. However, sheath waves can also be induced if standing waves occur on the outer jacket due to poor matching or if energy from a nearby antenna is "received" and the cable shield acts like an extended antenna.

In reality, both specially well matched narrowband antennas for individual services as well as poorly matched broadband antennas are used. The antennas should usually be as compact as possible and the designers are therefore always looking for a compromise with a smaller design.

Sheath waves usually have only minor influence to the radiation characteristic of the antenna and there may also be moderate additional losses.

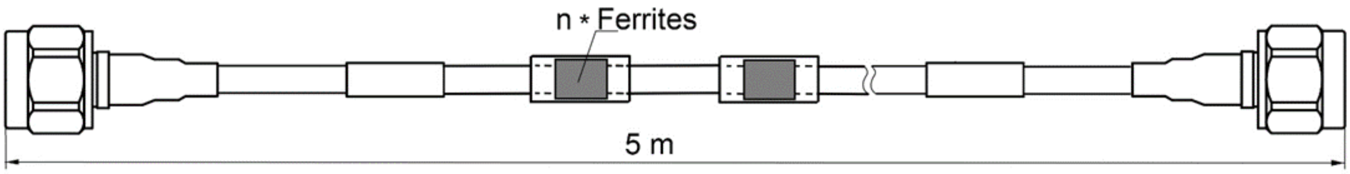
The sheath wave current I3 only flows on the outside of the cable shield back to the ground (housing) of the transmitter amplifier and, maybe via it's power supply to the protective ground of the mains network.

Due to the unwanted emission of conducted and/or radiated electromagnetic waves, the RF leakage current caused by the sheath waves interfere with EMC measurements. Additionally, the differences in the ground potential at the two ends of the coaxial cable, sheath waves lead to common mode signals that are superimposed on the transmitted signal as interference voltage and may thus cause hum loops.

Sheath wave blocking avoids these unwanted leakage currents and thus make a significant contribution in preventing from radio interference. A sheath wave block acts like a classic coil. The sheath waves are opposed to a high inductance and mostly ohmic resistance, which accordingly attenuates the current flow. However, this does not affect the energy movement ***on the inside*** of the cable shield. Only the sheath currents *on the outside* of the cable shield are significantly attenuated.

For optimum attenuation of the sheath waves, it would be best to place those inductances directly at the antenna base. All antennas with "asymmetrical" components such as ground planes, windoms, long wire antennas or dipoles and beams should therefore only be operated with suitable sheath wave blocks.

2. emv Service GmbH: Special Sheath Wave Blocking Cable for cell phone measurements



Our special sheath wave blocking cable consists of suitable ferrite cores that are distributed over the entire length of the coaxial cable. The inductors in this case consist of a coil with only one turn and therefore has only a limited inductance. To achieve a sufficient blocking effect of approx. 30 dB, a corresponding number of ferrite cores are placed in series along the cable. These act as a current-compensated choke or common-mode choke. At the same time, the ferrites act as a transformer, so that the transmit signal is supported as a push-pull signal.

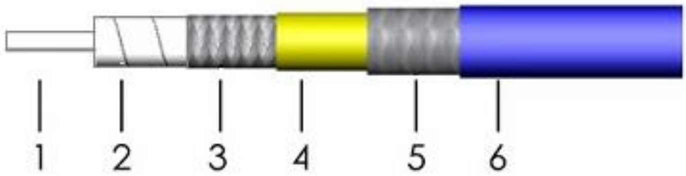
Due to the "one turn coil design" of the ferrite cores, there are no "parasitic" effects compared to other sheath current blocks. Additionally, this principle is extremely broadband and low-loss. The power loss resulting from the absorption of the sheath waves is distributed over the many ferrites and therefore does not play a major role.

Attenuation & RF Power

Frequency GHz	0,01	0,05	0,1	0,5	1	5	10	50	100	500	1000	2000	3000
Total Cable Assembly Attenuation dB	0,1	0,1	0,1	0,1	0,1	0,1	0,3	0,5	0,7	1,1	1,7	2,2	2,9
CW Power W	500	500	500	500	500	400	400	400	300	300	200	100	100

Construction

	Description	Diameter	Material
1	Center Conductor	1.29 mm	Solid SPC
2	Dielectric	3.68 mm	Expanded PTFE Tape
3	Outer Conductor	3.86 mm	SPC Strip
4	Interlayer	4.01 mm	Aluminium Polyester
5	Outer Shield	4.42 mm	SPC Braid
6	Jacket	4.95 mm	FEP
	Ferrite Cover	10.00 mm	Shrink Tubing
		PTFE, FEP: teflon	*SPC: silver plated copper*



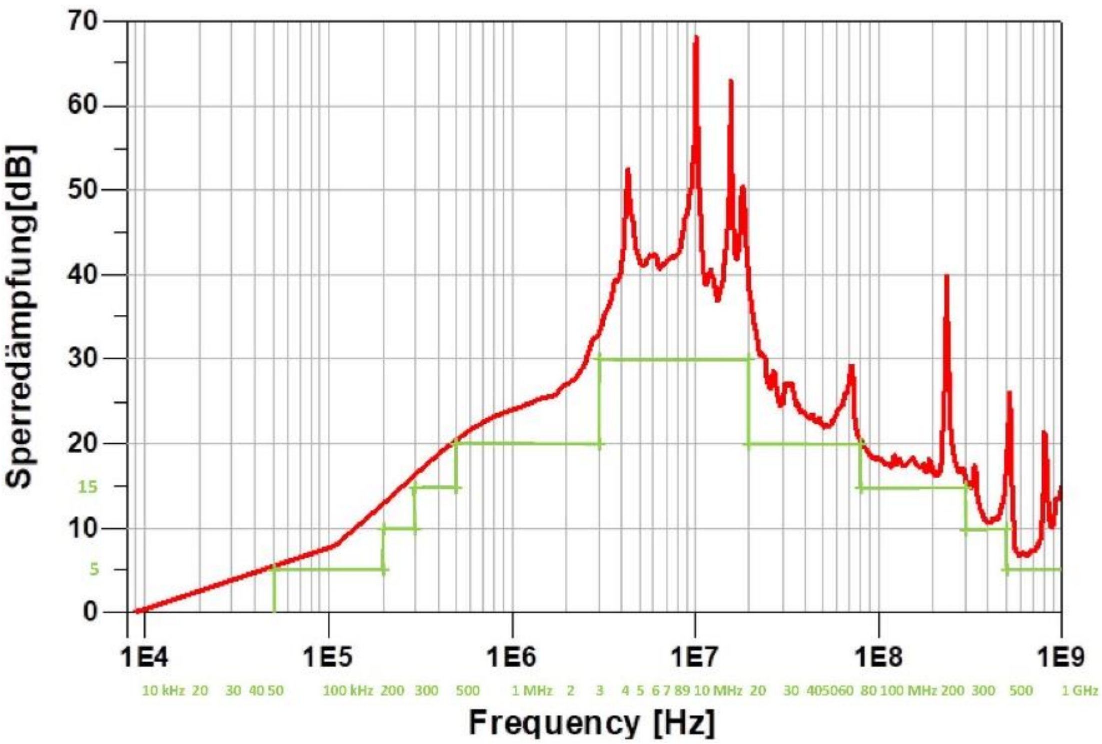
Bend Radius: installation	75 mm
Bend Radius: repeated	150 mm
Weight	approx. 5 kg
Temperature Range	-55 ... +85 °C

Sheath Wave Attenuation (typical)

Sheath Wave Attenuation	from
5 dB	50 kHz
10 dB	200 kHz
15 dB	300 kHz
20 dB	500 kHz
30 dB	3 MHz

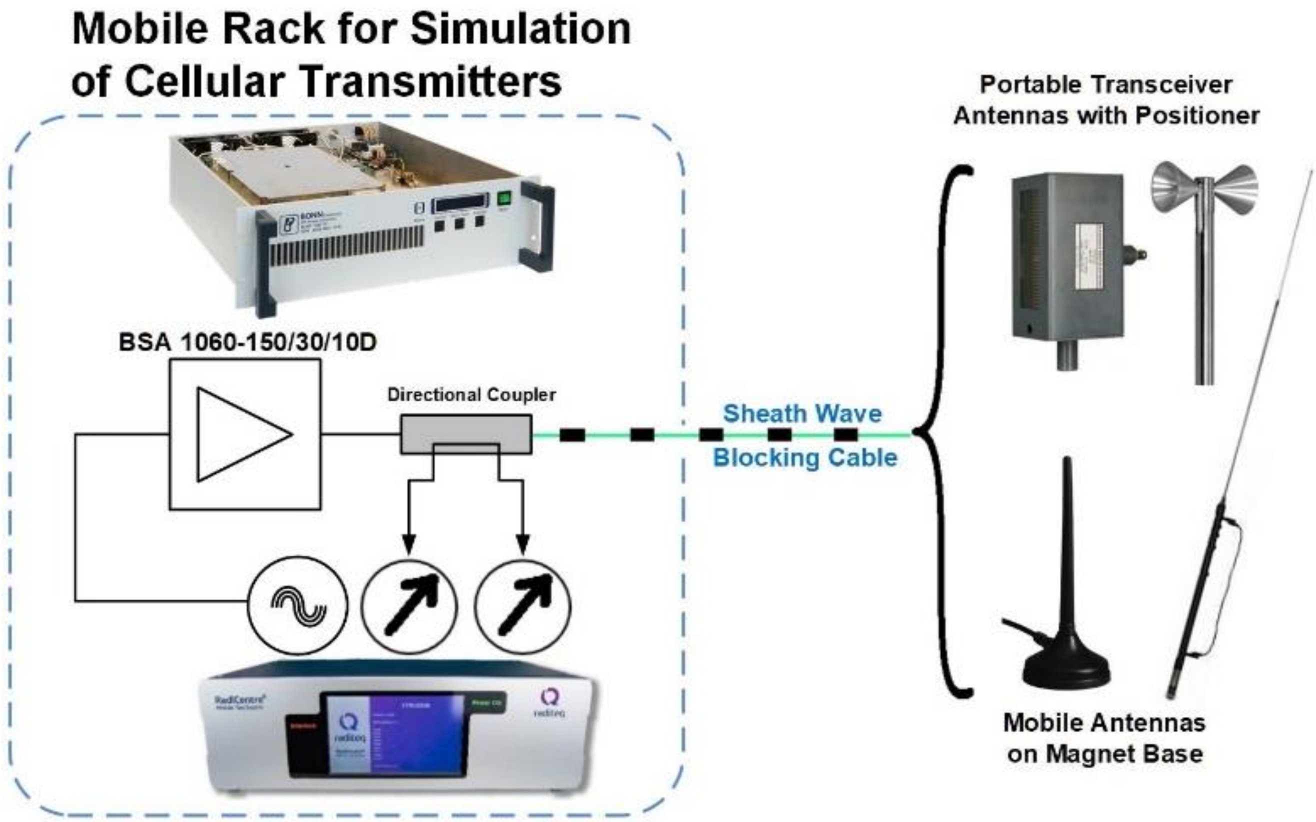
Electrical

Impedance	50 Ω
Isolation Voltage	1000 V
Shielding Effectiveness	>95 dB
Cut-Off Frequency	30 GHz



3. Typical application: cell phone measurements

- ISO 11451-3 Vehicle Test Methods – Part 3: On-board transmitter simulation
- ISO 11452-9 Road Vehicles - Component Test Methods – Part 9: Portable transmitters



4. Examples of typical vehicle antennas