Reducing CMC with a choke

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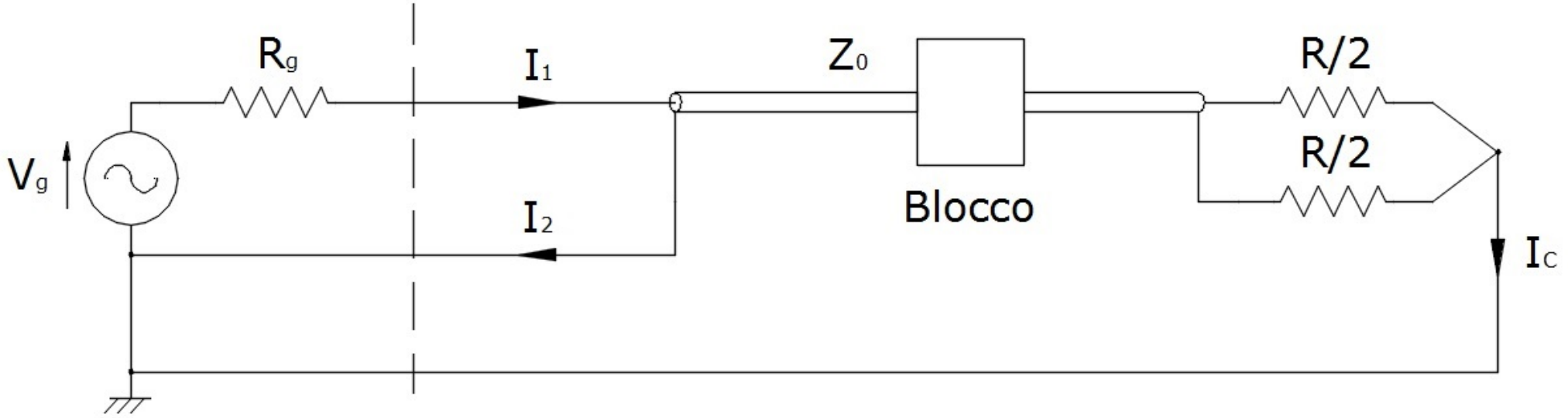
Common Mode Currents (CMC)

Common Mode Currents (CMC) are the currents that flow in both conductors of the transmission line in the same direction and are the cause of radiofrequency radiation in the surrounding space. Reducing common mode current brings the currents flowing in the transmission line back into balance, leaving only the differential mode currents (CMD).

The reduction of CMC is achieved by inserting a blocking circuit in the loop through which the common mode current flows, in a way that it does not impede the flow of the differential mode current.

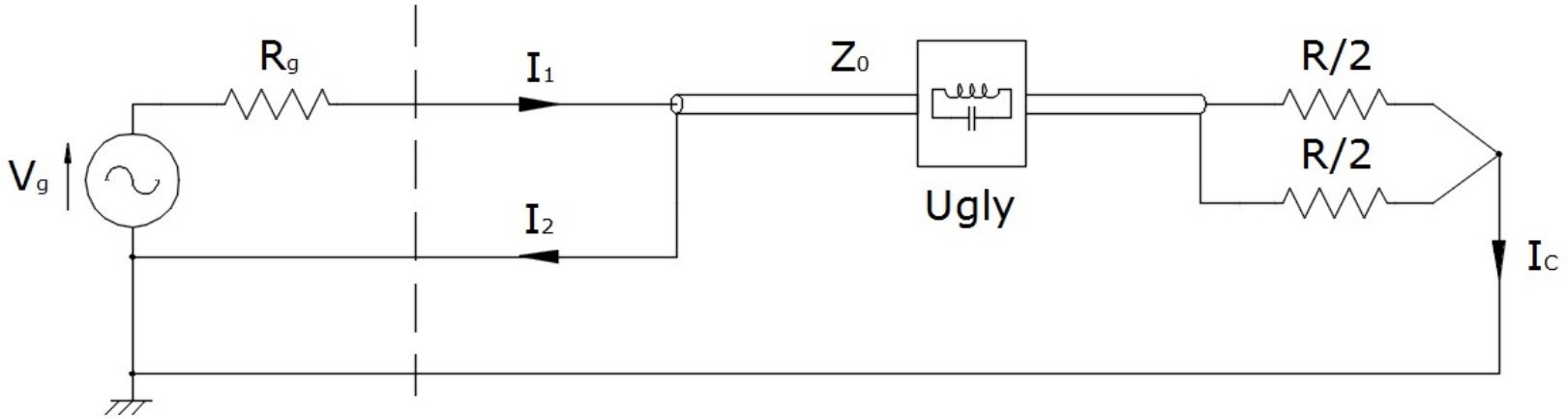
In practice, there are two types of blocking circuits commonly used:

- Parallel resonator, commonly referred to as an 'Ugly Bal-Un;
- Blocking inductance, commonly known as a ‘Choke’.



UGLY Bal-Un

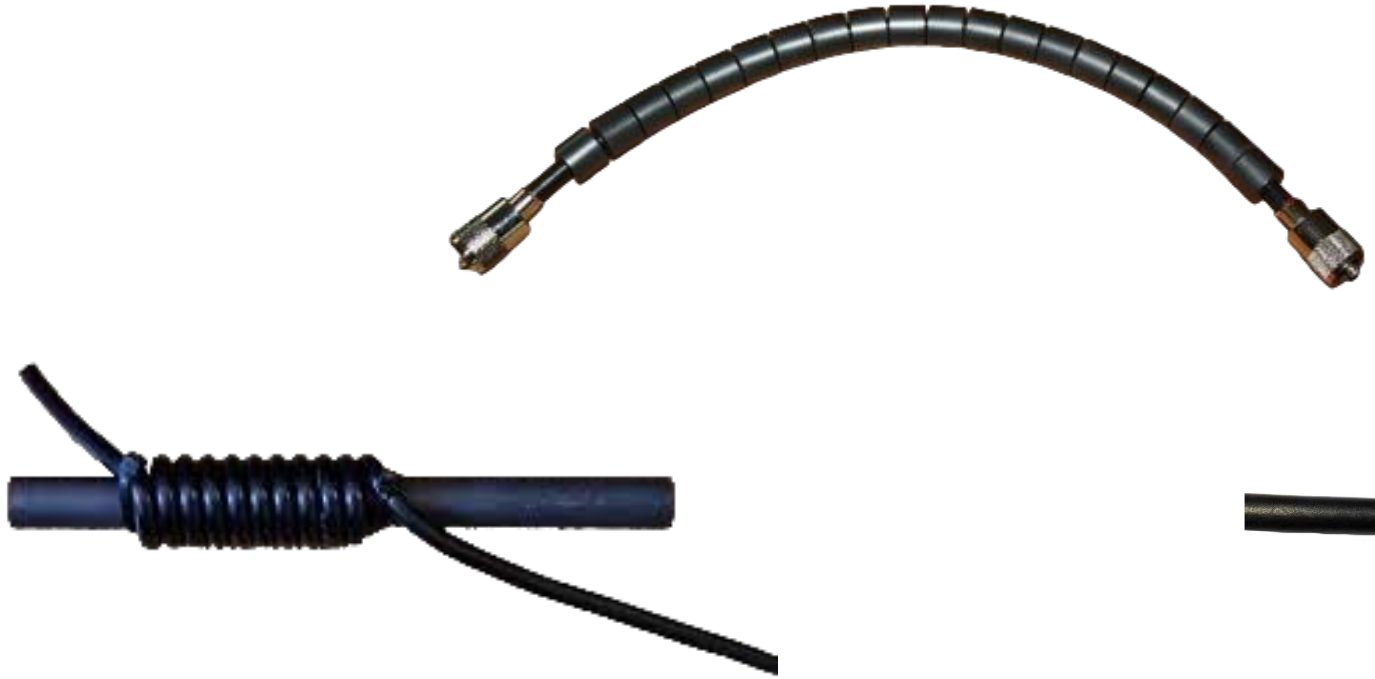
The Ugly Bal-Un is a parallel resonator that is implemented by winding n turns of coaxial cable. In fact, the wound coaxial cable effectively acts as an air inductance, while the distributed capacitance created between the coaxial cable turns constitutes the parallel capacitor.



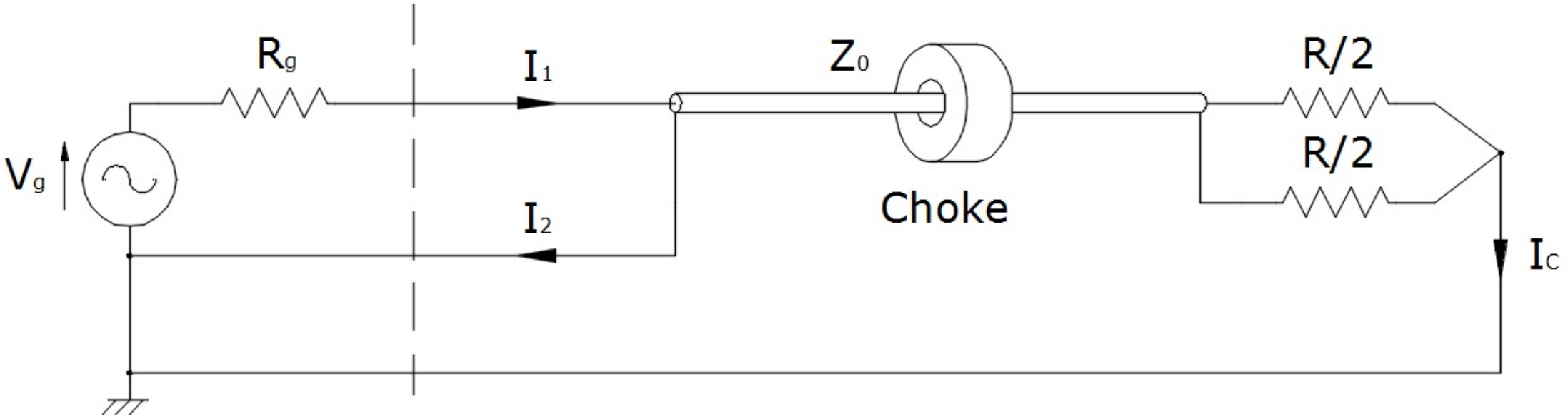
The blocking effect of such a circuit is very high at the resonance frequency because, typically, the circuit's Q is quite large. Unfortunately, its resonance frequency is influenced by installation and external environmental factors. Moreover, due to the high Q, these devices are not capable of effectively covering more than two or three frequency bands.
The difficulty in calibration and the uncertainty about its effectiveness make the Ugly Bal-Un less commonly used.

The ‘choke’

A choke is a blocking inductance that is implemented by inserting an inductance along the path of the common mode current (CMC). Typically, this inductance is achieved by inserting ferrite sleeves along the line, or more conveniently, by winding the coaxial cable around a ferromagnetic material, such as a ferrite rod or a toroid.



Il choke

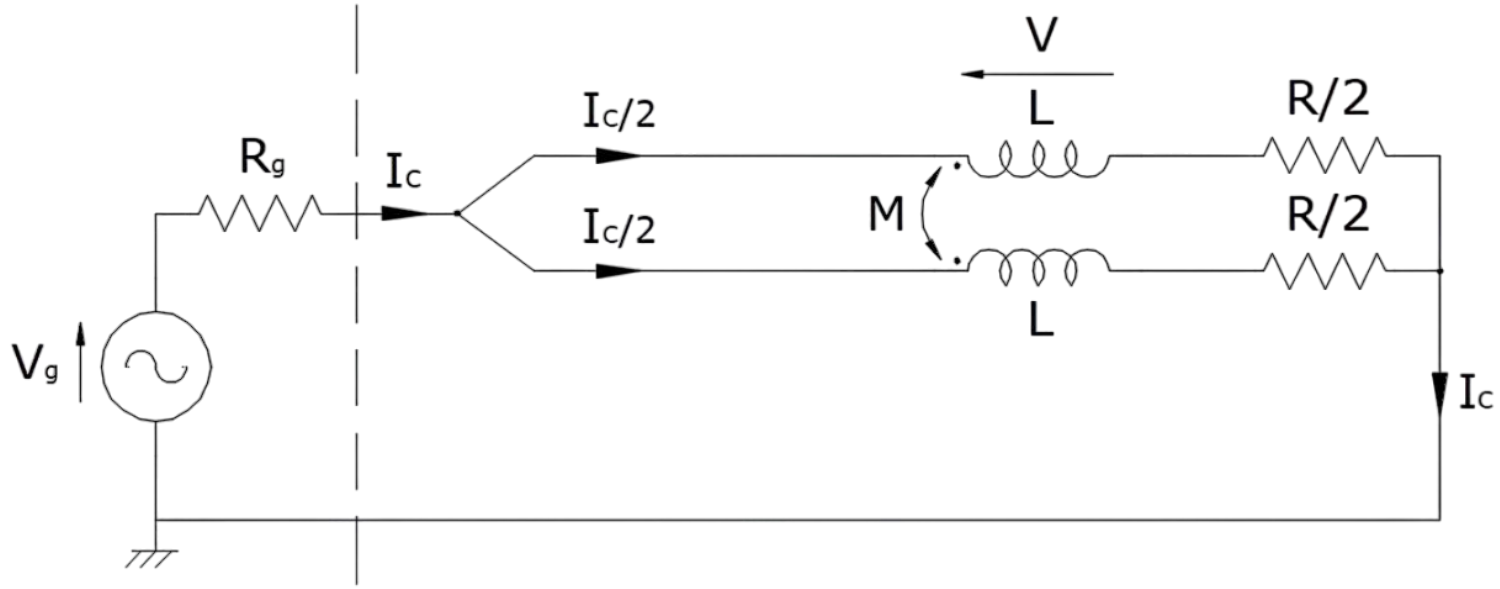


The blocking effect of a circuit made in this way is less pronounced than that of a resonant circuit, but it is not influenced by installation or external environmental factors. Moreover, the use of ferrite allows for the coverage of multiple frequency bands and sometimes even an entire frequency spectrum, such as in the case of HF.

In the video, we will discuss this type of choke, specifically those wound on ferrite toroids.

Il choke

Inserting a choke along a transmission line is equivalent to inserting an inductance on both conductors. The inductance will ONLY affect common mode currents. In fact, the differential mode currents will only see the distributed inductance!



Usually, the common mode current, I_C, evenly splits between the two conductors of the line because the inductances L, produced by the choke, are equal and the load is balanced. Additionally, the coupling coefficient, k, of these inductances is very close to unity. As a result, the mutual inductance M≈L and the distributed inductance is very small. This is especially true when using coaxial cables, which is nearly always the case.