EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education

MINISTRY OF EDUCATION,
YOUTH AND SPORTS

Insertion loss measurement of capacitor filters

Measurement tasks for practicals of the subject KEI/EMC2

Zdeněk Kubík

Version EN_06. 10. 2021

ESF II project of the University of West Bohemia in Pilsen,

reg. number: CZ.02.2.69/0.0/0.0/18_056/0013239

Measurement description

The capacitor is used like a base part of suppression filter. The most important parameter of the filter is insertion loss. The parameters of capacitors are crucial for correct behaviour of the filter – especially parasitic parameters of the capacitors can influenced the resulting insertion loss of the filter. The dependence of the insertion loss at electrical / mechanical properties of capacitors will be illustrated during the measurement.

Theoretical analysis of the measurements

Insertion loss can be easily measured by spectrum analyzer (SA) with tracking generator (TG) (see Fig. 1). The TG is coupled with SA and there is possible to perform insertion loss measurement in the set frequency range. The measurement results are viewed like a gain on the SA screen – insertion loss is given by equation:

$$Insertion\ loss = -1 \cdot Gain. \tag{1}$$

The block diagram for insertion loss measurement is shown in Fig. 1. In this case, the insertion loss is measured without load of the black box.

NOTE: Be carefully during connection of coaxial cable to the input of the SA – if you use some auxiliary power source, every time use pulse limiter (or DC block) at the SA input.

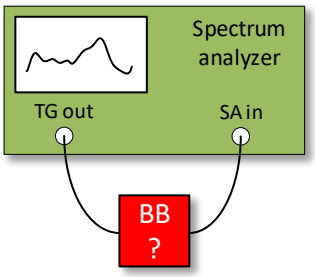


Fig. 1. Insertion loss measurement of Black Box using spectrum analyzer

Schematic of the measurement

The schematic diagram of the measurement is presented in Fig. 2. Fig. 2a) represents measuring setup without capacitor, where the measurement base for capacitor is connected to the SA and TG. The normalization must be performed at this time (for the expected frequency range and TG setting). Fig. 2b) shows connection of the measured capacitor. The gain of the capacitor is measured at the screen of the SA, insertion losses are given by equation (1).

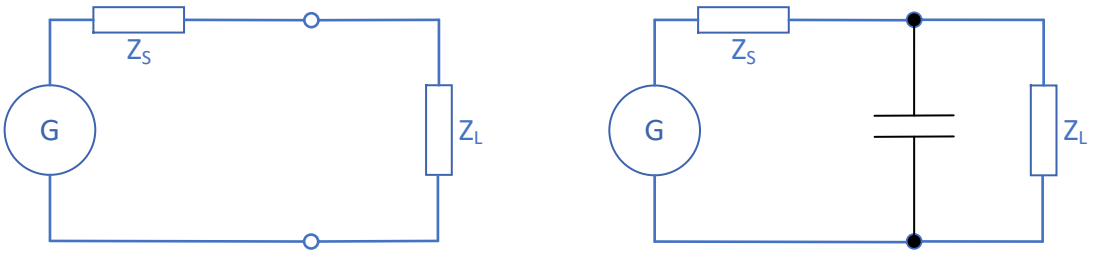


Fig. 2. Schematic diagrams a) without and b) with connected the measured capacitor

Fig. 3. represents the connection diagram of real measurement base and measuring fixture with capacitor.

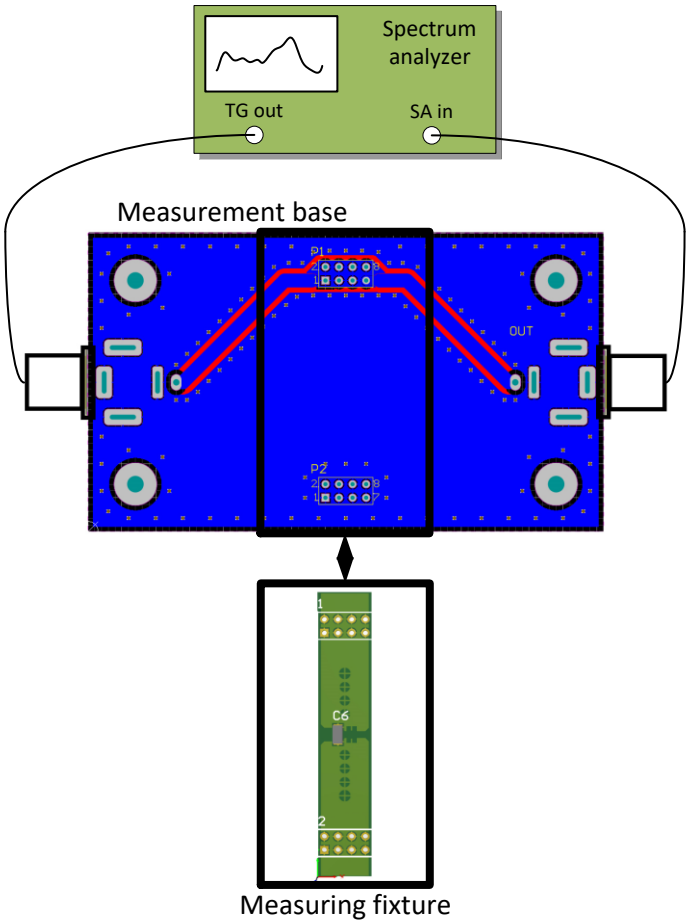


Fig. 3. Real connection insertion loss of capacitors

Measurement tasks:

1. Check the capacitance values of the capacitors placed in measuring fixtures. Set the frequency range of the measurement according to capacitance value (the frequency range depends on the value, expected range can be up to hundreds of MHz).

NOTE: If you are unsure of the frequency range for a given capacitor value, you can try to measure it in advance. Turn on the TG (without normalization) and find the resonant frequency of the capacitor. Then set the frequency range at SA so that the resonance of the capacitor is approx. on the half of the screen. Then remove the capacitor and perform normalization. Then connect the capacitor again and perform the measurement.

2. Turn on the TG output.
3. Connect the measuring fixture to the measurement base and measure the gain.
4. Download the measurement result to the computer.
5. Change the measuring fixture with capacitor by another one and perform the step 3. and 4. again.
6. Compare the measurement results and make a measurement report.

NOTE: The measurement settings of the SA and TG can be found in the document “Basics of spectrum analyzer measurement“.