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

MINISTRY OF EDUCATION,
YOUTH AND SPORTS

Insertion loss measurement of loaded choke filters

Measurement tasks for practicals of the subject KEI/EMC2

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Version EN_06. 10. 2021

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

Measurement description

The choke is used like a base part of suppression filter. The most important parameter of the filter is insertion loss. The parameters of choke are crucial for correct behaviour of the filter – especially parasitic parameters of the chokes can influenced the resulting insertion loss of the filter. The dependence of the insertion loss on the current flowing through the choke 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.

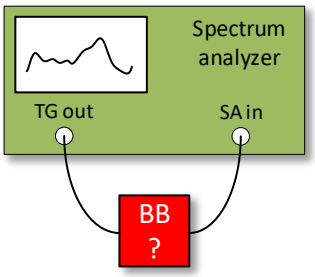


Fig. 1. Insertion loss measurement of Black Box using spectrum analyzer

The current influences the saturation of the choke. If the choke is saturated, the impedance (and the insertion loss too) is decreased (up to DC resistance).

NOTE 1: Never connect / disconnect the normalization fixture or choke fixture if the input of SA / output of TG is connected! Every time is necessary to disconnect them (before changing of the normalization / choke fixture) – after change can be the input of SA / output of TG connected again!
NOTE 2: Never connect / disconnect the power source / load from bias tees if the if the input of SA / output of TG is connected! Connect the whole power circuit at first, then can be connected the input of SA / output of TG! Before disconnection of power circuit disconnect the input of SA / output of TG!

Schematic of the measurement

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

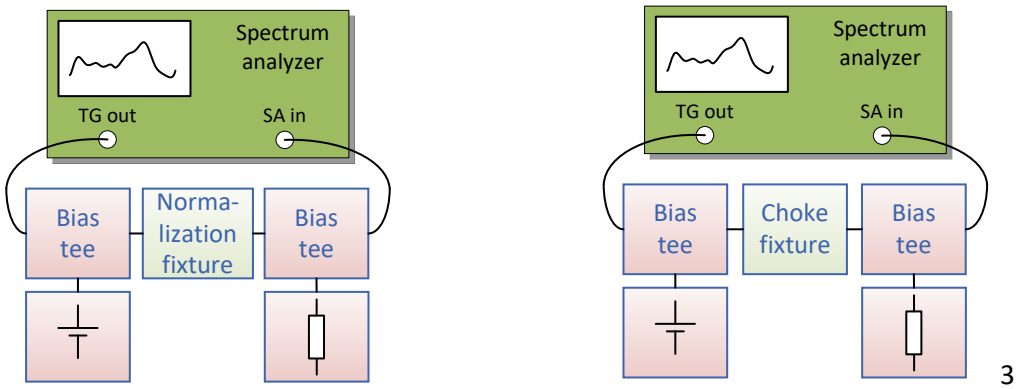


Fig. 2. Schematic diagrams a) with normalization fixture b) with measuring fixture

Measurement tasks:

1. Connect the power circuit – power supply and load resistor to the bias tees. Set input voltage to 5 V, current limit to maximum value of the load resistor.
2. Connect the measurement base to the bias tees.
3. Check the inductance values of the chokes placed in measuring fixtures. Set the frequency range of the measurement according to inductance 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 choke value, you can try to measure it in advance. Turn on the TG (without normalization) and find the resonant frequency of the choke. Then set the frequency range at SA so that the resonance of the choke is approx. on the half of the screen. Then remove the choke, insert normalization fixture and perform the normalization. Then connect the choke again and perform the measurement.

4. Connect the normalization fixture to the measurement base.
5. Connect the input of SA / output of TG to the bias tees.
6. Turn on the TG output.
7. Perform the normalization (it is not dependent on the current).
8. Disconnect the input of SA / output of TG from the bias tees.
9. Connect the measuring fixture with choke (or CMC) to the measurement base.
10. Connect the input of SA / output of TG to the bias tees.
11. Perform measurement for 3 values of current (for example minimal, maximal, and half of maximum current of the choke).
12. Download the measurement results to the computer.

13. Disconnect the input of SA / output of TG from the bias tees.
14. Connect another measuring fixture with different choke and perform the point 10. – 13. again.
15. 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“.