

PRACTICUM III

Fundamental Basics of Modern Technologies

Practical # 2

Thermal Noise in Active and Passive Networks

Goals:

- Determine noise properties of passive (attenuators) and active (amplifiers) devices by direct measurement of voltage transients with the digital oscilloscope and spectrum analyzer (you will probably need to write your own programs for data processing):
 - Measure the noise power of the amplifier in the oscilloscope when connected to a matched load, open-circuit, and short-circuit; build the spectrum of the noise signal;
 - Measure noise power of MiniCircuit ZFL-1000 amplifier when connected to a matched load, open-circuit, and short-circuit, use Y-factor technique to measure noise temperature and noise figure of the amplifier;
 - Measure noise figure of a matched lossy line (attenuator).
 - (optional) Study noise spectrum, and measure noise temperatures with the spectrum analyzer

Available equipment:

- Digital oscilloscopes Rohde&Schwarz RTO1024 or Tektronix DPO 70404C.
- Signal analyzer Rohde&Schwarz FSV (spectrum analyzer)
- Co-axial matched load (50Ω), and short-circuit..
- Amplifier MiniCircuit ZFL-1000LN (maybe two, connected in series).
- Liquid nitrogen

List of topics to be studied before the lab:

- Thermal noise, noise power, spectrum of noise, equivalent noise temperature
- Y-factor method for noise temperature measurement
- Noise Figure, noise figure of a cascaded system (2 amplifiers), noise figure of a matched lossy line (attenuator)

Literature:

- David M. Pozar *Microwave Engineering* // John Wiley 2011
- A. Van der Ziel *Noise* Prentice-Hall; 1st edition (January 1, 1954) (Russian translation: Ван дер Зил *Шум* // М:1973)
- User's guides and manuals for oscilloscopes and spectrum analyzers: <https://www.rohde-schwarz.com/> and [Tek.com](https://www.tek.com/)
- R&S®FSV User Manual (online version): <https://www.rohde-schwarz.com/>
- Low noise amplifier specification: <https://ww2.minicircuits.com/pdfs/ZFL-1000LN+.pdf>