S-26.3120 Radio Engineering, laboratory course

Lab 2: GSM Base Station Receiver

Pre-study report

January 10, 2014

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1 Measurement and setup descriptions

Present all the required measurement setups (draw a figure) and procedures. Take into account the attenuation of the cables. In which range is the attenuation of coaxial cables at 900 MHz? Pick the most suitable measurement equipment if there are several options to choose from.

The figure on page 8 in [1] suggests that for a standard PE coax cables the attenuation ranges between 0.32 . . . 1.36 dB/m at a frequency of 900 MHz. Even lower losses may be achieved with more expensive cables (down to roughly 0.2 dB/m, as suggested on page 29 in [1]). Similarly, some maltreated cables may have an attenuation in excess of 2 dB/m. In addition, one should not overlook the attenuation from connectors and connecting.

When it comes to this lab course and our measurements, an attenuation of roughly 0.5 dB/m would most likely be a realistic estimate.

1.1 1 dB compression point of the RX pre-amplifier block

The compression point is a measure of maximum power at which the input amplifier works in linear mode and sets limit to the received signal power level. The frequency of 900 MHz is conveniently around the center of the RX band.

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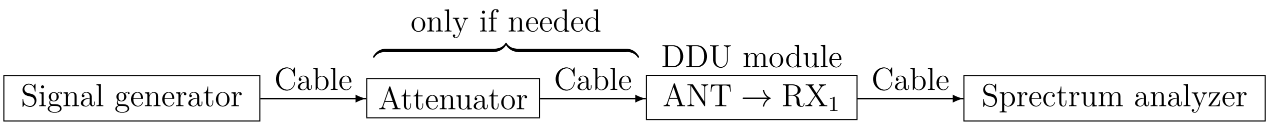

Figure 1: Measurement setup used in the first measurement task.

1.2 Gain of the RX pre-amplifier block

The bandwidth of the RX block should account for the GSM specification for the RX band limits. Measure the 3 dB bandwidth of the block and determine approximately the equivalent noise bandwidth (graphically using the additional material) and the TX-band (stop band) attenuation.

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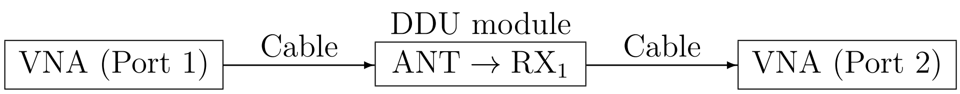

Figure 2: Measurement setup used when determining the gain of the pre-amplifier block.

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1.3 Noise temperature of the RX pre-amplifier block

Determine the noise temperature of the RX block (consisting of bias tee, diplexer and pre-amplifier) with the Y-coefficient method. Use the noise diode as active noise source (and as passive noise source at room temperature when supply voltage is switched off).

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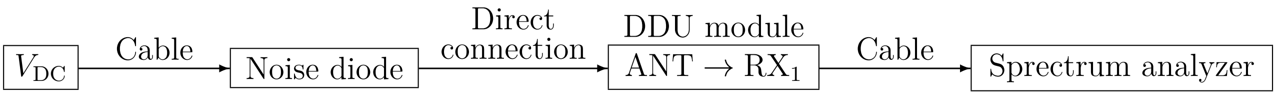

Figure 3: Noise temperature measurement setup

1.4 Sensitivity of the RX pre-amplifier block

Measure the sensitivity of the RX block using suitable equipment.

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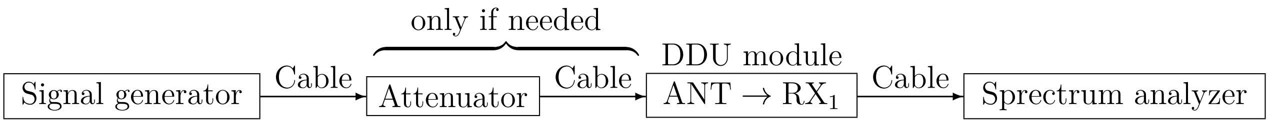

Figure 4: Measurement setup used in the sensitivity measurement.

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2 Pre-study calculations and related tasks

The following subsections will present answers to pre-study tasks 2.2 – 2.4.

2.1 Mismatch attenuation

A signal generator is connected to the input of the RX pre-amp block. The VSWR (voltage standing wave ratio) of the pre-amp is 2.0 and the VSWR of the output of the signal generator is 1.6.

a) What is the range of additional attenuation due to this mismatch in the measurement of the pre-amp block?

b) In what range is the attenuation due to mismatch, when an ideal 10 dB attenuator is connected between the signal generator and the pre-amp block? What is the benefit/drawback of inserting this attenuator?

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2.2 Noise temperature

The noise temperature of the pre-amp block is determined using the Y-coefficient method. The noise level of the spectrum analyzer HP8596E is $P_{\mathrm{SA}} < -125$ *dBm when the input is matched and the resolution bandwidth is 30 Hz.*

a) How much gain is required from the LNA in order to measure the noise temperature with the HP8596E? The noise figure of the amplifier is 2.8 dB and the attenuation of the bias Tee and the diplexer is 0.7 and 0.4 dB, respectively.

b) Does the order (i.e. which is first in the chain) of the amplifier, bias tee and the diplexer in the pre-amp block have any influence on the result of Y-coefficient measurement? If yes, say why.

Text here.

2.3 Requirements with evolving standards

Discuss briefly the major changes in the requirements for the RF performance of the blocks in the RX chain when we move from 2G to 3G to 4G systems.

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References

[1] Huber + Suhner, *RF Cables*, Edition 2013/09. Available online at `http://ipaper.ipapercms.dk/HUBERSUHNER/Technologies/Radiofrequency/RFCablesEN/` [Retrieved: January 10th, 2014].

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[2] D. M. Pozar, *Microwave Engineering*, J. Wiley & Sons, 4th Ed., 2012. ISBN: 978-0-470-63155-3.

[3] M. Steer, *Microwave and RF Design – A Systems Approach*, SciTech Publishing, 2010. ISBN: 978-1-891-12188-3.