S-26.3120 Radio Engineering, laboratory course

Lab 2: GSM Base Station Receiver

Final report

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1 Introduction

TODO: Huy and Sampo (1st paragraph: general intro, 2nd: the measuremets, 3rd: structure of this report)

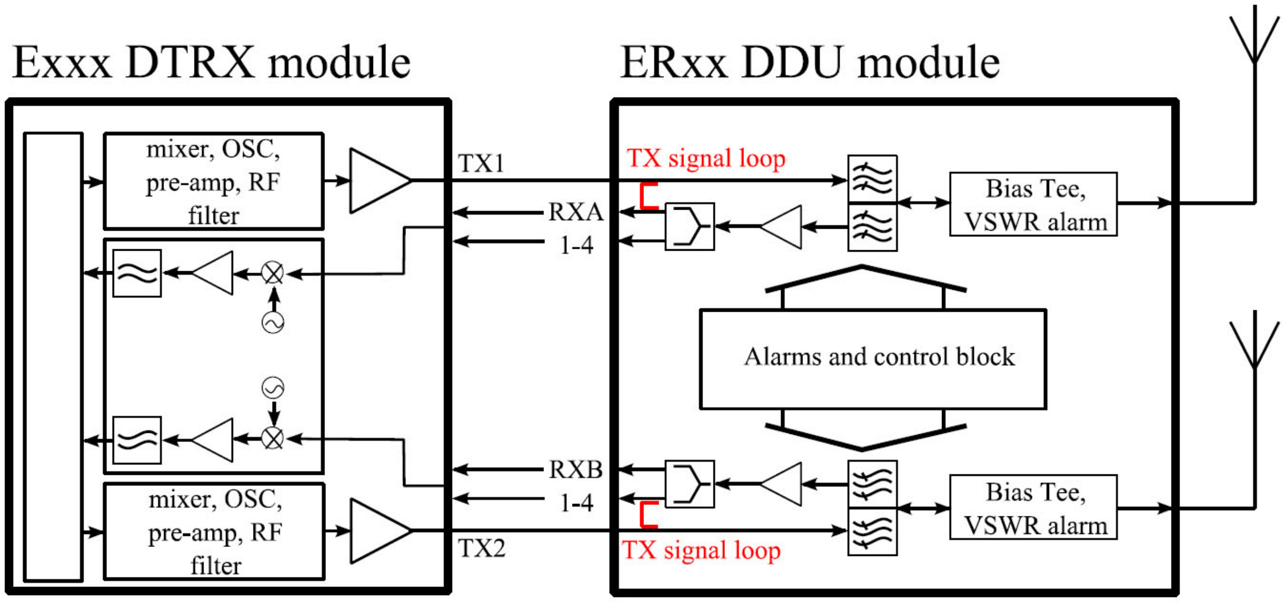

Figure 1: Receiver under study.

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2 Measurement steps

TODO: Tuomas

2.1 1 dB compression point

TODO: Tuomas

2.2 Frequency response

TODO: Tuomas

2.3 Noise temperature

TODO: Tuomas

2.4 Sensitivity

TODO: Tuomas

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3 Results

TODO: Huy and Sampo (general results and intro to more specific results)

3.1 1 dB compression point

TODO: Huy and Sampo

3.2 Frequency response

TODO: Tuomas

3.3 Noise Temperature

TODO: Huy and Sampo

3.4 Sensitivity

TODO: Huy and Sampo

3.5 Dynamic range

TODO: Huy and Sampo

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4 Error estimates

TODO: Huy and Sampo (make additions, corrections, change the style to avoid excess repetition etc.)

In this section, error estimates for the two types of measurements are presented. The values presented here are only rough estimates based on literature (with more or less general cases) and their soundness in this case is somewhat questionable. In this section, we do not take human errors (see previous section) into account. It is just stated that systematic errors arising from the cables and connections are possible in measurement all measurements. Thus they are valid only for "correct" measurements, and are more of the "provided for completeness" nature. Probabilities are not given due to the nature/basis of the estimation.

4.1 Spectrum analyzer

Each of the components inside the spectrum analyzer contributes to the total uncertainty, depending for example on the signal frequencies, amplitudes, and measurement settings. The Agilent (former HP, manufacturer of the used SA) has made available a document that specifies the different error sources, giving also rough estimates for some spectrum analyzers. According to the document [3], the error estimates vary broadly among different analyzer models, giving worst case uncertainties exceeding ±6 dB. On the other hand, the document gives also representative values of amplitude uncertainties, which in our case yields about ±1 dB.

The second error source for the spectrum analyzer is the power marker reading. In each of the tasks, the spectrum analyzer was set to average 500 measurement points, which should average out most of the random errors. However, reading the power marker in the screen, there was a noticeable fluctuation in the shown power value. Based on the experience obtained during the measurements, the power marker error is estimated to be approximately ±0.5 dB.

In conclusion, the error estimates that can be taken into account numerically are the manufacturers representative value of approx. ±1 dB, and the power marker fluctuation of roughly ±0.5 dB. These uncorrelated errors may be summed to achieve the total uncertainty of the SA measurements of approx. ±1.5 dB.

There is also the question of calibrating the spectrum analyzer properly with the time interval defined by the manufacturer. Agilent suggests to have the spectrum analyzer calibrated thoroughly once in a year, and quick-calibrated if there are changes operating environment [4]. If the spectrum analyzer used in the measurements is not calibrated correctly, it is possible that the measurements are not reliable. In this case, the calibration is the most important error source, and the device should be calibrated correctly before estimating any other errors.

4.2 Vector network analyzer

For the VNA, different error sources and ways to cope with them are listed in the lecture slides discussing VNA measurements. The different sources are noise, cabling/connector repeatability, directivity, isolation, mismatch and environment induced drift.

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Noise and cabling/connector repeatability are random errors, which can be averaged out. In our case, only the noise was averaged, since we did not touch the cabling. Systematic errors arising directivity, isolation, and mismatch in this task were for the most part neglected with a calibration. Before conducting measurements, the VNA is always calibrated using a standard calibration module. The calibration moves the reference planes to the connectors of the test cables, and somewhat cancels the systematic errors from the connectors and cables used in a specific measurement. Finally, the environment induced drift is not relevant, since the measurement was done inside a short time interval.

Rohde & Schwarz provides specifications that describe the measurement uncertainty of the VNA in question in different frequency bands. For transmission measurements in the frequency range of 50 MHz to 3 GHz, accuracy for signal powers of $-50 \ldots 0$ dB is better than 0.2 dB (0.3 dB for powers of $-50 \ldots -70$ dB) with 0 dBm transmit power. [5] The reader should note that these ranges was exceeded from both ends during the measurements (the measurement power range was roughly $-100 \ldots +4$ dBm).

In conclusion, two things are assumed. First, calibration is assumed to cancel the systematic errors arising from cables and connectors. Second, random errors are cancelled with averaging. The manufacturer provides error estimates for the device itself, giving an error estimate of under 0.3 dB that is mostly applicable in our case. The topics discussed in the last paragraph of the last subsection apply here to some extent to here as well.

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5 Conclusions

TODO: Huy and Sampo

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6 Feedback

TODO: Huy and Sampo

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References

[1] C. Icheln, S. Khanal, *GSM Receiver laboratory assignment instructions*, S-26.3120 Laboratory course in Radio Engineering course material.

[2] C. Icheln (edited), *Lecture supplement handout*, S-26.3120 Laboratory course in Radio Engineering course material.

[3] Agilent, Spectrum Analysis Basics, Application Note 150. Available online at `http://cp.literature.agilent.com/litweb/pdf/5952-0292.pdf` [Retrieved: Jan 2nd, 2014].

[4] Agilent, 8590 Series Analyzers Calibration Guide. Available online at `http://cp.literature.agilent.com/litweb/pdf/08594-90106.pdf` [Retrieved: Jan 2nd, 2014].

[5] R&S ZVL Vector Network Analyzer Specifications, Version 06.00, Dec 2008. Available online at `http://www.upc.edu/pct/documents_equipament/d_160_id-655-2.pdf` [Retrieved: Jan 2nd, 2014].