Radio Frequency Engineering Laboratory

Exercise 3 Spectrum Analysis

Within this course you will get familiar with the basic principles of spectrum analysis carried out with swept frequency tuned spectrum analyzers.

To be prepared for the lab course the following sources are recommended and can be found on the course webpage (http://www.emce.tuwien.ac.at/hfadmin/354059/index.htm)

German:
Deutschsprachiges Tutorial, das vom RF/HF-Messgerätehersteller Rohde&Schwarz herausgegeben wird. Es ist auszugsweise mit freundlicher Genehmigung des Unternehmens für Lehrzwecke freigegeben. ***Christoph Rauscher, "Grundlagen der Spektrumanalyse"***

Überblick über Spektrumanalysatoren nach dem Sweep-Prinzip
- 3.2 Analysatoren nach dem Überlagerungsprinzip
- 4.1 HF-Eingangsteil, Frontend
- 4.2 ZF-Signalverarbeitung
- 4.3 Ermittlung der Videospannung, Videofilter
- 4.4 Detektoren

Leistungsmerkmale von Spektrumanalysatoren:
- 5.1 Eigenrauschen
- 5.2 Nichtlinearitäten
- 5.3 Phasenrauschen (spektrale Reinheit)
- 5.4 1-dB-Kompressionspunkt und maximaler Eingangspegel
- 5.5 Dynamikbereich

English:
Tutorial ***Christie Brown, "Spectrum Analysis Basis",*** Teacher's Corner Keysight (former HP - http://www.keysight.com/upload/cmc_upload/All/E206WIRELESS_SABASICS.pdf)

Previous knowledge from the following topics in “VU RF Techniques” (see also lecture notes “Radio Frequency Systems”) is required. This knowledge is mandatory for the multiple choice test at the beginning of the lab course:

Chapter 1, and 4: Frequency conversion, heterodyne receivers;
Chapter 2.3.4 , 1, and 4: Thermal noise, noise figure, SNR;
Chapter 3: Nonlinear RF-circuits, intermodulation;
Chapter 6: Spectra of digitally modulated RF-signals (frequency response of their spectral power density);
Chapter 4.7: Channel selection, link budget;

This will give you a sufficient basis for successful participation in the lab course, and the final lab examination, as well.

Main topics of the lab course:

- Theory of operation and block diagram of swept frequency tuned analyzers
- Spectral resolution
- Signal dynamics
- Sensitivity and linearity
- Interpretation and assessment of measurements with narrow band / broad band – signals, and with coherent / stochastic (noise-like) signals

Program of measurements

Narrow band signals, (frequency domain representation):
the resolution bandwidth of the instrument (spectrum analyzer) is larger than the signal bandwidth, e.g. high spectral purity RF-generators, GSM 900/DCS 1800 spectra with low data rates.
Discuss/measure:

- Amplitude resolution, frequency resolution and accuracy.
- Measurement of very weak signals embedded in noise,
- resolving closely spaced signals (equal amplitudes versus large amplitude dynamics).

Limits of linearity, (frequency domain representation):
harmonics of narrow-band signals, intermodulation produced by the spectrum analyzer itself (intrinsic intermodulation), distortion, dual beat experiment, intermodulation with noise-like broadband signals.

The concept of spectral power density, (frequency domain representation):
noise power measurement, power of noise-like signals. Amplitude distribution measurements.

Broadband signals, (frequency domain representation)
the resolution bandwidth (measurement bandwidth) is smaller compared with the signal bandwidth, e.g. GMSK, UMTS with large data rates. Channel power measurement.

Pulsed signals, (time domain representation)
RF-envelope of real world mobile communication signals („ZERO SPAN“)