Alejandro Neff

Ramon Pfiffner

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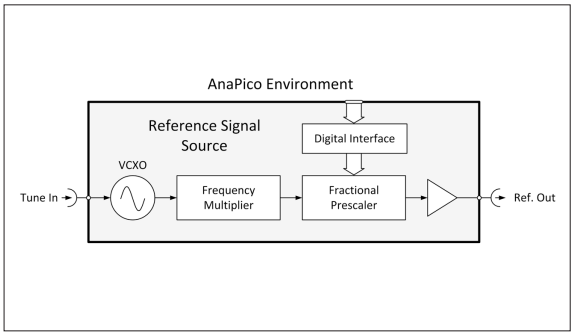
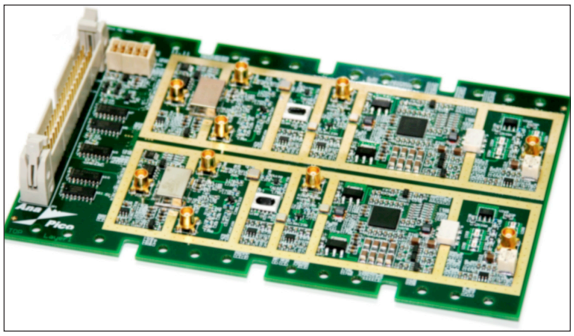
| Graduate Candidates | Alejandro Neff, Ramon Pfiffner |
| Examiner | Prof. Dr. Heinz Mathis |
| Co-Examiner | Stefan Hänggi, Enkom Inventis AG, Gümligen BE |
| Subject Area | Mobilkommunikation |
| Project Partner | AnaPico AG, Zurich |

# Very-low-noise, programmable dual reference signal source from 1 to 400 MHz

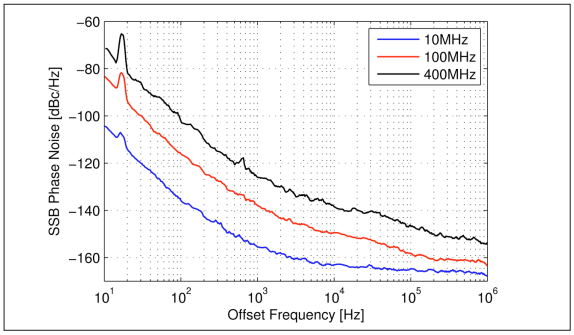
## A compact hardware solution for phase noise measurement applications




Simplified system overview



Assembled PCB with two independent reference signal sources




Output phase noise performance at different output frequencies

Introduction: Today's mobile communication systems are part of everyday life and their features and capabilities increase every year. In particular, modern modulation techniques allowing higher data rates make high demands on the signal precision. Phase noise is one of the most important parameters for signal precision and must continuously be improved to meet the increasing demands. Generally, to be able to measure phase noise of a device under test (DUT), the measurement instrument requires a reference signal source with a much lower phase noise than the DUT. The industrial project partner, AnaPico AG, manufactures phase noise measurement instruments based on the cross-correlation method, requiring two adjustable and independent reference signal sources. The task of this thesis is to develop, build and test a reference signal source extension board for the existing hardware, in accordance with the following specifications:

- Output frequency range: 1 to 400 MHz
- Frequency tuning: programmable by software and an external voltage signal
- Phase noise: lower than –135 dBc/Hz at 100 MHz and 1 kHz offset
- Constant output power level: 13 dBm ±1.5 dB
- Overall PCB dimensions: 16×10 cm (max. height approx. 2.5 cm)

Approach/technologies: First, general methods and designs of reference signal sources are reviewed. Circuits of several suitable working principles are realized and evaluated by measurement. For the final design, a frequency multiplier and a fractional prescaler are chosen. The frequency is generated and is fine-tuneable by a voltage-controlled crystal oscillator (VCXO). The two reference signal sources and their power supplies are tightly arranged to fit onto a PCB of the required dimensions. Test software is also developed and integrated into the existing software environment, provided by AnaPico. Due to various frequency-dependent losses in the system, the power level would not remain constant over the full frequency range. This is dealt with by measuring the power deviation and implementing a compensation function in the firmware. To check the spectral purity, an exact spurious-frequency analysis is carried out and the overall phase noise is measured. Finally, the properties and overall performance of the sources realized are assessed in accordance with the specifications.

Result: A fully functional prototype system has been realized successfully. All required specifications are met. The overall phase noise of every system depends on the actual oscillator used and is further increased by all following stages. The given VCXO has a phase noise value of –140 dBc/Hz. The total phase noise degradation is minimized to approximately 1.5 dB, resulting in an overall phase noise value of –138.5 dBc/Hz. Regarding the output power level deviations, a tolerance of just ±0.5 dB is achieved, which is also considerably better than specified. Finally, the spurious-frequency analysis resulted in a remarkable, worst-case spurious-free dynamic range value (SFDR) of –41 dBc at 389 MHz.