Radio Frequency Measurements on SBX Daughter Boards using GNU Radio/USRP N-210

Rafik Zitouni † ‡, Stefan Ataman‡ and Laurent George* †
† ECE Paris, ‡ UPEM University of Paris Est, *LIGM / ESIEE Paris, France

Abstract

This poster reports Radio Frequency measurements performed with SBX daughter board, USRP N210 and GNU Radio. We measured the output power across a frequency bandwidth and the Total Harmonic Distortion (THD) parameters. We confirm the bandwidth stated by Ettus Research. However, the output power was found to be constantly decreasing with increasing of the output frequency. USRP Hardware Driver (UHD) gain was identified as an amplification parameter available in transmitter flow graphs. Modification of this parameter has to be done with care. The Total Harmonic Distortion (THD) indicated that an important power emission on unwanted harmonics. The obtained results can be reused to define an analytic model to predict the output power.

Introduction

Why we have done these measurements?

• We have only a brief technical note about the SBX daughter boards and their Radio Frequency (RF) performances given by Ettus Research [1].
• The output power and frequency bandwidth are the most important parameters of a Software Defined Radio (SDR). They define the performances of RF Front End (FE) of the GNU Radio/USRP SDR.
• Several research works have been performed using USRP N210, SBX daughter boards and GNU Radio. The authors of these works promote good results without an effective knowledge of USRP N210 performances.
• The SBX daughter board is supposed covering a large frequency band from 400 MHz to 4400 MHz.

Measurement Setup

• USRP N210 is connected to an SBX daughter board. The flow graph generates the carrier and transmit it through USRP/SBX. We measured the output power of signal on each central frequency using Spectrum Analyzer LeCroy Waverunner 640 Zi [4].
• Signal output power can be adjusted by two parameters: the DAC values and the UHD gain. THD can be adjusted via Multiply Const block (DAC value ∈ [0, 1]) and USRP sink, respectively.
• We fixed DAC equal to 1 and we changed UHD gain equal to 10 dB and 20 dB.

Experiment Results

• The expected output power of an SBX daughter board, with an additional transmission gain, is a function of UHD gain in watt and the DAC:

  \[ P_{\text{out}} = \langle P_{0}\rangle - \text{UHD gain} \]  

  \[ P_{\text{out}} = 100 \sqrt[2]{\frac{P_1 + P_2 + \ldots + P_N}{P_1}} \]  


Conclusion

• The measurements confirm the SBX daughter boards bandwidth from 400 MHz to 4400 MHz.
• The output power was found to decrease with increasing carrier frequency.
• We show that beyond a given threshold for the UHD gain, the THD increases swiftly, causing an important power emission on unwanted higher harmonics.

References


Contact Information

• LinkedIn/izitouni
• Email: zitouni@ece.fr
• Phone: +33 (0) 6 35 53 11 34