Abstract

This thesis deals with the EMC characterization of analog front-ends, in particular the operational amplifier and the 2.4 GHz RF receiver. The former is largely used in electronic systems for its low-cost and versatility; it can be found almost in any front-end for signal conditioning, for example to accommodate the output of a sensor to the input of an analog to digital converter. The latter grows in importance for the Internet of Things applications being the 2.4 GHz Industrial, Scientific and Medical radio band licence free and widely used for wireless networking.

An initial objective of this study was to analyze the response of operational amplifiers to continuous wave interference referring in particular to the Direct RF Power Injection method. The upset induced by disturbance has been discussed by theoretical analysis, simulations and measurements. It has been found that small-signal models have limited validity in predicting the susceptibility of amplifiers.

The natural progression of this work was to analyze the response of amplifiers subjected to multi-tone disturbance. The upset of such interference has been found to be not only the generation of a DC offset but also the appearance of a low-frequency beat component in the case of intermodulation distortion.

This is an important issue for future research. On one hand, actual disturbance, intentional or unintentional RF emissions, are poorly described by the CW approach. It is sufficient to think about the wireless data transmissions. The RF emission for equipment based on the time division multiple access is mostly a high-frequency burst with a slow repetition rate. On the other hand, the interference injection test set-up can be modified by using an arbitrary waveform generator to measure and evaluate the response of both analog and digital circuits when subjected to actual interference.

Another important finding in this study was that 2.4 GHz transceivers were susceptible to low-frequency disturbance. Several interfering waveforms, not only the continuous wave, were injected directly in the receiver front-end once the wireless communication has been set. The measurement set-up was similar to the DPI method and results showed relevant errors for the square wave injection, even the interruption of the communication. The errors induced by the low-frequency interference were related to the time in which the input transistors of the LNA were

switched-off. If the LNA does not provide an useful signal for a time that is equal or greater than the symbol period, then the stages that follows in the receiver chain can't successfully decode the information.