Investigating HPEM effects on GaAs p-HEMT low-noise amplifier

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Abstract— This paper presents a study of HPEM (High Power Electromagnetics) effects on a GaAs e-PHEMT low noise amplifier (LNA). The study aims to evaluate HPEM coupling effects on the LNA's active element. The presented results include measurement of the LNA destruction threshold, as well as its response below destruction level.

Keywords-HPEM; IEMI; LNA; GaAs; HEMT; pHEMT

I. INTRODUCTION

Studying the effects of IEMI is an important issue in the EMC community [1]. Also, increase in availability and portability of IEMI sources was reported [2]. This study focuses on irreversible and reversible effects of IEMI on a low-noise amplifier (LNA). The LNA is the first active element of most RF receiving front-ends, and is therefore most likely to fail due to IEMI front-door coupling.

II. DEVICE UNDER TEST

The device under test is a low noise amplifier specifically designed for conducted high power interference studies. Its operating bandwidth is roughly 800 to 2000 MHz with 12 to 20 dB gain depending on the designated operating frequency.

III. EXPERIMENTAL SETUP

The setup is close to the usual Direct Power Injection (DPI) method. It allows the monitoring of the DUT time domain response to HPEM pulses and frequency domain characterization through S-parameters measurement.
The waveform used was a 100 ns rectangular pulse modulated carrier at 1.575 GHz.

The aim was to measure its "destruction threshold", which is the carrier average power ("Pin") for which a single pulse causes irreversible loss of the LNA functionality.

III. RESULTS AND DISCUSSION

A. Destruction of GaAs active element

Destruction of the LNA's active element was observed for an input power of 46.5 dBm (45 W) (carrier average power). No recovery of the DUT functionality is possible afterwards without replacing the active element. The destruction mechanism was further investigated.

B. Degradation of the DUT's functionality

Progressive "degradation" of the DUT S-parameters was observed before destruction. Recovery is possible and has been observed. Further investigation is required to explain this phenomenon. Carrier trapping is most likely.

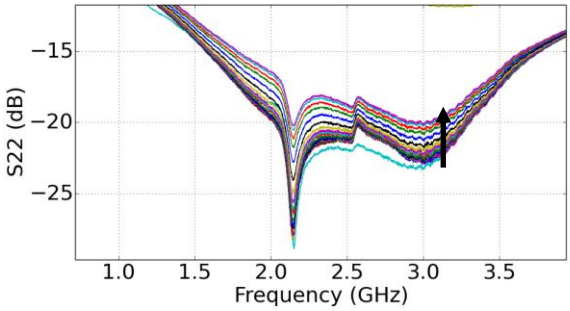

Figure 2. S22 parameter absolute value after each pulse. The value increases with higher values of Pin. The top-most curve corresponds to the last incremented value of Pin before destruction.

IV. CONCLUSION

The experiments presented in this paper show how transistor-scaled overvoltage effects can have an impact on circuit-wide functionality. Noticeable effects of exposure to an HPEM environment can appear, even for non-destructive power levels.

REFERENCES

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