Study on the Effect of HPEM Pulse on RF Front-end

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Abstract—Direct injection test and high power radiation test are carried out respectively in order to investigate the effect of HPEM pulse on a RF front-end. From the comparison of test results, the correlation between two experimental methodologies can be verified.

Keywords-HPEM, Effect, RF Front-end

I. INTRODUCTION

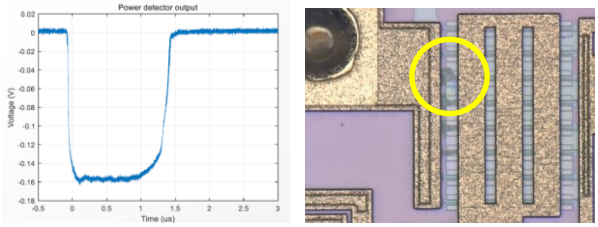
The RF front-end, composed of an antenna, a filter stage and a low noise amplifier, is one of the vulnerable parts of RF receiving system when it is exposed to high power electromagnetic(HPEM) environment and the threatening electromagnetic signal is induced by the front door coupling. A lot of researches have been reported to investigate the effect on HPEM pulse for RF front-ends from circuit level to system level by using various experimental methodologies [1,2]. When these experiments were planned and designed in detail, common interests might be efficiency and reality for the HPEM effect analysis. In this point of view, we will introduce two different types of HPEM effect tests on RF front-end, direct injection test and high power radiation test will be introduced and the test results will be compared.

II. EFFECT TEST

A. Direct Injection Test

The main feature of direct injection test on RF front-end is simplification. In this test setup, the wave propagation from HPEM source to a receiving antenna can be eliminated and the threat signal is induced into RF circuit under test directly. Instead of real high power sources, the solid state power amplifiers(SSPAs) are typically used to generate the simulating HPEM threat signal. When the SSPAs is used in the HPEM effect test, the core advantage is that parameters of electromagnetic signal can be controlled quiet freely in time domain as well as frequency domain due to its wideband characteristics. So, it is possible to simulate a number of HPEM environment cases efficiently using this abbreviated test methodology.

To study the effect of RF front-end in a telecommunication system, one kilowatt in-band SSPA with a signal generator is prepared to generate the equivalent HPEM threat. Then, the input and output signals of every component are monitored while changing parameters of the injected signal such as frequency, power, pulse width, and so on. Figure 1. (a) shows the typical square pulse profile of the injecting signal generated at SSPA and Figure 1. (b) shows the damaged low noise amplifier circuit after direct injection tests.



(a) (b)

Figure 1. (a) Injecting HPEM signal, (b) Damage of RF circuit (yellow circle).

B. High Power Radiation Test

In spite of efficiency and versatility of direct injection test, the test results should be verified in the real environment conditions. Because it must be a test method with assumption and there are some differences with the real HPEM environment. One of the most unmatched conditions is the injected signal characteristics. Practically, gigawatt class high power sources such as a relativistic vacuum tube generate a specific nonlinear output pulse signal due to pulse shortening, mode competition, frequency shifting, and so on [3]. Therefore, radiation effect tests on the RF front-end including a receiving antenna with a high power source are carried out at outdoor experimental site. In the comparison of the two test results, the correlation between two HPEM effect test methods can be verified.

III. CONCLUSION

In this paper, the direct injection test and the high power radiation test to investigate the HPEM effects via front door coupling were discussed correlatively. Results of the comparison test give us reliability of the experimental method for various types of RF front-end.

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