Emulation of Transient Field Coupling into Electronic Systems

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Several investigations focusing on transient susceptibility of electronic devices under normal operation conditions have been published. Especially EMP und UWB pulses with short risetimes are capable of disturbing the appropriate function of electronic devices and systems. By the use of field strength of several kV/m not only breakdowns of the system are detectable. In the worst case, parts of the whole chip maybe irreversibly destroyed. The vulnerability of the systems increases with higher integration of the implemented chips. In the past, transient field susceptibility tests have been carried out with pulse generators feeding TEM waveguides. The necessary equipment is very large and expensive. In order to reduce efforts and costs a measurement setup which emulates the field coupling by the use of line-led exposure is presented in this paper. First measurement results are shown.

Former investigations show that the effects of transient field coupling into electronic systems are heavily dependent on the system dimensions and the system state during exposure. Especially amplitude and shape of the coupled-in signals are determined by the length of the interconnections between the system components. The resulting disturbance signals can be approximated mathematically by a damped sinusoidal signal:

$$u(t) = U_0 \cdot (e^{-\alpha t}) \cdot \sin(\omega_0 t) \tag{1}$$

The parameters U_0 and ω_0 depend on the specific system. For this reason the emulation of field coupling must provide a possibility to vary these parameters in order to emulate different system dimensions. Therefore a pulse forming resonant circuit has been developed. Exited by a pulse which has to have significant spectral components in the resonant range of the system but is arbitrary otherwise, the circuit generates an output according to (1). The resonant frequency ω_0 can be varied via tunable capacitors while the amplitude U_0 can be determined by the use of linear attenuators. The generated disturbance signal can be applied line-led to individual pins of the investigated electronic devices (Pin-Injection).

The measurements carried out with the described setup show that the coupling of transient fields into electronic systems can be emulated by the use of line-led exposure in combination with pulse forming networks. Microscopic analysis shows many parallels between field test and emulation. Thermal destructions as well as breakthrough effects, as they are known from field tests, can be reproduced. Even complex effects like the dependence of the distribution of destructions on the chip based on the system state during exposure are reproducible.

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