Measurement of the Stochastic Electromagnetic Field Coupling into a Double Wire Transmission Line

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***Abstract*—Measurements of the field coupling to double wire transmission lines have been carried out in a mode-stirred chamber. The coupled voltage at one end of the line was measured by amplitude and phase via a balun for different frequencies and line lengths using an oscilloscope. The other line end was open-circuited. For comparison with simulations, the average field strength was determined using field probes. The measurements were done for different stirrer positions and the results were analyzed statistically.**

***Keywords*—electromagnetic coupling; immunity testing; reverberation chambers; statistical distributions; transmission lines**

I. Introduction

Closed-form formulas for the stochastic field-to-wire coupling [1] were published and shall be experimentally validated.

II. Measurement Setup and Results

The setup is shown in Fig. 1. Eight mechanical line lengths between 10 cm and 150 cm were analyzed. The electrical line lengths were determined from the minima of the input reflection coefficient. The wire diameter was $d_0 = 0.8$ mm, the wire separation $2h = 32$ mm. According to this the characteristic impedance is $Z_\mathrm{c} = 525.5\,\Omega$ and transmission line theory is valid up to ≈ 3 GHz. The line beginning is terminated with $100\,\Omega$ via the balun, the end is left open. 36 stirrer positions and 801 frequencies between 200 MHz and 1 GHz were measured.

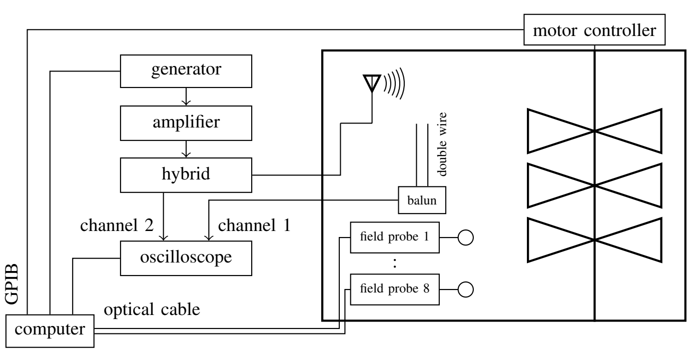

Figure 1. Schematic of the measurement setup in a reverberation chamber.

The average magnitude of the coupled voltage is shown in Fig. 2 as a function of the frequency and in Fig. 3 as a function of the line length. The voltage was normalized to the chamber constant E_0 [2] and h to get a dimensionless quantity. In Fig. 2 the transmission line resonances are clearly visible. In Fig. 3 a critical line length of a quarter of the wavelength is observed, at which the coupling reaches a first maximum. Fig. 4 presents the statistical distribution of the mean normalized voltage magnitude.

For immunity tests especially the distribution of the maximum or rather the maximum-to-average ratio is interesting, which was calculated according to [3]. Here this ratio is ≈ 2.3.

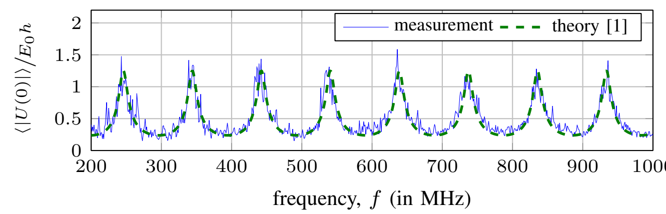

Figure 2. Normalized average magnitude of the coupled voltage at the beginning of the line as a function of the frequency for a line length of 150 cm.

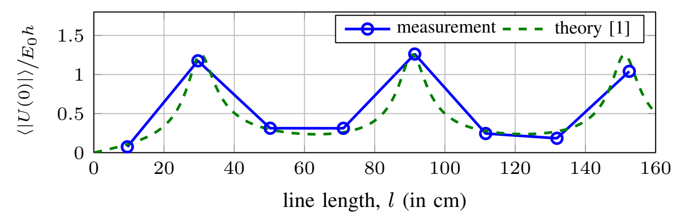

Figure 3. Normalized average magnitude of the coupled voltage at the beginning of the line as a function of the line length at a frequency of 248 MHz.

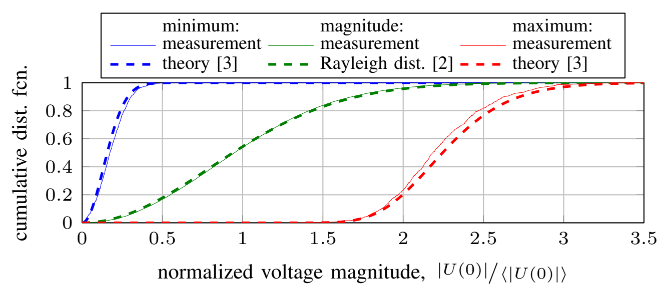

Figure 4. Cumulative distribution function of the magnitude of the coupled voltage at the beginning of the 150 cm long line normalized to the mean value.

III. Conclusion

In general a good agreement between the theoretical and experimental results could be observed.

References

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