Tutorial Com. E:
High Power Electromagnetics: Effects on analogue and digital electronics

C. Kasmi, D. Martinez, F. Vega, N. Mora
Directed Energy Research Center, Technology and Innovation Institute, Abu Dhabi, UAE
chaouki.kasmi@tii.ae

Electromagnetic interferences represent a non-negligible threat for the security and safety of critical infrastructures [1, 2]. The trend in society is to increase the number of autonomous systems [3, 4] which relies on the deployment of smart devices. Multiple sensors [5, 6] and actuators are enclosed within smart devices powered by complex software. Many studies have reported the susceptibility [7, 8, 9, 10, 11] to intentional electromagnetic interferences. Nevertheless, it is commonly accepted that the criticality of hardware and software failures induced by IEMI is difficult to assess especially for closed source devices where the detection of a failure remains a challenge. Few successful attempts [12, 13] have shown that once the possibility to instrument a device under test, the detection, the classification and the hardening process become natural.

We propose in this tutorial to review the different techniques applied to perform a deep analysis of the effects induced IEMI. We propose to go through different evaluation reports in order to highlight how the evaluation of IEMI effects on analogue and digital electronic functions have been performed and how they can be improved.

References

[1] D. V Giri and F. M. Tesche, "Classification of intentional electromagnetic environments (IEME)," IEEE Trans. Electromagn. Compat., vol. 46, no. 3, pp. 322–328, Aug. 2004.
[2] N. Mora Parra, "Contribution to the study of the vulnerability of critical systems to Intentional Electromagnetic Interference (IEMI)," p. 240, 2016.
[3] M. R. Endsley, "Autonomous Driving Systems: A Preliminary Naturalistic Study of the Tesla Model S," J. Cogn. Eng. Decis. Mak., vol. 11, no. 3, pp. 225–238, 2017.
[4] F. Alesiani and S. Gajek, "Remote Testimony: How to Trust an Autonomous Vehicle," in 2016 IEEE 83rd Vehicular Technology Conference (VTC Spring), 2016, pp. 1–5.
[5] J. Heidemann, M. Stojanovic, and M. Zorzi, "Underwater sensor networks: applications, advances and challenges," Philos. Trans. R. Soc. A Math. Phys. Eng. Sci., vol. 370, no. 1958, pp. 158–175, 2012.
[6] N. T. Depenbusch, J. J. Bird, and J. W. Langelaan, "The AutoSOAR autonomous soaring aircraft part 2: Hardware implementation and flight results," J. F. Robot., vol. 35, no. 4, pp. 435–458, 2018.
[7] J. Delsing, J. Ekman, J. Johansson, S. Sundberg, M. Backstrom, and T. Nilsson, "Susceptibility of sensor networks to intentional electromagnetic interference," in 2006 17th International Zurich Symposium on Electromagnetic Compatibility, 2006, pp. 172–175.
[8] M. Vitkovsky, T. M. Antonsen, E. Schamiloglu, and S. Hemmady, "Predictive Modeling Of Erroneous Software Behavior In Embedded Digital Systems Due To Extreme Electromagnetic Interference," in 2019 International Conference on Electromagnetics in Advanced Applications (ICEAA), 2019, pp. 1304–1307.
[9] C. Kasmi, J. L. Esteves, and K. Armstrong, "EMC/EMI and Functional Safety: Methodology to characterize effects of interferences on devices," in 2016 Asia-Pacific International Symposium on Electromagnetic Compatibility (APEMC), 2016, vol. 01, pp. 1178–1180.
[10] C. Kasmi, J. Lopes-Esteves, and M. Renard, "Autonomous electromagnetic attacks detection considering a COTS computer as a multi-sensor system," in 2014 XXXIth URSI General Assembly and Scientific Symposium (URSI GASS), 2014, pp. 1–4.
[11] J. L. Esteves, "Electromagnetic Watermarking: exploiting IEMI effects for forensic tracking of UAVs," in 2019 International Symposium on Electromagnetic Compatibility - EMC EUROPE, 2019, pp. 1144– 1149.
[12] C. Kasmi et al., "Event Logs Generated by an Operating System Running on a COTS Computer During IEMI Exposure," IEEE Trans. Electromagn. Compat., vol. 56, no. 6, pp. 1723–1726, Dec. 2014.
[13] S. Zug, A. Dietrich, and J. Kaiser, "An Architecture for a Dependable Distributed Sensor System," IEEE Trans. Instrum. Meas., vol. 60, no. 2, pp. 408–419, Feb. 2011.