ABSTRACT

Electromagnetic Interference (EMI) disrupting operations of electronic systems has been studied for decades. Many theoretical techniques and protection mechanisms are proposed to reduce impact of EMI on electronic systems. However, a new breed of EMI, Intentional Electromagnetic Interference (IEMI) has recently gained significant attention due to its potential threat to computer networks and communication systems in addition to its potential applications by the military. In this dissertation, we carry out a theoretical and experimental study of mixed signal circuits subject to on & off – board IEMI. Our ultimate goal is to develop a general framework for the EMI analysis of complex systems comprised of cable bundles and Printed Circuit Boards (PCBs) housing mixed signal circuits. In this context, we first consider on–board EMI effects on digital circuits, particularly on an inverter to show the vulnerability of digital devices to RF interference and investigate both system and device level upsets due to adjacent EMI sources on PCBs. Next, we review port analysis techniques to show the applications of the S-Parameter matrix for on–board EMI/EMC analysis. Subsequently, we extent the port analysis method with hybrid S-parameters to account for external field coupling to mixed signal circuits. In other words, we introduce additional hybrid S-parameters that establish a link between the existing board ports and external EMI. Thus, we can handle both on – board and off – board EMI problems concurrently. The new hybrid S-Parameter

matrix can be integrated into standard circuit tools such as HSPICE and Advanced Design System (ADS, Agilent Technologies) and also allows for both time domain and Harmonic Balance simulations of non-linear RF-digital components via broad-band network characterization. We lastly employ hybrid S-parameters to carry out experimental and theoretical studies on RF power amplifiers, performance evaluation of digital modulation schemes and digital timers to address external EMI on communication systems and automotive electronics.