Automotive electronics are very demanding due to their very high safety and reliability requirements and the harsh environment in which they operate. The main design challenges posed by this harsh environment translate in a high voltage supply with high power interferences, a high ambient temperature and high electromagnetic (EMC) and electrostatic (ESD) interferences. EMC in particular is a difficult topic to cope with during IC design. Where design for EMC has long been regarded as an art rather than a science, this situation has changed in recent years and this is discussed in the next chapter.

The radiated and conducted EMC of an automotive module is a function of the behavior of the chip, the package and the PCB subsystem and on their interactions. Analog simulation of such complete system, including all large-signal RF noise sources and coupling paths is clearly not feasible. The first paper by Thomas Steinecke discusses a design and verification flow for EM emission. The complexity is reduced by splitting the problem in three software tools: EXPO targets the IC-feasibility phase, NEMO generates dynamic current profiles of digital sub-modules and XcitePI is a sign-off simulation of the complete module.

Injection of large power EMC signals on a chip input and high voltage electrical transients, conducted on the supply lines or coupled to an input generate large substrate currents in junction-isolated technologies. The resulting design challenge is similar to controlling the substrate currents generated by switching inductive loads. Michael Schenkel describes in his paper the two types of substrate current and their effects in relation to technology variations and technological, layout and circuit protection strategies.

The next three papers address various aspects of EM immunity. The first paper by Franco Fiori analyzes the distortion generated by EMC signals on the input differential pair of an operational amplifier and on MOS switches in Switched Capacitor circuits. A double differential input pair is presented, which largely improves the immunity of the operational amplifier while a non-linear model is derived for the MOS switch to predict the demodulation of the EMC input signal. The combination of the opamp model with the MOS switch model allows an accurate prediction of the EMC behavior of a complete SC circuit.

Derek Bernardon, in his paper, discusses the DPI test on various building blocks. First, the current flow in the package and the coupling effects to the substrate of the RF power signals, generated in the DPI test, are evaluated. Based on the understanding of these effects, circuit improvements are devised for a comparator on a smart power chip. In a second example,
different circuit concepts for an internal voltage regulator are compared and validated. The last example shows how this understanding is used to further optimize the electromagnetic immunity of an existing bandgap circuit.

In the last of the three papers on EM immunity, Aarnout Wieers proposes a structured methodology to evaluate the immunity of analog continuous time circuits. Instead of very time consuming transient analyses for many frequencies in the wide EMC frequency range, a methodology, based on AC analysis and large-signal node impedance is proposed. This methodology is first explained on a simple emitter follower and then applied on a more complex CAN receiver with a resonance in the cabling and the PCB attached to it. The last example is a current reference, based on an, EMC sensitive, external resistor.

Finally, the last paper of this chapter proposes a new approach to extend IC emission modeling into the EMC domain. Mart Coenen first discusses the three on-chip noise sources and their different modeling methods. The application with its impedances and transfer function is the next model component and the measurement setup and signal interpretation is the last component of the model. The proposed modeling concept resolves most of the present EMC emission modeling issues and is currently under development and discussion in international standardization bodies.