Chapter III
Electromagnetic Compatibility
Issues in Automotive Communications

Todd H. Hubing
Clemson University International Center for Automotive Research, USA

ABSTRACT

Engineers and engineering managers involved in the design of automotive electronic systems need to have a basic familiarity with electronic noise and the electromagnetic compatibility (EMC) issues that influence the design and the performance of automotive systems. When EMC issues are addressed early in a product’s design cycle, the resulting designs often meet all EMC requirements without significant cost or performance problems. EMC problems detected after a product has been built and tested, on the other hand, can be very difficult and costly to fix. This chapter reviews automotive EMC requirements and discusses the design of automotive electronics for EMC. The objective of the chapter is to provide non-EMC engineers and engineering managers with basic information that will help them recognize the importance of designing for electromagnetic compatibility, rather than addressing electronic noise problems as they arise.

INTRODUCTION

There are more electronic systems in the average car than there are in the average house. Dozens of computers, connected to sensors and actuators through kilometers of wiring, control everything from the engine to the brakes. Electronic systems determine the vehicle’s performance, handling, and fuel economy. They also navigate, entertain, communicate and help to keep the driver and passengers safe and comfortable.

Electromagnetic interference is a significant concern to the automotive system designer. Packing all of these electronic systems in close proximity and getting them to function reliably in all possible situations is becoming increas-
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ingly difficult. Microcontroller circuits generally operate at radio frequencies. They emit radio frequency noise and are susceptible to radio frequency fields. In an automotive environment, electronic systems must be able to function in the presence of intentional radio transmitters that are mounted on the vehicle, located along the vehicle’s route, or carried into the vehicle by the driver or passengers.

This chapter provides an overview of the electromagnetic compatibility requirements that automobiles must meet. Significant electronic noise sources and coupling paths are described, and aspects of the major automotive communication buses that affect electromagnetic compatibility are reviewed. The chapter concludes with a discussion of design features that affect the electromagnetic compatibility of automotive systems.

AUTOMOTIVE EMC REQUIREMENTS

In order to help ensure that a vehicle will not have problems with electromagnetic interference, extensive electromagnetic compatibility (EMC) testing of each model is performed as the vehicle and its components are being developed. There are a number of EMC test standards for automobiles. The most widely referenced standards for unintentional electromagnetic emissions from vehicles are known as CISPR 12 (IEC, 2008) and CISPR 25 (IEC, 2002). CISPR, which is an acronym for Comité International Spécial des Perturbations Radioélectriques, is an organization that develops and supports a variety of international standards governing EMC. CISPR 12 defines test procedures and emission limits for radiated emissions from vehicles. CISPR 25 defines conducted and radiated emissions tests for vehicular components.

CISPR 12 and CISPR 25 only address electromagnetic emissions. There are no CISPR standards for evaluating the susceptibility of vehicles or components to electromagnetic disturbances. Electromagnetic susceptibility (or immunity) standards are developed and maintained by another international standards organization, the International Electro-Technical Committee (IEC). Various IEC standards describe procedures for evaluating the susceptibility of a vehicle or component to various disturbances such as strong RF (radio frequency) fields, power bus transients, and electrostatic discharge.

CISPR 12

According to the introduction in the standard, “CISPR 12 has been developed to serve the road vehicle and related industries with test methods and limits that provide satisfactory protection for radio reception.” It is designed to protect broadcast receivers operating at frequencies between 30 MHz and 1 GHz from unintentional electromagnetic emissions from a vehicle located 10 meters or more away. The standard applies to automobiles, trucks and boats, but not to aircraft or trains.

The test procedure calls for the vehicle to be parked in a flat area free of buildings, trees or other objects that might reflect electromagnetic fields, as illustrated in Figure 1. Electromagnetic emissions from the vehicle are measured with an antenna located 10 meters away. Measurements are made with the vehicle’s engine idling at 1500 RPM, and also with the engine off but the rest of the vehicle powered on. Electric propulsion vehicles are measured on a dynamometer. For hybrid vehicles, a separate test is performed for each form of propulsion.

Making electromagnetic measurements in an open field presents a few technical challenges including weather and ambient noise from local transmitters such as radio and television stations. For this reason, the CISPR 12 standard allows these measurements to be made in an absorber lined shielded enclosure (ALSE) provided these measurements can be shown to correlate to open field measurements. Most large automotive manufacturers operate or lease an EMC test facility with an ALSE.