Chapter 6
Electromagnetic Compatibility (EMC)

An important topic in electronic systems design is electromagnetic compatibility (EMC), which concerns the unintentional generation, propagation and reception of electromagnetic energy. Every electronic system must meet EMC standards evidenced, for example, by the mandatory CE mark affixed to the system if sold inside the European Union or the EMC compliance mandated by the Federal Communications Commission (FCC) in the United States. The education and skill set of every engineer should therefore include a basic knowledge of EMC-related issues and their consideration in electronic system design (Sect. 6.1).

EMC is often the hidden culprit behind undesired circuit functionalities and unwanted signals. This is mostly due to the unintentional *coupling* of circuits that are either part of, only partially part of, or completely outside the system of interest. These couplings are dealt with in Sect. 6.2, and design options for their prevention, for example, by selecting appropriate *reference grounds*, are covered in Sect. 6.3.

While coupling deals with electrical circuits influencing each other with their fields, electronic assemblies and devices can also be disturbed by fields generated by external sources. Hence, one of the most important measures for assuring the EMC of systems is *shielding*. Section 6.4 introduces the principle of shielding, and discusses shielding against different types of fields.

A related discipline to EMC, *electrostatic discharge* (ESD), is covered in Sect. 6.5. The causes of electrostatic build-up and discharge are discussed as well as ESD protection measures.

Finally, we provide recommendations for good EMC practice in electronic systems design in Sect. 6.6.

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6.1 Introduction

The topic of "Electromagnetic Compatibility" (EMC) is concerned with the technical and legal aspects of the mutual interaction of electronic systems and their interaction with their surroundings through electromagnetic fields.

EMC guidelines, such as the "Blue Guide" on the implementation of EU product rules [1], stipulate that manufacturers and sellers of electronic systems are obliged to test these products for EMC. This ensures that equipment is developed to function properly in its electromagnetic surrounding, and that it does not interfere with other equipment. Two conditions must be met for compliance with these requirements. First, a system acting as an emitter should not emit unapproved disturbances (*interference*), and second, a system acting as a receiver should not be susceptible to external disturbances. The second aspect is a system's *immunity* to outside/external disturbances. Selective EMC measures should be put in place to maintain approved emission and immunity levels so that electronic systems can operate properly alongside one another.

The terms "emitter" and "receiver" do not refer to communication channels in this context, but more generally to all electronic systems, as many of them emit electromagnetic energy unintentionally as a byproduct of their operation. For example, every computer system emits energy due to its clock frequency; conversely, computers are also susceptible to disturbances: take, for example, communication problems with peripherals that are near disturbance sources such as an electric motor.

Disturbances, emitted by a *source of disturbance* ("culprit"), travel via a coupling path to the receiver, a *susceptible device* or *receptor* ("victim") . While disturbance sources and susceptible devices can easily be characterized by measuring their interference and immunity, insight into the physical fundamentals of electrical engineering is needed for identifying intermediate coupling mechanisms (see Sect. 6.2). And, knowledge of the coupling mechanisms is needed for selecting suitable countermeasures, such as shielding for sources as well as receptors (see Sect. 6.4), and thus for compliance with statutory emission and immunity levels.