Electromagnetic compatibility of electronic devices and the main measures aimed at ensuring it in devices

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Abstract. The article deals with the concept of electromagnetic compatibility, classification of types of interference sources that affect the normal functioning of electronic devices. It also addresses the main recommended measures, the implementation of which can guarantee the maintainability and reliability of the vehicle and provide EMC.

1. Introduction

The main goal of the development of modern technology is to increase its performance, accordingly, developers face a number of new tasks, one of which is to provide EMC.

Electromagnetic compatibility of radio electronic means is the ability of transmitters and receivers to function in a live environment with the required quality when exposed to interference. I.e. the energy emitted by the transmitters only reaches the desired receivers, receivers react to signals of transmitters according to their purpose, with undesirable effects are absent. It should be noted that the EMC is characterized not only by the interaction of the devices themselves, but also by the interaction of their components.

The problem of EMC primarily concerns receivers, because this violates the quality of the received useful signal [1].

Manifestations of this we often meet in everyday life: noise during a telephone conversation, crackling when turning on or off an electric device.

A large number of separate sources of interference causes the space in which electronic devices operate; they can be divided into two large groups: natural sources that relate to natural electromagnetic phenomena, for example, atmospheric pressure discharges that occur during a thunderstorm, possible static electricity discharges between bodies. Other natural sources play too small a role for the area under consideration. Such sources include sources of geomagnetic fields, solar and cosmic origin, which manifest themselves in the form of atmospheric noise.

The second group of sources is artificial sources, which consider the phenomena that occur during the operation of devices, electric power plants located near the devices.

Electromagnetic interference emitted by various sources affects the devices, their grounding, power supply systems, they can affect separately from each other or in combination, provided that they are randomly superimposed on each other. Inside the electronic means, they can get together with useful signals or with the supply voltage along the wires [2–4].
In addition to the above interference caused by external sources, internal interference may also occur, which propagates through wires or in the form of a field inside the system. Such interference can be attributed to parasitic feedback in a lot of cascaded amplifiers, treason of the current in the wires of the power supply.

Sources of internal noise can be attributed:
- supply voltage with a frequency of 50 Hz;
- change in the potential in the power supply network wires of electronic devices;
- change signals in the wires of the control or data lines;
- switching processes in inductors.

In addition, other factors may occur in electronic devices that may cause a violation of the normal functioning of the device.

When designing electronic devices, taking into account the EMC, technical measures are of great importance, which solve such problems as: ensuring both the internal noise immunity of the device, and noise immunity to external influences that may occur during the operation of the electronic device.

The very same technical measures to ensure the EMC can be divided into 3 groups: circuit solutions, activities related to the development of the design and activities related to the mathematical support.

Let us take a closer look at the circuit solutions, for clarity, we will take some elements of the device in question, namely: 1) electronic equipment, 2) power supply. In Figure 1, they are shown under the corresponding numbers.

![Figure 1](image)

Figure 1. Circuit solutions to the challenges of providing EMC: 1 – Electronic equipment; 2 – power supply; 3 – system of reference potential, ground connection, grounding; 4 – communication with other devices; 5 – input and output circuits; 6 – other devices; 7 – analog and digital sensors; 8 – land; 9 – analog and digital artists and signaling devices

2. **Electronic equipment**
The idea of choosing a noise-resistant electronic unit is based on the fundamental difference between the useful signal and the interference, therefore, we can formulate several recommendations for ensuring EMC in the device:
- The choice and implementation of the idea of signal processing with subsequent recognition of interference, for this it is necessary, based on the requirements for the reliability and quality of the electronic means, to use mathematical software and circuit techniques that will recognize interference, signal their presence, suppress them or, possibly, be able to compensate for random short-term disturbances.
- Use of redundancy in the exchange of data and signals of execution and signaling through the use of test signals, repetition of transmitted signals, parallel transmission of the same information by different clock cycles [5, 6].

3. **Power supply of devices**
The concept of ensuring the EMC of power supply systems of devices is based on blocking the possible emission of interference, preventing the mutual influence of individual functional elements through the internal power supply system.
This EMC can be provided by the following measures:
- The use of varistors, zener diodes, as elements limiting the overvoltage of elements, at the input of the power supply network;
- Use of filters at the connection point of the network wires to protect the device from high-frequency network interference and the ingress of such interference into the network;
- design the device so that the input and output wires are not next to each other [7].

Now let's look at the design-related activities that can be taken to provide an EMC device. Such measures are necessary primarily because they can provide their own noise immunity of the device, weaken the radiation of the device to an acceptable or necessary level. For this purpose, the following measures are taken:
- It is recommended to create at least two zones inside the housing: one with an undisturbed space, shielded by a metal screen that absorbs high-frequency vibrations well, in this space you should place particularly sensitive blocks, high-frequency logic, memory, and a second, semi-quiet zone, in which switching devices, network, and auxiliary elements should be located;
- It is necessary to make a clear separation of the wires with weak signals and the power wires with signals in which, according to the operating conditions, there may be large du/dt or di/dt.

In programmable systems with memory, software and technical measures can be provided to ensure EMC, for this it is necessary to develop such a system for checking the normal functioning of the signal-processing device that, if violations in the operation of the device are detected, the system will signal this.

The problem of electromagnetic compatibility is increasingly mentioned at scientific conferences, in technical and scientific literature, regulatory documents related to the provision of EMC are being tightened, and this fact has a quite logical explanation: problems directly related to EMC can cause accidents, multimillion-dollar losses, failures in the operation of technical means, breakdowns of electronic means, etc.

Due to the use of microprocessor devices, low-power transmitting devices that are widely used in everyday life, it becomes more difficult to comply with all the requirements for EMC. A graph of the efficiency of the EMS from production of devices and the cost of their production, as shown in Fig. 2 shows the situation: it is at the product launch stage to mass production, it is more difficult to ensure EMC requirements at the appropriate level. To fix this, improvements are needed, therefore, the cost of manufacturing the device can significantly increase [8-10].

![Figure 2. Graph of the dependence of the efficiency of the EMC on the stages of production of devices and the costs of their production](image-url)
4. Conclusion
One of the most promising areas in the field of ensuring electromagnetic compatibility in the design of electronic devices is the development of various methods that will contain instructions for calculating the minimum distances between the components of devices, recommendations for the optimal arrangement of elements on the board. Such techniques can be useful in the design of radio-electronic devices, can increase production efficiency, and also increase the service life of the designed and manufactured devices.

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