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MEASUREMENTS AND THE NEED FOR EFFECTIVE EMC DESIGN

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1 Introduction

The proliferation of electronic systems in recent times has resulted in a large increase in electromagnetic interference. This interference is present within systems and between sub-systems, and also between systems which are intended to be independent. In order to control the interference and keep it within acceptable limits, the immunity or susceptibility of equipment to external interference has to be assessed along with the amount of interference produced by each item of equipment. If all this information is available, the likelihood of unacceptable interference being present may be assessed. In a well designed system, a margin of Electro-Magnetic Compatibility (EMC) is achieved.

2 EMC Measurements

A set of measurements could be devised for each particular system design, however, the operational environment of equipment may often only be poorly defined and may change throughout its lifetime. It is therefore convenient to use a set of agreed and well defined tests based on national or international specifications of emission and immunity levels. Consideration of the problem shows that it is impossible to define exactly the operational environment of any individual item of equipment. Consider the owner of a hand portable micro-computer. The promotional literature implies that such machines may be used in the home, office, production area, or public transport (eg aircraft). In these different environments, the threats to, and posed by the machine are different. In each case the imposed EMC specification may be different.

EMC specifications and tests therefore must mimic in a simplified, but possibly severe, way the perceived operational environment of the Equipment under Test (EUT). For example, a typical immunity specification requires that a device be immune to interference from radio frequency (r.f.) radiation of intensity 10V/m in the frequency range 27MHz to 500MHz (BS 6667). The test method specifies that a cw carrier of the required field strength shall be scanned across the frequency range. No modulation sidebands are required, only a single carrier. While this may be regarded as a harsh environment for equipment to withstand it is not a realistic electromagnetic environment. Consider also a radiated emission measurement performed in the frequency range 30MHz to 1GHz on an open field test site as described below. It is difficult to relate the EMC test receiver display under these circumstances to the interfering input voltage at a UHF TV receiver when the EUT is operated at a neighbouring domestic property.

It should therefore be realised that the performance of an EMC test according to a specification is not a measurement in the same sense as say the measurement of the power output of a hifi amplifier. Thus an EMC test is the performance of a procedure that, if successful for the EUT, implies that the EUT will not have an EMC problem in the operating environment for which the test was written.

EMC testing can be divided into two categories, assessment of the immunity of equipment to interference, and assessment of emissions from equipment. Each of these can be further sub-divided by consideration of energy transfer by radiation or conduction.

3 Design for EMC

The nature of the EMC measurement procedures indicates that design for EMC is a matter of the management of the unwanted energy generated within an electronic system, and the unwanted energy incident upon the system from outside. In the past EMC was tackled as an afterthought and was often very expensive as a result of post-design modification.

To prevent emissions from equipment, both the electrical and mechanical design of the equipment has to be considered. Modern digital electronics, by the very nature of its' waveforms, generates electrical energy which is not absolutely necessary for the operation of the equipment. The energy is contained in the fast rising edges of the digital signals. If this energy is radiated by the equipment, then EMC problems may result. The efficiency of the energy radiation process is determined by the mechanical design and the layout of the circuit cards and their interconnections, and any screening that the equipment enclosure may provide. If proper care is taken in the initial design phase then the logic families which minimise the unwanted energy generation can be chosen. Potential radiation sources can be identified, and appropriate layout and screening schemes can be chosen. Right First Time EMC design is a practical proposition. Careful design of equipment cables and their connections prevents conducted emissions and radiation from cables. Precautions such as filters help as do considerations of cable screening and the prevention of the entry of cables into "dirty" screened areas.

At the same time as external emissions are considered, the internal cross-talk between different parts of the same equipment needs attention. Again careful mechanical and electrical design is required.

An equipment's immunity may also be enhanced by design. It is often assumed that an EUT that emits little spurious energy is also likely to have a high level of immunity. This approach must be treated with caution. If low emissions are as a result of good mechanical layout and screening, then the immunity is also likely to be high. If, on the other hand, low emissions are solely due to the use of a slow, low power, logic family, then the immunity may be poor. The lack of screening required to prevent emissions may permit efficient coupling of external, unwanted energy into the system. Low power or "quiet" logic families require much less disruptive energy to upset them than the fast high power "noisy" families.

It can be seen that design for EMC incorporates a realistic assessment of the external threats to the system and of the potential victims of interference from the system. At the initial design stage choices can be made of device type and screening. A set of EMC specifications will also become apparent if they are not already pre-determined. The message of the EC Directive on EMC is clear. Equipment under design now must incorporate EMC design if its' sale throughout the Community is not to be jeopardised. EMC design starts at the initial design stage and is not an afterthought.

Where does the designer go for training in EMC design? We are dealing with electromagnetic energy, and the understanding of electromagnetics is traditionally thought of as difficult by most engineers. Much can be achieved by common sense and good design practice. More can be done with some understanding of the phenomena involved. In-service training for designers and managers is increasingly common and EMC courses are available. Don't be left behind!