

Defining the Risks of Electromagnetic Interference and Proposing Electromagnetic Compatibility's Standards for Libyan State

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Abstract: *It goes without saying that the aspects of the scientific progress achieved by humans in the modern era of the development is the rapid devotement in electrical devices used in homes, institutions and utilities for purposes such as lighting, heating, air conditioning, industrial places, communications devices and medical equipment. besides, the effective role played by this technology in raising the level of comfort and saving money and time for the people in various parts of his or her life, but these devices have become a source of essential bases of environmental pollution that threaten human's health and affecting the electrical appliances in that environment due to electromagnetic interference. Therefore, this article discusses definition of undesirable Electro-Magnetic Interference by brief some of regulations of Electro-Magnetic Compatibility, starting with the general and scientific definition of Electro-Magnetic Compatibility and its history. Furthermore, this paper covers the most important and difficult Electro-Magnetic Compatibility's standards. Finally, the paper reviewing some of the US and European standard to drive from them a proposed method to create standards for Libyan state by calculating the average between the same type form European and US Standard.*

Keywords: magnetic, EMC, Interference

1. Introduction

The extensive usage of electronic Devices for telecommunication, computation, robotics and other purposes make it essential for different circuits to function in close nearness to each other. All too often, these circuits affect each other harmfully. Electromagnetic interference (EMI) has become a main problem for circuit engineers, and it is possible to become even more severe in the future. The great number of electronic devices in common use is partly responsible for this trend. In addition, the use of integrated circuits and large scale integration has reduced the size of electronic equipment. As circuitry has become smaller and more complex, more circuits are being packed into less space, which increases the possibility of interference. In addition, clock frequencies have increased intensely over the years in many cases to over a gigahertz. It is not uncommon today for personal computers used in the home to have clock speeds in excess of 1 GHz [1].

The purpose of the article is to raise the awareness of electromagnetic interference (EMI) which causes problems to human being and other electronic devices. Moreover, (EMI) has taken a place since the beginning of invention of telegraph radio transmitting.

Thus, (EMI) can produce fatal accident such as; Antilock Braking Systems (ABS) systems on both airplanes and automobiles were susceptible to (EMI). Besides, accidents happened when the brakes performed inappropriately due to (EMI) interrupted the (ABS) control system. Furthermore, a heart attack patient was being taken to the hospital with a monitor defibrillator attached to the patient. But, every time

the ambulance staff turned on the radio to request medical advice, the machine switched off and the patient died that was due to the combination of insufficient immunity of monitor defibrillator and excessive radio frequency (RF) field strength from passing by radio station transmitter sector [2] and, many other alike mysterious tragic events so that made the scientists instigate and study why did that occur. After making a lot of experimental and getting a lot of results analyzed, scientists showed these were happened due to the electromagnetic wave interference. Besides, that is led to have the Electromagnetic compatibility (EMC's) standards to ensure the human's and other electric devices' safety [3]. (EMC) is the ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment . However (EMI) signals have to be known and classified in order to reduce that interference signals to understand and specified the (EMI) effect and its interferences sources.

Therefore, there are four main test of (EMC) which are radiation emission, radiation immunity, conducted emission conducted immunity[1], each of these tests have international and regional standard. Libyan state is full and associated member in some international commission organization such as international electro-technical commission (IEC) but, it does not have any EMC standards . Therefore, Libyan EMC standard has to be proposed to obligate the electrical and electronic providers to insure the safety of Libyan citizen whether in industrial or residential environment. Firstly, this paper discusses some EMI actual accident. Secondly, the history and the definition of (EMC) and its test and

standards. Finally, proposing, method to create Libyan EMC standards by using European's united states' standards.

2. Electromagnetic Compatibility

An air plane explodes in air killing all 230 passengers on board. A hospital inject pump suddenly stops its transferring medication without triggering any alarms. A nuclear power plant goes on alert status when turbine control valves spontaneously close. Each of these actual events was a symptom of an electromagnetic compatibility problem [4].

In 1996, TWA Flight 800 bound from New York to Paris exploded over the ocean soon after take-off. After a long investigation that involved salvaging and reconstructing major portions of the aircraft, the results shows that the cause of the explosion was a spark in the center wing fuel tank that ignited the fuel mixture. This spark was likely the direct result of a large voltage transient, possibly a power line transient or electrostatic discharge [6].

In 2007, the results of a study conducted by researchers at the University of Amsterdam documented nearly 50 incidents of electromagnetic interference from cell phone use in hospitals, and classified 75 percent of them as significant or harmful.

Spontaneous valve closures at the Niagara Mohawk Nine Mile Point 2 nuclear power plant were due to interference generated by staffs' wireless handsets. Despite the tremendous emphasis on safety and security that is placed on the design and construction of all nuclear power plants, the relatively weak emissions from common wireless handsets resulted in a major malfunction [6].

Unfortunately, these are not unusual isolated incidences. Electromagnetic compatibility problems result in many deaths and billions of dollars in lost revenue every year. The past decade has seen an explosive increase in the number and severity of EMC problems primarily due to the proliferation of microprocessor controlled devices, high-frequency circuits and low-power transmitters[6] as these EMI problems EMC s over come with electromagnetic standards to insure the EMI in safe limits .

2.1 Definition of (EMC)

Electromagnetic compatibility (EMC) is the capability of electrical and electronic devices, and components to function properly even in the presence of other devices that radiate electromagnetic waves (EMW). This means that each part of equipment emitting EM waves or noises must have it limited to a certain level and that each individual device must have adequate immunity to (EMW) disturbances in the environment it is meant to function in [6].

2.2 Brief History of (EMC)

The necessity of (EMC) started from the beginning of the discovery of wave transmitting and that take a place on 1904, Theodore Roosevelt signed an executive order

authorizing the Department of Commerce to regulate all private radio stations and the Navy to regulate all government stations. Different types of radio transmitters were assigned different frequency allocations and often were only allowed to operate at certain times in order to reduce the potential for radio frequency interference (RFI) [6].

In order to alleviate this problem, the Federal Communications Commission (FCC) was established in 1934 as an independent agency of the U.S. Government. It was empowered to regulate U.S. interstate and foreign communication by radio, wire, and cable. (FCC) regulations and licensing requirements significantly reduced the number of radio frequency interference problems [7].

In 1954, the first Armour Research Foundation Conference on Radio Frequency Interference was held. This annual conference was sponsored by both government and industry. Three years later, the Professional Group on Radio Frequency Interference was established as the newest of several professional groups of the Institute of Radio Engineers. Today, this group is known as the Electromagnetic Compatibility Society of the Institute of Electrical and Electronics Engineers (IEEE) [8].

The impact of these regulations was overwhelming. At a time when the market for computers was growing exponentially, many of the latest, most advanced designs were being held back because they were unable to meet government EMC requirements. EMC short courses, test labs, magazines, and consultants began appearing throughout the world. The international attention focused on EMC encouraged additional research, and significant progress was made toward the development of more comprehensive test procedures and meaningful standards [7].

Fortunately, the past 20 years have also resulted in significant breakthroughs to aid engineers in their efforts to anticipate and correct potential EMC problems. Aided by increasingly sophisticated electromagnetic modeling tools, researchers have developed a much greater understanding of the coupling mechanisms responsible for EMC issues. Models have been developed that can anticipate worst-case scenarios and assist with the development of products that are guaranteed to meet their EMC requirements [8].

2.3 Tests of (EMC)

There are four main tests in order to make the equipment under test (EUT) meet with the standards. Firstly, Radiation emission is the first and most difficult test to meet with (EMC) requirements. Therefore, (EUT) is passed in the radiation emission test if the emitted electromagnetic wave from (EUT) is below the standard limits. The radiation emission test has to be in environment that is calibrated to measure the emitted waves only from the (EUT) and that is only applied in two places which are Anechoic Chambers (AC's) as showing In figure. 1 or open area test site (OATS) which provides no interference of electromagnetic waves and it can be held in uninhabited places like dessert[1].

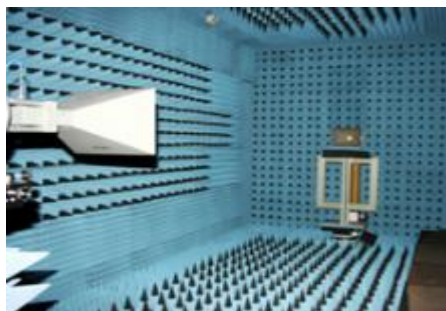


Figure 1: Anechoic Chamber

Secondly is radiation immunity, which is the ability of the (EUT) to function properly under hard conditions. Radiation immunity is performed by pumping certain value of electromagnetic wave on the (EUT) at (AC's) or (OATS) and monitoring the (EUT) whether the (EUT) functioning properly or not. Thirdly, conducted emission test is measuring electromagnetic waves which emitted from the (EUT's) wire and, compare it with standards. Finally, conducted immunity test which simply refers to (EUT's) immunity to unwanted noisy RF voltages and currents carried by its external wires and cables [1].

2.4 Standards of (EMC)

The (EMC) standards are required for trouble free co-existence and to ensure satisfactory operation. Furthermore, Standards are required to provide compatibility between electrical, electronic, computer, control and other systems. Moreover, Standards are required as manufacturer user interaction and user's knowledge on EMI are limited. Therefore, there are many classifications of (EMC) standards types. The first type of classification is the international or regional standards such as ; International Electro-technical Commission (IEC) and, other countries like United states as Federal communications committee (FCC)[9]. All of the standards has common type of classifications which are depends on the environment of the device, whether it is in industrial or residential environment. Usually, the residential standards are stricter than in industrial standards. Thus, many countries have their own standards which they came mainly from the two main standards (IEC) and, (FCC) standards . Furthermore, all standards have different types depend on the natural of the equipment such as; house hold devices, industrial equipment or machines, automobiles, and, communication devices, each of those types have specified standard for the same test [10].

2.4.1 International Electro-technical Commission for EMC standards

The International Electro-technical Commission[10] (IEC); is an international standards organization, that prepares and publishes International Standards for all electrical, electronic and related technologies – collectively known as "electro-technology" . Therefore, the International Electro-technical Commission (IEC) develops and publishes IEC standards, which are based on a global consensus. IEC standards cover massive range of electrical technologies from generating power, distribution of electrical network, labeling, performance, test methods, and other guidelines for electrical and electronic products. [11].

There are many standards which has been done by The CISPR (Comité International Spécial des Perturbations Radioélectriques) – in English, the International Special Committee on Radio Interference – is one of the groups founded by the IEC and it has its own standards for (EMC). Therefore, this paper review some of most important standards. Figure2 shows the (CISPR 22) standard limits in $\mu\text{V/m}$ dB for 10 meters radiation emission test for residential and industrial devices, where class A limit for industrial equipment and for residential devices is class B [12]. Furthermore, as the (CISPR 22) shows that the class A is more difficult to pass compare it with class B that is due to the lack of awareness of safety procedures with normal people in residential environment.

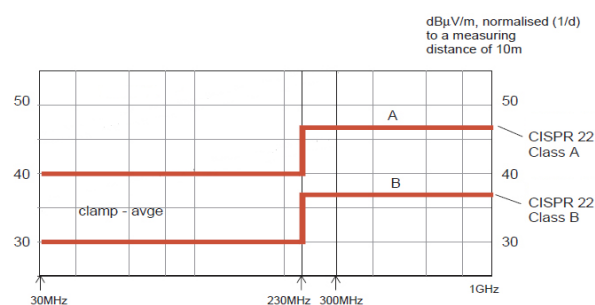


Figure 2: (CISPR 22) standard radiation emission limits.

2.4.2 Federal communications committee (FCC) for EMC standards

The Federal Communications Commission (FCC) is an independent agency of the United States government created by statute (47 U.S.C. 151 and 47 U.S.C. § 154) to regulate interstate communications by radio, television, wire, satellite, and cable. The FCC works towards six goals in the areas of broadband, competition, the spectrum, the media, public safety and homeland security, and modernizing itself [16].

The FCC Declaration of Conformity or the FCC label or the FCC mark is a certification mark employed on electronic products manufactured or sold in the United States which certifies that the electromagnetic interference from the device is under limits approved by the Federal Communications Commission [13]. The FCC label is found even on products sold outside the US territory, because they are either products manufactured in the US and had been exported, or they are also sold in the US[13]. It is in that sense similar to the CE (Conformité Européenne) in English European Commission Declaration of Conformity used on certain electronic devices sold in the Europe figure.3a shows the US label and figure.3.b shows the European label[14].

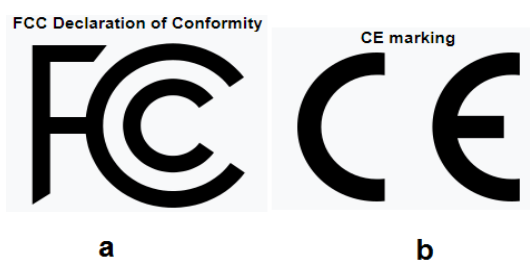


Figure 3: US FCC and, European certified label

Formerly, devices classified under part 15 or part 18 of the FCC regulations were required to be labelled with the FCC mark, but in November 2017 the mark was made optional. Devices must still be accompanied by a Supplier's

Declaration of Conformity. Figure 4 shows (FCC) standard limits in uV/m dB for radiation emission test for residential and industrial devices, where class A limit for industrial equipment and for residential devices is class B [12].

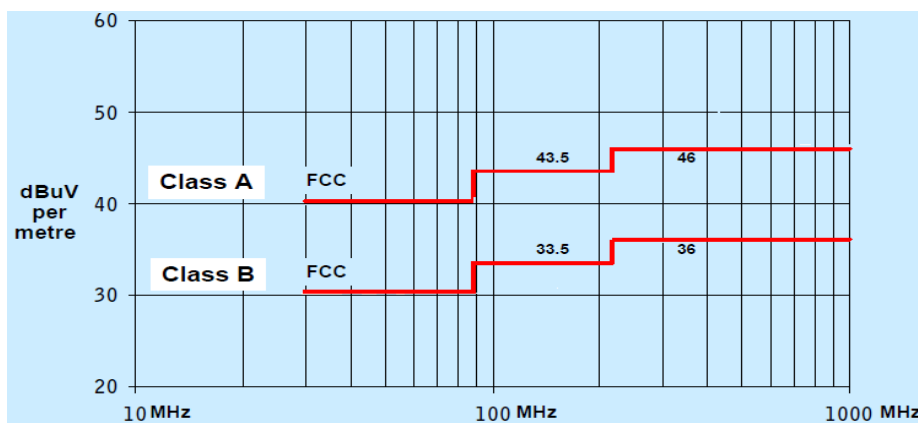


Figure 4: (FCC) standard limits radiation emission

3. Proposing a method to generate Libyan standards

It goes without saying that International Standards make things work. They give world-class specifications for products, services and systems, to ensure quality, safety and efficiency [1]. They are instrumental in facilitating international trade. Therefore, Libyan government has standards which represented in Libyan National Center for Standardization and Metrology (LNCSM)[16]. However, (LNCSM) has covered almost of the trading products but, still has lack of electrical and electronic devices' standards, Libyan government is full member in (IEC) but Libyan government does not have its own standards like other country [15]Therefore, this article propose to use the (IEC's) and (FCC's) electromagnetic compatibility (EMC) to create a

Libyan (EMC) standards by given an example of one test of (EMC).

3.1 Creating Libyan (EMC) standards for Libyan government

As well known that (IEC's) and (FCC's) standards have come after many scientific conferences and many application by scientist and EMC's engineering since the discovery of transmission of the electromagnetic waves. Therefore, (IEC's) and (FCC's) standards are most reliable standards to use them to create a Libyan standards for Libyan state. Thus, by calculating the average of standard for radiation emission 10 meters set up from both the (IEC's) standards. Furthermore, figure 5 shows the deferent of limit between (CISPR22's) and, (FCC's) standards for radiation emission limits in 10 meter test in μ dB V/m[1][16].

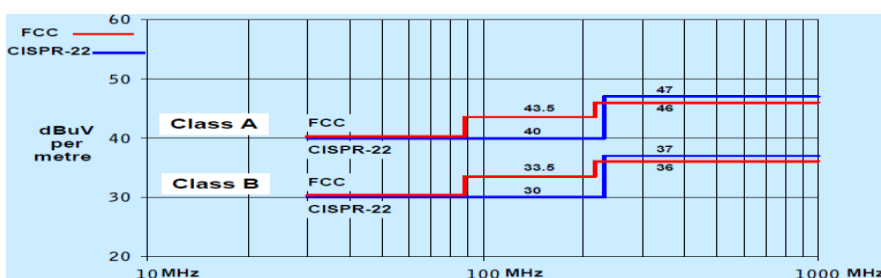


Figure 5: (CISPR22's) and, (FCC's) standards for radiation emission limits in 10 meter

By calculating the average of (CISPR22's) and (FCC's) standards and set them to be Libyan (EMC) standards for radiation emission limits for 10 meters test for both classes A and B where Class A for industrial places and class B for

house hold places. Figure 6 shows the proposed standards for Libyan state for radiation emission limits by calculating the average of (CISPR22's) and, (FCC's) standards.

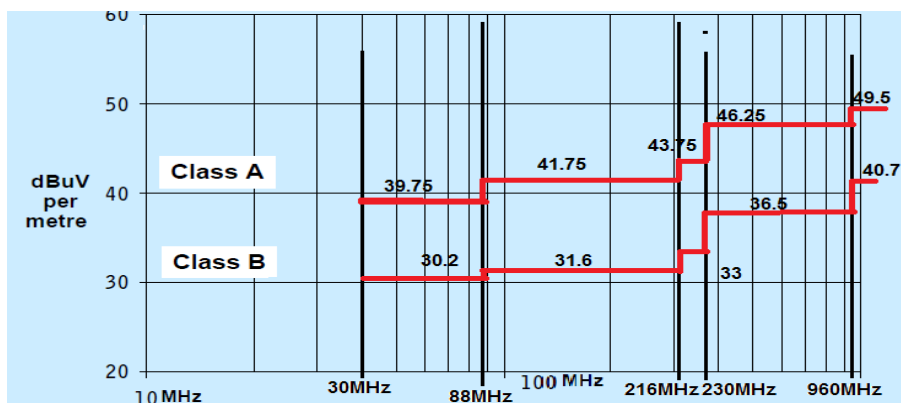


Figure 6: Proposed radiation emission limits by using (CISPR22's) and, (FCC's) Standards

4. Conclusion

This paper discusses the risks of undesired Electro-Magnetic Interference (EMI). Besides, the definition and brief history of electromagnetic compatibility has covered in this article in order to identify these organizations. This article presents some international standard represented in (CISPR22) and (FCC) respectively. The main purpose of this work is to propose Libyan (EMC) standards by using computing the average of (CISPR22's) and (FCC's) standards 10 meters set up for radiation emission limits.

5. Recommendation

Libyan state does not have its own standards so, forming a committee consists (EMC) engineers, physicians and specialized scientist by Libyan National Center for Standardization and Metrology (LNCSM) is very important and, the committee has to be sponsored by Libyan government. Besides the committee rule is to obtain Libyan (EMC's) standards by using the paper's technic or having another recommendations from the members of the committee. Those standards have to be legislated by the Libyan House of Representatives. The committee has to enforce the local or foreigner providers to meet with Libyan standards and install the Libyan National Center for Standardization and Metrology (LNCSM) label after legislation as showed in figure 7 [15].



Figure 7: Libyan National Center for Standardization and Metrology's quality label

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References

- [1] Clayton R.Paul." *Introduction to Electromagnetic Compatibility* ". A JOHN WILEY & SONS, INC. PUBLICATION. New York 2006.pp 1 - 3 .
- [2] R.D.Leach,M.B.Alexander, " *Electronic System Failures and Anomalies Attributed to Electromagnetic Interference*" NASA Reference Publication 1374, July 1995.
- [3] A.O.M. Alhasady, " *Proposed new method to measure common-mode current on high Frequency circuits*" International Journal of Science and Research (IJSR), Volume 7 Issue 5, May 2018.
- [4] Industrial safety guidelines for nuclear facilities / International Atomic Energy Agency. Description: Vienna : International Atomic Energy Agency, 2018. | Series: IAEA nuclear energy series, ISSN 1995–7807 ; no. NP-T-3.3 | Includes bibliographical
- [5] Learning EMC LLC.(n.d). introduction to EMC. Provided form <https://www.learnemc.com/introduction-to-emc>.
- [6] *Techopedia*. (n.d). *Explains Electromagnetic Compatibility (EMC)*. Retrieved from <https://www.techopedia.com/definition/1737/electromagnetic-compatibility-emc>.
- [7] The first Amendment Encyclopedia. John. S. (n.d) Communications Act of 1934. Retrieved from <https://www.mtsu.edu/first-amendment/article/1044/communications-act-of-1934>
- [8] History of the Armour Conferences. Daniel Hoolihan. (n.d). provided from, https://www.emcs.org/acstrial/newsletters/winter06/history_of_armour.pdf
- [9] C. W. Trueman, "An electromagnetics course in EMC applications for computer engineering students," IEEE Trans. on Education, vol. 33, no. 1, pp. 119-128, Feb. 1990.
- [10] D. Weiner, "EMC education at Syracuse University," Proc 1992 IEEE International Conference on EMC, Atlanta, USA, pp. 168- 170, Aug. 1992.
- [11] "IEC Statutes and Rules of Procedure" . IEC. 2011-07-01. p. 30 retrieved from https://www.iec.ch/members_experts/refdocs/iec/stat_2001-2018e.pdf .

- [12] FCC mark. The Federal Communications Commission. (n.d) provided from. https://en.wikipedia.org/wiki/FCC_mark
- [13] Compliance Engineering magazine. 'Inside FCC Part 15 and Canada's Corresponding Standards By Roland W. Gubisch'. Archived January 13, 2012, at the Wayback Machine.
- [14] Wikipedia. International Electro technical Commission. (*February 2017*). https://en.wikipedia.org/wiki/International_Electrotechnical_Commission#Full_members%22%2020-4-2018.
- [15] Libyan National Center for Standardization and Metrology (LNCSM) . (n.d) retrieved form http://www.lncsm.org.ly/saturn_8870/lncsm/Services/quality%20mark.html.12-5-2018.
- [16] Federal Communications Commission. (n.d). provided from https://en.wikipedia.org/wiki/Federal_Communications_Commission