

## **Electromagnetic Compatibility**

A Motorola Report on the Interactive Effects of Electromagnetic Energy  
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We live in a world dependent on electrical and electronic devices or equipment for our safety, security, quality of life, health and well-being. Each day, advances in technology produce new applications with added economic and social benefits to more people in more countries around the world.

As this trend continues, we must be aware of unintended consequences, such as potential interaction that could affect the performance of electrical and electronic devices that permeate our lives. One prominent concern has involved possible interference with medical devices. A March 1995 report to the U.S. Congress noted that "the increasing use of existing wireless technology, the introduction of new communications services using frequencies and transmission methods not used before, the growth in medical electronics, and the increasing use of sensitive medical devices outside hospital settings all increase the potential for interference among existing electronic equipment, including medical devices." Since that time, there have been considerable technical advances in reducing such risks, in large part due to an increased awareness among manufacturers in a number of fields that has led to design improvements and cross-industry cooperation to enhance the compatibility of their products.

Electromagnetic compatibility (EMC) and electromagnetic interference (EMI) involve the potential for the normal operation of some devices to be disrupted by exposure to electromagnetic fields. Such fields may come from any number of sources, not limited to wireless phones or other radio products. Experience demonstrates that these issues are well-understood, manageable and often preventable. In short, there is no technical reason why such concerns should inhibit the deployment of wireless communications products or services.

### **The EMC Challenge**

Electromagnetic compatibility is not a new concept. It has drawn greater attention with the proliferation of wireless communications, but is not an issue unique to these technologies. Quite the contrary, a wide range of devices and systems can be susceptible to interference. The EMC challenge is to do what is possible to assure their compatibility.

Whenever emissions of electromagnetic energy – in whatever form – are incident with an electronic device that has been inadequately shielded, designed or installed to guard against such interaction, the performance of that device may be affected. Motorola supports national and international standards that promote the compatible use of electronic devices. Standards in many parts of the world recommend or require that medical devices be designed to meet minimum levels of immunity from electromagnetic emissions in the frequency range (150 kHz to 3 GHz) corresponding to most wireless communications technologies.<sup>1</sup> Other products,

including electronic systems in automobiles or aircraft, often are tested to assure they are not affected by electromagnetic fields that might be anticipated from radiofrequency (RF) sources.

Motorola supports cooperative approaches to meeting the EMC challenge, including engineering solutions, government policies, consumer education and other efforts that recognize this as an important but manageable priority.

### **EMC and Medical Equipment**

A growing number of hospitals are using wireless devices to support the communication needs of their staff. Concern that RF transmitters may disrupt the normal function of medical devices in some circumstances<sup>2</sup> is often addressed by restricting their use in critical-care areas, although some hospitals apply broader restrictions throughout the facility. While certain precautions may be justified in some physical settings, policies imposed without proper in-house testing and characterization of the electromagnetic environment may be unwarranted and fail to recognize the several dimensions of the EMC challenge. A recent ISO technical report provides information and recommendations for the proper deployment, use, and management of wireless equipment in healthcare facilities that can largely mitigate or eliminate the risk to life-critical EMI events. In recent years, we have seen a growing realization among health care professionals, government officials and others that wireless communications technology has a critical role in the future delivery of health care services – and need not be kept out of this important arena by concerns about EMC.<sup>3</sup>

Interference with medical equipment, particularly in hospitals, can have numerous causes, including electromagnetic fields from other medical devices or electrostatic discharges. Outside hospital environments, EMI can result from proximity to airport metal detectors, in-store security devices and a variety of other electrical and electronic equipment. The U.S. Food and Drug Administration (FDA) collects reports of medical device malfunctions and has said that of those suspected to be related to interference, few were thought to involve phones or other portable radio products.

As suggested above, proper design and installation of medical devices, coupled with proper characterization and management of potential sources of electromagnetic emissions in the local environment, can guard against EMI. But unless the manufacturers and users of medical equipment understand the nature of the EMC challenge, short-term solutions may single out certain potential sources of interference while overlooking important others. Policies on the use of wireless communications in hospitals and other medical settings should be developed with care and guided by technical assessments of the equipment present, the proximity to potential sources of interference and other factors. In areas where sensitive equipment is not located in the immediate vicinity, there should be no need to restrict the use of low-power radio products. In critical-care areas where sensitive medical equipment is concentrated, hospital officials should conduct testing to determine which specific devices, if any, are susceptible to interference and what precautionary measures, if any, are warranted. Where a potential for interference is identified, the solution may lie in remedial engineering of sensitive medical devices. This may involve the addition of appropriate shielding or filtering, or in nothing more than proper installation or repositioning. Tagging sensitive devices and establishing minimal separation distances for portable radio products can provide additional margins of protection from EMI. Augmentation of existing wireless networks, especially in proximity of critical-care areas, also can be an important aspect of EMC management. If appropriately deployed, on-site base stations or amplifiers can permit the use of wireless

communications devices at emission levels below thresholds for interference even with sensitive medical equipment.

In short, the potential for interference will vary from one location to the next, depending on combination, type and even the brand of electronic equipment in use, as well as the physical layout and other factors. It can be controlled through the application of appropriate EMC management practices.

### **EMC and Heart Pacemakers**

Clinical studies confirm the potential for digital mobile phones to interact with the operation of some implanted heart pacemakers. This interaction can affect the pacing provided by the implanted devices. However, these effects have been observed only under certain controlled conditions that generally do not mirror common use. Recent revisions of the relevant immunity guideline<sup>4</sup> state the following: “We are not aware of any verified reports to the FDA, Health Canada, MHRC in the UK, or other recognized regulatory agencies of pacemaker interference from mobile phones that have resulted in patient harm.”

To put this issue in context, it is important to note that:

- By nature of their design, some pacemakers are more immune than others to EMI.
- Where interference has been observed in clinical tests, it has occurred only when phones were placed in extreme proximity to pacemakers and operated at constant transmission and full power.
- When observed, the interference was reversible and generally disappeared when the phone was withdrawn from the pacemaker location by a matter of inches.
- Interference does not occur as a result of "bystander" exposure of pacemaker wearers to phone use by others.
- Interference has not been associated with the use of analog phones.

Public health authorities generally agree that this does not pose a significant problem for pacemaker wearers and have suggested precautionary measures<sup>5</sup> as follows:

- When a phone is turned on, even in standby mode, avoid placing it in a shirt or coat pocket directly over the pacemaker.
- When using a wireless phone, hold it to the ear opposite the side of the body where the pacemaker is implanted. A separation of ~6 inches (15 cm) generally has been accepted as an effective guideline to guard against any potential for interference.
- Finally, report any difficulties to the appropriate regulatory authorities.

As part of an ongoing effort to fully evaluate the possible interactive effects of radio waves, Motorola has participated in and supported comprehensive pacemaker testing in the United States and Europe. The results of this research provide a solid basis for confidence that by following the simple precautions outlined above, pacemaker wearers can enjoy the benefits of mobile phones and similar portable communications devices.

## **EMC and Hearing Aids**

Worldwide, the predominant sources of reported interference with hearing aids appear to be non-RF devices, including fluorescent lights, electric motors, computers and airport metal detectors. This interference most often takes the form of a buzzing sound or other noise.

Like pacemakers, hearing aids appear to differ from one brand or model to the next in their susceptibility to interference from digital wireless phones. Design and placement of the hearing aid may influence the potential for interference. For example, this interaction often has been associated with older, poorly shielded units. On the other hand, hearing aid design enhancements and the steady trend toward lower operating power levels for wireless phones help lessen the potential for interference.

Experts agree this is not a public health or safety issue. A 2001 FCC Report and Order required mobile phone manufacturers and network operators to provide handsets that meet specific criteria to minimize bothersome audible interference.<sup>6</sup> All hearing aids sold in the European Union must meet a minimum level of immunity from interference from external sources of radiofrequency (RF) energy, including wireless phones. Motorola and the wireless communications industry continue to support programs that address electromagnetic compatibility related to hearing aids and other products.

Motorola and the wireless industry have participated in and supported efforts to identify additional measures that can assist hearing-impaired individuals in their use of portable communications devices. The ultimate solution is to assure that hearing aids, like other electronic devices, are designed and built to minimum, effective levels of protection from possible sources of interference, including wireless phones and other RF devices. Some hearing aid manufacturers already design adequate safeguards into their products. Others are recognizing the need and gaining the ability to do so. In any event, the best path to EMC is to understand the electromagnetic environment and increasing the immunity of devices to external sources of electromagnetic fields.

## **EMC and Automobiles**

Over the last few years, press reports have raised questions as to about whether the signals from mobile phones or other RF devices can interfere with the proper function of anti-lock braking systems or other electronic systems in motor vehicles. There have been anecdotal reports suggestive of such possible interaction, but no documented occurrences.

As the number of electronic components in automobiles has grown, automakers have become more sensitive to – and skilled at – designing electromagnetic compatibility into their vehicles. This does not appear to be a serious problem. We are not aware of documented cases where the RF signals from mobile phones or radios interfered with anti-lock brakes, airbags or other electronic systems in motor vehicles. Nor, based on our knowledge of the science and engineering involved, do we see evidence that such events could occur, assuming the proper design, manufacturing and installation of the automotive systems in question.

Motorola has worked closely with automakers to meet this challenge, in its dual role as a manufacturer of RF-emitting devices as well as electronic automotive components. Electronic components typically are built and tested to withstand exposure to RF fields stronger than those emitted by portable radio products. Motorola provides guidance on the proper installation of radios in vehicles to mitigate any potential for interference.

## **EMC and Airplanes**

There has been considerable discussion about whether devices that emit electromagnetic fields – including but not limited to radio devices – can affect the operation of electronic systems aboard aircraft. There have been anecdotal reports about possible interference but the occurrences were not verified and supporting evidence is limited. Nonetheless, the in-flight use of radio devices is prohibited as a precautionary measure.<sup>7</sup>

Air travelers have become familiar with pre-takeoff announcements that include restrictions on the use of mobile phones and other electronic devices. In-flight use of wireless phones has been prohibited as a matter of law or government policy in the United States and many other countries. The principal reason is to prevent interference with terrestrial wireless phone networks. Large multi-industry efforts are under way to address the feasibility of providing air-to-ground or air-to-satellite-to-ground communication within commercial aircraft without disrupting normal terrestrial services.

## **Conclusion**

As the RF environment becomes increasingly congested and complex, there is no simple or single answer to the challenge of electromagnetic compatibility. At the same time, it is important to keep in mind, as stated some years ago in a report to the U.S. Congress, that "interference between different wireless devices is potentially serious, but also is amenable to technical and regulatory solutions." In the end, it requires commitment from all involved parties to assure that advances in wireless and microprocessor technology continue to deliver an array of benefits to people around the world without unintended consequences.

Susceptibility to electromagnetic interference must be considered before medical devices and other products reach the marketplace. Immunity to EMI should be designed into products and confirmed through rigorous testing. These safeguards must consider not only the potential sources of EMI that exist today, but also those on the horizon. In many instances, engineering solutions to potential problems are readily available.

This is a continuing challenge and a shared responsibility. With determination and some creative management, these issues can be addressed to assure the sustained growth and success of our respective industries and the continued benefits of existing technologies as well as those yet to come.

## **For Further Information:**

U.S. Food and Drug Administration -- Center for Devices and Radiological Health  
<http://www.fda.gov/cdrh/emc/index.html>

American Society of Healthcare Engineering  
<http://www.ashe.org>

U.K. Medicines and Healthcare Products Regulatory Agency  
[http://www.mhra.gov.uk/home/idcplg?IdcService=SS\\_GET\\_PAGE&nodeId=5](http://www.mhra.gov.uk/home/idcplg?IdcService=SS_GET_PAGE&nodeId=5)

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## **About Motorola**

*Motorola is known around the world for innovation and leadership in wireless and broadband communications. Inspired by our vision of Seamless Mobility, the people of Motorola are committed to helping you get and stay connected simply and seamlessly to the people, information, and entertainment that you want and need. We do this by designing and delivering "must have" products, "must do" experiences and powerful networks -- along with a full complement of support services. A Fortune 100 company with global presence and impact, Motorola had sales of US \$36.8 billion in 2005. For more information about our company, our people and our innovations, please visit [www.motorola.com](http://www.motorola.com)*

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<sup>1</sup> The International Electrotechnical Commission (IEC) has published a standard (IEC 60601-1-2:2001, Medical electrical equipment - Part 1-2: General requirements for safety - Collateral standard: Electromagnetic compatibility - Requirements and tests) recommending that all life-supporting medical electrical equipment and systems be immune to field strengths of 10 V/m and those that are not life-supporting be immune to field strengths of 3 V/m in the frequency range 80 MHz – 2.5 GHz. It also requires medical-equipment manuals include minimal separations between various radio-frequency sources and medical devices and sets limits for emissions and immunity test levels for electrostatic discharge (ESD), conducted radio-frequency electromagnetic fields, bursts, and surges (largely based upon CISPR emissions and TC 77 immunity standards)

<sup>2</sup> ISO TC215 TR #21730 (2005) "Health informatics — Use of mobile wireless communication and computing technology in healthcare facilities — Recommendations for electromagnetic compatibility with medical devices"

<sup>3</sup> References:

Aziz O., Aziz S., Paraskeve P., Darzi A. USE OF MOBILE PHONES IN HOSPITAL: TIME TO LIFT THE BAN? *Lancet*, Vol. 361, Pg. 788 - , 2003

Klein A. A., Djajani G. N. MOBILE PHONES IN THE HOSPITAL-PAST, PRESENT AND FUTURE. *Anaesthesia*, Vol. 58, Pg. 353 - 357, 2003

(authors not listed) CELL PHONES AND WALKIE-TALKIES: IS IT TIME TO RELAX YOUR RESTRICTIVE POLICIES? *Health Devices*, Vol. 28, Pg. 409 - 413, 1999

Cohen T., Ellis W. S., Morrissey J. J., Bakuzonis C., David Y., Paperman W. D. SAFE USE OF CELLULAR PHONES IN HOSPITALS: FUNDAMENTAL PRINCIPLES AND CASE STUDIES. *J Healthcare Inform Manag* , Vol. 19, Pg. 38 - 45, 2005

Morrissey J. J. MOBILE PHONES IN THE HOSPITAL:IMPROVED MOBILE COMMUNICATION AND MITIGATION OF EMI CONCERNS CAN LEAD TO AN OVERALL BENEFIT TO HEALTHCARE. *Health Physics*, Vol. 87, Pg. 82 - 88, 2004

Myerson S. G., Myerson A. R. MOBILE PHONES IN HOSPITALS. *British Medical Journal*, Vol. 326, Pg. 460 - 461, 2003

Soto R. G., Chu L. F., Goldman J. M., Rampil I. J., Ruskin K. J. COMMUNICATION IN CRITICAL CARE ENVIRONMENTS: MOBILE PHONES IMPROVE PATIENT CARE. *Anesthesia & Analgesia* , Vol. 102, Pg. 535 - 541, 2006

<sup>4</sup> Association for the Advancement of Medical Instrumentation (AAMI) PC69

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<sup>5</sup> References:

US FDA statement: (<http://www.fda.gov/cdrh/emc/pace.html>)

Health Canada: Alert Letter No. 108

MHRC statement: statement (PTN No 61)

Australian Department of Therapeutic Devices (bulletin #34)

Pacemaker Committee of Japan: <http://www.medtronic.co.jp/ja/misc/keitai.html> (in Japanese)

<sup>6</sup> American National Standard ANSI C63.19 (2001; rev 2006)

<sup>7</sup> RTCA SC202 DO 294 (2005); DO-294 suppl (2006); DO-294b (2006)

FCC NPRM (2005) WT Docket 04-435, *Amendment of the Commission's Rules to Facilitate the Use of Cellular Phones and other Wireless Devices Aboard Airborne Aircraft*