WiTricity®

AM Radio and Wireless Power Transfer for Electric Vehicles (WPT-EV)

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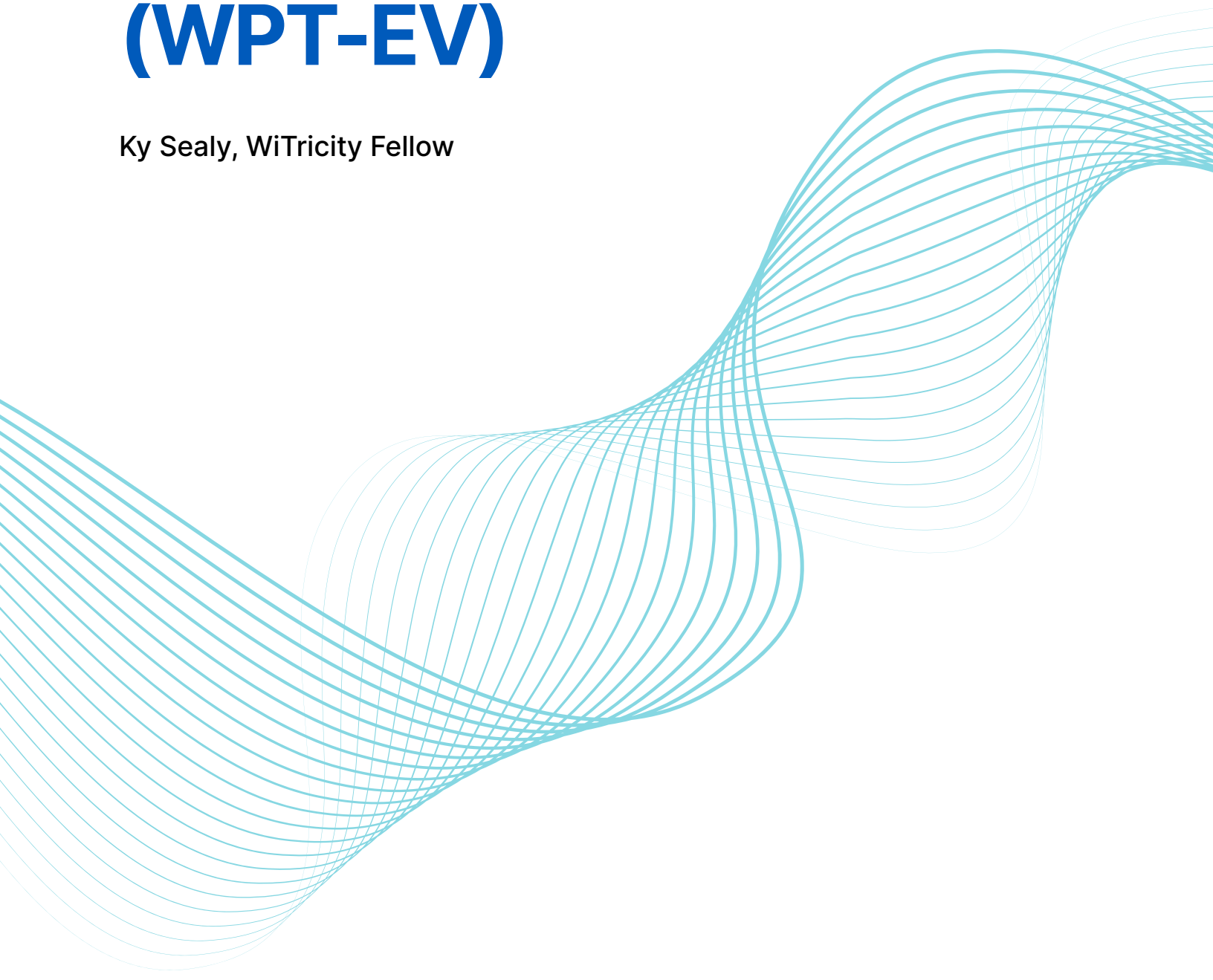


AM Radio and Wireless Power Transfer for Electric Vehicles (WPT-EV)

High-Level FAQs

Does WiTricity's wireless charging system interfere with AM radio?

No. WiTricity's wireless power transfer system for EVs (WPT-EV) does not interfere in any appreciable way with AM radio. Global radio regulations do not allow any electronics to cause harmful interference to radio that has allocated spectrum, and wireless charging systems are no exception.

Why do some people claim that WPT-EV interferes with AM radio?

Since the inception of AM radio in the early 1900s through to the 1920s when AM radio became a dominant method of public broadcasting through to the 1950s and 60s, electronics have improved dramatically. As a result of the increased number of electronics and technological innovations that we enjoy daily, the ambient radio noise conditions have also increased over the decades. Since the 1950s, the invention and common use of the transistor as a means to provide electronic switching of all kinds has resulted in a technological revolution. Along with this technological revolution came drastic improvements in energy efficiency, computing power, and innovation; however, as a result, radio noise worldwide has also increased as would be expected. AM radio, in particular (as opposed to FM radio and digital variations), is particularly sensitive to electronic noise. Broadcasters and amateur radio enthusiasts still utilize forms of AM radio for some communication, and it has become frustrating for them to protect the spectrum that they have enjoyed for the last century despite minimal improvements in the use of AM radio itself. These radio incumbents view all electronic devices as potential interferers, and they constantly push regulators to create more strict requirements, sometimes impossible requirements, for non-radio devices that are more prominent. Wireless power transfer is a relatively new technology that is not well understood by radio incumbents. The term "wireless" can be particularly deceiving because "wireless" is traditionally associated with communication, and therefore they fear that wireless power will inadvertently harm AM broadcasts. However, this concern is not founded in any scientific manner and is based solely on theoretical projection; no broadcaster has shown any scientific data with actual systems to show that wireless power for electric vehicles causes any harmful interference whatsoever. In fact, wireless power for EVs uses completely different physics than AM radio, which keeps the wireless power transfer local only between the powering ground pad and the vehicle receiving pad.

How do you know for sure that WPT-EV does not cause harmful interference to AM radio?

We have performed extensive testing and continue to perform testing with expert EMC laboratories as well as standards and regulatory authorities to help them understand the safe and efficient nature of

wireless power transfer as well as the physics associated with it. In fact, WiTricity worked with the SAE (an organization that creates automotive standards) in a cooperative research project to perform extensive interference testing with licensed amateur radio experts (including our own) to test early prototype versions of WPT-EV in very worst-case conditions. These tests resulted in an extensive study that was reviewed by a large panel of experts and regulatory authorities in the United States of America. The study was then contributed by the USA to the ITU-R (the organization that sets the global radio regulations) and included in annex 12 of Recommendation ITU-R SM.2451-1[1] as the only study that utilized actual WPT-EV systems to test the impact on AM amateur radio. This is just one of many tests, and WiTricity continues to perform testing with others such as in the European Union. All tests show that when WPT-EV systems meet the current regulatory requirements, they do not cause any harmful interference to AM radio – including public broadcasting radio and amateur radio.

Scientific Background for AM Radio and Wireless Power Transfer for Electric Vehicles

AM Radio - important but old

AM is short for "amplitude modulation", which is how AM radio sends sounds via radio waves. This method of radio signal modulation was the first method used in early radio because it was the simplest to create for transmission and the simplest to receive with passive components and demodulate into sound that is provided over a speaker. However, this type of radio has some severe drawbacks in terms of sensitivity to interference and even its inefficient use of radio spectrum.

The way that AM radio works is that a radio frequency (RF) carrier wave is produced at a much higher frequency than the audio signal. The audio signal is added to this carrier wave directly and this results in the carrier wave being "amplitude modulated" or in other words, the carrier wave amplitude changes with the audio signal that is added to it. Figure 1 below shows an RF carrier wave and Figure 2 below shows the carrier wave with amplitude modulation by an audio signal.

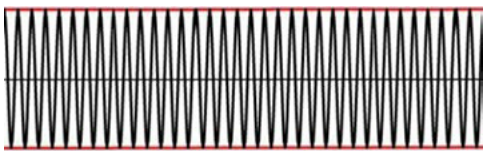
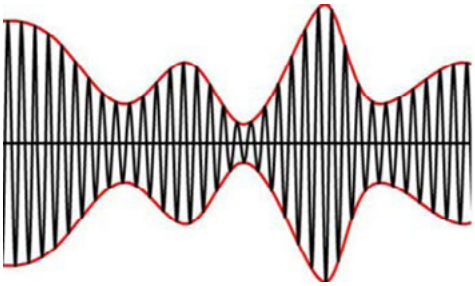


Figure 1. RF carrier sinusoidal wave



[1] https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2451-1-2022-PDF-E.pdf

Figure 2. RF carrier amplitude modulated by an audio signal

When looking at the frequency spectrum (i.e., frequency vs. radio power), the RF carrier wave appears as a single spike at the carrier frequency, but the audio information appears on both sides of the carrier frequency called “sidebands”. Figure 3 below shows the frequency spectrum with the carrier frequency in black and the audio sidebands in green (not strictly in proportion).

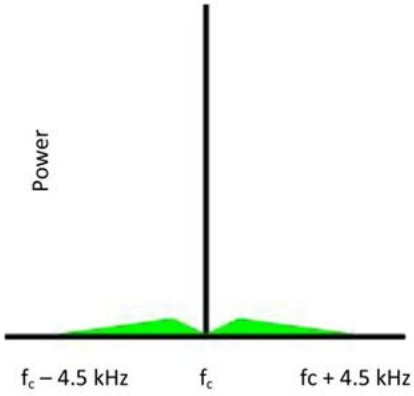


Figure 3. AM Radio frequency spectrum - carrier (black) and audio signal (green)

An AM radio receiver sees the carrier frequency with its amplitude modulation and performs filtering to remove the carrier wave and preserve only the audio information. However, as can be seen in Figure 3, AM radio inefficiently utilizes the spectrum because the same information is copied above and below the carrier frequency. In amateur radio, this is often improved by pre-filtering out one of the sidebands and leaving only the other. This type of AM modulation is a subset of AM radio called “single sideband (SSB) modulation” with “lower sideband modulation (LSB)” utilizing only the lower frequency sideband and “upper sideband modulations (USB)” utilizing only the higher frequency sideband. Public broadcast AM radio utilizes the full AM spectrum without filtering one of the sidebands.

Because all electronics (especially electronics such as common switch-mode power supplies, LED lamps, etc.) emit some radio noise, this noise can, in some cases, be added directly to the AM signal at the receiver. Furthermore, the audio output of the AM radio signal is directly affected by many more environmental factors that cause audio fading, audio pitch shifting, audio noise, and other audio characteristics that most people are familiar with having listened to AM radio. Due to these issues and many other reasons, FM radio became a more prominent method of radio communication and was followed by many more sophisticated techniques and other digital techniques that are most prominent today (e.g., in cellular phones, Wi-Fi, Bluetooth, etc.), and these more efficiently utilize radio spectrum. However, AM radio still remains important and is still used – especially in HF amateur radio communications.

Wireless Power for Electric Vehicles and Electromagnetic Emissions

Introduction

The ITU Radiocommunication Sector has been actively working on and creating recommendations for wireless power transfer. This technology is recognized by national administrations globally as being

important to our technological future. Specifically, ITU-R Recommendations SM.2129[2] and SM.2110[3] broadly consider wireless power transmission (WPT) and define WPT as "the transmission of power from a power source to an electrical load wirelessly using the electromagnetic field". More specifically, non-beam WPT is considered to include "near-field inductive, resonant and capacitive coupling", and beam WPT is "transmission via radio frequency radiated transmissions in the far-field".

Wireless power transfer for electric vehicles (WPT-EV) is now globally standardized (e.g., SAE J2954, IEC 61980, ISO 19363 standards) and utilizes only non-beam WPT – specifically magnetic resonance WPT to wirelessly transfer power from a ground pad assembly to a vehicle pad assembly that charges the EV battery. Per Recommendation ITU-R SM.2110-1, WPT-EV uses a fixed frequency (usually 85 kHz or 85.5 kHz) within the designated 79 – 90 kHz band recommended by the ITU. Despite that fact that wireless power does not broadcast anything (i.e., the power remains highly localized between the ground pad and vehicle pad), this band was chosen to ensure that there would be no interference to radio of any kind – including AM radio which operates at higher frequencies. Some radio incumbents claim that their concern is not with this fundamental frequency but rather "harmonic" frequencies that can be generated by the electronics that enable the wireless power. However, many do not fully understand the difference between radio technology and wireless power so this can lead to confusion.

WPT-EV is not a radio and does not broadcast anything

When an AM radio station is broadcasting, it creates the AM signals, amplifies these signals, and transmits them via coaxial cable to a very high and very large radio antenna. To be effective, the antenna is designed to be physically very large (approaching the wavelength of the carrier frequency in the hundreds of kilohertz) and the majority of power is propagated into the surrounding free space. Due to the nature of propagation and its constant spreading, the power at the receiver decreases with distance from the transmitting antenna. This type of radio propagation is called "far-field" propagation.

Figure 4. AM Radio station in Switzerland

[2] https://www.itu.int/dms_pubrec/itu-r/rec/sm/R-REC-SM.2129-0-201908-I!!PDF-E.pdf

[3] https://www.itu.int/dms_pubrec/itu-r/rec/sm/R-REC-SM.2110-1-201910-I!!PDF-E.pdf

For AM radio stations, the power is transmitted into space regardless of whether there is an AM radio receiver to receive the signal. In contrast, WPT-EV does not and cannot effectively utilize far-field propagation to transfer power. Instead, wireless power is only transferred when the vehicle assembly pad is directly over the ground assembly pad. The wireless power transmission occurs by localized magnetic fields coupling between the coils. When one coil is not present, the power cannot be transferred and does not go into free-space – instead the power transmission ceases. This is one property of a non-beam wireless power system or a "reactive near-field" or "evanescent" coupled system. This fundamental difference is often misunderstood by radio incumbents because they work primarily with far-field transmissions and free-space propagation and not near-field reactive systems such as wireless power transfer.

But what about harmonics or other electrical noise from WPT-EV

Now that we have properly established that WPT-EV is no different from an interference point of view than any other set of electronics – including wired EV charging, WiTricity recognizes the importance of ensuring there is no harmful interference to AM radio – or any other radio. In fact, WiTricity utilizes Wi-Fi to communicate between the vehicle and the ground pad assembly, and this cannot be interfered with – otherwise, the WPT-EV system wouldn't work! For this reason, WiTricity has undertaken significant efforts and expended significant resources in conjunction with SAE and other third-party labs, researchers, and regulators to study the effects of WPT-EV on radios. The results of all of these studies show that WPT-EV does not cause any harmful interference to AM radio despite the particularly sensitive nature of this type of radio.

Conclusions

In summary, wireless power transfer for your electric vehicle does not interfere with AM radio. It is safe[4], efficient[5], and convenient[6]!

Figure 5. WiTricity WPT-EV System

[4] https://www.innovationnewsnetwork.com/analysing-safety-wireless-electric-vehicle-charging/20502/

[5] https://witricity.com/newsroom/blogs/what-is-efficiency-how-do-you-measure-it-and-why-should-you-care/

[6] https://witricity.com/newsroom/

WiTricity has many resources to help you stay informed about wireless EV charging.

- Stay in-the-know by subscribing to our monthly **newsletter:** https://witricity.com/newsletter
- Check out our other **white papers:** https://witricity.com/media/additional-resources
- Watch **videos** that bring wireless EV charging to life: https://witricity.com/media/videos
- Read our **blog** with posts featuring keen insights and information on the hot topics surrounding wireless EV charging: https://witricity.com/media/blog

WiTricity is the pioneer in wireless charging for electric vehicles, leading the development and implementation of magnetic resonance technology across passenger and commercial vehicles alike. The company's products are backed by an extensive patent portfolio critical to ratified global EV wireless charging standards including SAE, ISO, and GB. Automakers and Tier 1 suppliers rely on WiTricity to help accelerate the adoption of EVs by eliminating the hassle of plug-in charging and setting the stage for future autonomy. Beyond EVs, WiTricity technology is indispensable to the wireless charging of all products, from consumer electronics to micro-mobility to robotics.

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