



Another EMC resource
from EMC Standards

EMI Stories 891 - 900

Helping you solve your EMC problems

EMI stories – numbers 891 - 900

Created 8th June 2022

Some of these stories are extracted from official documents and reports, some are personal anecdotes, and some come from research.

Some of these EMI stories had harmless or amusing outcomes, some lost companies large amounts of time / money, even causing bankruptcy, and some caused (or could easily have caused) injuries and deaths.

My experience is that these stories only represent the very tip of a large iceberg, with unguessable costs for manufacturers and society as a whole. As electronic devices and technologies continue to advance; more (and more complex) software and wireless communications are used; as electronic systems are increasingly integrated into systems-of-systems which no person can understand fully, and even into systems-of-systems-of-systems (including the “Internet of Things”, IoT, and autonomous vehicles): the only thing of which we can be certain is that EMI problems will occur more frequently and have larger impacts on cost and safety.

I hope these stories help identify possible EMI problems in advance, so that they are dealt with as part of the normal design/development procedure and don't create the embarrassment and costs of trying to correct poor EMC design after products have been shipped or systems installed.

If you have any suitable stories or know of any relevant research or reports, please tell me about them so they can be included (anonymously, if preferred) in this list.

Compiled by Keith Armstrong, keith.armstrong@cherryclough.com

891) GPS/GNSS – Jamming and Spoofing are Real

Jamming is a kind of radio interference, which overpowers weak GNSS signals, causing accuracy degradation and possibly even loss of positioning. Unintentional jamming sources include radio amateurs, maritime and aeronautical radiolocation systems as well as electronic devices located close to the GPS/GNSS receiver. There are also intentional jamming devices called “jammers”, which are sometimes found on board of vehicles trying to avoid road tolling.

Spoofing is an intelligent form of interference which makes the receiver believe it is at a false location. Spoofing has appeared in the news in a spectacular experiment where a Tesla car was “misled” to take an exit from a highway rather than following the highway as it was supposed to. Consequently, both jamming and spoofing can have an adverse effect on INS systems, which make use of GPS/GNSS positioning.

(Taken from: “Jamming and Spoofing are Real!” by Maria Simsky, a Technical Content Writer at Septentrio, in the May 2022 edition of New Electronics magazine. Also see:

<https://www.septentrio.com/en/learn-more/insights/insights/why-secure-gps-receivers-are-crucial-gnss/ins-systems#>

<https://www.septentrio.com/en/learn-more/insights/spoofing-your-gps-attack-proof>

<https://www.maritimeglobalsecurity.org/media/1043/2019-jamming-spoofing-of-gnss.pdf>

<https://www.navtechgps.com/gps-jamming-and-spoofing-how-real-is-the-threat-to-your-business/>

<https://www.crfc.com/blog/how-to-deal-with-gps-jamming-and-spoofing/>

<https://www.duncan-parnell.com/blog/whats-the-difference-between-gps-spoofing-and-jamming>

An internet search will find a very great deal more about GPS/GNSS jamming and spoofing.)

892) Surges can make some hair treatment products fail in a dangerous way

30 March 2022. We have just finished testing a set of hair curling tongs. All very well, until Surge testing. It was not immediately obvious, but apparently the surge transients were able to create a very dangerous failure condition in which the sample appeared to be working as intended, but the heating elements would now be powered on immediately (and for as long as) the curling tongs were connected to the mains supply, irrespective of any operator input.

That was probably the worst thing about this failure state; the user could plug them in and nothing would light up, so seemingly they were 'off' and awaiting a user input (as would be expected). They could press power 'on' and the LEDs would come on, and ostensibly they could set a required temperature, because the user inputs and visual feedback seemed to be responding exactly as intended. But, unknown to them, the heater elements had already switched on the moment mains was connected, and presumably only temperature limited by the safety circuit (this specific aspect has not been confirmed). The results have been fed back to the importer, and the offending sample has been returned to the manufacturer in order to try to establish what exactly had happened, and how such a failure can be prevented in the future.

4 April 2022. Further to the last email the plot thickens slightly, in that the curlers are actually part of a



Image: Shutterstock 533050525

range of products which use similar circuitry. We have also just tested a set of hair straighteners which seem to be based upon the same microcontroller, but have a more advanced user interface.

We have discovered that these samples fail in exactly the same way, but in this case the heater plates heat up as soon as power is applied, even though the LCD clearly says 'OFF'.

Thankfully the importers are very good to work with and they liaised with their manufacturer to identify the root cause and rectify it. Slightly worryingly, the products came with an existing EMC test report claiming compliance from the country of manufacture, so it is pleasing that they did not take this at face value.

Subsequently, we tested the updated design samples and both affected products survived the surges without issue.

(Kindly provided by Product Approvals Ltd, Telford, UK., www.productapprovals.co.uk. I hope to update this item in future, with the technical details of the modification that fixed the problem – Editor.)

893) The most serious rail accident in China was caused by lightning damage to a PCB

On July 23rd, 2011, what was considered (in 2012) to be the most serious railway accident in the Chinese railway system occurred, killing 40 people and injuring 172.

At 20:30:05, the high-speed train D301 from Beijing to Fuzhou collided with the rear-end of the D3115 train on the Yong-Tai-Wen High-Speed coastal railway line, because of a fault in the control system.

On that day, the area where the accident occurred experienced severe lightning from 19:27 - 19:34, according to the meteorological department. It was that severe lightning which caused the fault in the control system, by destroying a data acquisition board at about 19:30. That data acquisition board consequently failed to collect consistent information on track occupancy and failed to identify the correct position of the D3115.

(See: “Applying systems thinking approach to accident analysis in China: Case study of “7.23” Yong-Tai-Wen High-Speed train accident” by Yunxiao Fan, Zhi Li, Jingjing Pei, Hongyu Li, Jiang Sun School of Engineering and Technology, China University of Geosciences (Beijing), Beijing, China, published in Elsevier’s “Safety Science” Volume 76, July 2015, pages 190-201, <https://www.sciencedirect.com/science/article/abs/pii/S0925753515000454?via%3Dihub>)



Image: Shutterstock 1522240913

894) “Tubular Bells” contains morse code at 16kHz, intended for submarines

In the 1980s, vinyl records gave way to Compact Discs, But at least one CD of that era contains a hidden message: Virgin Records’ 1983 release of the album *Tubular Bells*, recorded a decade earlier at Richard Branson’s Manor Studios in Shipton-on-Cherwell, England.

You see, an hour’s drive north from Shipton is a suburb of Rugby called Hillmorton, where at the time the British government operated a very-low-frequency (VLF) radio station to send messages to submarines. It seems the powerful emanations from this nearby station, broadcast at a frequency of 16 kilohertz (within the audio range), were picked up by the electronic equipment at Branson’s studio and recorded at a level too low for anyone to notice.

After learning of this, I purchases an old copy of *Tubular Bells*, ripped a WAV file of one track, and piped it into a software-defined-radio (SDR) package. Tuning to 16kHz and setting the SDR software to demodulate continuous-wave signals immediately revealed Morse code. I couldn’t copy most of it, but I could make out many repetitions of VVV (“testing”) and GBR (the station’s call sign).

This inadvertent recording aptly demonstrates that VLF transmissions aren’t at all hard to pick up accidentally.

(From: “A Barometer for Space Weather” by David Schneider, in the “Hands On” section of *IEEE Spectrum*, February 2022, pages 16-17, <https://spectrum.ieee.org/magazine/2022/february/>.)

895) Examples of EMI with implanted neural stimulators for urinary incontinence

Here are some Medical Device Record (MDR) numbers from the USA's Food and Drug Administration (FDA), that were used in a presentation by the FDA's Dr. Yasaman Ardeshirpour, PhD.

- MDR # 2182207-2021-02096, Reported 12/02/2021 – Device: INTERSTIM II

Patient claimed that the implanted device is shocking her when she walks through metal detectors or security gates at stores.

- MDR # 3004209178-2021-17372, Received 11/20/2021 – Device: INTERSTIM II

Patient said that their device they have now turns on and off on its own when they go inside [a 'big box' store].

- MDR # 2182207-2021-01662, Received 9/27/2021 – Device: INTERSTIM II

Patient passed through a security bollard in a shop and experienced sharp pain around the implanted device lasting a number of hours.

- MDR # 3004209178-2021-06948, Received 4/29/2021 – Device: INTERSTIM II

Patient reported a history of experiencing shocking when walking through theft detectors at stores like [big box store]. Patient runs through the detectors because once they literally jumped off the floor with both feet.

Adapted from a slide by Dr. Yasaman Ardeshirpour, PhD

Dr. Ardeshirpour is in our review Office but worked in the OSEL EMC lab for a few months with Howard Bassen a couple years ago on a project measuring emissions from Electronic Article Surveillance (EAS) systems and evaluating immunity of a specific type of neural stimulator, for urinary incontinence. That's why all these problem reports are for the same device.

She gave a presentation about this project to our division in December 2021 as part of an interview for a job opening in our division for an EMC engineer. She had a lot more examples than these.

Most of this information is available in our publicly accessible MAUDE database. In fact, the database says "Walmart" instead of "[big box store]"! I think maybe there was one that I couldn't find.

(Taken from an email to the Editor on 27th January 2022 by Jeffrey L. Silberberg, Senior Electronics Engineer, FDA/CDRH, Division of Biomedical Physics, Office of Science and Engineering Laboratories, Center for Devices and Radiological Health, U.S. Food and Drug Administration, in which he provided the above as: "...a slide that you could use for your Banana Skins".

The FDA's publicly accessible MAUDE database is accessible to all, and you can retrieve the records above by visiting <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMAUDE/TextSearch.cfm> and typing the Medical Device Record number (MDR #) into the search field (leaving out the 'MDR #').

896) 5G phones: How serious is the threat to US flights?

US mobile networks AT&T and Verizon have agreed to postpone the expansion of their 5G service at some airports. The service was due to start operating in more places on Wednesday after two earlier delays. But ten leading US airlines say the new technology could cause thousands of flights to be delayed.

What is 5G and how could it disrupt US aviation?

5G is the next generation of mobile internet connection. It lets people download and upload data much more quickly, and allows more devices to access the mobile internet at the same time.

To do this, it relies on greater use of radio signals. In the US, the radio frequencies being used for 5G are in part of the spectrum known as C-Band.

These frequencies are close to the ones used by radio altimeters on aeroplanes, which measure the height of the aircraft above the ground, and also provide data for safety and navigation systems.

The concern is that interference from 5G transmissions could stop these instruments from working properly, and cause safety problems, particularly when aircraft are coming in to land.

The risk to planes is potentially very serious. In late 2020, the RTCA - a US organisation which produces technical guidance on aviation issues - published a report warning of the possibility of "catastrophic failures leading to multiple fatalities, in the absence of appropriate mitigations".

More recently, the US aviation regulator, the FAA, warned that 5G interference could lead to problems with a number of different systems aboard Boeing's 787 Dreamliner. These could make it difficult to slow the plane down on landing, causing it to veer off the runway.

How will flying be kept safe?

Planes won't be allowed to use radio altimeters in circumstances where there could be a risk of serious interference. But that will restrict the ability of some aircraft to land, for example, in poor visibility. Airlines for America, which represents ten major carriers, has warned that this could lead to more than 1,000 flights being delayed or cancelled in bad weather and mean at times "the vast majority of the travelling and shipping public will essentially be grounded". It has also suggested a large part of the US aircraft fleet will be "deemed unusable" because of restrictions on their operation.



Image: Shutterstock 419990866

Do other countries using 5G share these concerns? Not to the same degree. That's because the way in which 5G is being rolled out varies from country to country. In the EU, for example, networks operate at lower frequencies than those which US providers are planning to use - reducing the risk of interference. 5G masts can also operate at lower power. Nevertheless, some countries have taken further steps to reduce possible risks. In France, there are so-called "buffer zones" around airports where 5G signals are restricted, while antennas have to be tilted downwards to prevent potential interference.

UK regulators and airlines do not seem unduly worried. In a safety notice published in December, the Civil Aviation Authority (CAA) said that "there have been no confirmed instances where 5G interference has resulted in aircraft system malfunction or unexpected behaviour". It also stressed that "different national mobile telecommunication strategies may mean that some [countries] have a higher threat exposure than others". The UK regulator says it plans to work internationally to gather further data on the issue.

What else are the US authorities doing in response?

Regulators in the US have already taken a number of steps. The FAA has established temporary buffer zones around 50 airports, where 5G providers will limit their activities. But these are much smaller than the zones already being used in France, and US transmitters will operate at significantly higher power levels. It has also begun identifying which altimeters can be used safely in areas where 5G has been deployed - and those which are not reliable enough and will need to be replaced. It has also identified airports where GPS systems can be used to guide approaching aircraft rather than radio altimeters. But the airlines insist this isn't enough: they claim the 5G network should not be activated at all within two miles of affected airports.

What have the 5G firms now said?

Verizon and AT&T have agreed to "temporarily" delay the rollout of 5G at what AT&T said was a "limited number of towers around certain airport runways". Some 5G masts won't be switched on while talks continue to find a permanent solution. This should reduce the possibility of interference with onboard systems. In a statement, President Biden said the delay would only affect about 10% of the masts involved in the expansion of 5G. The firms had already postponed the 5G rollout twice, and had agreed to the temporary buffer zones mentioned above.

Both companies expressed their frustration at the latest hold-up. AT&T said regulators had had two years to plan for the start of 5G service. They also pointed out that 5G has already been implemented in some 40 countries. Last month the US wireless industry body CTIA accused the aviation industry of "scaremongering", and warned that delaying the introduction of 5G would cause real economic harm.

(Taken from "5G phones: How serious is the threat to US flights?" by Theo Leggett, Business correspondent, BBC News, Published 19 January, <https://www.bbc.co.uk/news/business-60042178> downloaded 27 Jan 2022. Also see:

<https://www.eenewswireless.com/news/detecting-interference-5g-avionics-systems?fnid=143668>;

<https://www.aol.co.uk/news/exclusive-major-u-airline-ceos-180306171-124446280.html>)

897) Electricity meter errors of several hundred percent caused by real-life waveforms

VI. CONCLUSION Using an arbitrary-waveform testbed [23], the EMC of 16 electricity meters is determined using a set of test waveforms caused by nonlinear loads. These meters represent a broad range of meter types used all over Europe and probably the rest of the world. They are built by 10 different manufacturers, rolled out in six different European countries between 2008 and 2019, and use the most common types of current sensors (Rogowski coil, Hall sensor, CT, shunt).

The test waveforms are recorded in the laboratory when testing isolated household appliances as well as onsite at various European metered supply points. The results confirm earlier findings showing that some specific household appliances can distort specific meters [15], but additionally show that several waveforms recorded onsite at residential buildings and small- and medium-size enterprises, i.e., waveforms as seen by electricity meters in real life, can cause meter errors as large as several hundred percent.

It should be emphasized that these huge meter errors were also observed for meters that passed the tests described in [14]. This unambiguously demonstrates that present standards do not cover the most disturbing conducted interference occurring in present real-life situations due to the increased use of nonlinear electronics.

(Taken from "EMC Testing of Electricity Meters Using Real-World and Artificial Current Waveforms", by Helko E. van den Brom et al, IEEE Trans EMC, Vol. 63, No. 6, December 2021, pages 1865–1874, available from: <https://ieeexplore.ieee.org/document/9527395>. Editor's notes:

- a. The underlining emphasis in the copied text above, is mine.
- b. [15] is our number 969
- c. [14] is IEC 61000-4-19:2014, "Electromagnetic compatibility (EMC) - Part 4-19: Testing and measurement techniques - Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2 kHz to 150 kHz at a.c. power ports," 2014.
- d. All electronics are nonlinear!

898) Potential Interference of VHF-FM Radio and AIS Reception

The United States Coast Guard (USCG) have published Safety Alert 13-18, regarding numerous reports on poor reception of VHF frequencies used for radiotelephone, digital selective calling (DSC) and automatic identification frequencies (AIS).

What happened?

- Poor reception was noticed when around LED lighting on-board vessels (navigation lights, searchlights and floodlights); interior and exterior lights and adornment lighting are just some of the few lighting systems containing LED lighting;
- The radio frequency (RF) interference caused was found to create potential safety hazards;
- A maritime rescue coordination centre was unable to contact a ship involved in a traffic separation scheme incident by VHF radio. The ship had also experienced very poor AIS reception;

- Other ships in various ports experienced degradation of VHF receivers, including AIS, caused by their LED navigation light. LED lighting installed near VHF antennas has shown to interfere with the reception.

What lessons were learned?

- RF interference may not be immediately obvious to maritime radio users. However, it may be possible to test for interference caused by LEDs;
 - turn off LED light(s)
 - tune the VHF radio to a quiet channel
 - adjust the VHF radio's squelch control (until the radio outputs audio noise)
 - re-adjust the VHF radio's squelch control until the audio noise is quiet (slightly above the noise threshold)
 - turn on the LED light(s) – if the radio outputs audio noise, then the LED lights have raised the noise floor
 - if the radio does not output audio noise, then the LED lights have not raised the noise floor;
 - If the noise floor is found to have been raised, then it is likely that both shipboard VHF marine radio and AIS reception are being degraded by LED lighting.

The USCG has requested that anyone experiencing this kind of problem, to send reports to Coast Guard Navigation Center. The full safety alert can be found on the USCG's website: <https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/INV/Alerts/1318.pdf?ver=2018-08-16-091109-630>.

(Taken from IMCA Safety Flash 24/18, 2018, available from <https://imcaweb.blob.core.windows.net/wp-uploads/2020/06/IMCASF-24-18.pdf> or <https://www.imca-int.com/safety-events/potential-interference-of-vhf-fm-radio-and-ais-reception/>)

899) Multiple sources of EMI can affect spacecraft

Multiple sources of interference can affect the spacecraft's proper performance and functionality determined by the nature of the spaceflight program [1]-[7]. The after-effect may lead to the diminishing or even total loss of key functionality, with consequences in terms of science data, increased costs, bad scheduling, etc.

Moreover, corrupted measurements or noisy data, reduced performance of power supplies, erroneous commanding, and power distribution subsystem unreliability [8], [9] are common issues.

In general, the EMC component is a key link in the spacecraft-system engineering chain. Overall, a satisfactory EMC state for the overall platform requires a keen grasp of the underlying electromagnetic theoretical aspects as well as a certain level of familiarity with the established modus operandi in the fields of development, fabrication, and testing.

(Taken from: "Spacecraft Hull Effect on Radiated Emissions and Optimal Onboard Payload Allocation" by Anargyros T. Baklezos et al, published in: 2020 International Symposium on Electromagnetic Compatibility - EMC EUROPE, 23-25 September 2020, available from: <https://ieeexplore.ieee.org/document/9245708>.)

900) EMF Shieldite protection pendants and USB sticks

(Every 100th Banana Skin is chosen either for its humour or its claims to stretch recognised boundaries, and this is one of the latter. Although it is very amusing to anyone who understands real RF and EMF shielding that works, it is apparently not meant to be. – Editor.)

What is an EMF shieldite protection pendant?

The shieldite emf personal emf protection pendant is rated best emf shielding and natural substance for rf shielding click here to learn more...

Iyashi® EMF Protection.... is the only EMF protection device that transmutes EMFs rendering them harmless.

Iyashi® EMF Protection products are made from Shieldite.... (which) includes the rare fullerene carbon molecules forming in



clusters of 60-70 molecules. Shieldite is actually electrically conductive which allows it to interact with the EMF's and transmutes the EMF's in the surrounding area as well as providing absorption of the harmful bi-products.

Like carbon filters removing contaminants from water, Shieldite alters EMF waves in the surrounding area to a safe wavelength for the body cellular structure. This is only possible when infusing the Shieldite mineral with our proprietary (*sic*) B.F.I.T.



NEW EMF Shielding personal protection – Much more powerful emf protection against (*sic*) rf shielding...[click here to learn more](#)

The pendant is filled with a new paramagnetic rare-earth mineral infusion that does much more than just retune ambient EMF's to coherent frequencies.

By correcting the carcinogenic effect of positive ionic direction, the Aulterra Energy Pendant provides many benefits including:..... (*and a great deal more like this – Editor*)

Enhanced with
Nanotechnology



This protection device is rated best **emf shielding home devices for 5G**.

These are hard to get your hands on because they are the best I've found for electromagnetic fields, hopefully you can still get one for yourself. Read the review below or [click here](#) to learn more...

(*This device claims to be a "Whole House EMF Neutralizer (USB)" - Editor.*)

(*I found the website in which the above products appear, <https://emfshielding.org/>, during a Google search on 'RF Shielding' that I had hoped would turn up some special shielding materials I was not already aware of. This was not the only site offering such products with claimed RF and/or EMF shielding benefits, clearly aimed at ordinary people (not electronic engineers) worried about the health effects of electromagnetic fields. Many of these sites also appear to try to increase such peoples' fears about health effects. Does anyone want to complain about these products to the UK's Advertising Standards Authority? – Editor*)