A POLYCOM WHITEPAPER

Audio Electronics and the "Mobile Phone Buzz"

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"Hey, this thing is buzzing. We better turn off our mobile phones."
"I think it's the guys at the other end."
"Can you guys turn off your mobile phones?"
"Why? We don't hear anything."

Overview

In the past, when you were in a conference call, it probably felt like any other telephone call, except you had the advantage of hands-free, high quality audio. Nowadays, as more and more complex mobile devices make their way into the hands of business executives and consumers across the globe, the dynamics of the conference call have changed. Mid-conversation, a buzzing noise starts as people frantically grab their mobile devices and move them away from the conference phone, knowing full well that they may be the offender. We typically know what causes the buzz, but we may not realize why it's happening or that there's a new wave of conference phones available that will put an end to this phenomenon. This paper will explore what exactly is causing that annoying buzz, why it's happening, and how it can be remedied.

As long as radios have been in existence, the opportunity for interference has been there. But in today's crowded world of high-tech, wireless devices, the problem has become pronounced. The truth is that building a good radio is a real challenge, but building a bad one turns out to be surprisingly easy. We have all heard stories of the guy who picked up a local radio station in his fillings, or the rusty radiator that buzzed in time to the "Top Ten" playing on the AM dial. They sound far-fetched, but some of these stories are actually true. What is happening is that really strong radio waves, for example from a nearby station, can force a less-than-perfect electrical connection to act like a detector that strips out the really high radio frequencies and leaves just the audio we hear. So, two rusty pipes fitted together can act like an accidental detector, but so can transistors, connectors, and a variety of other parts commonly found in electronics. When they're pushed hard enough, they reveal their darker sides, and add "noisemaker" to

Just How Strong Are "Typical" Radio Transmissions?

Electronics respond to field strength, and field strength is a result of some transmitted power (typically measured in watts) located some distance away. The greater the distance, the lower the field strength. However, when the transmitter is nearby, the signal strength can be very high, even if the transmitter is only a couple of watts. In fact, a mobile phone sitting two inches from a wired phone can produce electric fields as strong as a major radio station only twenty feet away! Compounding this phenomenon is the fact that newer mobile phones and PDAs not only emit stronger fields and operate in new frequency bands, they also use more complex modulation than previous versions. This aggravates the interference problem. It is these extremely strong and unusual signals that are making new design techniques necessary today.

The most common (and abrasive) form of interference is the buzzing sound that seems to come without warning when a mobile phone is sitting near a susceptible speakerphone or stereo system. Curiously, once the phone is picked up and a conversation is in process, the interference generally disappears. The reason for this is that mobile phones adjust their transmit power once a call is established; if there's a station nearby, a mobile phone will usually operate at fairly low levels while the call is going on. However, when exchanging data such as ringing and messaging, they operate at full strength for a short time, which can be enough to be picked up in a susceptible device, and sent to either the near or far end (or both). Another good example of this is when you're driving your car listening to the radio with your mobile device nearby, when the buzzing begins. Nine times out of ten, you can expect a call, e-mail, or voicemail to arrive right along with the buzz.

But sometimes, you don't hear the interference even as it is occurring. That's because interference often enters a telephone device through its microphone path—the microphone itself, or the sensitive electronics that amplify the microphone signal. When this happens, the sound is sent directly to the far end, and you may never hear it. This is why there is sometimes confusion in a conference call, when no one knows where the sound is coming from.

The remedy to this problem, as we'll see below, is to plan for susceptibly and then conduct thorough testing to ensure minimal to no interference will occur.

Stop the Buzz!

Mobile phone transmissions can get into a sound system through multiple "paths." The susceptibilities differ from system to system. One system may have especially vulnerable microphones, while for another it may be the speaker amplifier, and in another it's the internal wiring within the display system. Today's mobile phones and PDAs are also more invasive because they operate at frequencies that are 20 times higher than FM radio. This gives them shorter wavelengths and lets them get in through "smaller openings." The table below shows the most common mobile phone frequencies compared to common radio and TV frequencies - you can see that mobile phone frequencies are eight to 3,000 times higher and consequently, far more invasive.

Format	Frequencies
GSM *Global System for Mobile Communications*	900 MHz 1800 MHz 1900 MHz
GPRS *General Packet Radio Service* *Data (SMS, web, MMS, WAP) transmission using GSM structure on Blackberrys, phones, pagers, and PDA's from T-Mobile and AT&T*	900 MHz 1800 MHz 1900 MHz
CDMA *Code Division Multiple Access*	800 MHz 900 MHz 1700 MHz 1800 MHz 1900 MHz
CDMA2000/1X	450 MHz 800 MHz 1700 MHz 1800 MHz 1900 MHz 2100 MHz
FM Radio	88 MHz - 108 MHz
AM Radio	540 kHz - 1700 kHz

Note: TDMA, IDEN, and analog are rapidly being phased out.

Interference Susceptibility: How Can You Test for It?

Testing for susceptibility is typically done by putting the device to be tested into a shielded chamber and then exposing it to radio waves of a specified strength, frequency range, and modulation (see the image below for a typical test configuration). This is often done with a combination of signal generators, which will provide repeatability, along with actual mobile phones of varying makes and models, to build confidence and reduce the chance that some “corner case” has been missed.

During this test, the device is monitored for noise (for example, does it hum louder than some defined level? Does it buzz?) and for malfunctions (Does it reset? Does it hang up the call?). Major manufacturers such as Polycom have been working on understanding and solving this problem for the past several years, and a new generation of systems is already available that is virtually immune to nearby mobile phones and cordless data devices. At the same time the American National Standards Institute (ANSI) has a task group, C63, which focuses on definitions and methods of measurement of electromagnetic noise and signal strengths (radiated and conducted), determination of levels of signal strength, levels of unwanted sources, limiting ratio of noise (and/or unwanted sources) to signals and development of methods of control of, and guidelines for influence, coupling and immunity. Polycom is a founding member of this project and is working on an industry standard to provide a uniform basis of comparison while, at the same time, address the susceptibility of devices to mobile phones and PDAs.

The only surefire solution to the ever-increasing conference phone “buzz” problem is to be sure that you have a mobile phone-resistant telephone—something that enables courtesy to others on the call as well as personal convenience.

In order to prevent interference from mobile phones, Polycom has built multiple layers of robust protection to help assure that the adverse effects are eliminated.

- Microphone design – Microphones are some of the most sensitive components in a good audio system, and are therefore, especially susceptible to strong radio fields. Polycom has developed a new series of extreme high-immunity high definition (HD) microphones, and uses these in its new audio products to close this avenue of entry to strong transmissions.
- Cabling – Unless interference issues are understood and addressed, connecting long cables to a device has the same effect as connecting a long antenna.. Polycom's new systems integrate especially robust isolation and filtering technologies into input and output connections, including everything from POTS to USB and IP interfaces.

- Speaker system – Loudspeakers themselves are not especially vulnerable to radio signals, but their amplifiers can be. Speaker connections must be carefully treated to prevent them from picking up transmissions and routing them into the speaker amplifier, lest they be detected, amplified, and driven back into the loudspeaker as loud audible sounds.
- Digital electronics – Polycom's current systems have hundreds of digital signals and millions of transistors, all of which achieve power efficiency by being responsive to low signal levels. To protect them from responding to unwanted signals also, Polycom's modern communication systems combine secure physical metallic shields with comprehensive signal isolation strategies, to keep unwanted radiation from penetrating the processor architecture and inducing malfunctions.

Integrating all these functions into a system requires both experience and extensive testing. It is not uncommon for a system to require three or four iterations of redesign and testing to produce a result robust enough to be suitable for a hardcore business application. Polycom leverages its technological expertise and its commitment to creating best-in-class products to address this problem.

Summary

Radio interference is nothing new, but our awareness of it is at an all-time high. The proliferation of mobile devices compounds the problem in ways never imagined possible. Fortunately, there are solutions available today that will stop the "buzz" and offer the best quality audio available in today's market.

About the Author

Jeffrey Rodman is co-founder and CTO of Polycom. Jeff has been at the forefront of audio and video communications for most of his career. Drawing from this diverse experience in the industry and from his background as virtuoso pianist and composer, Jeff has developed a keen appreciation for the importance of clear, reliable vision and sound in human interaction, and the ways in which delivery of transparency in perception can be delivered in remote conferencing.

Jeff holds a BSEE Cum Laude and an MS in electronic engineering from CSUN. He has written numerous articles, songs, and one musical, and frequently speaks on topics of communications and media, being consulted when the topic turns to telepresence and HD Voice.

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