

Crystal Radio Sets and Op Amps—Both Can Detect RF Signals

Q: How are unwanted noise and dc offsets getting into my precision amplifier circuit?



A: On each birthday when I was young, my dad would take me to the toy store to pick out my present. He always vetted the toy, saying something like, “Now really, what are you going to do with that?” Or, “How long do you think that will last?” I sometimes think that he wanted to make sure that he would enjoy my choice as well. His questions forced me, even at an early age, to think critically about the decisions and choices I was making.

Some of my favorite childhood toys were: an erector set and a Radio Shack 101 project electronics kit, but my earliest kit, the one that sparked my interest in electronics, was a crystal radio set. I tuned in AM radio stations and magically plucked them from the airwaves... with no batteries or power supply! How cool was that? How did it work? Some 40+ years later, who would think that I would tie that crystal radio set into an op amp RAQ? Actually, it wasn't hard.

A crystal radio uses a PN junction to rectify an RF signal envelope to produce a detected voltage. Did you know that some op amps can do the same thing? All op amps feature some variation of a differential pair front end. Depending on the current flowing in the diff pair, and the unwanted RF signal frequency and strength, the diff pair can actually act as a high-frequency detector. That's great if want to listen to an AM radio station, but not good if that signal inadvertently enters your precision amplifier circuit. In many precision applications, the signals are very small voltages. When these unwanted signals are detected in the op amp, they produce a wide spectrum of signals and harmonics—as well as dc voltages. These dc components can shift bias levels and introduce system errors.

So what can you do? A variety of shielding, filtering, and layout techniques exist, but all add complexity to the circuit. Perhaps the best solution is to use one of ADI's new precision op amps with built-in EMI filtering capability. The [AD8657](#), [AD8659](#), [AD8546](#), [AD8548](#) and soon to be released [ADA4661-2](#) precision op amps all feature built in EMI filtering. This added technology greatly simplifies the designer's job, reduces complexity, shrinks board area, and lowers cost.

When you want to listen to an AM radio station, get a crystal radio; when you're looking for peace and quiet, choose a precision amp with built in EMI filtering. You'll be glad that you did.

References

Application Notes

[AN-671: Reducing RFI Rectification Errors in In-Amp Circuits](#)

Technical Documentation

James Wong, Joe Buxton, Adolfo Garcia, James Bryant, "Filtering and Protection Against EMI/RFI" and "Input Stage RFI Rectification Sensitivity", Chapter 1, pg. 21-55 of *Systems Application Guide*, 1993, Analog Devices, Inc., Norwood, MA, ISBN 0-916550-13-3.

Walt Kester, Walt Jung, Chuck Kitchen, "Preventing RFI Rectification", Chapter 10, pg 10.39-10.43 of [Practical Design Techniques for Sensor Signal Conditioning](#), Analog Devices, Inc., Norwood, MA, 1999, ISBN 0-916550-20-6.

Tutorials

[MT-070: In-Amp Input RFI Protection](#)

[MT-095: EMI, RFI, and Shielding Concepts](#)

[MT-096: RFI Rectification Concepts](#)

Webcasts

[Guarding RS485 Communication Networks from Harmful EMC Events](#)