The ARRL Clean Signal Initiative

Learn about ARRL's effort to tidy up amateur transmissions.

Mike Ritz, W7VO

We've all heard them on the HF bands: overmodulated and distorted signals causing splatter on SSB, and key clicks on CW. The problem is often so bad that it's hard to get within 5 kHz of them to work that elusive all-time new one. It is frustrating, to say the least. What can be done about it?

In mid-2020, this question led to a few email exchanges between myself and Ward Silver, NØAX. Our conversation eventually led to the formation of an ARRL Programs and Services Committee (PSC) subcommittee, the Working Group on Transmitter Cleanliness, whose goal was to learn what ARRL could do to help solve these issues. The subcommittee consisted of myself and several other ARRL PSC members with RF engineering backgrounds, such as Kristen McIntyre, K6WX, and Carl Luetzelschwab, K9LA. Also in the group were Ward, Rob Sherwood, NCØB, and representation from the ARRL Lab.

In my initial discussions with Ward, I had suggested that sanctioning the transmitting station in some way, through regulations or other operating rules, would provide the incentive to improve signal quality. However, we quickly recognized that few amateurs intend to transmit poor-quality signals, so punitive rules would be ineffective. There had to be a better way to attack the problem. After additional discussion, we decided that the best solution would be to go after the sources, or root causes, of poor-quality signals: limited FCC regulations due to amateur radio's "self-policing" nature, which leads to compromised commercial transmitter/amplifier design standards for signal purity, a lack of education about the technical causes of spurious emissions, and a lack of adequate operator training for proper transmitter and/or amplifier adjustments.

Root Causes of the Problem

The following are considered to be the root causes of poor-quality signals:

- Over the years, transmitter signal purity has lagged behind receiver performance.
- Solid-state amplifiers use MOSFETs, which often exhibit compromised linearity compared to vacuum tubes.
- Due to the use of digital technology in designs, transmitted composite noise levels are sometimes too high.
- Intermodulation distortion (IMD) from misadjusted speech and data modulation in transmitters can be too high.
- Keying artifacts (clicks) are a problem in some transceivers, especially if misadjusted.
- The FCC has set maximum values of spurious emissions, as outlined in Part 97: §97.307, but we can do more to address signal purity.

Amateurs new to HF operating are less aware of how to properly adjust their transmitter for the cleanest signal on any mode. Even more experienced amateurs may be unfamiliar with and misuse the latest technology, particularly solid-state amplifiers.

While a generally cleaner tube linear amplifier can be misadjusted, the only adjustment for solid-state amplifiers is drive level. Some solid-state amplifiers rely on an ALC connection, which is problematic at best. The input/output curve regarding the linearity of LDMOS amplifiers often ranges from mediocre to poor.

Should the FCC RM-11828 petition be adopted, there could be thousands of new hams on the HF bands with little training in how to adjust their transceivers for optimal signal quality. Also known as ARRL's *Petition*

for Rulemaking, the proposal calls for an expansion of privileges for Technician-class licensees. It would include limited phone privileges on 75, 40, and 15 meters, as well as RTTY and digital mode privileges on 80, 40, and 15 meters. Education is therefore necessary for amateurs to make the best use of current technology. At the same time, manufacturers must understand the performance expectations of amateurs and deliver equipment that meets those expectations.

Over the last 20 years, competition among amateur radio manufacturers has forced significant receiver performance improvement, thanks to hams voting with their pocketbooks. So far, this has not happened much on the transmit side of the equation. Predistortion, a design technique known to help with signal purity and address IMD, is a currently niche feature available from only a few select manufacturers.

The result of the working group's effort was an 11-page white paper, *The Clean Signal Initiative, An Opportunity Presented,* which called for the creation of the CSI. This proposal was formally approved by the PSC in their November 2021 meeting, and was subsequently approved 15-0 by the full ARRL Board of Directors in January 2022.

The Role of ARRL in the CSI

The CSI is envisioned as an extension of ARRL, which has traditionally established performance expectations and educated amateurs on how to meet them. ARRL has also historically worked with manufacturers to correct design shortcomings and provide validated test metrics and procedures. This strategy has contributed to exceptional receiver performance over the years — now, it's time to work on transmitters and amplifiers.

ARRL must be seen as a credible and responsible institution in defining and correcting problems. The ARRL Lab and technical advisers have taken the lead in addressing these types of performance issues, which serves to tangibly benefit ARRL's membership and raise the profile of the entire organization.

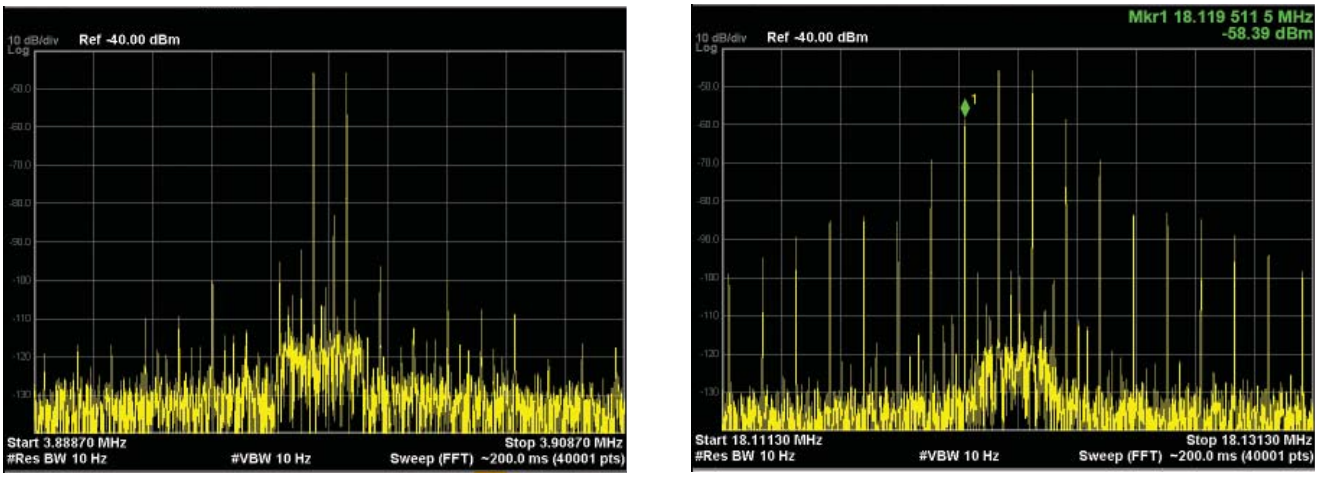
A key concern of the CSI is the education of amateurs regarding signal purity. This aligns well with ARRL's focus on improving its marketplace position by providing quality educational materials for members.

Under the direction of ARRL staff management, the ARRL Education and Learning Department will work with the Lab and the new ARRL Technical Standards Committee to develop materials that explain how to meet technical and operational expectations. They will also teach amateurs how to use their radio controls effectively to minimize spurious emissions.

The Role of the ARRL Lab in the CSI

The CSI's associated standards and educational elements must be established as a core function of ARRL Headquarters, funded and staffed appropriately within the Technical Standards Committee.

Creating a package of industry specifications that will affect manufacturers is an open-ended process. It will affect product design and development for many years, extending the impact of discussing performance deficiencies in *QST* Product Review.



Transmit two-tone intermodulation distortion (IMD) products. The clean signal is depicted on the left, and the unclean signal is depicted on the right.

The Lab has established a cadre of volunteers (the Test Review Team) to advise ARRL on various test methodologies, procedures, and developments that necessitate changes in ARRL's testing and reporting. Manufacturers need credible, ongoing contacts and liaisons. As such, the CSI will build on the work of the Lab and its full-time staff and volunteers. The Test Review Team will provide expert input on the best ways to test equipment, as well as benchmark recommendations that could be used by the CSI program. The Lab staff will thus give the CSI a stable home in the organization.

Similarly, educating amateurs will be an ongoing program to generate publications in various formats. The Lab staff will work with the ARRL Editorial Department and the Education and Learning Department to spread awareness about the CSI program and the best ways to achieve maximum equipment performance and on-the-air cleanliness. The Lab will work with the National Conference of Volunteer Examiner Coordinators Question Pool Committee to ensure that appropriate topics are included in the three levels of license exams. The Lab will also act as a trusted party to resolve disagreements about performance issues.

The 5-Year Goals of the CSI

Over the next 5 years, the CSI aims to achieve the following goals:

- Repurpose the existing Test Review Team into the Technical Standards Committee, which will be an extension of the Lab, including staff and outside consultants to maintain and represent CSI materials and programs.
- Work with major amateur radio transceiver manufacturers to create technical performance benchmark standards on a per-parameter basis, as maintained by the Lab, in addition to defining metrics and terminology.
- Agree on test procedures and the publication of results with major transceiver manufacturers, and add transmitter tests and results to *QST* Product Review.
- Create a program to certify equipment that passes standards evaluation tests, either as a whole or by individual parameters.
- Look at the feasibility and desirability of working with the IARU to internationally develop these standards.
- Create a program within the amateur community for assessing signal purity, including rationale stated in terms of on-the-air effects, while also assessing whether an organized monitoring function is warranted and/or practical.
- Develop educational materials to explain and instruct amateurs on how to meet primary expectations, both technically and operationally, by using their radio controls effectively.
- Report to the Board of Directors biannually (two times per year) on status in conjunction with Board meetings, to outline on-the-air results, standards and educational deliverables, and resource needs.

The Next Step for the CSI

One of the Lab staff now chairs the Clean Signal Initiative Committee (CSIC), formulated from a combination of Lab staff, representatives from several major amateur radio transceiver manufacturers, and several outside RF subject matter experts. They are working to define important parameters for transceiver cleanliness testing standards, based on what the Lab already does in *QST* Product Review. Part of this work is establishing standards parameter certification levels, such as "Meets" and "Exceptional."

Ensuring that manufacturers are treated as stakeholders in the CSI process will smooth out wrinkles that develop as parameter specifications and benchmarks evolve. That does not mean that the CSI will stop there, though! The goal is to push the limits of what can be achieved with transmitter cleanliness. Eventually, the current CSIC will morph into the Technical Standards Committee introduced earlier. They will be responsible for maintaining the program and establishing new standards as technology evolves.

There have been discussions as to whether the CSI needs to incorporate amateur receiver performance standards, as the FCC is mulling over creating their own receiver performance standards to mitigate RFI noise pollution.

I would like to thank the members of the committees who worked so hard to make the CSI a reality, the Board for their support of the program, and especially Ward, NØAX, who gave the program its name and inspiration.

Mike Ritz, W7VO, an ARRL member for more than 40 years, was first licensed in 1974 as WN6HKP and earned his Amateur Extra-class license in 1983. He also holds a General Commercial Radio Operator License that he earned in 1976. He had a long engineering and management career in the RF and telecommunications data hardware industry before retiring in 2014. In November 2018, he was elected Director of the ARRL Northwestern Division, and he was elected Vice President of the ARRL Foundation in January 2022.

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