



# CPT-1 Interference Issue, Final Report

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## Executive Summary

Interference on Los Angeles County DCS primary operating frequency (“CPT-1”) has been heard for the past few weeks by several DCS members and at all but a few sheriff stations. The interference manifested as short digital data bursts (less than 2 seconds in duration) and occurred every few minutes; these bursts were both annoying and disruptive to normal DCS communications. Intense detective work and investigation over several weeks by the DCS Technical Team led to discovering that this interference was a spuriously generated signal from an automated digital packet station transmitter at the home of an amateur radio operator in Alta Loma CA. The ham operator was contacted and worked cooperatively with members of the Technical Team to resolve the issue. The interference was eliminated when the operator placed a selective frequency filter on the transmitter to attenuate the spurious signal while still allowing the primary digital packet signal to transmit. In this solution, the primary digital function could continue without disruption and the interference to the DCS operating frequency was eliminated. Monitoring of CPT-1 subsequent to this fix has shown no recurrence of the interference.

## Full Report

**Understanding the problem.** Several weeks ago, a disruptive interference, which sounded like digital packet data, began to be heard on LAC DCS VHF frequency 147.27MHz aka CPT-1. (It was first reported by the Technical Team lead to DCS management on 24 September 2018.) Members of the DCS tech team attempted to determine if this signal could be time correlated with some other legitimate digital transmission elsewhere on the two-meter band. After considerable searching, it was discovered that there was time correlation with a transmission on 145.67MHz. Even though this frequency is not a standard coordinated digital packet frequency, it was nevertheless clear that the signals on 145.67MHz and 147.27MHz were occurring simultaneously. The difference between the two frequencies of 1.6MHz (147.27 - 145.67) was unexplained. But, the tech team further uncovered that there is an AM radio station (KAHZ) in the Pomona CA area operating at 1600kHz or 1.6MHz. Could there be some form of mixing of the two source signals—145.67MHz packet data signal and the 1.6MHz from the AM radio station—to yield the spurious signal at 147.27MHz? The team was intrigued by this idea, but more insight about the source signal was needed.

Digital packet decoding software (Sound Modem from <http://uz7.ho.ua/packetradio.htm>) was installed by Tech Team lead Deane N5DQ (Staff 50) to gain insight about this digital data stream. Here is a short excerpt from just one such intercept of that data stream:

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1:Fm W6RO To W6KK-2 <RR R R2> [15:45:59R] [+++]  
1:Fm W6KK-2 To W6RO <I C R2 S2 Pid=F0 Len=83> [15:46:21R] [+++]  
DX de VE1KF: 7136.0 UT9EU OP Mike, 59 NS 2246Z FN84
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It appeared that this was an automated interchange between amateur radio club station W6RO aboard the Queen Mary ship and W6KK in Alta Loma regarding the spotting of Ukraine DX station UT9EU on frequency 7136kHz by an observing Canadian station VE1KF. So, it was clear that this was a digital packet cluster station used for HF DX spotting. But, it wasn't clear yet where the source station was located. However, since each packet group involved the call sign W6KK and the fact that this ham operator has an extensive background in HF DX operations (according to his QRZ.com personal page), there was a strong likelihood that the digital packets were emanating from his amateur radio station in Alta Loma (approximately a 50 degree bearing from Palos Verdes CA). Not all signals on 145.67MHz created a spur on 147.27MHz, just those packets labeled **Fm W6KK-2**.

The tech team knew that it needed to observe (in the frequency domain) the receive power levels of both the source frequency at 145.67MHz and the spurious signal frequency of 147.27MHz. A spectrum analyzer (Rigol DSA815) belonging to tech team member Jerry NG6R (T-03) was deployed, along with a 4-element 2m Yagi antenna. This setup was positioned at the QTH of Dick WA6NSR (Staff 3), which is high enough on Palos Verdes peninsula to have an unobstructed view of the Alta Loma area. The antenna was pointed generally northeast and the spectrum analyzer was configured to measure relative power levels at both the source frequency (145.67MHz) and the spur frequency (147.27MHz). Dick had reported prior to this activity that he could clearly hear the digital packet interference on CPT-1 from his home. So, his QTH was an ideal location at which to run these tests.

A typical spectrum analyzer screen shot is shown in Figure 1. Through trial and error, the photo was captured at the instant that the short data burst occurred on 145.67MHz. This source frequency had been preset on the spectrum analyzer as Marker 3, as can be seen at the far left in the photo. The companion spur signal at Marker 4 occurs at the preset frequency of 147.27MHz. Note that the vertical scale in this particular photo is 5dB per division. So, the relative difference is ~13dB (86dB - 73dB). Right away, we noted that if these two signals are actually coming from the same transmitter (i.e., from the same location), then the station creating them would be in violation of FCC Part 97.307(e), which requires that any spur be below -60dB, relative to the fundamental, for transmitters greater than 25W and -40dB for transmitters less than 25W. Several similar photos were taken at this time; for all instances, the average power difference between the source signal and the spur was about 12dB.

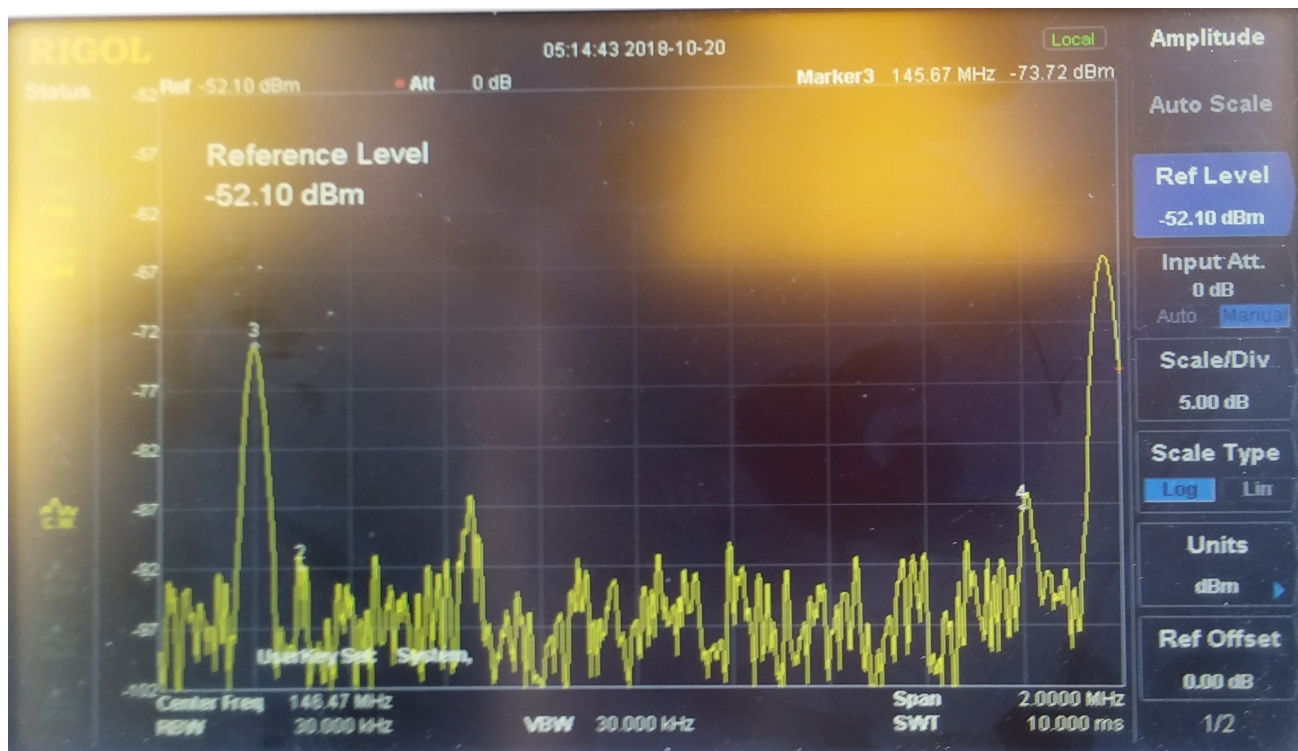


Figure 1. Screen shot of spectrum analyzer showing the digital packet source signal at Marker 3 (145.67MHz) and the unwanted spur signal at Marker 4 (147.27MHz). The relative power level difference between these two signals is approximately 13dB. Note that the vertical scale is 5dB per division. [Date photo taken 10/19, not 10/20]

Upon further reflection on the 1.6MHz difference frequency and the possibility that there could be a signal mixing process occurring between a source FM signal at 145.67MHz and an AM radio station signal at 1.6MHz (from the 5000W AM radio station KAHZ actually located only 10.6 miles from the home QTH of

W6KK), it followed from theory that there should be two spurs from this mixing product, not just one. In addition to a spur at 147.27MHz (145.67 plus 1.6), there should be a spur at 144.07MHz (145.67 minus 1.6). We set up the spectrum analyzer again and, indeed, confirmed the theory and captured both spurs, as can be seen in Figure 2.

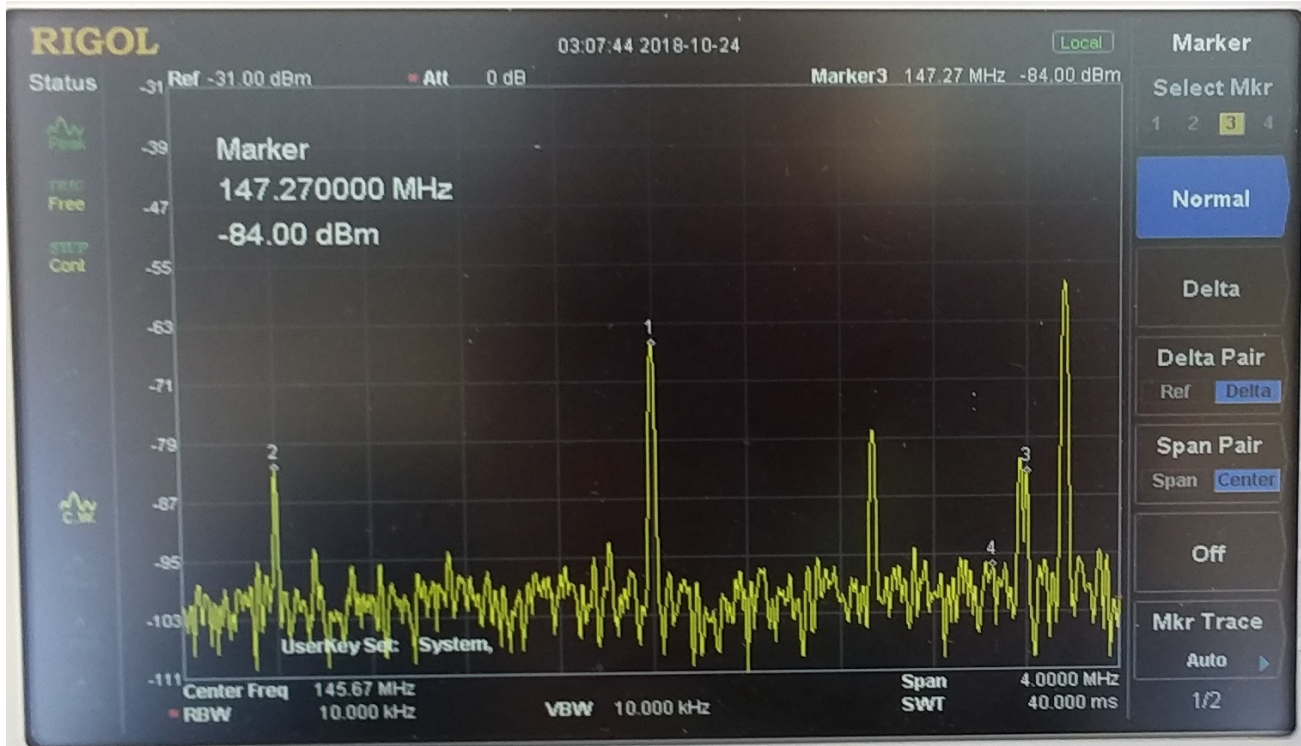


Figure 2. Screen shot of spectrum analyzer showing the digital packet source signal at Marker 1 (145.67MHz) and unwanted spur signals at Marker 2 (144.07MHz) and at Marker 3 (147.27MHz). The relative power level difference between the source signal and the two spur signals is approximately 17dB in this photo. Note that the vertical scale in this display is 8dB per division. Also note the uneven and “ragged” nature of the spur at 147.27MHz, perhaps corroborating the theory that the source signal and the amplitude-modulated (AM) radio station are mixing at some location. [Date photo taken 10/23, not 10/24]

**Road Trip.** It was clear to the tech team members that the physical location of both the source signal and the spur signals needed to be confirmed. Were they both emanating from a transmitter at the QTH of W6KK? Or was there mixing of the digital packet source signal in such a manner that the source signal emanated from one location and the spur signal emanated from a different location (such as the AM radio station located about ten miles away)? A road trip was undertaken to answer this question and to determine how strong will be the spur on CPT-1 frequency as we near the QTH of W6KK. A trip was taken to Alta Loma CA on 23 October 2018 by Tech Team members Deane N5DQ (Staff 50) and Jerry NG6R (T-03), as well as Gary WA6MEM (ARRL LAX Section Technical Coordinator).

A location approximately midway along a direct line between W6KK’s QTH (Alta Loma) and AM radio station KAHZ (Pomona) was selected for running additional tests. Figure 3 shows the general arrangement for this test. The bench-test-quality spectrum analyzer was set up in the rear of the vehicle so that photos could be taken; it was powered by a large storage battery with a DC-to-AC inverter. The 2m Yagi antenna was elevated approximately 25 feet on a telescopic mast; it was aimed first in the direction of W6KK QTH and then in the direction of the AM radio station.

Examination of photos of the spectrum analyzer display taken from this location, which showed the source signal and both spurs, demonstrated conclusively that the spurs were emanating from the same direction as the digital packet source signal. I.E., the relative power level difference (source to spurs) was approximately

the same whether pointed toward W6KK or pointed toward the AM radio station—about 13-15dB. Furthermore, both the source signal and spurs were considerably stronger from the direction of W6KK QTH.



Figure 3. Arrangement for capturing spectrum analyzer data in the vicinity of both W6KK ham radio station (suspected origin of the digital packet source signal) and AM radio station KAHZ. This ad hoc roadside test location was about midway between the two stations (approximately five miles away from each). (Left) Gary WA6MEM and Deane N5DQ in the foreground (Right) Gary WA6MEM and Jerry NG6R analyzing spectral data

A quick drive from this roadside test location over to the neighborhood of W6KK confirmed that the spur levels at both 144.07MHz and 147.27MHz were significant. An HT tuned to either spur frequency, even with its rubber duck antenna completely removed, was actually front-end overloaded in the block near the QTH of W6KK. At this point, no doubt remained that the origin of the spur signal interfering with CPT-1 was at the QTH of W6KK.

**Contact with W6KK.** On departing Alta Loma for home, there was focused discussion about the next best step to resolve the problem. Several diverse approaches were aired, but it was finally agreed that first a “candid and friendly” email would be sent to W6KK describing our findings to date and asking for his help. Depending upon the nature of his response (including the possibility of NO response), our potential next step(s) after that could be more firm. [After all, it was virtually conclusive that FCC Part 97.307(e) was being violated.] An email to Charlie W6KK, using the email address found on his QRZ.com page, was sent by Jerry NG6R on 24 October 2018. It was fairly lengthy, going into the chronology of the problem and included photos that demonstrated clearly that the spur was emanating from his station location. An offer of technical help was extended if he so desired. He replied by email the next day (25 October) and asked for a phone number so that he could make contact to discuss the issue. A telephone discussion ensued, ending with a conclusion that he would attempt to try different candidate fixes.

**Interference fix, final testing.** It was agreed in this telephone discussion that Jerry NG6R would again set up the spectrum analyzer and Yagi antenna on 26 October at the home of Dick WA6NSR to observe what Charlie W6KK believed would represent a fix to the interference issue. Cell phone numbers had been exchanged and coordination during the testing was done by phone. The fix installed by W6KK was to place a narrow-band cavity filter centered about the source frequency of 145.67MHz, with a fairly steep skirt that would significantly reduce the power emanating at both spur frequencies of 144.07MHz and 147.27MHz. Approximately 2dB of insertion loss was the penalty at the digital packet source frequency for installing this filter.

Figure 4 shows the resulting spectrum with the cavity filter installed, as observed from Palos Verdes. Marker 1 is the digital packet source frequency at 145.67MHz. Marker 2 is at 144.07MHz but is obscured down below the noise floor. Marker 3 at 147.27MHz is also in the noise floor region but can be observed toward the right side and is at -104.44dBm, compared to the source signal power level at -80dBm (a 24dB difference).

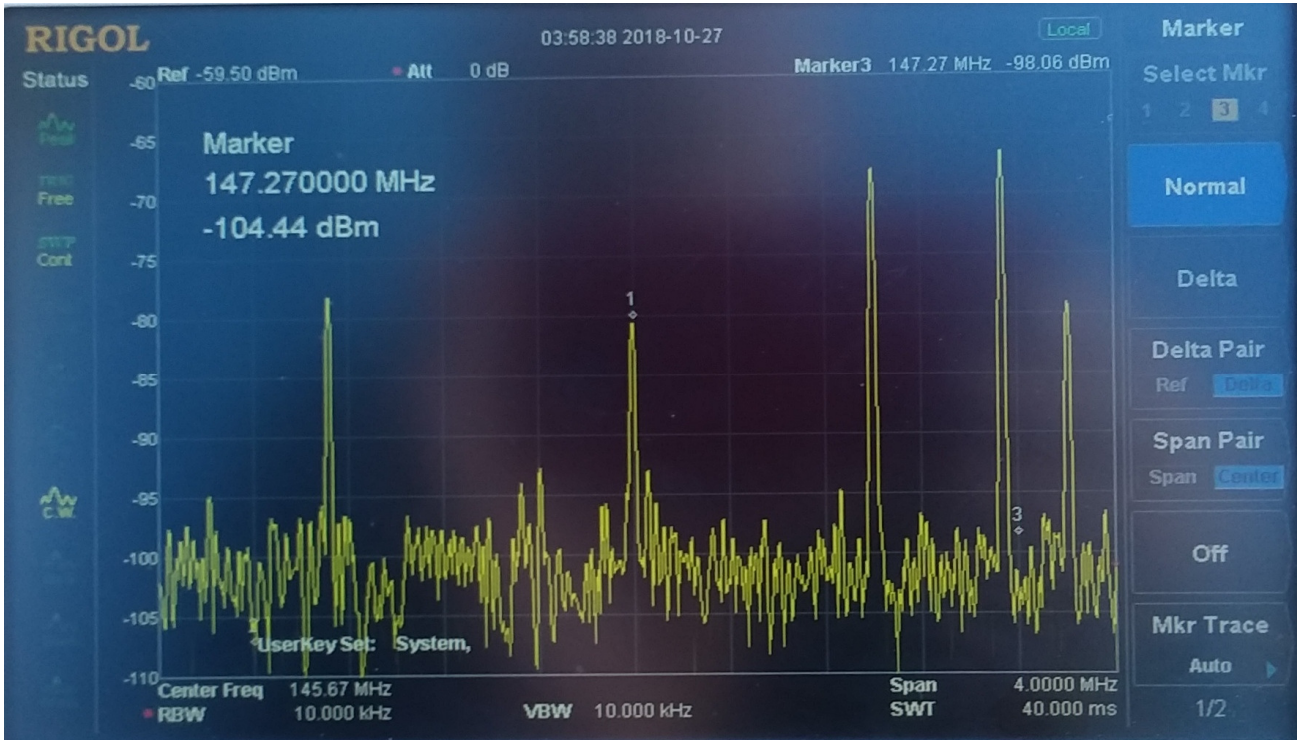


Figure 4. Screen shot of spectrum analyzer, after cavity filter installed at W6KK, showing the digital packet source signal at Marker 1 (145.67MHz) and unwanted spur signals at Marker 2 (144.07MHz) and Marker 3 (147.27MHz). The relative power level difference between the source signal and the two spur signals is greater than 24dB, far greater than had been observed prior to installing the cavity filter. However, it is likely that the power level difference is considerably more than 24dB, but the signals are too weakly received at this distance from the source (from Alta Loma to Palos Verdes) to demonstrate that assertion directly. [Ignore the other strong spikes in this photo that represent unrelated signal sources that happened to be on the air when this photo was taken.] Note that the vertical scale in this display is 5dB per division. [Date photo taken 10/26, not 10/27]

**Final caveats.** Obviously, the true difference in power levels between the digital packet source (Marker 1 at 145.67MHz) and the spurs (Marker 2 at 144.07MHz and Marker 3 at 147.27MHz), as shown in Figure 4, wasn't discernable in this test because the signals are so weak that the spurs are now below the noise floor. The only way to truly determine how far down the spurs are below the source signal is to move the spectrum analyzer closer to the source, i.e., another road trip to get closer to the source so as to raise the source power level another 10dB or 20dB. The tech team opted instead for a "wait and see" approach. If the DCS use of CPT-1 frequency of 147.27MHz is without digital packet interference over the next few weeks, it's fairly conclusive that the spur signal from W6KK is no longer a source of interference. Should that situation change, the investigation can be reopened and additional steps taken to find a better solution. No interference has been reported from any DCS station or DCS member since the installation of the filter.

Some anecdotal evidence also exists that the interference issue has been resolved. Charlie W6KK was asked soon after we made initial contact with him to confirm that he also could hear the spur on 147.27MHz. He drove around his neighborhood and reported that he too could hear the spur on his HT. However, after the cavity filter was installed, he repeated that experiment and reported back that he could no longer hear the spur on the CPT-1 frequency.

Relative to the 1.6MHz frequency difference between the source signal and the two spurs, it's unlikely that the mystery of its significance will ever be solved. Charlie W6KK thought first of the standard difference between transmit and receive repeater signals on the 220MHz band, which is 1.6MHz. He mentioned that he was involved with a 220MHz repeater system but didn't elaborate. He was baffled by how an AM radio signal at 1600kHz could be entering into his digital packet transceiver, but did acknowledge that the unit is quite old and has been in service for a long time. He reported that no changes had been made recently that might account for the sudden creation of these spurs, but because of equipment aging, didn't rule out the possibility of connector corrosion. Sometimes such metal corrosion can form a semiconductor or diode, the key component in a mixer.

**Conclusion.** No additional testing is planned at this time until/unless there is a recurrence of interference on CPT-1. While there is no provable explanation of how/why the spurs were being created, the insertion of a cavity filter following the packet transmitter has seemingly eliminated the interfering spur. The Technical Team believes that this issue has been resolved, but will be ready to react immediately if there should be any future reports of interference on CPT-1.