C Crane FM Transmitter 2 Field Test
Manufacturing Tolerence Test
October 23, 2016

The mission of this test is to check manufacturing tolerances, specifically related to the output of the C. Crane FM 2 Part 15 transmitter utilizing field strength measurements.

A total of 10 brand new factory sealed C. Crane FM Transmitter 2 units were purchased for this test from various common sellers. This includes various sellers on Amazon, eBay, retail websites and directly from C. Crane. Each was powered with brand new alkaline batteries, all with the same date of manufacture, all from the same manufacturing batch. The batteries were then each tested on a digital volt meter and only those with matching voltages were used.

My standard setup for testing Part 15 transmitters was used. Testing is done in a wide open field with no buildings, trees, etc within ½ mile or more. I have used this same location for numerous tests and the locations of the transmitter and field strength meter are marked and identical each time I use the test site. The Potomac FIM-71 with it's matching calibrated dipole antenna was used, last calibrated 11 months before this test by Potomac. The tests are all done with the receiving and transmitting antennas 7 feet above ground as specified in the Potomac manual so that the proper antenna factor can be applied. Tests were done with the transmitting and receiving antennas 3 meters apart as specified in the FCC rules. The transmitters were attached to a 1x2 wooden pole held vertical in a cement holder. The transmitters are affixed to this with their antennas at exactly the 7 foot mark. Transmit antennas were all placed in the perfectly horizontal position for these tests, as the receiving antenna is also horizontal. (See variations on last transmitter test). No metallic or conducting materials were near the transmitter other than the field strength meter itself. All transmitters were tested at the frequency of 101.5 mHz. Only one transmitter was mounted for each test. As you may know this particular transmitter has a permanently attached 6 foot cable terminated in a 1/8 inch stereo jack for audio input. As I've learned the position of this cable can affect field strength, so for all tests here this cable was brought straight down below the transmitter and affixed to the mounting pole. All transmitters were tested for field strength within a span of 20 minutes. All under the exact same conditions, with the same equipment, on a sunny 60 degree day with no wind.

The Results

Ten transmitters were tested for field strength. I found the C. Crane FM Transmitter 2 to be built with very good consistency. Field strength ranged from a low of 98 uV/m to a high of 110 uV/m, all well within the FCC limit of 250 uV/m at three meters, although this explains why their coverage is advertised as only being 30-75 feet. I had also tested the C. Crane transmitter a year ago, checking for compliance only, and that example had a field strength of 110 uV/m, again, demonstrating good consistency between units. The units in the middle range all came in at 103-105 uV/m.

Interesting Observations & Additional Tests:

I observed unexpected effects while testing various FM Part 15 transmitters a year ago and took this opportunity to repeat some experiments after the testing for field strength was completed on the 10th transmitter. With no change in setup or testing conditions I performed the following tests with the stated results.

In each test above the 6 foot audio cable was pulled straight down the wood pole from the transmitter. I noticed in previous tests on various transmitters that an audio cable can have a great affect on field strength. I wrapped up the cable as it was when it arrived in the package, into a bundle approximately 4 inches long. I affixed this coil of the cable at the top of the pole behind the transmitter. The field strength of the transmitter dropped from 110 uV/m to 83 uV/m. Clearly showing that the audio cable is either operating as a counterpoise to the antenna, or at the very least contributing to radiated signal. I returned this cable to the straight down position below the transmitter, field strength went right back up to 110 uV/m. Similar effects can be done by moving the audio cable off to the right or left at an angle to the transmitter as it hangs down from the transmitter.

For the next test I wanted to investigate again the affect of other things sitting in the vicinity of the transmitter. One year ago I observed this affect while testing a Decade CM-10. I noticed that various things sitting on the desk with the transmitter would have an affect on the field strength when they were moved about the desk, but I didn't take any controlled measurements.

As a quick test of this effect I set a small metal tape measure on top of the transmitter at the top of the pole. The field strength went from 110 uV/m to 140 uV/m. I the pulled the tape out to approximately the same length as the transmitter antenna was long in the other direction, which gave the appearance of a dipole although the tape measure was in no way connected to the transmitter. The field strength jumped to 254 uV/m! I pulled the tape out to 3 ½ feet, the longest I could go without the tape folding from it's own weight and the field strength jumped to 490 uV/m. This CLEARLY shows that even having a wire or something metal near the transmitter can have a dramatic effect on field strength! Without connecting anything to the transmitter, or making any modification to it whatsoever I could multiply the field strength by four times! And again, after removing the tape measure from atop the transmitter it dropped back to it's normal 110 uV/m.

I then moved the transmitter antenna from it's horizontal position to vertical, and the field strength dropped to 64 uV/m. This clearly shows that polarization will affect field strength. Moving the receiving antenna to the vertical position as well brought the field strength back to 110 uV/m. I imagine most users of the transmitter would have the antenna in the vertical position, as would most FM receivers used by listeners. Polarization may not prove as dramatic of a change at greater distances.

As a double check of the Potomac readings I pulled the Z-Tech 506 from the shop and tested field strength again on this last transmitter, and confirmed 110 uV/m at 3 meters. The 506 is a more modern device than the Potomac with many more capabilities and often when doing such tests I'll pull it out to verify readings. My own form of double checking things.

As I discovered with another transmitter I've been working with, frequency selected will have an affect on output. Simply using a spectrum analyzer I could watch output change with frequency. Oddly with the C. Crane the output remained rather steady as I moved the frequency from 101.5 to the top of the scale. But going the other way caused a dramatic drop in output, dropping as low as 50% less output down near 88 mHz. This was to be expected as the antenna match gets closer the higher the frequency goes, but it remained fairly steady from 101 to 107.7

Clearly the C. Crane FM Transmitter 2 is a very consistent performer, if somewhat underpowered compared to others available. And depending on surroundings, it's fully legal.