E Field Probe Testing Update

Introduction

Following the RSGB Convention SMD Workshop build on 9th Oct 2016, and the publication of the EFP Manual subsequent to that, there has been some private discussion with a few people, whose ability and opinions I respect, about the mounting of the E Field Probe Active Antenna. This document contains the results of testing I have carried out as a result of those discussions.

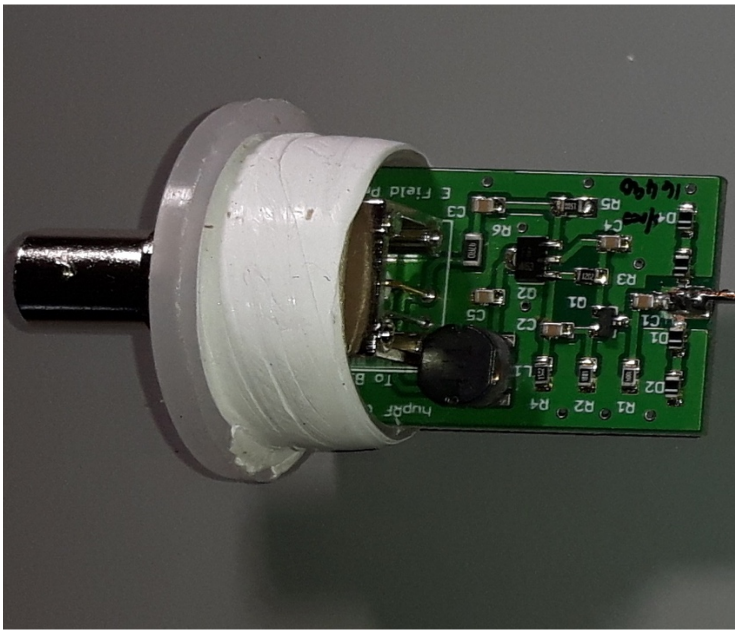
It also contains an update on the mounting of the probe unit. I have received information which has allowed me to locate some suitable weatherproofing caps so that the probe and its antenna (plate or rod) can be housed in a plastic tube. That is also discussed here.

It is hoped that this document can provide further advice and guidance to constructors in how to mount their E-Field Probe Active Antenna, and whether to use a wire probe antenna or a plate antenna.

Probe Mounting

Let's deal with the probe mounting first, as that is pertinent to all of the subsequent tests. Samples have been received from a company producing plastic plugs, and these are suitable for weatherproofing standard 32mm white plastic waste pipe to produce an active antenna which can be mounted simply at the top of a pole.

There are two different plugs used. The upper cap is a cap which fits outside the tube, so there is no path for moisture ingress. To be absolutely certain, there would be no harm in a wrap of self-amalgamating tape around the lower part of the cap. No preparation is required beyond cutting the waste pipe to the required length and cleaning up the cut. Chamfering the outer edge of the cut end is probably a good idea.



The lower seal is a flat plate with a circular extrusion on the top, so that it will fit inside the tube, and seal the bottom. It is a slightly loose fit in standard waste pipe, but a few turns of plumbers PTFE tape around the flange makes it a nice snug fit. Some preparation is required to accommodate the neck of the BNC socket on the probe. See Fig 1.

Fig 1 – Active Probe PCB mounted in flanged end cap

The Active Antenna Probe PCB is just the same width as the inside of the circular extrusion at its maximum diameter. So it fits very nicely, but this means the centre of the 12mm dia hole for the BNC connector is not in the centre of the flange. This hole needs to be centred 6mm away from the centre of the flange, towards the edge. If the Active Antenna Probe is to be permanently mounted, then is would be advisable to also drill a small hole (1.5 to 2mm dia), towards the other edge of the flange to allow the inside of the tube to 'breathe' and let any condensation out.

Once the bottom flange cap has been assembled, and the preferred antenna (probe rod or plate) attached to the Active Antenna PCB, the bottom cap can be put in place and the probe can be tested. For full installation, then again, a wrap of self-amalgamating tape around the bottom will give a good seal and secure it in place.

Testing comparisons

Four specific installation situations have been tested and the results captured for comparison purposes. The reference signal for all of the tests was the MSF 60kHz time reference signal from Anthorn, Cumbria, in the north west of the UK. The tests were conducted over a relatively short time period to minimise fluctuations due to propagation changes between Anthorn and the test location in Suffolk.

The tests were based on the use of a metal support pole vs a fibreglass (ie non-conducting) support, and on the variations between rod antennas and and plate antenna probes.

Measurement was made using an SDR-IQ Rx, centred on 60kHz and with a 10kHz display bandwidth for each case. Spectravue software (v3.39) was used for the measurements.

1 Metal Support pole, 400mm wire probe

Situation: A 4m long aluminium pole was used, attached to an aluminium angle ground stake. The braid of the coax from the probe was grounded at the base of the pole - grounding did not rely on the conductive pole. There was no electrical connection between the pole and the active antenna probe - ie the outer of the coax was not connected to the top of the pole. Due to the mounting arrangement, the top of the conductive pole extended above the Active Antenna PCB, so there was some small overlap between the pole and the probe rod - see Fig 2.

For the metal pole testing, the Active Antenna Probe used a 400mm long piece of 1mm dia ECW.

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Fig 2 Metal pole mounting, showing overlap of pole and Probe.

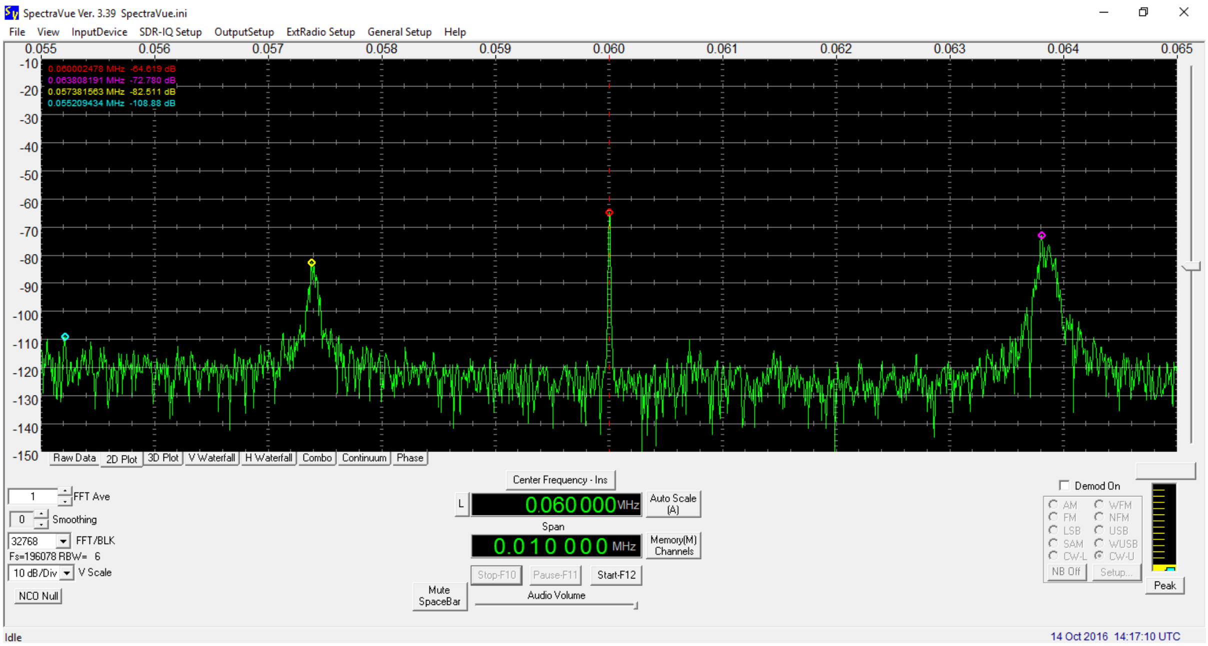

Fig 3 – Received signal spectrum – metal pole support, 400mm wire probe

From Fig 3, the signal level at the red marker (60kHz) is -64.619dB.

2 Fibreglass support pole, 400mm wire probe

Situation: The length of the fibreglass pole was the same as the metal pole, so we are looking at readings taken at comparable heights. The only difference between them was the nature of the supporting pole, and any propagation changes. Fig 4 shows the received spectrum under the same conditions as Fig 3.

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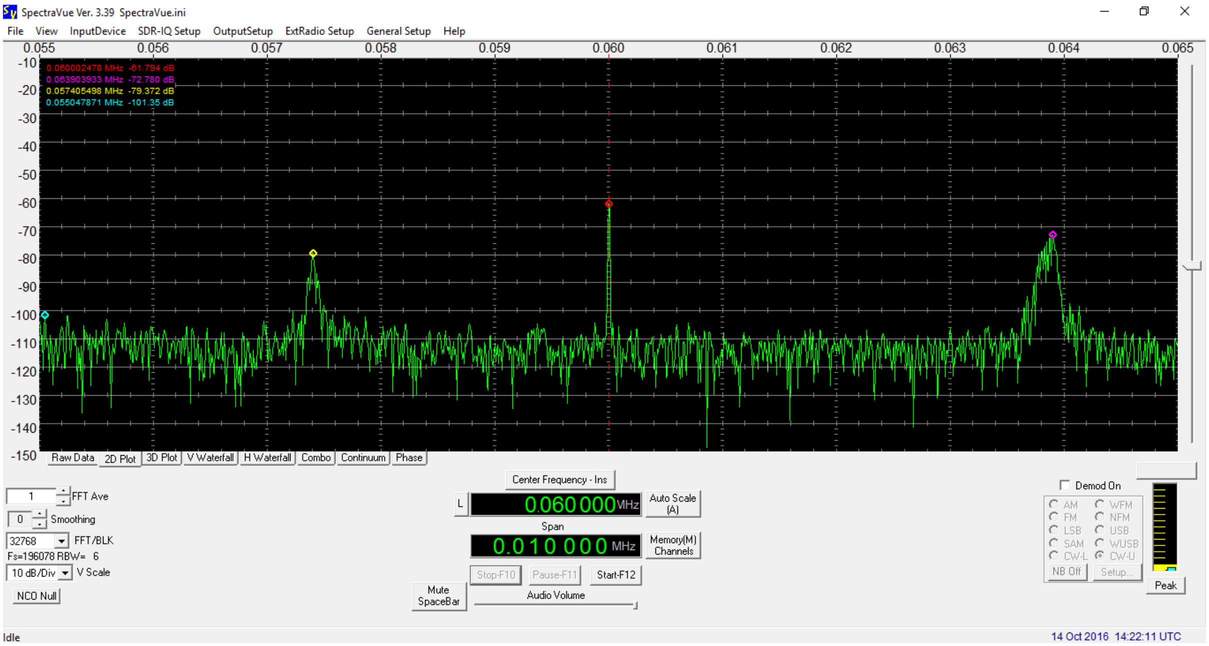

Fig 4 – Received signal spectrum – insulating pole support, 400mm wire probe

From Fig 4, the marker level at 60kHz is -61.794dB – just a small amount higher than the metal pole situation.

3 Fibreglass support pole, 180mm plate probe

Situation: As for test 2, but the active antenna probe wire was replaced with a flat plate of scrap single sided PCB material, approx. 23mm x 180mm. The antenna PCB and probe are shown in Fig 5.

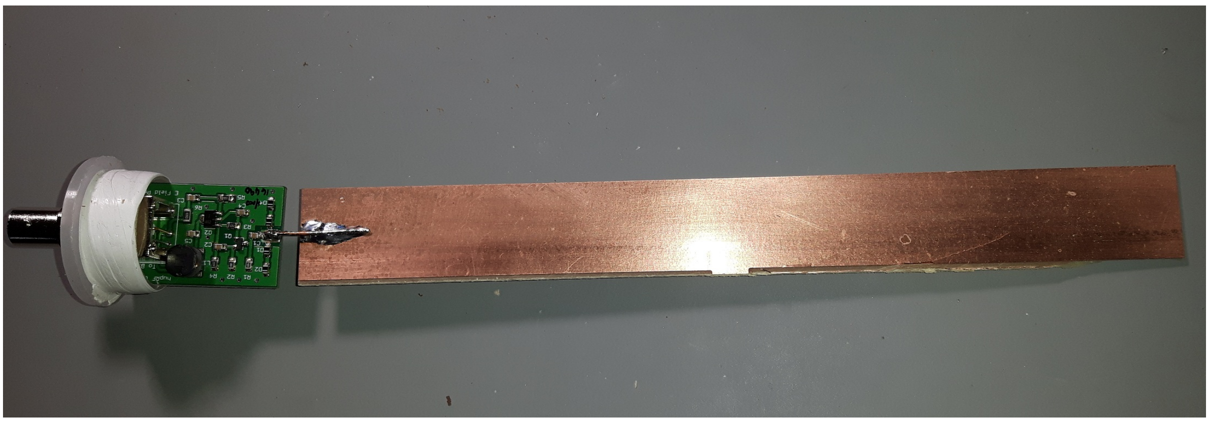

Fig 5 – Active antenna using a flat plate rather than a wire probe

The system was remounted and the spectral response measured, as in Fig 6

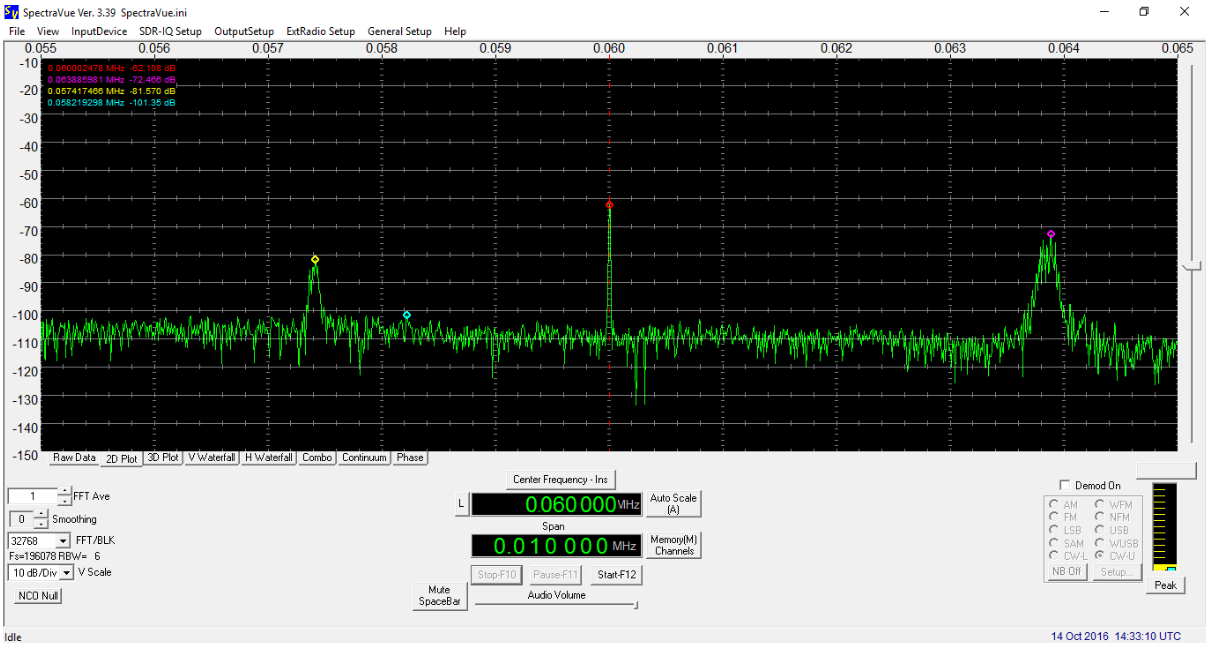

Fig 6 – Spectral response from Active Antenna using a long plate

From the display of Fig 6, it can be seen that the level of the received 60kHz signal is -62.108dB

4 Fibreglass support pole, 95mm plate probe

Situation: Knowing from previous less rigorous tests that the length of a wire probe has a direct bearing on the received signals strength, the long probe plate was reduced by 50%, to approx. 95mm, to examine the significance of the plate length.

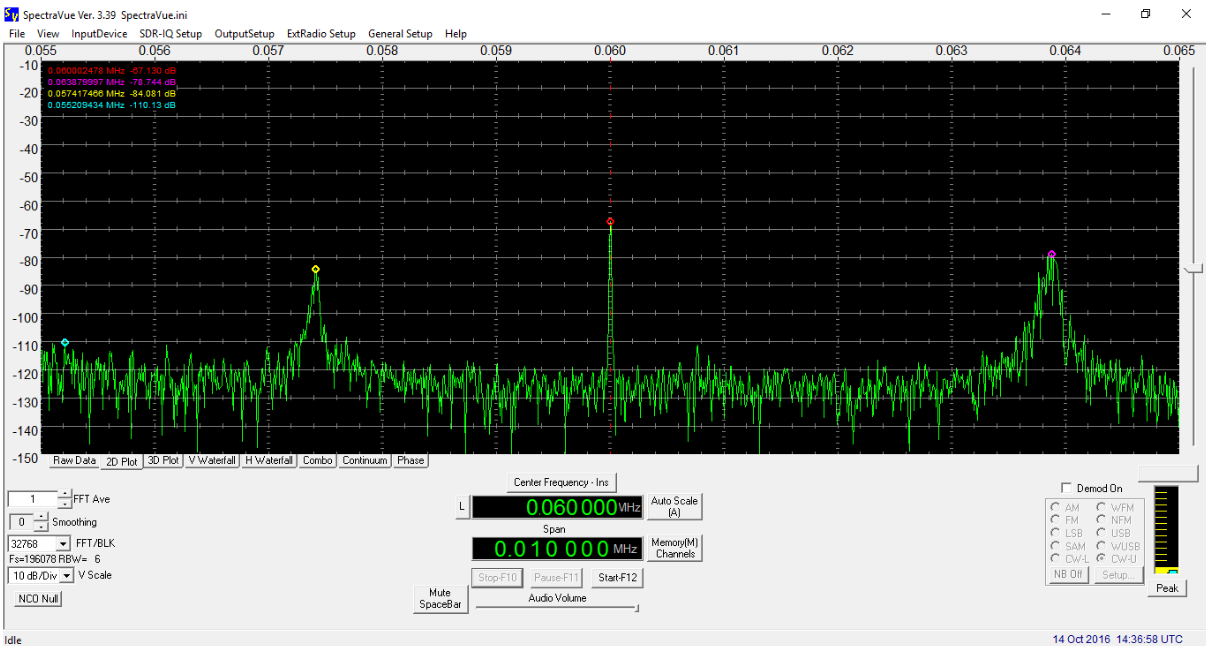

Fig 7 – Spectral response from Active Antenna using a short plate

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From Fig 7, it can be seen that the same signal is showing a level of -67.130dB.

Comparison and Comments

Whilst these are quite 'rough and ready' tests, they do show some interesting results – some of which are entirely predictable.

The one result that was a surprise was the result using the metal, conductive, support pole. Previous literature searches, and some discussion, had indicated that a non-conductive support was essential for optimum operation of the E-Field Probe Active Antenna. Any presence of an earthed object, above the level of the local ground would cause a temporary distortion of the E field which would reduce the effectiveness of the antenna.

Given that the level of signal measured using a metal pole support is only 2.82dB lower than that measured using the non-conductive support, this assertion is very questionable. The pole used in these tests was not 'hard' grounded directly, but through contact with the ground stake, to which it was held tight with bungee cords. Whether hard grounding would make a significant difference, is hard to estimate, but probably not. Thus it appears that it is not essential to use a non-conductive support.

It is likely that the small difference in level is more attributable to the overlap of the metal pole and the Antenna Probe, rather than it being a metal pole per se. IT may still be advisable to use a non-conductive top support, to avoid that overlap, but there does not appear to be any significant penalty in using a metallic pole for support.

Test	Support	Probe	Length (mm)	Signal Level (dB)	Diff (dBc)
1	Metal	1mm wire	400	-64.619	-2.825
2	Fibreglass	1mm wire	400	-61.794	0
3	Fibreglass	23mm plate	180	-62.108	-0.314
4	Fibreglass	23mm plate	95	-67.130	-5.336

Table 1 – Comparison of measured results

Aside from the discussion regarding the support pole material above, there is little to choose between the results of the various tests, and those differences are entirely as expected. Table 1 tabulates the measurements for comparison, and also has an extra column so we can see how each of the systems performed, as compared to the one that gave the highest received signal level. Commensurate with the original findings that a longer wire probe increased signal levels significantly, we see the same relationship here between the long and short plate antenna probes.

What it does also show is that there is very little difference (0.3dB) between the use of a relatively long wire probe (400mm), vs a rather shorter plate probe (180mm), so a very similar performance could be expected from a shorter overall antenna, if a plate probe is used. A plate probe that is a sliding fit into the waste pipe housing of the finished antenna would be a structurally more sound than a loose wire, and would be likely to last longer in use, since the movement of the plate would be very limited, and minimal stress would be placed on the solder joints. Further strength could be gained by gluing a nonconductive brace from the ground side of the probe PCB up to the plate to give more rigidity. Supporting a wire probe would probably pose more challenges than the plate.

Issues and Assumptions

These measurements have only been done at a single frequency. It was deliberately chosen to be a reliable source, and the measurements all taken over less than a 20 minute period to minimise variations. Further work would be needed to ascertain if these comparisons are equally as valid down at 20kHz and up into the HF region.

Similarly, the measurements of the plate antenna performance have only been done at a single plate width. No investigation has been carried out about the relationship between the width of the plate and its length. 23mm was used as convenient width as it fitted the tube being used!

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