AMRAD Active Antenna Frequently Asked Questions (FAQ)
Updated 21 August 2001

GENERAL

The folks at QST gave me 5 pages for my article and I used 7 pages so I already overran my available space. Still, some questions remain to be answered. I am assembling this FAQ to fill in some of those answers.

It is amazing how much effort can be spent on a one transistor amplifier. Hopefully, as I hone my technical skills I can graduate to more complicated circuits at some time in the future.

We are working on an LF upconverter and an LF noise blanker project for the future. Andre' is working on a 200 watt LF transmitter.

First, there is a missing dot in the QST schematic. In Figure 6, at the bottom of R3, there needs to be a dot connecting ground to the line that has C2, C3, C4, and R5 connected to it. Thanks go to Marsh, NC7V for catching this.

1. *Jim Strohm N6OTQ asks:*

Question. Can you offer some insight into why the CP-666 FET was chosen as the active element for this antenna? On reviewing the data sheet, I could find little to recommend the part, except for:

- *Relatively wide operating temperature range (protects against environmental extremes)*
- *Relatively high voltage ratings (offers some added ESD resistance)*
- *Through-hole / metal can packaging (easier to handle)*

On the down side:
- *Relatively expensive ($14.70 + $5 shipping)*
- *Relatively difficult to obtain (single-sourced and not carried in distribution channels)*
- *Relatively difficult to heatsink in suggested application*
- *No on-die transient suppression or ballast resistors (easier to "blow up")*

What was the driving factor? For $20, you could put in a high-power bipolar like the MRF454, or some other RF power FET that's easier to mount and heatsink than a TO-39 package.

Answer. Good Question. It is all in its incredible linearity. I tried a boatload of FETS and nothing else came close. My intermod test setup showed the differences. Normally, an active antenna would require some form of tuning to tame the intermods. This transistor enables us to avoid tuning and all that goes with it.

The input impedance of this amplifier is almost 2.2 megohms with 27 pFd parallel capacitance. Most of the 27 pFd is the gate capacitance. Small signal FETs have lower capacitance but not the linearity. Higher power FETs have too much capacitance and I suspect the linearity will not be as good. Now if I could find a CP-666 with lower capacitance we could improve the design.

You can get similar intermod performance out of a U310 if you can get the load up to several K ohms but getting the signal down a cable gets too hard. The post amplifier kills all the good intermod performance unless you go to a pair of $50 bipolars that are no longer made.

One downside of this device is the fact that the gate is connected to the case. As a result, the heat sink and all the input circuitry has to be isolated as much as possible from the output circuitry. Note that off-the-shelf TO-5 heat sinks can't handle the heat as they are too lightweight. I had to go to a home brew heat sink to get the delta T (temperature rise) down where I wanted it especially inside the PVC pipe. This thing will work in the middle of Saudi Arabia now.

But the linearity is the factor. Look at the 3rd order and 2nd order intercept points, they tell the story. If the builder is going to spend $75 for all the parts, the $20 makes the difference between a mediocre and a high performance design.

Note that all the CP-6XX series have the same price so I picked the highest voltage version for improved lightening protection. I talked with Crystalonics and they said all the transistors in that series are the same die. The only difference is the test voltage used. You will find this transistor series in high-end military receivers like the Cubic R3030. See our web page for the manual on this receiver.

Once the transistor is installed, DS1 and C1 limit the amount of energy that can be put into the gate. We hope this approach has made the active antenna pretty bullet proof. Somewhere, sometime, I am sure a lightening strike will take out a CP-666 though.

If you want a cheaper transistor, try the U310 or J310 in place of the CP-666. Rumor has it that even though the two are the same die in different cases, that the U310 is more linear. Your intermod levels will not be as good but still respectable. Adjust the power supply to 12 volts and adjust the bias pot for a current of 30 ma. This will eliminate the heat sink. Carefully watch the pinout of the J310/U310.

You can put in the CP-666 later, add the heat sink and crank up the voltage. Thus, you can retrofit later and not have to throw away much of anything. This change may be attractive to the mobile user as the antenna can be used on 12 volts in the car.

2. DavidKA0IJV asks:

Question. Is it suitable for MOBILE - "RV" Applications? (Fiberglass Body) class "C" 26ft?

and Dwayne, W7BDS asks:

Question. I am interested in building the antenna, plan to use it on our motor home. The mfg of the coach mounted the AM antenna on the fiberglass w/o any ground plane. I think this would work better with the antenna you write about. The question I have is, will it work well using 12 volts rather than the 24 V. I see in the picture of the power supply a fitting that appears to be J4, which is labeled 24Volt. I would rather not use converter, as it just adds another component out there to listen to for the radio. The two outputs will work well for the ham receiver as well.

Answer. We have used these antennas for mobile use. Most of the vehicle noise can be reduced a lot by using the antenna ground screw at the base of the antenna to ground the antenna at the body surface. Ideally, the surface of the vehicle would have a grounding bolt at the point the antenna mounts but most people cannot do that so some compromises will be needed.

I had the good fortune of having an aluminum ladder on my van and it was well grounded. I mounted the antenna on the ladder and grounded it right there on the ladder. Without that ground, the noise was high and made the whole mobile set up very marginal.

Our antenna is based in part on the design by Ralph Burhans in the Radio Electronics, March-June 1983 and May, 1986 Ham Radio magazine. In those designs he used various transistors. The most commonly available one is the J310. By substituting the J310 for the CP-666 our current design can be adjusted to run on 12-15 volts for mobile use. See the answer to Question #1 for more details.

Power can be put in on J4 from the mobile 12 volt system eliminating the need for 110 volt, 60 Hz power. Some filtering might be needed. Ground loops can introduce noise so some attention may be needed on grounding beyond the grounding of the antenna itself. Some RVs are fiberglass and finding a ground can be a problem. Use of chicken wire and foil may help but setting up with a pole in an RV park may work best.

When set up in an RV park, a pole can be used to mount the antenna and a ground rod used at the base of the pole. AMRAD member Andre', N4ICK, found a 24 foot painting pole at Home Depot that collapses down and makes a good active antenna mount. I have some military surplus straps that I can use to lash the painting pole to the vehicle or other temporary mounting point. If you are out in the country away from strong signals you may want to try a longer whip on the active antenna. This will improve your HF performance.

I have modified the TenTec RX320 for LF. See our web site on receivers for the details on doing this modification. The RX320 can be run off of a cigarette lighter cord in the vehicle. With a notebook computer and a 12 volt antenna, I can listen to LF, MF and HF very effectively without any 110 volt, 60 Hz power.

We have taken this out on the beach on the Outer Banks of North Carolina and found it very effective. However, some intermods were found and for us to search for the really weak European Radio Amateur LF signals we needed the added performance of the 24 volt design using the CP-666. For that application we used a pair of 12 volt gel cells which could run all night on a charge.

3. Andre'. N4ICK asks:

Question. In the QST article, I find that R1 in fig 6 is designated as "15 ohms, see text". I could find no reference in the text to R1.

Answer. R1 was selected to reduce the resonance at the top end of the antenna around 25 MHz. See Figure 1. If you find yourself in a really dense RF environment, you can substitute a choke to cause the antenna to roll off below the AM broadcast band.

4. Leo W1SOJ asks:

Question. T1 - 24V Xformer, split - bobbin design, Signal transformer DP-241-4-24. I am unable to find this in Digikey or Mouser Catalog - any info would be appreciated.

Answer. You can buy it direct from Signal Transformer. They take orders for only one transformer cheerfully.

Signal Transformers,
500 Bayview Avenue,
Inwood, New York 11096

http://www.signaltransformer.com,
(516) 239-5777

5. Stan, WA1ECF asks:

Question. What is the receiver on the QST cover ? Is that the CUBIC ?

Answer. The receiver is the Drake R8. The Cubic is much more military looking. Download the manual on our web site under Receivers for the Cubic and the pictures were not completely trashed by the Acrobat conversion process.

Question. What software is being used on the laptop ?

Answer. The software is ARGO. It is the result of a huge amount of work overcoming Windows non-standardization of the audio interface by AMRAD friends Alberto, I2PHD and Vittorio IK2CZL. So much for so called standards but they proved you can over come with enough effort and persistence. You can download the latest version at <http://www.weaksignals.com/>.

6. Derek, G3GRO raises the question about internal grounding and meeting the European safety regulations as follows.

"The outer of the BNC antenna connector is connected directly to the +24V power supply which is in turn fed by a transformer from 240V AC mains with no independent safety earth connection to exposed metal parts. If the antenna lead is disconnected, then the outer of the BNC is left floating. I think this would contravene the present EU safety regulations."

Answer. Derek raises an important point on safety. The AMRAD Active Antenna power supply is designed to follow the concepts of being double insulated. However, it may not meet the details for this. To expand on this issue:

In the United States, Underwriters Laboratories <http://www.ul.com/> addresses the requirements for electrical safety. The insurance companies and the manufacturing industry support them. They have 3 standards of interest here.

First is the overall standard for Double Insulation, UL 1097, Double Insulation Systems for Use in Electrical Equipment. Second is the standard for double insulation in electronic equipment which is UL 2097, Double Insulation Systems for Use in Electronic Equipment. Third is the standard for the power transformer like we use which is UL 506, Specialty Transformers.

To design the active antenna power supply to fully meet the double insulation standard, we would have to have all three standards and review all aspects of the design. These standards are sold to "clients" and the cost for all three is $566. This illustrates how UL is oriented to industry but does not address the homebrew design.

My understanding of the double insulation category is that if there are two levels of electrical insulation, then the appliances or electronics can dispense with the ground lead and still be considered safe. The first level of insulation is the magnet wire insulation on the primary winding. The second is the insulation provided by the nylon bobbin between the primary winding and the other parts of the power supply. In addition, the primary winding power does not flow through the PC board and the wiring is spaced at some distance from the low voltage circuitry. This was done to isolate the AC power line noise but also served to protect the user from simple failures causing the power line voltage appearing on the low voltage exposed parts such as the antenna BNC connector.

The transformer provides a thickness of 0.032 inch or 0.863 mm of nylon in the bobbin. It appears that UL requires a minimum of .31 mm so we would appear to meet that.

But then Derek asks about the European safety requirements. We would need to buy another set of standards from the European Standards Organization.

If someone out there has these specs and would like to further shed light on this question, we would be interested in hearing from them.