Field Day Antenna Rotation :

Generating 50Hz FD power for a rotator without using a petrol generator

30 December 2011

Up until now, I have used the "Armstrong" method of rotating my antenna arrays in my field day setups. A couple of factors affect this method : (1) rain – it usually means getting wet to turn the antennas into the correct direction (and, it seems to me that many of our FD's occur during wet weather), and (2) pointing accuracy – the higher the antenna gain then the more accurately it needs to point in the "correct" direction.

If you haven't encountered the term "Armstrong" before, it simply means rotating the masting pipe manually, usually by gripping the base of the pipe in your hands and twisting clockwise or anticlockwise to point the antennas nominally in the correct direction. Note I mention "nominally" because the aiming precision is usually questionable, even more so when the rain is coming down.

The accuracy of 'pointing' needs to be better as the frequency in use rises. At 50 MHz, the 4 element yagi is typically about 75 degrees wide (measured at the 3dB points either side of the front) so is not unduly critical. The 11 element at 2m is 39 degrees wide, and the 15 element at 70cms is 32 degrees wide. My 26 element yagi at 23cm is even narrower at 24 degrees wide. In my case, all of these antennas are mounted on the same masting pipe so all are rotated at once and the better the pointing accuracy, the better the results/signals achieved.

The simplest way is to use a conventional antenna rotator to do the physical part of the job but the concept of using one in the field has it's own issues : the simpler end of these devices typically require a 50 Hz AC voltage being fed to the motor windings, one side direct and the other winding via a high value (typically around 100uF) bipolar capacitor. To reverse the direction, the incoming motor AC voltage (around 20 – 28VAC) is swapped to the opposite side of the bipolar capacitor. This changeover occurs within the manufacturer's control unit, along with the direction indicating mechanism. The high end rotators all have internal power supplies designed for either 50 Hz or 60 Hz only, and won't operate from a DC source anyway. The technique described here works with these ones too.

I have had an old ChannelMaster TV rotator for about 40 years, and after it's bit of periodic maintenance, it still works well enough for this sort of task (FD use). It has just 3 wires between the rotator head and the control unit and requires a re-synchronisation process periodically to keep the control unit motor in sync with the head unit. A year or two ago, I fitted an internal multi-turn potentiometer off the rotator's vertical output shaft via a flexible coupling so that I could use an alternate method of determining it's actual direction/position – also taking the interconnection count up to six wires in doing so. Note that this is one of the simpler, low-end styles that will only run on 50Hz or 60Hz, sine (or nearly sine) wave power. Thus it becomes a practical no-rotator-outlay method of spinning the antennas in a field day environment.

Now back to original problem : without the normal mains power available in a field day setup, where do you obtain your 50Hz power to run something like this ??

My original thoughts were along the lines of building up a near-50Hz power inverter but this typically produces a square wave output and the motor windings really need a sine waveform – or something approaching one. It turned out that after I bought a replacement 1000 watt UPS to run the computer equipment here, that left the old 300 watt one (a Sola 310 series) free for alternate uses. Sure, the internal battery was rubbish after a few years of idling along but the UPS electronics itself was functioning fine. If it is nothing else, it is basically a 50Hz power inverter.

I had an old (but not quite stuffed) 12V 7AH SLA (Sealed Lead Acid) battery so I disassembled the necessary bits and fitted this one in place of the old one (which was completely unserviceable) inside the case. Then the power was turned on and the battery voltage was checked : 12.4V and rising with the charge being applied by the UPS's internal rectifier assembly. The next test was to see if the rotator would accept the output waveform from the UPS. The 240VAC to the rotator was connected to the UPS output socket and it worked normally on the normal AC mains throughput and then when I pulled out the source 240V mains plug, the inverter started up and the rotator continued to move. The overall FD antenna rotation theory was going to work for me if I could get the UPS to start with just a 12V DC supply instead of from a "mains fail process".

I started looking at ways to get the thing to start up just on DC (some do and some don't) when I chanced across a paragraph in the Sola 310 User manual :

"COLD START FEATURE - 50 Hz Environments Only

Note : The units will always operate at 50 Hz when started from battery using the cold start feature.

*Your SOLA 310 UPS is equipped with a cold start feature which allows start up of the UPS **with no mains input present.** This allows smooth startup of your system even if there is no mains line or generator available.*

Most UPS systems require that power be present so the UPS is already running when power is lost. This is not necessary with your SOLA 310.

*If your SOLA 310 was turned off for some reason (i.e., moving the UPS or cleaning it) and you need to restart the UPS during mains power loss, simply turn on the rear panel **System On/Off Switch** while depressing the **Test/Silence** switch on the unit's front panel. The SOLA 310 will start up from battery."*

There are probably many other UPS's around that will do this same thing – a DC startup – but in different ways and requiring different methods. Sure, the actual wiring changes to achieve the outcome may be different but the principle is going to be the same.

The fact that it would start up if the Test/Silent switch was depressed while the rear rocker switch was operated was great so I immediately did the test by pressing the relevant buttons and up came the UPS. I then made a quick dig into the parts box for a DPDT toggle switch. One pole was wire across each switch function and then the internal battery reconnected : up came the UPS, beeping every few seconds as it would normally do when running on battery. I set the rotator to spin again and off it went, clockwise (CW) to anti-clockwise (or counter-clockwise CCW), maximum to maximum and then back again. That confirmed my idea for a 50Hz FD power source would work in practice.

I wanted to be able to run the UPS on demand, and by on demand I mean that I wanted to be able to 'selectably' power it up from my PICAXE-based rotator controller (detailed in a separate project article). The two pole switch was then replaced by a 5A DPDT 12V relay, this latter item being mounted with some double sided tape inside the front panel, and the two relay coil leads extended out through the rear panel. The application of 12V to the relay brought up the UPS and letting it drop out caused the UPS to drop it's output voltage. That is truly "on demand...".

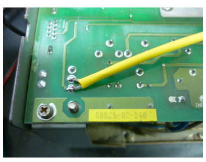
I also added a fused heavy-duty red/black figure-8 power cable that feeds through a slot at the back and connects via a shottky power diode in the positive lead to, and wired across the internal 12V SLA battery. That allows me to use an external 12V source once the internal battery is expended, and that 'changeover' is automatic as soon as the internal SLA drops by 0.4V below the external battery bank.

Oh, a side note : the beeping from the UPS was driving me crazy (crazier?) so I unsoldered one side of the internal piezo buzzer. Now the UPS runs off battery (or external power) and all you can hear is the vibration of the transformer via the UPS's metal case. It isn't going to be powered on for long anyway as the total rotation time from CW to CCW is about 45 seconds...

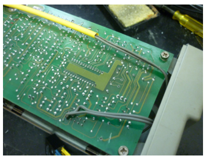
Now if you are wondering why I am going to all of this trouble rather than using a petrol-style 240V 50Hz generator, the answer is simple. A generator will contribute electrical noise in your receiver/transceiver when it is running, and also consume fuel, and if you are going to want to turn your antennas periodically, the generator must be running (virtually) all of the time. My technique allows a 50Hz mains voltage (ie 240V AC) to be created on demand and only for as long as it takes for the antennas to rotate to the new position. That saves on the overall energy usage and minimises the interfering noises into the receiver.

Many of us probably have old unused UPS's around but we haven't yet cottoned on to a new use for them – maybe until now…

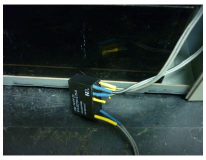
This is the front view of the old Sola 310 series 300 watt UPS modified in this article



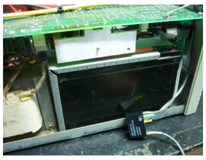
The wiring across the rear rocker switch was fed through some yellow heatshink due to it's proximity to the 240VAC generated within the UPS



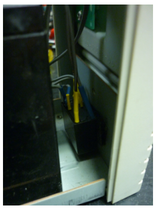
The figure-8 cable at bottom centre is wired across the Test/Silent switch from the front panel. It was found by tracing the flexible lead from the front panel to the socket on the underside of the PCB and measuring with an ohm-meter while pressing the front panel switch !



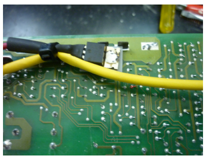
This is the 12V relay added to switch both of the circuits....



And where it fits with respect to the remainder of the UPS... The black block behind it is the 12V 7AH SLA battery.



After mounting the relay on the inside of the front panel using double sided adhesive tape...



Top centre : This is the dual shottky power diode soldered to the protruding 12VDC battery terminal. The black heatshink over it's leads covers the red wire that goes out through the rear panel for the external 12V supply feed.