DADARS

DERBY AND DISTRICT AMATEUR RADIO SOCIETY

Incorporating Derby Wireless Club (1911)

DADARS Newsletter

April 2020 Lockdown Edition

SPECIAL LOCK-DOWN EDITION

Due to the current lockdown, meetings at the Club room were suspended on 16th March 2020 until such a time that the threat to the membership is diminished.

Introduction

Hello and welcome to the April edition of the DADARS ‘Lockdown special’. I am sure you are all aware that the Club temporarily suspended operations on March 16th 2020 to protect the membership from the COVID-19 virus. Many of the members are classed as vulnerable. It was a bit sudden. However, Boris closed down clubs and meeting only a few day later so it was quite timely.

AGM

When life returns to normal and safety resumes, the Club will hold an AGM to decide direction and elect leadership. In the meantime, we must keep our heads down and stay safe. Enjoy the sunshine whilst queuing at the supermarkets.

Lockdown

I hope you are all coping well under lockdown conditions. I am beginning to realise what it must be like to live in captivity. My family is classed as ‘Vulnerable’ so we have to stay indoors most of the time.

The level of household bickering and irritation has definitely increased - probably by 10dB. I could murder for a decent Cappuccino and a fruit scone.

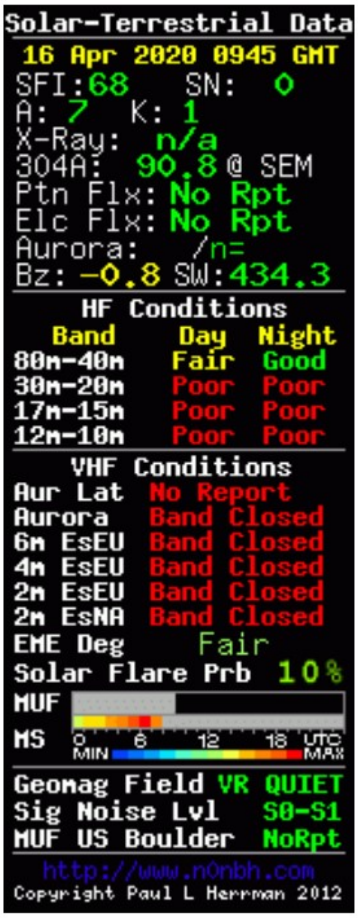
Help Pass the Time

Here is a quiz to pass the time. You need someone to help with this. Person 1 reads out the list below and person 2 writes down the spelling and the meaning! One point for a correct spelling, one point for the correct meaning and usage. You then mark your score and then change over. It is both irritating and educational and should kill half an hour. I scored 3.

Acerbic, Sundering, Ineffable, Redolent, Juxtaposes, Crenellation, Retinue, mendacious, Eschew, Angst, Apocryphal, Prescient, Proselytize, Sepulchral, Rheumy, Benison, Prescient, Comportment, Putative, Inimical, Fawned, Obsequious, Egregious, Sinecure, Anodyne, Febrile, Solipsism, Torpid, Baize, Persiflage, Enervate, Altruism, Sommelier, Pseudonym, Candour, Apoplectic, Evince, Woke, Venality, Miasma, Surreptitiously, Immemorial, Sapience.

Propagation SC25

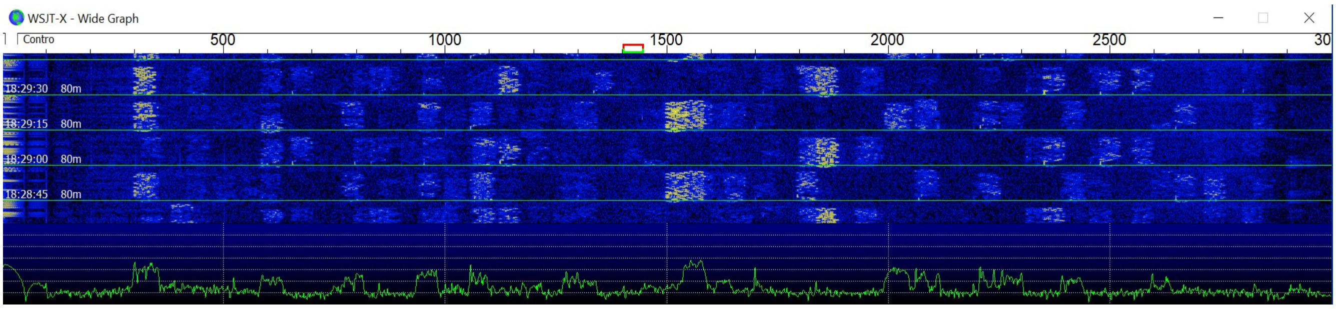
It seems that January to March/April 2020 resulted in 14 sunspots that heralds the start of sunspot cycle 25 (SC25).



The total number of spotless days stretched to 81 of which 10 were on consecutive days. The last geometric storm occurred on 19th February 2020.

In fact, the first two new sunspots, ending a long period of relative quiet on the surface of the sun, occurred in November 2019 and were designated as NOAA 2753 and 2754.

The HF bands should steadily improve year by year but do not hold your breath.



Time Adjustment on Windows 10 (G4AKE)

Just before Christmas 2019, I performed a demonstration of FT8 in the DADARS Club room. The lack of internet access and zero phone signal made time synchronisation of my laptop clock impossible. Luckily, the free running clock remained within 300ms of actual time allowing the demonstration to proceed.

It is obvious on WSJT-X when the clock on Windows is out of step. The third column 'DT' shows the time deviation in seconds. From experimentation, it seems that FT8 works fine if the timing is reasonably close (within +/- 2.5 seconds). However, as the clock moves further away from the exact time, the number of decodes decreases.

Unless I am missing something, I could not find an easy way of manually changing the Windows 10 clock to the nearest millisecond.

Solution

What is required is a simple programme running on Windows 10 that can read the current time, increment or decrement this by a set amount and then reset the computer with the new time. Fortunately, the Windows 32 function: 'GetSystemTime' returns a structure SYSTEMTIME that includes resolution in milliseconds.

```
typedef struct SYSTEMTIME
{
  WORD wYear;
  WORD wMonth;
  WORD wDayOfWeek;
  WORD wDay;
  WORD wHour;
  WORD wMinute;
  WORD wSecond;
  WORD wMilliseconds;
}
```

I initially used 'C' code to create a solution and thought it would result in a simple 10-minute 10-liner program. However, it turned out to be quite difficult and a pain in the proverbial.

Imagine that the date and time happened to be exactly: 31/12/2020 at 24:59:59 and 999ms. If you add 1ms to this, the time display changes to 1/1/2021 at 00:00:00 and 000ms. The incremented time must carry through all the time denominations and take into account leap years and the variation in the number of days in the month!

Worst still, you have to be able to subtract a value and ripple backwards in time. The algorithm used in each direction is slightly different. Just to make things worse, you cannot represent negative time using the SYSTEMTIME structure. The Windows data type 'WORD' is just a binary representation of a positive number. It means that the eight WORD data types in the structure must be copied into eight 'INT' integer structures for processing and then copied back again after the process is complete.

The python language includes a 'time delta' function in the 'timedelta' library that allows time data to be incremented or decremented as required. That is exactly what is needed. The following code reads the windows clock and sends out the modified time using Window 10 API 'SetSystemTime'.

Please note: to allow the 'SetSystemTime' function to work, the Python code must be run as administrator. If you attempt to run the program as a user without administrator rights then it will do nothing.

I should point out that Microsoft warns users not to mess with the windows clock. Setting it back into the past could upset some programs. Consider yourself warned - proceed at your own risk.

Luckily, when used intelligently, these codes only change the clock by tiny amounts and so it is unlikely to cause problems. After using this code, when I have finished with FT8, I normally resync the computer time using an internet time server that overwrites any changed settings. Ironically, after doing so, the time accuracy of the computer is usually worse than before!

The Python Code

```
import sys
from datetime import date
from datetime import time
from datetime import datetime
from datetime import timedelta
import win32api

print("Time Adjust")
print("input the time change in microseconds (use plus or minus): ")
value = input()
print("Value is: ", value)
c = int(value) * 1000

date_before = datetime.utcnow()
print ("The previous time is" , date_before)
date_after = date_before + timedelta(microseconds=int(c))
print ("The Processed time is" , date_after)

d=date_after.strftime("%f")

time_tuple = ( int(date_after.strftime("%Y")), # Year
               int(date_after.strftime("%m")), # Month
               int(date_after.strftime("%d")), # Day
               int(date_after.strftime("%H")), # Hour
               int(date_after.strftime("%M")), # Minute
               int(date_after.strftime("%S")), # Second
               int(int(d)/1000), # Millisecond
              )

dayOfWeek = datetime(*time_tuple).isocalendar()[2]
t = time_tuple[:2] + (dayOfWeek,) + time_tuple[2:]
win32api.SetSystemTime(*t)
print("\n")
date_after = datetime.utcnow()
print ("The Updated time is" , date_after)
```

The Python code was created using Python 3.8 and run using IDLE that came with the package. For the code to work, the IDLE must be started in 'Run as Administrator' mode otherwise the Windows API will fail to update the clock.

The most confusing part is the Windows API. That must be installed into Python 3.8 using PIP install -U pywin32. In the code, the related command is: import win32api

For the C code, I used Visual Studio 2019 which is free and relatively simple to use. Be aware, C calculates negative modular mathematics incorrectly giving negative results. Interestingly, Python gets it correct.

If anyone in the Club wants the ‘C’ Code listing or just the executable, let me know and I will email it.

Feature Article

A 630 Metre Radio Station in a Small Garden
by Chris G8DXT

I built my first crystal set back in the nineteen sixties in a shed at the bottom of the garden and instantly became hooked on LF radio. I migrated to VHF when I gained my radio licence but always kept an interest in the signals on the long wave band. My MSF clock was a reminder of a simpler and less frantic time.

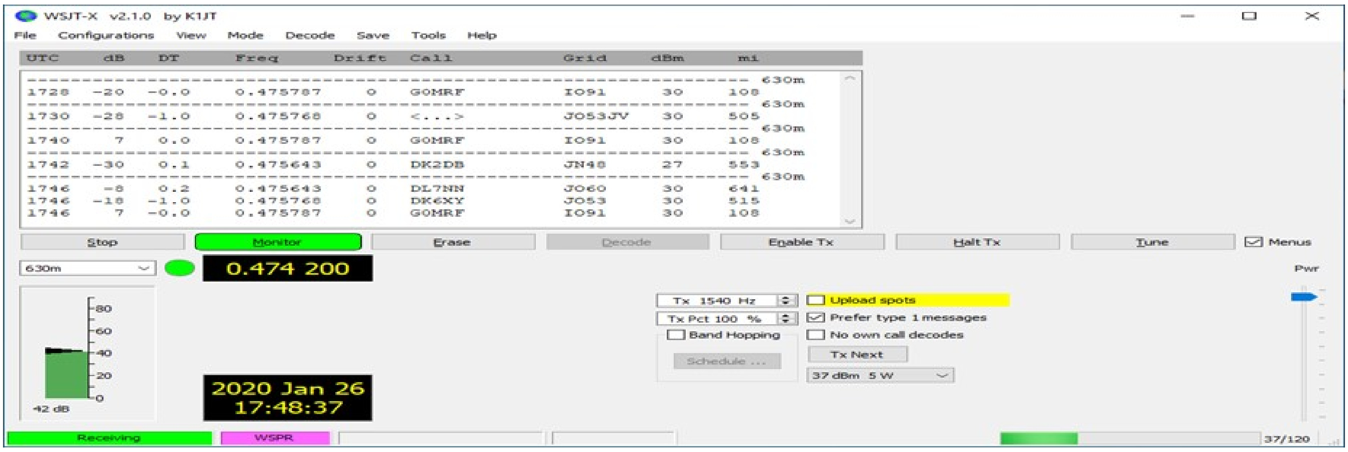


Figure 1 - WSJT Software on 475.2 kHz

The LF frequencies took on an unexpected upturn when new allocations were granted initially on 73 kHz and 500 kHz and then the current frequencies of 135.7 - 137.8 kHz and 472 - 479 kHz.   I bought a copy of the book LF today to get an idea of what other people were up to and before long became QRV on 136 kHz with a DDS signal generator driving a linear amplifier outputting upwards of 30 watts.

The TX aerial consisted of two earth spikes, one in the front garden and one in the back. It seemed I could radiate a signal that could be heard by my field strength meter at quite a distance.

Back in the shack using a Racal RA1772 and an active E-field antenna mounted on a mast about 25 feet above the ground, I could receive and decode all manner of interesting LF signals including the commercial stations SXV in Greece at 135.8 kHz and DCF39 in Germany, just below 139 kHz. The only problem was I could not hear anyone calling CQ. Perhaps it was time for a rethink and so the project got put on the back burner for a while.

In the meantime, I began looking into Small Magnetic Loop aerials for use on the HF bands. It was apparent that for the 2200 metre band a loop with a circumference of even one tenth of a wavelength was not going to fit within the confines of my garden.

Take two. Move up a band to 472 kHz. Although still on the large size with a wavelength of 630 metres, flattened down and screwed across five 6x6 foot fence panels, it might be possible to produce a usable loop antenna that was 6 feet high and 30 feet long.

An online calculator indicated that an input of 20 watts would produce a loop current of 7 amps. The terminal voltage would be in the order of 800 volts and a radiation efficiency approaching 1% might be achieved.

Suitably enthused I put together a single turn loop using some old coax of unknown origin and a ferrite toroidal matching transformer. Unfortunately, the maximum loop current would only peak at less than one amp which did not bode well. Then the rain started in October and did not stop so the project was again placed on hold.

I did however make progress over the winter receiving WSPR signals. Happily, there was activity on the band; things looked promising for when the weather improved.

Take three. March 2020 and it has finally stopped raining and things are beginning to dry out. After much contemplation I had decided to replace the coax that I had erected last year with a new loop made from two lengths of 6mm single core power cable connected in parallel and supported by electric fence insulators. The ferrite toroid matching transformer was replaced with a capacitive feed configured as a combined match and tuning unit. Current in the new loop was over 5 amps. This was much closer to the anticipated value indicated by the online loop calculator.

Figure 2 - April 2020 Spot the Loop

Using a WSPRlite module to feed a MOSFET power amplifier produced the 20 watts required for 200 mW ERP and proved to be an instant success generating reports from all over the UK.

These initial results indicate that this approach might be useful as a neighbour friendly, stealth aerial for the other bands including 160 metres and above.

Feeding a Fence-Panel Magnetic Loop Aerial

The small magnetic transmitting loop has been around for quite a time. The U.S. Army Loop antenna was designed by Kenneth H Patterson who at the time was working for the, U.S. Army Limited, War Laboratory. Patterson described a small portable octagonal antenna consisting of eight interlocking five-foot sections of 1½" aluminium tube and published the design in *Electronics* magazine, August 1967.

The antenna was developed for use in South East Asia to boost MF and HF signals transmitted in the frequency range of 2 - 5 MHz. The antenna was fed by a 50 ohm coaxial cable and matched to the loop with a network of three variable capacitors that provided loop tuning and impedance matching. You can Google 'army loop' or 'Patterson loop' for the full details if you feel the need.

The fence panel loop that I described previously is tuned and matched using the same principles. As the frequency allocation on the 472 kHz band is very restricted, I condensed the network down to two capacitors and use a fixed tuning point centred on 475 kHz, the recommended frequency for WSPR transmissions.

struct the tuning network and then waited the obligatory four weeks for the boat from China.

As it turned out the 1000pF capacitors were only 850pF and the disc capacitors were also all over the shop, again mostly less than the marked values. I suppose the moral of this is you get what you pay for, but this was an experiment and the price was right.

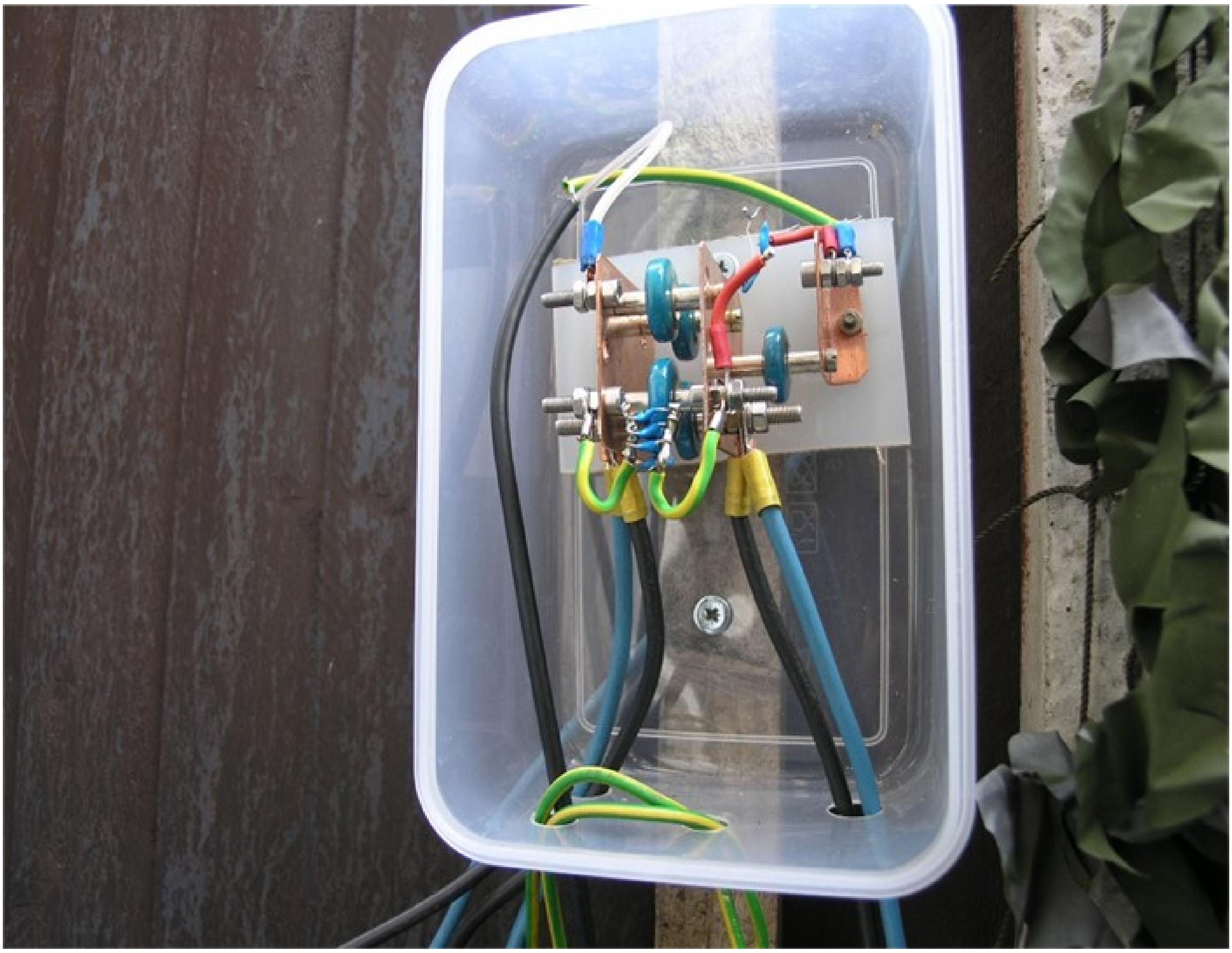


Figure 3 - Loop Tuning Unit

I measured the loop inductance at around 0.034 mH and calculated that I would probably need between 3nF and 4nF for the tuning capacitor given that the tuning and matching capacitors interact.

Although I was only initially testing things using 20 watts, given the low efficiency of the design the plan was to increase the input power by an order of magnitude later on if things went well. With that in mind I had ordered five 1000pF doorknob capacitors and a selection of 3kV disc capacitors to con-

Four of the door knob capacitors were mounted in parallel on two copper plates and the ends of the loop bolted across them. The fifth capacitor was mounted from one end of the loop to another separate copper plate for the coax feed. I connected two variable capacitors across the network and tweaked them for lowest SWR at 475 kHz.

The next step was to carefully disconnect the variables and measure them. Two fixed capacitors were then made up from a combination of 3kV disk ceramics and bolted in place. Be aware that the capacitors will warm up in use and being ceramic the values will drift.

With 20 watts applied things looked good with over five amps flowing in the loop as measured with a DIY clip on ammeter. If you want one, here is the circuit that I copied from an article on the web and it can also be found in several printed publications.

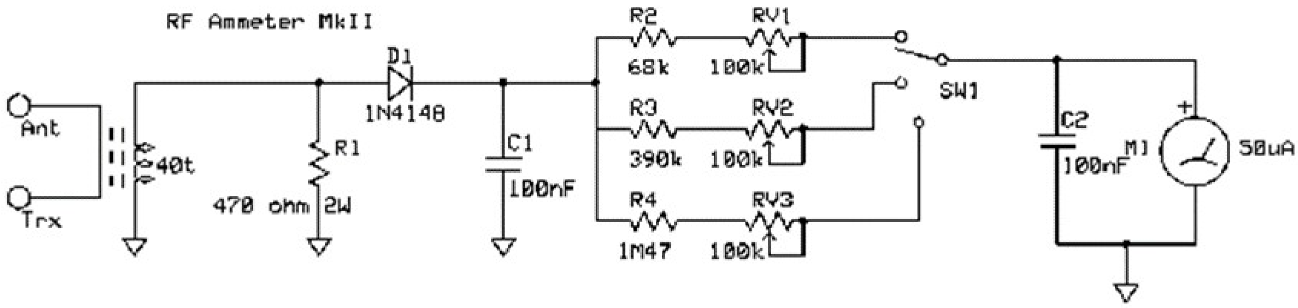


Figure 4 - Current Meter Circuit

The current transformer consists of a split ferrite core with 40 turns of magnet wire wound on one half. With 1 amp flowing in the primary, 20 milliamps are generated in the 470 ohm resistor which corresponds to approximately 13 volts across C1. The core, resistor, diode and C1 are all glued onto a clothes peg to enable the two haves to be convenienTly clamped around the component or conductor to be measured.

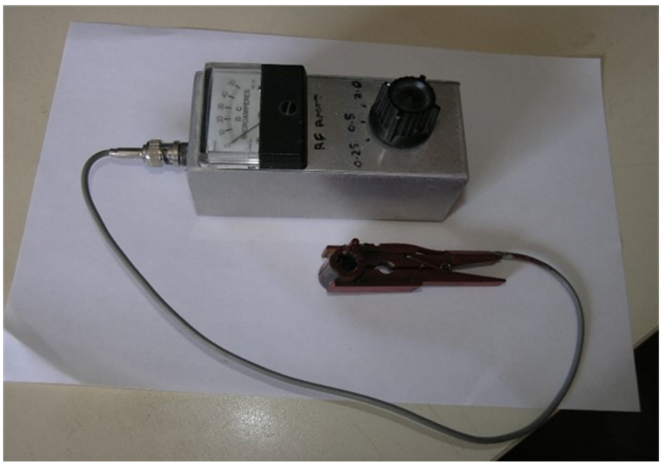


Figure 5 - Current Meter Finished Item

After reading several publications and searching the Web for inspiration, it soon became obvious that there were several possible designs for a simple transmitter for the medium wave band. The steam punk enthusiast was favouring valves and lots of volts. The MOSFET was the preference of the experimenter with less volts and lots of amps. That made the decision easy and I sent for a selection of MOSFETs and suitable gate driver chips. Figure 6 is one particular design for a transmitter using a totem pole driver and a single MOSFET that appears in many articles.

It seemed like a good place to start and so I wound some coils on formers cut from a 1” cardboard tube salvaged from the centre of a roll of kitchen-foil.

I had some 1mm PVC coated, multi strand wire that looked about the right size for the job and held it in place with super glue. The 1” diameter former required 30 turns for 12uH, 28 turns for 6.5uH and 42 turns for 16uH. A prototype was then built on a small piece of PC board bolted onto an aluminium plate with small PCB pads glued on in strategic places for hanging the components from.

The first MOSFETs to arrive were type IRFP450 with a max rating of 9 Amps, 500 Volts, and a maximum power dissipation of 190 watts. MOSFET transistors are generally considered* to be voltage operated devices similar to a triode valve with very little power required to drive them.

**By those who like their components to glow orange*

That is not the case when they are used as a high frequency RF switch. It becomes critical that the gate capacitance of the MOSFET device is charged and discharged in the shortest time possible to reduce the power dissipation during switching. Hence the use of the totem pole driver and a low value resistor.

The various bits were strung together across the bench and connected to a variable voltage power unit. A function generator supplied a 5 volt square wave drive pulse and a wattmeter was connected to the output. It all looked OK. The power meter was showing over 40 watts output - right up to the point when the bridge rectifier in the PSU expired in a most spectacular manner and so ended the first test.

Now that equates to an efficiency of 60%. The other 40 % has to go somewhere and it's not the MOSFET.

Figure 7 below is a thermal image of the PA stage spread out across the bench and it shows quite graphically where the other 40% of the power goes.

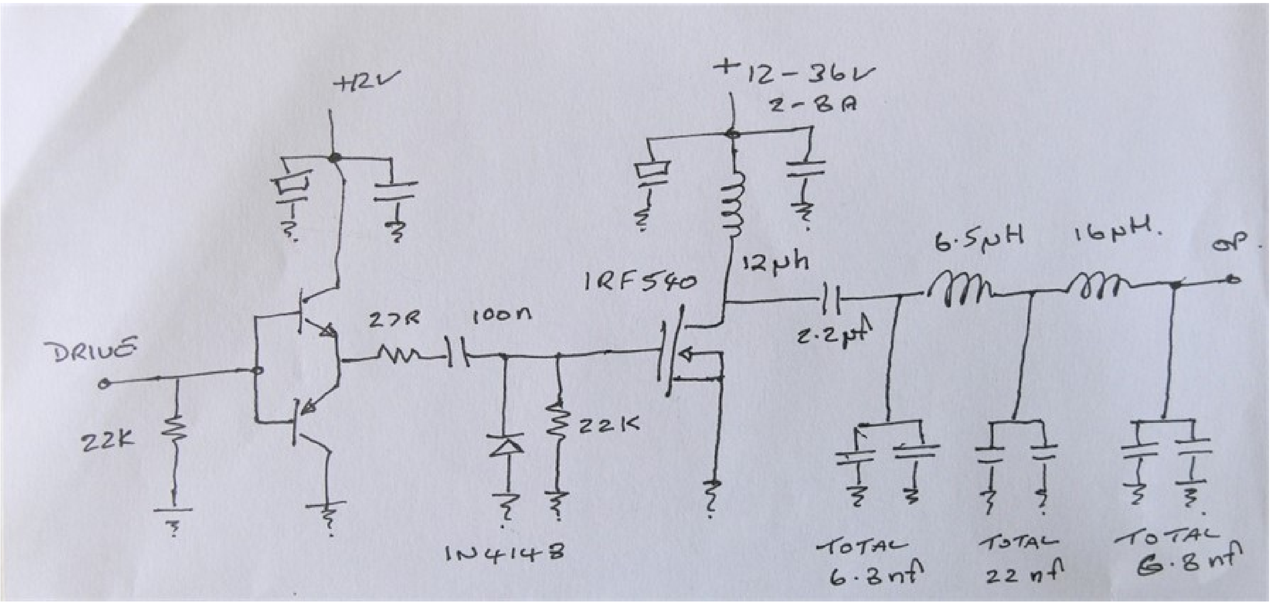


Figure 6 - PA Circuit Diagram - Totem Pole Driver

A new PSU using a current limited buck converter was connected in place of the original supply and the experiments continued.

The power output of the transmitter increases with the square of the supply voltage. Some people claiming 200 watts output when fed from a supply of 36 volts at 9 amps.

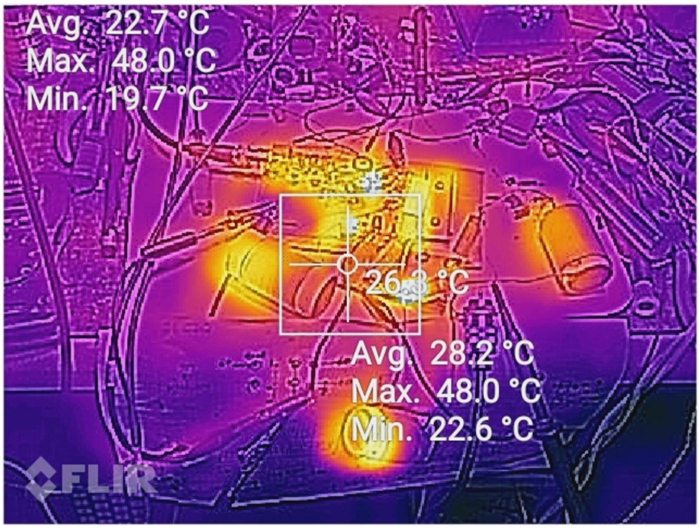


Figure 7 - Thermal Image of the PA During Transmission

The filter coils and capacitors are working quite hard when the PA was fed with 25 volts at 4 amps.

As I was going to be using WSPR mode, I needed the transmitter to be reliable and not prone to bursting into flame during unattended operation in the middle of the night.

The power regulator was turned down to 20 volts and the whole thing rebuilt using an IRF640 MOSFET, installed in a suitable case and a fan placed over the PA output components to ensure that things were kept cool.

The totem pole drive circuit was replaced by a TC4426 MOSFET gate driver chip so that I could key the drive pulses feeding the transmitter rather than using a high side switch in the PA supply for CW mode later on.

The output filter values were fine tuned to minimise the second harmonic by the simple method of introducing a short piece of plastic rod into the coil formers with a small piece of ferrite on one end and a brass slug on the other, and then tweaking the capacitors slightly as required for best results.

The circuit in Figure 8 shows the modifications to the gate drive circuitry as shown in the original diagram at the beginning of the article.

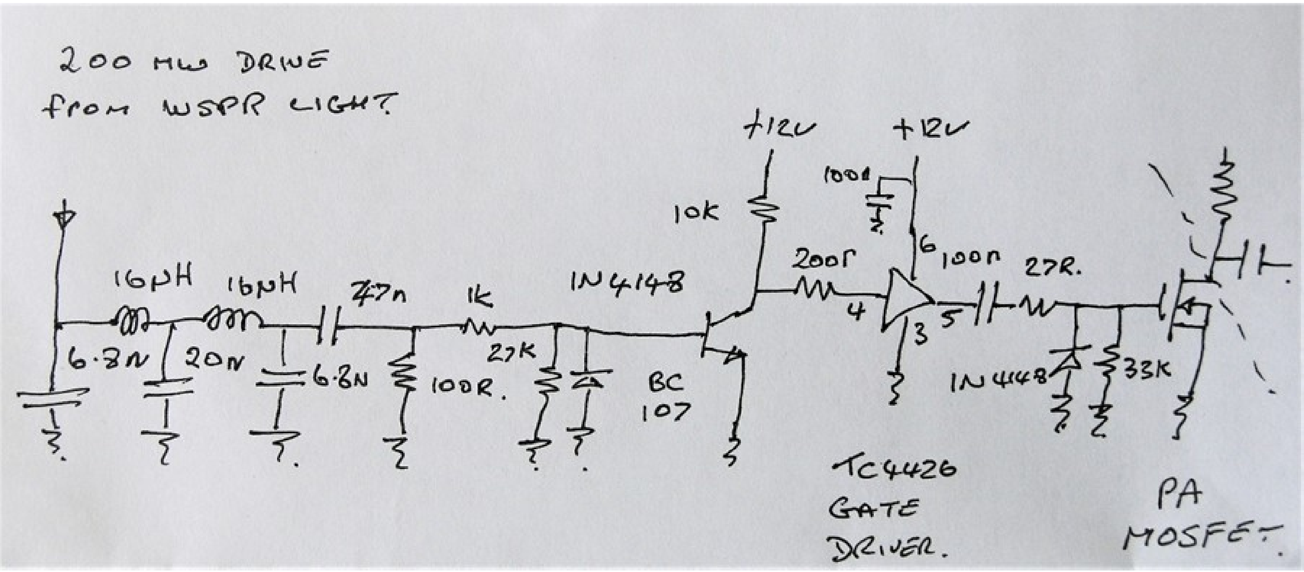


Figure 8 - PA Circuit - TC4426 Gate Driver

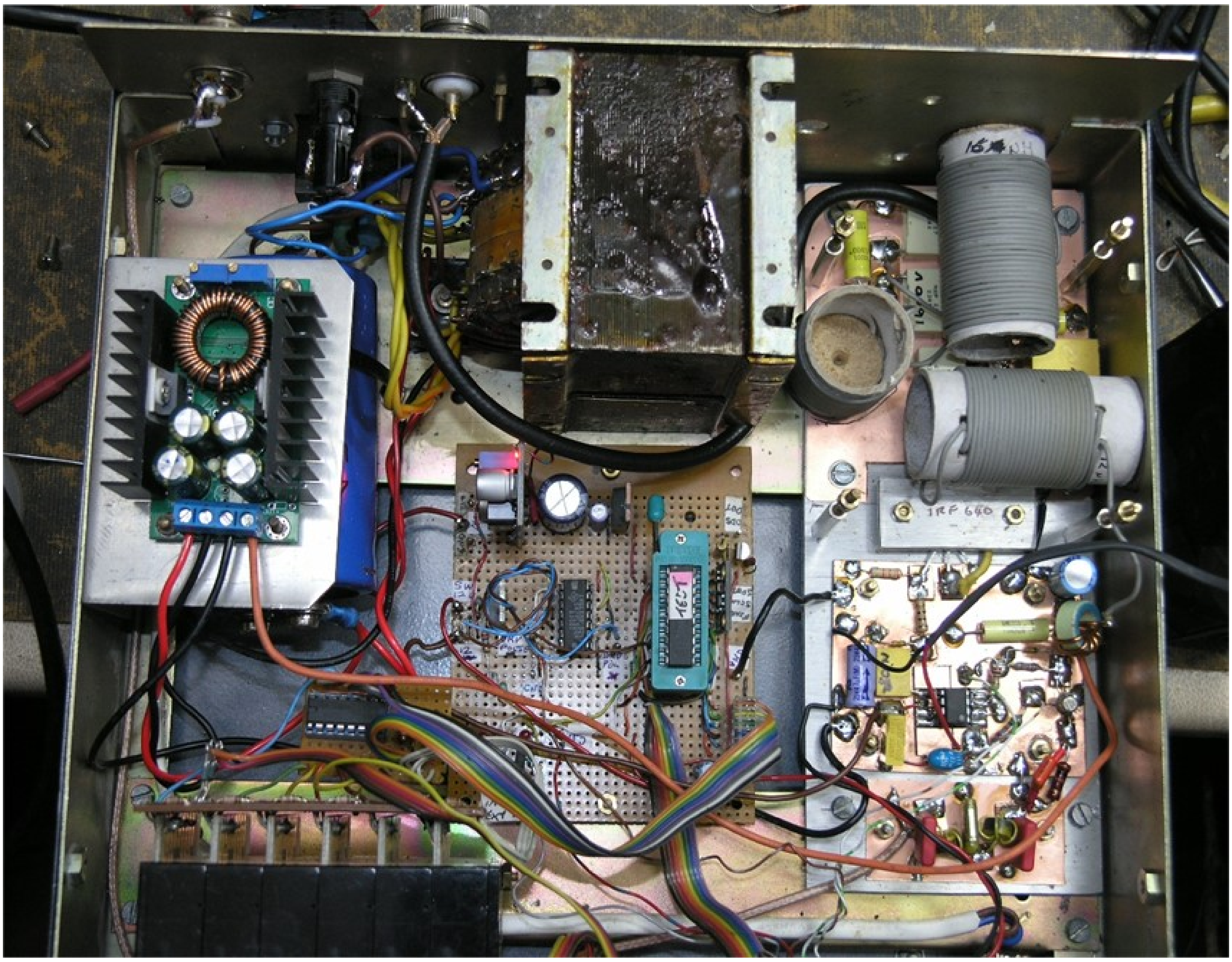


Figure 9 - Transmitter Layout with the Fan Removed

The TC4426 chip inputs are TTL compatible and also tolerant of signals up to the supply voltage. The two section Pi filter on the left of the diagram is there to clean up the output from a WSPRlite module and provide it with a safe termination.

Figure 10 shows the chassis with the fan mounted above the MOSFET and the output filter circuit.

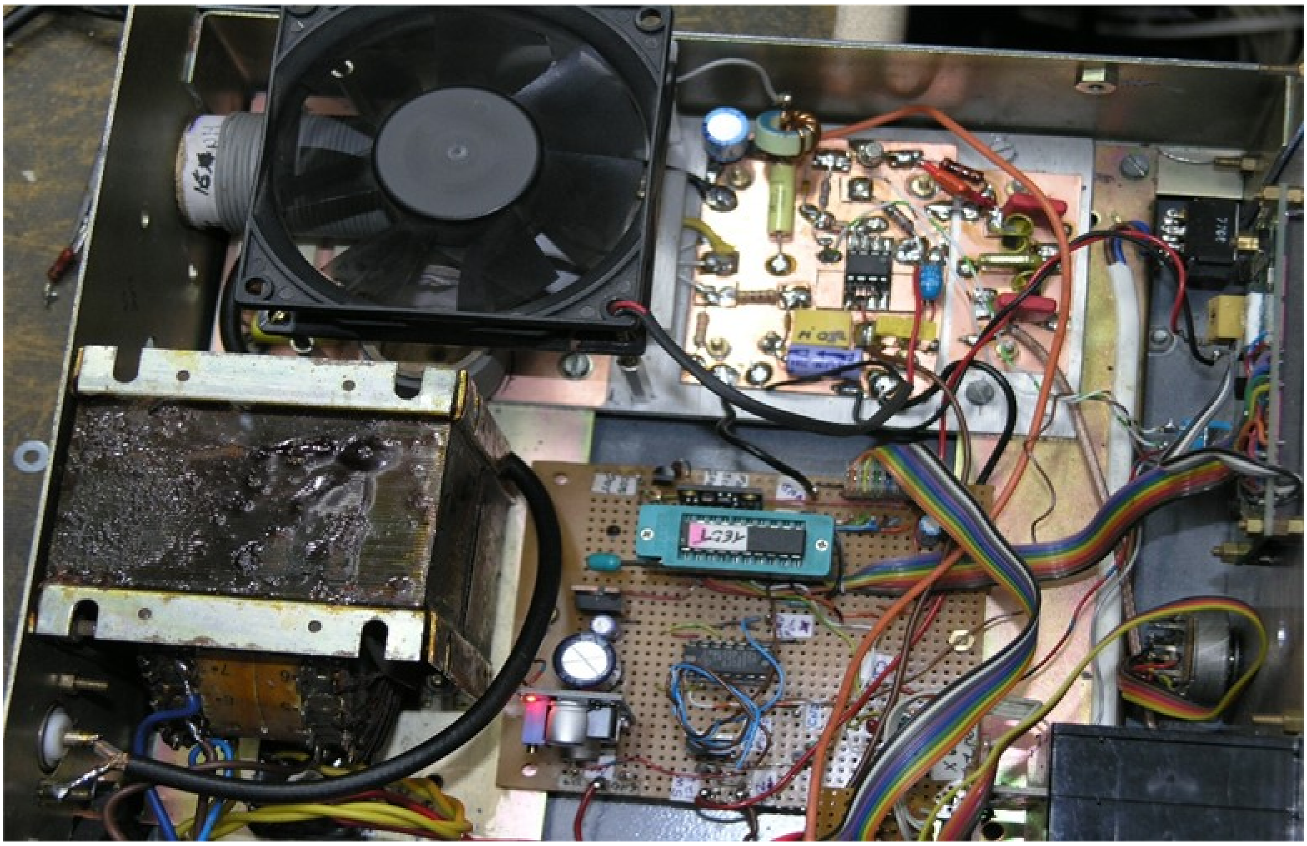


Figure 10 - Transmitter Layout with the Fan Fitted

The sine wave developed across the 100 ohm resistor is fed into the BC107 transistor to produce a square wave to feed the driver chip.

Figure 9 is a Photograph of the general layout of the transmitter in its case with the fan removed to show the PA board and filter layout on the right-hand side. The buck regulator is mounted on the aluminium bracket to the left.

The components mounted on the Vero board bottom centre are part of a DDS signal generator and a PIC controlled CW/QQRS beacon. Neither is required to generate the WSPR signal and both are beyond the scope of this article.

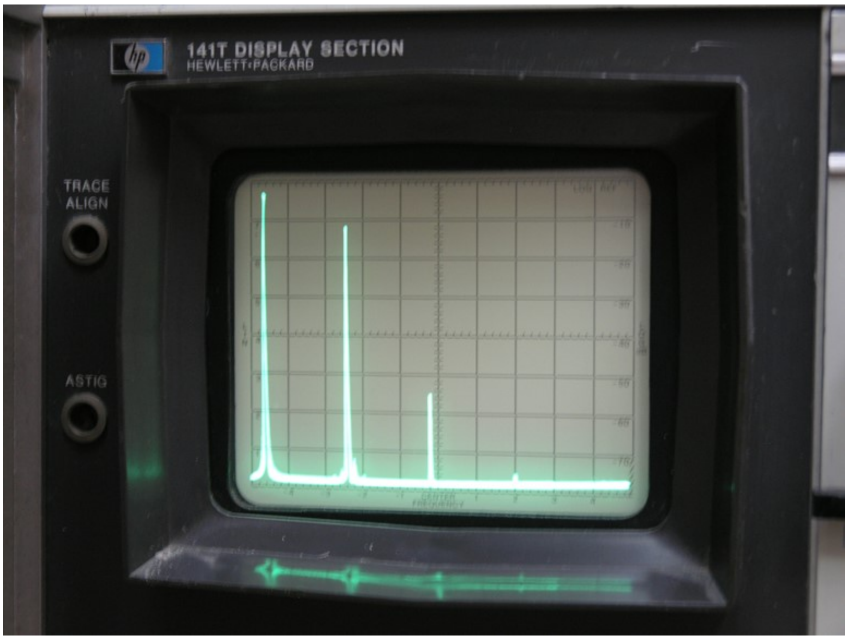


Figure 11 - Frequency Spectrum

This last photograph (Figure 11) is of a 0 - 2 MHz spectrum sweep showing the zero spike, carrier and second harmonic 45dB below the carrier at a nominal 30 watts output. If my arithmetic is correct that is about 1 mW at the antenna output, the third harmonic just measurable at -75 dB.

Results

Using the WSPR transmitter and fence loop antenna continuously for a few days resulted in the following spots. The fence hasn't caught fire yet so that 's a bonus.

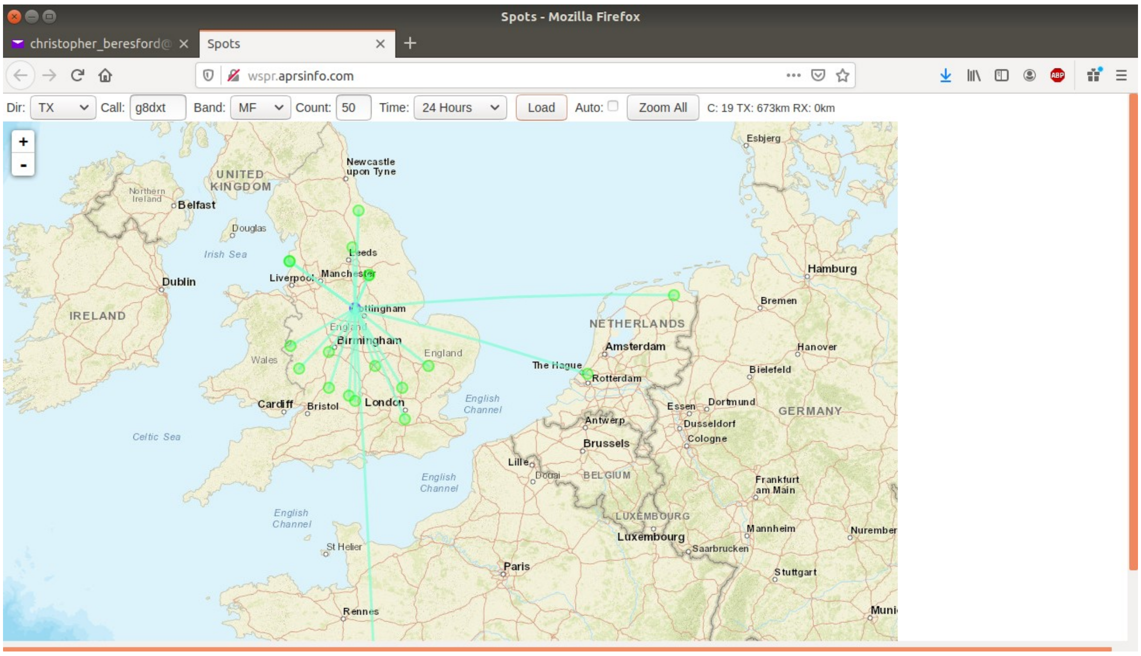


Figure 11 - WSPR Spots

That's all for this month. Thanks to Chris G8DXT for an excellent and interesting article. I look forward to the next.

73's Chris G4AKE
April 2020 Lockdown special.