In this issue

The CQ-DATV editors gratefully acknowledge all those authors that have contributed articles for this free magazine.

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Editorial

Welcome to issue 94 of our electronic ATV magazine. Remember all our previous issues are available in the CQ-DATV on-line library *https://www.cq-datv.mobi/ebooks.php*, here you can choose from e-book or PDF format downloads. You can also download the CQ-DATV omnibus, which is a PDF format compilation of all the magazines in one file, including this issue. But be warned, it's a 350MB download! Between issues we will keep you up to date on the CQ-DATV Facebook and remind you when the next issue is available.

The Broadcast Engineering Conservation Group are not letting the grass grow under their feet or should that be wheels given their fleet of refurbished Outside Broadcast vehicles. Their Facebook site and membership is growing both in popularity and content. It now features two old BBC films. One a production view of using a TV studio and the second one, a water borne OB.

John Gebuhr, WB0CMC is in the recycling business, in this issue he has acquired a UHF module from a digital transmitter that was being retired, containing 9 power amplifier boards, each with a 300-watt capability, for 470-800 MHz. OK John everyone in the editorial office is now envious.

We have two articles from Jim Andrews KH6HTV in the first one he is working with, Murray, K0TA in Chadron, Nebraska, in the far north-west corner of the state, just below the Black Hills of South Dakota. (Ian is old enough to remember the song and the film Murray, Calamity Jane). Here the Dawes County sheriff has asked Murray for the hams there to provide the county with an ATV repeater system. Jim has been working with Murray to engineer this ATV repeater.
In his second article Jim is investigating phase noise issue. He has purchases from e-Bay, a unit that houses an ADF5355 synthesiser module.
The unit tunes from 54 MHz to 13.6 GHz so it has legs and he is determined to solve its phase noise issues.
Lucien Serrano, F1TE is again looking at the QO-100 satellite and in this issue he is investigating an all-mode station based on the Adam Pluto.

Trevor is still inside his Grass Valley panel and has compiled some checks that have been useful to others following this project from adapting the software for different port chips to following through some of the ribbon cables which have given one or two problems.

From the Vault looks back a BASIC, the computer language that refuses to die. Trevor explains why he used a version of something from the 70's, admittedly a newly revamped version, for this long running project.

Please sit back and enjoy CQ-DATV 94. There is something for everybody in this issue, remember this is a free platform to support ATV and video projects and is dependent on your contributions.

That's a hint that although we have several thousand readers, it's the same handful of names delivering the content, so why not put pen to paper, or should that be fingers to keyboards?

The address for contributions is *editor@cq-datv.mobi*

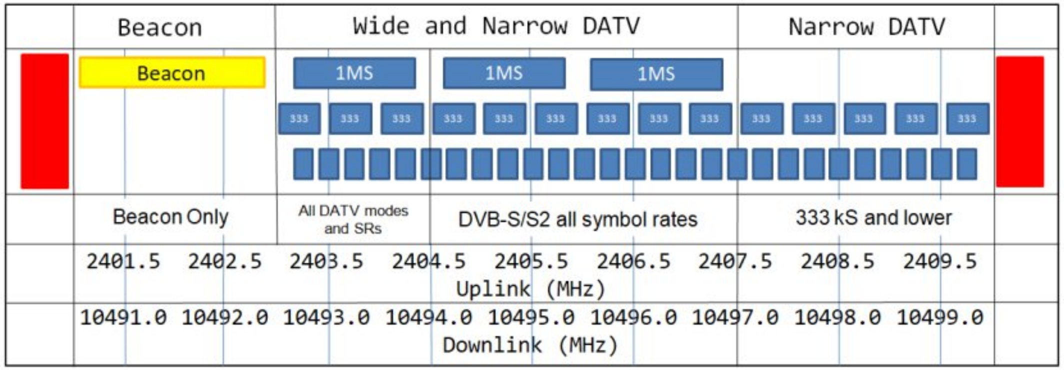
2021 Revision to the QO-100 Bandplan

Following discussions between the AMSAT-DL and the BATC, a revised bandplan for the QO-100 Wideband Transponder has been published.
The changes are only minor. In summary:-

- *An explicit statement that the playing of recorded music subject to copyright is unacceptable.*
- *Guidance on the occasional use of DVB-T and other experimental modes in the lower 1.5 MHz of the "Wide and Narrow" segment.*
- *Clarification that 500 kS DVB-S/S2 should not be used in the Narrow DATV segment.*

The full pdf can be read here: *https://tinyurl.com/ycjwczov*.

The graphical version is reproduced below.



Please respect the bandplan and guidance to enable us make the best use of this valuable resource and not risk losing it through unacceptable behaviour.
Thanks
Dave, G8GKQ BATC Chairman
Source: *https://tinyurl.com/y7h2kz2z*

General Notice Of Proposal To Vary Wireless Telegraphy Act Licences

The proposed EMF condition will only apply to licences that authorise equipment to transmit at power levels in excess of 10 Watts EIRP (or 6.1 Watts ERP). If the authorised transmit power specified in a licence is below this limit, the licensee will not need to take any action as a result of this variation. However, if a licence is varied in the future to authorise powers in excess of 10 Watts EIRP (or 6.1 Watts ERP), the licensee will need to comply with our proposed EMF condition. If a licence currently authorises equipment to transmit at power levels in excess of 10 Watts EIRP (or 6.1 Watts ERP), there are a number of simple ways in which licensees can comply (advice on how to comply is set out in our detailed Guidance on EMF Compliance and Enforcement).
https://tinyurl.com/y8b8wo5s

Summary of licence variation

The specific changes we are proposing to make to each licence class are set out in the"How we propose to vary licences"section below. In summary, our proposed EMF condition:

- *includes a new set of definitions relating to the EMF condition;*
- *imposes a requirement on licensees to ensure their equipment complies with the ICNIRP general public limits on (i) sites not shared with other licensees; and (ii) where applicable, sites shared with other licensees (advice on how to comply is set out in our detailed Guidance on EMF Compliance and Enforcement);*
- *sets out an exemption where licensees are not required to comply with the ICNIRP general public limits in emergency situations;*
- *imposes a requirement to keep records demonstrating*

compliance with the ICNIRP general public limits; and

- *imposes a requirement to take into account Ofcom's Guidance on EMF*

Compliance and Enforcement.

You can find more information on the background to Ofcom's EMF policy.
In addition to the proposed EMF condition, for some licence classes, we are making some minor non-substantive amendments. These are restricted to administrative changes to update references to legislation and remove other out-of-date information.

Source: *https://tinyurl.com/y9uwkpww*

2021 Activity and Contest dates

Here are the dates for the remainder of 2021:

- *April 17th and 18th is 23cm and up Activity Weekend.*
- *May 15th and 16th is All Bands Activity Weekend. Get the kit ready for the IARU*
- *June 12th and 13th is the IARU International Contest*
- *July 10th and 11th is Low Bands Activity, hopefully we will catch some Sporadic E.*

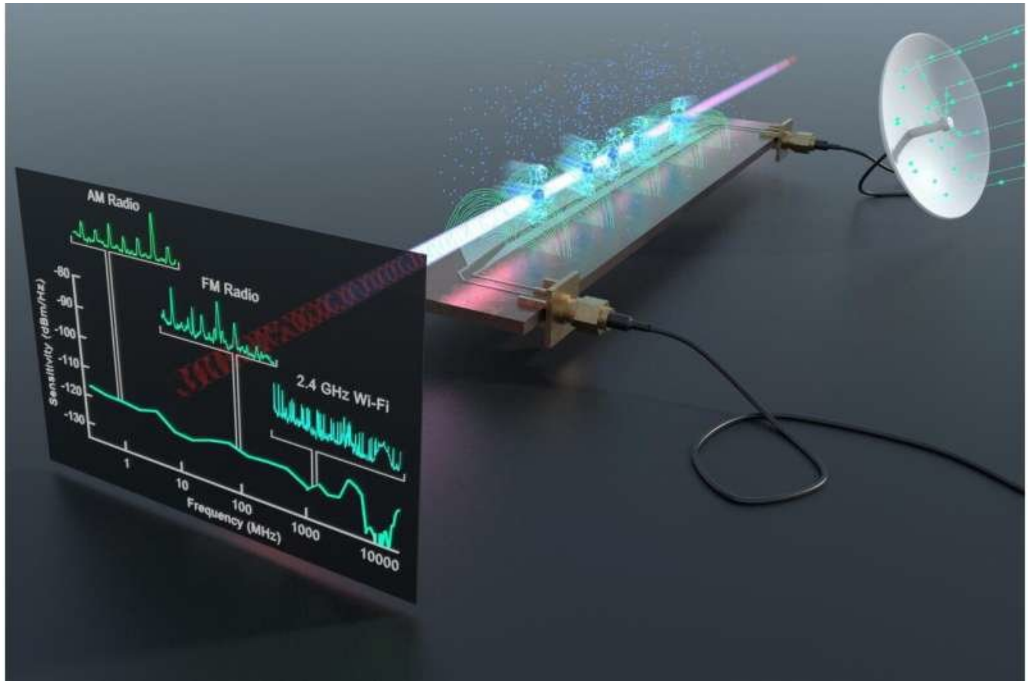
There are no Activity weekends in August due to the CAT.

- *September 4th and 5th is 23cm and 6cm Activity Weekend.*
- *October 2nd and 3rd is 2m & 70cm Activity Weekend*
- *November 6th and 7th is All Bands Activity Weekend*
- *December 24th to January 3rd 2022 is the Christmas*

Activity Ladder and the Repeater Activity Contest, both with online entries as last year.

Clive G3GJA
Source: *https://tinyurl.com/y8m4mwcg*

New quantum receiver the first to detect entire radio frequency spectrum



**A Rydberg receiver and spectrum analyzer detects a wide range of real-world radio frequency signals above a microwave circuit including AM radio, FM radio, Wi-Fi and Bluetooth.
Credit: U.S. Army illustration**

A new quantum sensor can analyze the full spectrum of radio frequency and real-world signals, unleashing new potentials for soldier communications, spectrum awareness and electronic warfare.

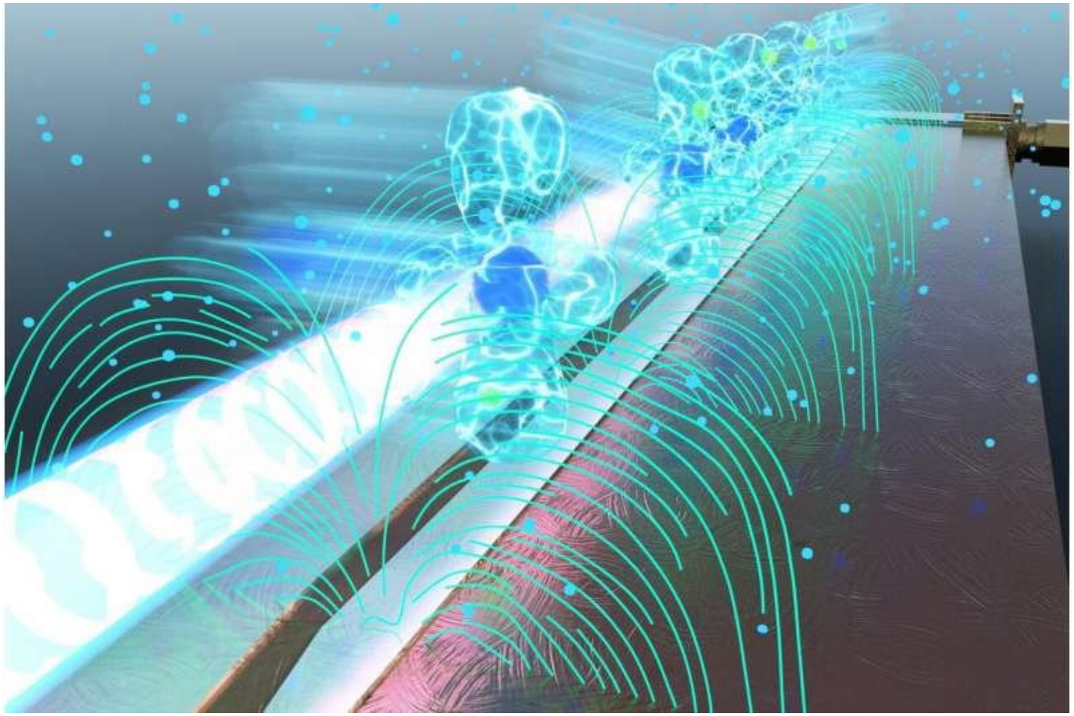
Army researchers built the quantum sensor, which can sample the radio-frequency spectrum—from zero frequency up to 20 GHz—and detect AM and FM radio, Bluetooth, Wi-Fi and other communication signals.

The Rydberg sensor uses laser beams to create highly-excited Rydberg atoms directly above a microwave circuit, to boost and hone in on the portion of the spectrum being measured. The Rydberg atoms are sensitive to the circuit's voltage, enabling the device to be used as a sensitive probe for the wide range of signals in the RF spectrum.

"All previous demonstrations of Rydberg atomic sensors have only been able to sense small and specific regions of the RF spectrum, but our sensor now operates continuously over a wide frequency range for the first time," said Dr. Kevin Cox, a researcher at the U.S. Army Combat Capabilities Development Command, now known as DEVCOM, Army Research Laboratory. "This is a really important step toward proving that quantum sensors can provide a new, and dominant, set of capabilities for our Soldiers, who are operating in an increasingly complex electro-magnetic battlespace."

The Rydberg spectrum analyzer has the potential to surpass fundamental limitations of traditional electronics in sensitivity, bandwidth and frequency range. Because of this, the lab's Rydberg spectrum analyzer and other quantum sensors have the potential to unlock a new frontier of Army sensors for spectrum awareness, electronic warfare, sensing and communications—part of the Army's modernization strategy.

"Devices that are based on quantum constituents are one of the Army's top priorities to enable technical surprise in the competitive future battlespace," said Army researcher Dr. David Meyer. "Quantum sensors in general, including the one demonstrated here, offer unparalleled sensitivity and accuracy to detect a wide range of mission-critical signals." The peer-reviewed journal Physical Review Applied published the researchers' findings, Waveguide-coupled Rydberg spectrum analyzer from 0 to 20 GigaHerz, co-authored by Army researchers Drs. David Meyer, Paul Kunz, and Kevin Cox



Researchers excite Rubidium atoms to high-energy Rydberg states. The atoms interact strongly with the circuit's electric fields, allowing detection and demodulation of any signal received into the circuit. Credit: U.S. Army illustration

The researchers plan additional development to improve the signal sensitivity of the Rydberg spectrum analyzer, aiming to outperform existing state-of-the-art technology.
"Significant physics and engineering effort is still necessary before the Rydberg analyzer can integrate into a field-testable device," Cox said. "One of the first steps will be understanding how to retain and improve the device's performance as the sensor size is decreased. The Army has emerged as a leading developer of Rydberg sensors, and we expect more cutting-edge research to result as this futuristic technology concept quickly becomes a reality."
Source: The Army Research Laboratory
https://tinyurl.com/4zrjy6es

Researchers use a Rydberg spectrum analyzer experimental apparatus at the DEVCOM Army Research Lab. Credit: U.S. Army

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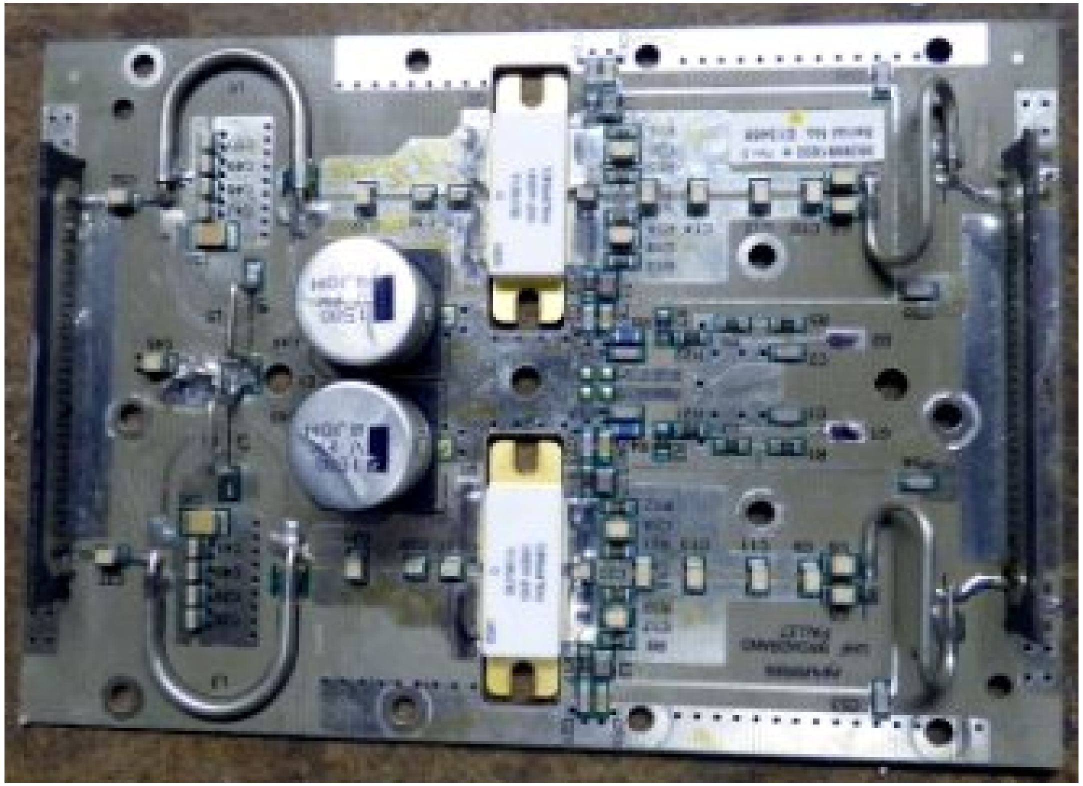
The Broadcast Engineering group seem to have been collecting old films made by the BBC on how to produce a TV programme and a very brave attempt at a floating outside broadcast unit to televise the Oxford Cambridge boat race. It is amazing to see how far we have come from a 10 man boat crew to televise and a boat with 9 people on-board.

If you want to see the films in full or have an interest in the history of television broadcast and the equipment used, then their Facebook site is well worth a visit.
Source: *https://tinyurl.com/u4kphw7c*

A Cheap ATV Amp for 420-450 MHz

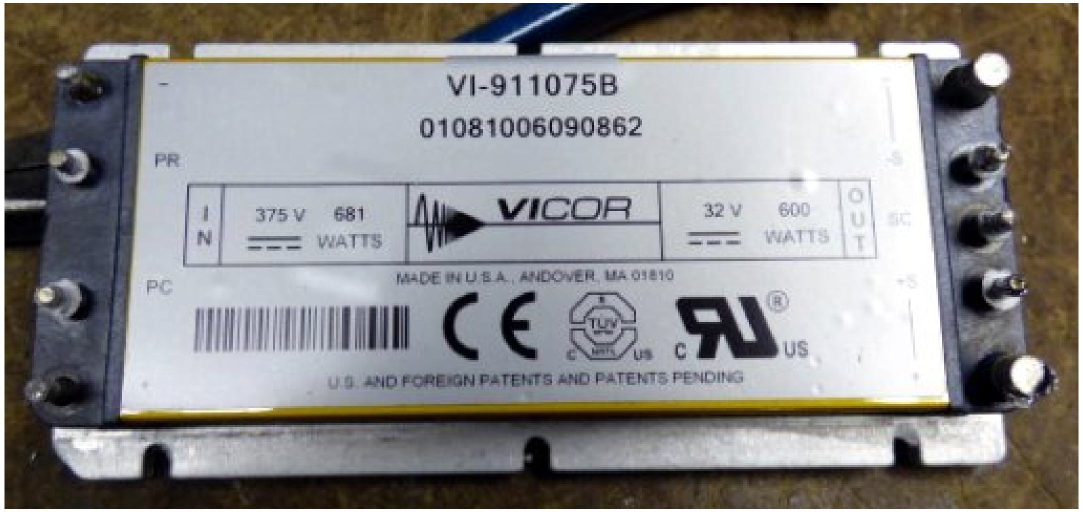
Written by John Gebuhr, WB0CMC
Reproduced from Boulder Amateur Television Club TV Repeater's REPEATER Febuary, 2021

A few weeks ago I acquired a UHF module from a digital transmitter that is being retired. It contained 9 amplifier boards, each with a 300 watt capability. One drove the other 8 for a combined output of about 2400 watts. They were speced from 470-800 MHz. I wondered if they would work down in the Ham band. There were also 5 DC-DC power supplies to run them. The boards run on 32 VDC.



Original 300 watt board It takes 15 watts of drive

With minor modifications they do work fine at 434MHz. Each board will operate either single ended or dual IO.



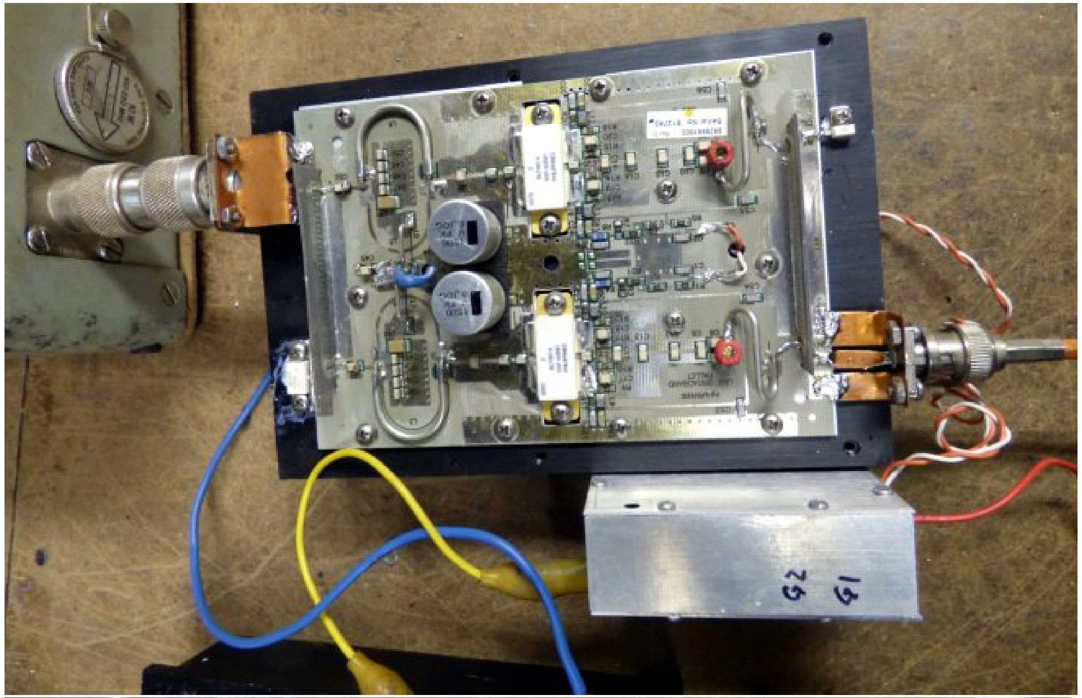
Power supply, 375VDC in 32VDC out @ 18 A max

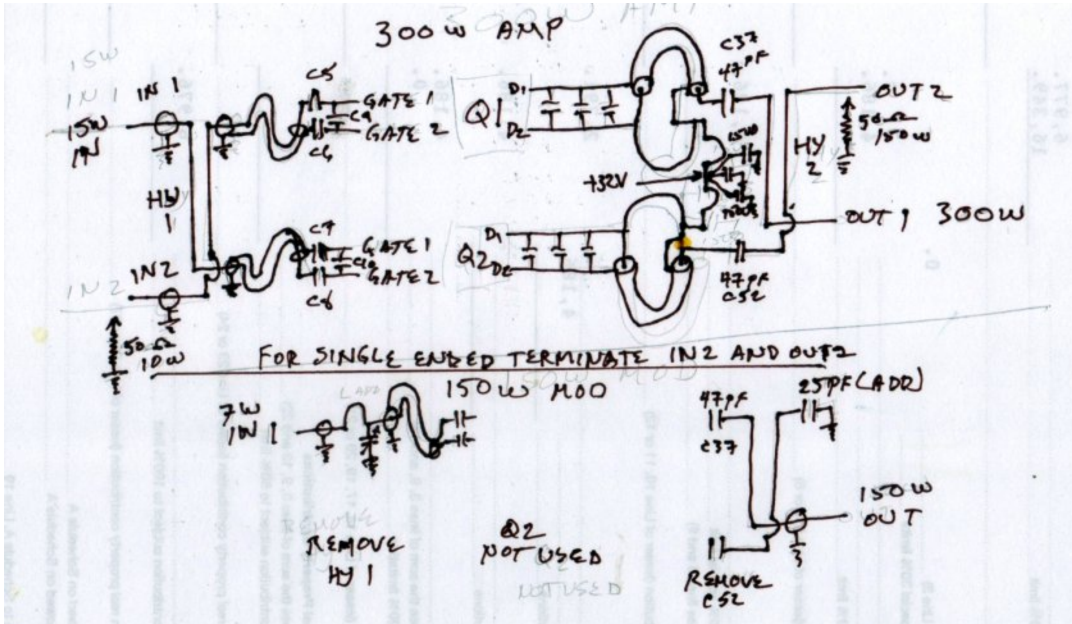
They have a 13-14dB gain and run class AB. For ATV I found a static bias of ½ A per device is adequate for good linearity and gain. Efficiency is about 25-30%. A 300 watt board modified for 434 is shown next page. This is connected for single ended operation.

The unused in and out are terminated in 50 ohms mounted to the heat sink. The two trimmers (red) are 3-20 pF caps and optimize the input match. No other mods are necessary. The box on the side is the gate bias control. The blue wire is the 32 Volt supply line. Power supply for this amp is on the right.

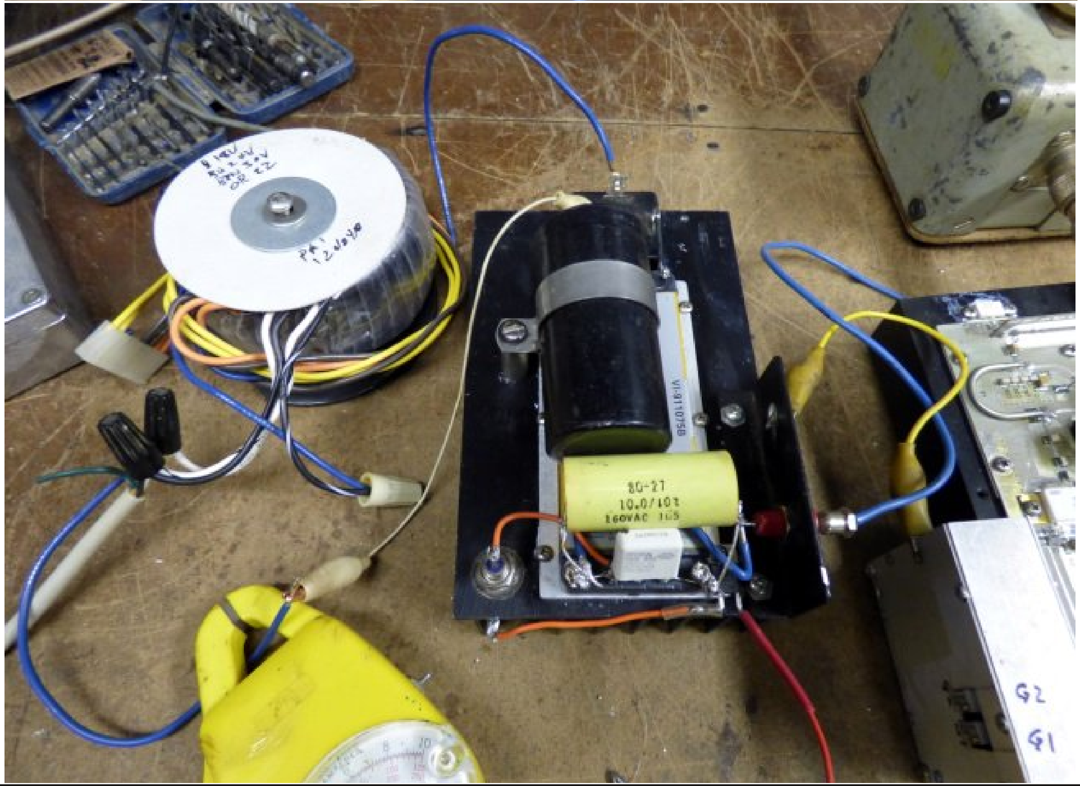
Primary power at 240 volts is about 2.5 A at 300 watts CW. I used a dual primary transformer to get 240 VAC to rectify. I also added the 20 volt winding in series to get 260 AC which gives about 355 DC filtered for the converter. A 15 watt PC electronics TX with color bars gives 175 watts on the bird. Killing the ped and video it goes to 300+ watts.

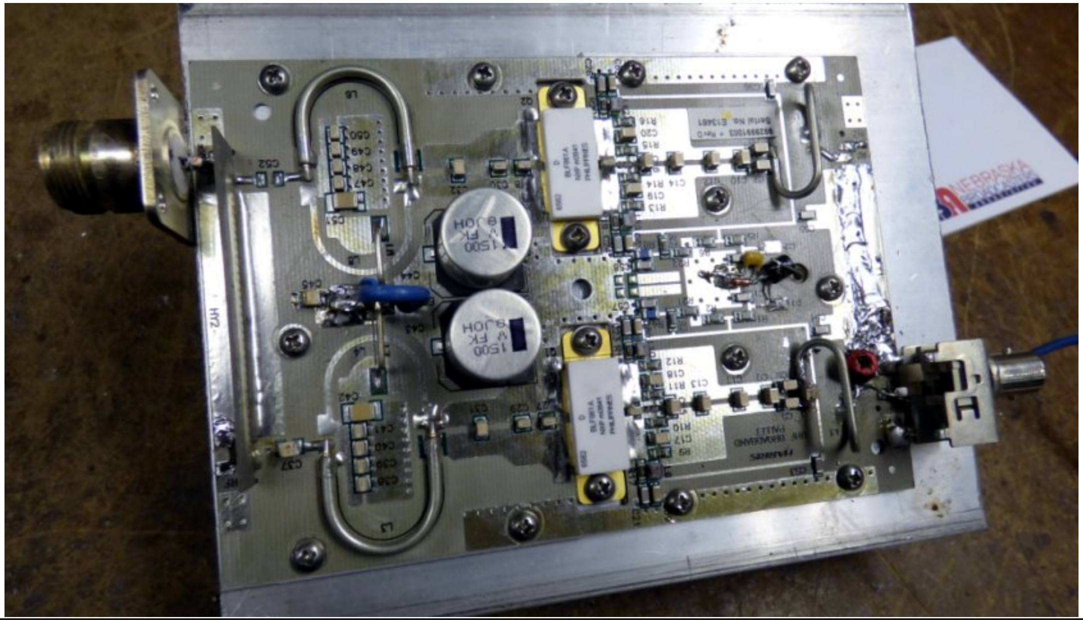
I will have to add a fan to this for longer transmit times since it does get pretty warm. Following is briefly what the amp is.





For a single 150 watt amp and a lot less heat to dissipate, it only draws about 9 amps at 150 watts CW, remove the input hybrid (HY1)and put a small loop and trimmer shown as the 150 W mod. Remove C52, the output cap of the unused half and add a 25pF at the out 2 terminal.





The little circuit in the middle is a 78L05 for biasing the gates. It needed a diode to ground from the regulator to get the 5.7 volts needed to give about ½ A static bias. The input cap is, again for matching and will have some effect on sync level but it is a set and forget adjustment. The unused side should have no gate bias.

The transmitter that these came out of was a Harris and ran on 480 VAC. The rectifier for the module used a “Y” connected bridge rectifier and cap to give the 375 volts DC for the inverter. The inverter will put out 32 volts with only 240 DC in but I doubt it would have much current capacity. At 350 it will run any of the configurations shown here.

I’ve got 3 of these 150 watt mods out there now with my 7 watt ATV transmitters and they do work well. 7 watts seems to be a perfect match for the 150 watt mod. It’s been fun. John, WB0CMC

Editor's Note: John says he has talked to the engineer from whom he got these amplifiers. The engineer told John he can have more modules if he wants them. So John is offering to obtain them for other ATVers. If you are interested in one of these amplifiers, contact John directly for details.

Does DATV Radiate as Far as FM-Voice?

Written by Jim Andrews, KH6HTV
Reprinted from Boulder Amateur Television Club TV Repeater's REPEATER March, 2021

The quick answer usually is NO! Although this is also dependent upon terrain.

Recently Tom, W6ORG, referred Murray, K0TA to me. Murray lives in Chadron, Nebraska, in the far north-west corner of the state, just below the Black Hills of South Dakota. The Dawes County sheriff had asked Murray for the hams there to provide the county with an ATV repeater system.

Murray was going to file for a grant to fund the project. I have been working with Murray to try to engineer an ATV repeater system. Our first step was to prepare RF coverage maps for several potential repeater sites Murray had identified. When I gave Murray some maps, he was shocked at the lack of coverage. Murray is a two way mobile expert and was quite familiar with what he could accomplish with two way FM voice radio repeaters in his area. My maps showed far less coverage. Murray asked "Why ?"

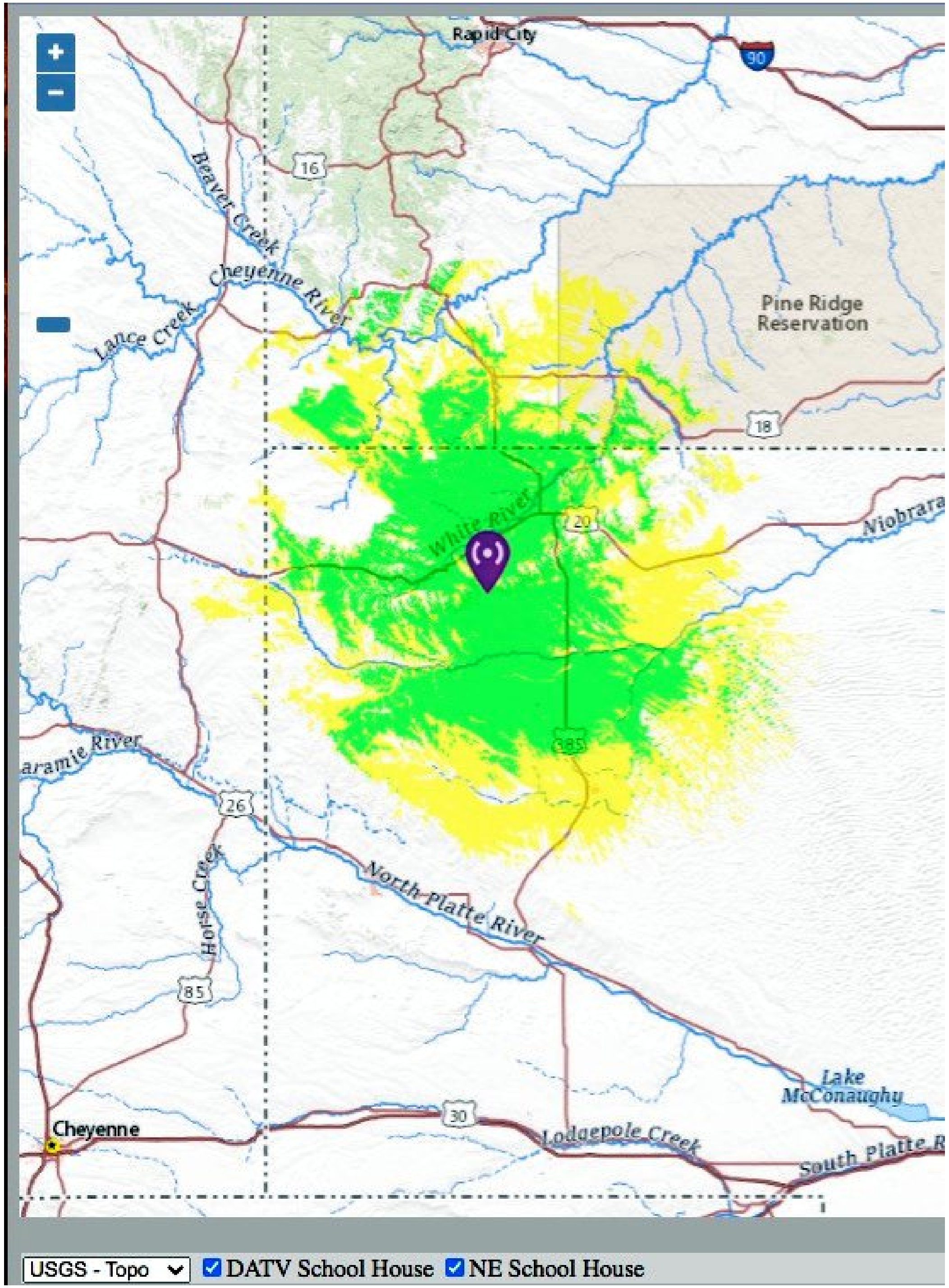
Well, the first and biggest difference is related to Bandwidth and the resultant Noise Floor. So, let's take some typical numbers to analyze The basic equation for thermal noise power is: Pn = k * T * B. k is Boltzman's constant (1.38064852 x 10-23) T is absolute temperature in Kelvin's (normal room temperature is assumed to be 295o K). B is band-width in Hertz. Using this equation for a 6 MHz, DATV signal, the noise floor for a receiver will be -106dBm. For an FM voice rig with 15 kHz bandwidth, it is -132dBm.

Now for the FM voice rig we want a minimum of 10dB S/N for a readable signal, or -122dBm (0.18μV) For DVB-T using a good low noise pre-amp on the receiver and 6 MHz BW, QPSK, 1080P resolution, and normal FEC of 5/6, the min. detectable signal requires 8dB S/N, or about -98dBm (2.8µV). So right away, DATV has a -24dB disadvantage. The next issue is that of available transmitter power. Let's use the same amplifier for both services. Taking my model 70-9B as an example. In FM service, it will put out 70 Watts (saturated). But for DVB-T service it puts out only 10 Watts (rms). The amplifier has to provide at least 8dB of head-room to accommodate the high peaks in the random, noise-like digital signal. So we see still another 8dB disadvantage. We are now up to a total of -32dB.

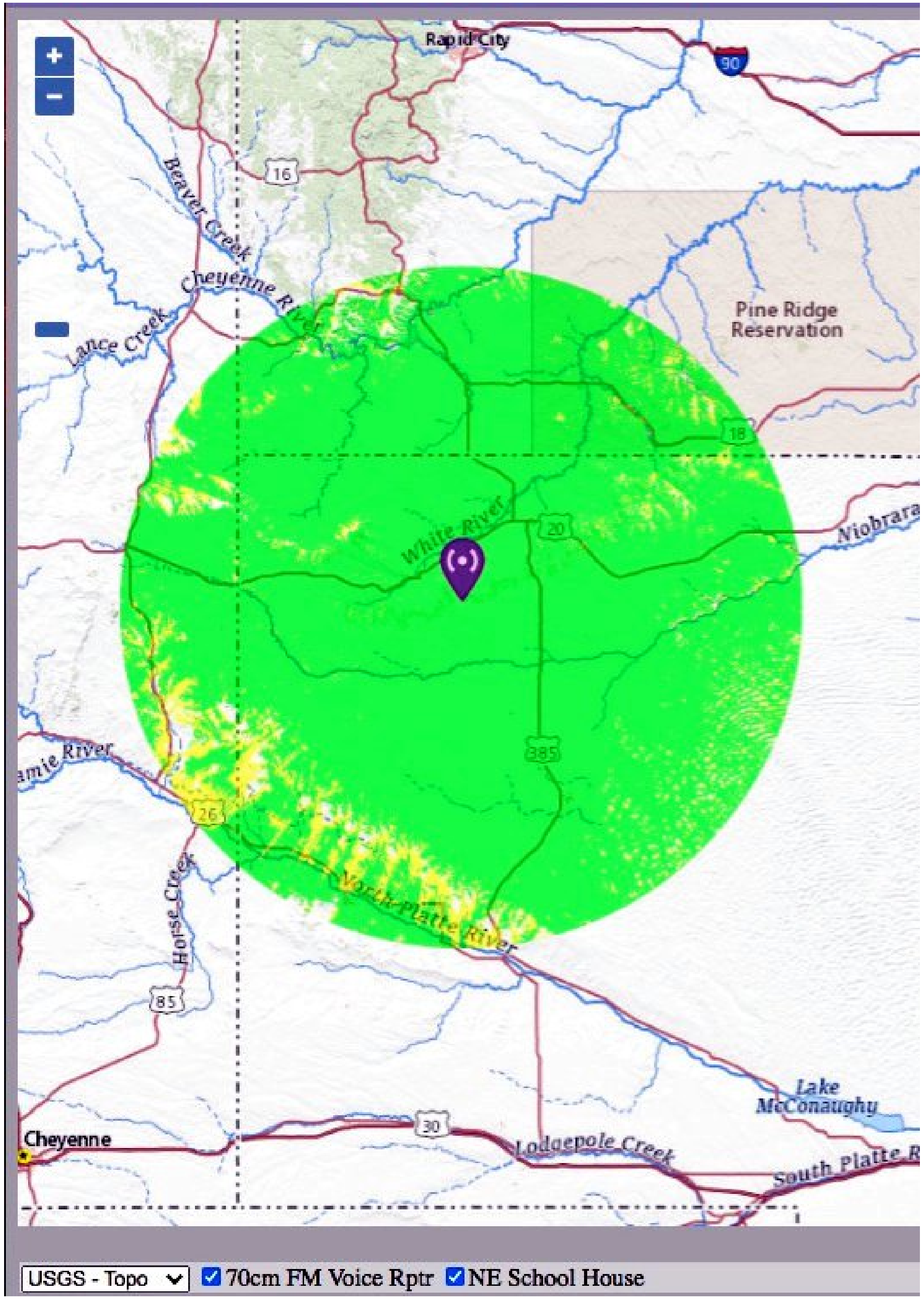
So, I will now run these numbers for one of Murray's Chadron, Nebraska repeater sites. I will use the same antennas, tower heights and coax feed lines. The receiving station will be Murray's 60ft. crank up tower with a high gain Yagi antenna. The maps shown below are the results of the comparison. The difference is quite dramatic.

Maps generated to a max. radius of 100km (62 miles). The tear drop denotes the repeater site. Yellow shading is for weak signal area (0 to 10dB). Green shading is for strong signal area with signal > 10dB above threshold.

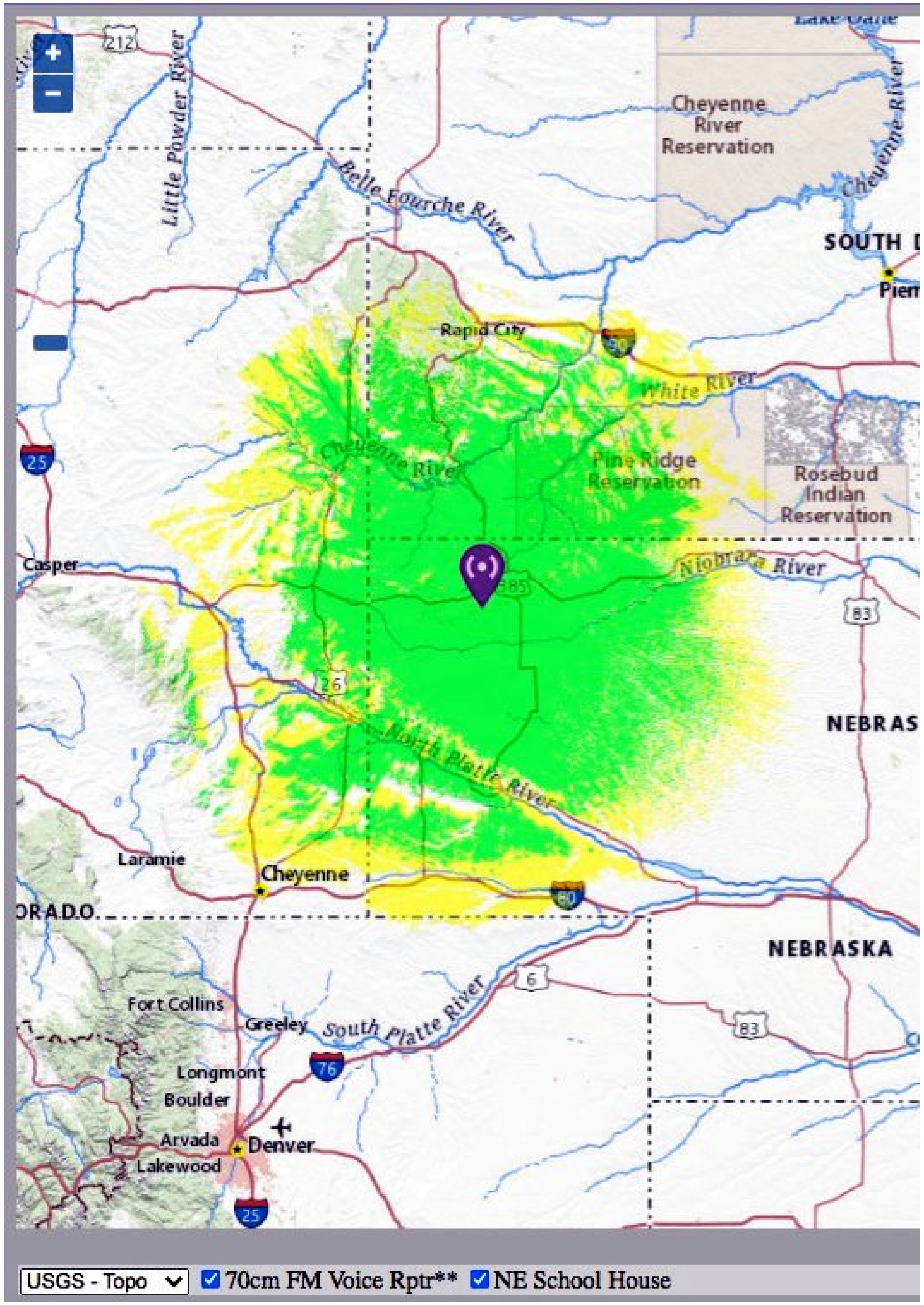
Note: Rapid City, SD is at top of map and Cheyenne, WY is in lower left corner of map.



70cm DVB-T coverage map



70cm FM voice coverage map

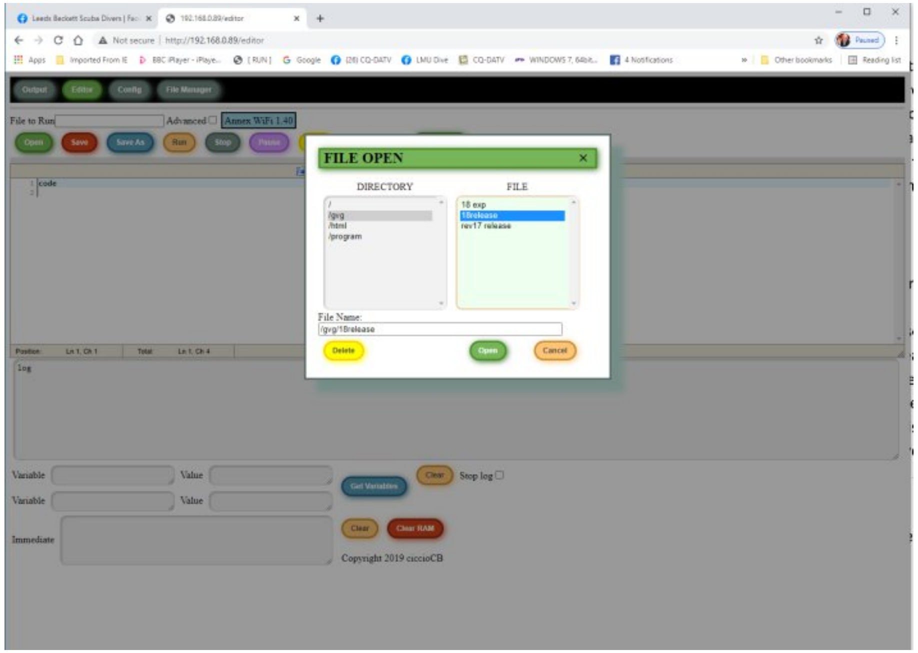


RF Coverage Map for 70cm FM voice repeater now computed for a 200km radius

Grass Valley Mixer Conversions - Part 27

Written by Trevor Brown, G8CJS and Mike Stevens, G7GTN

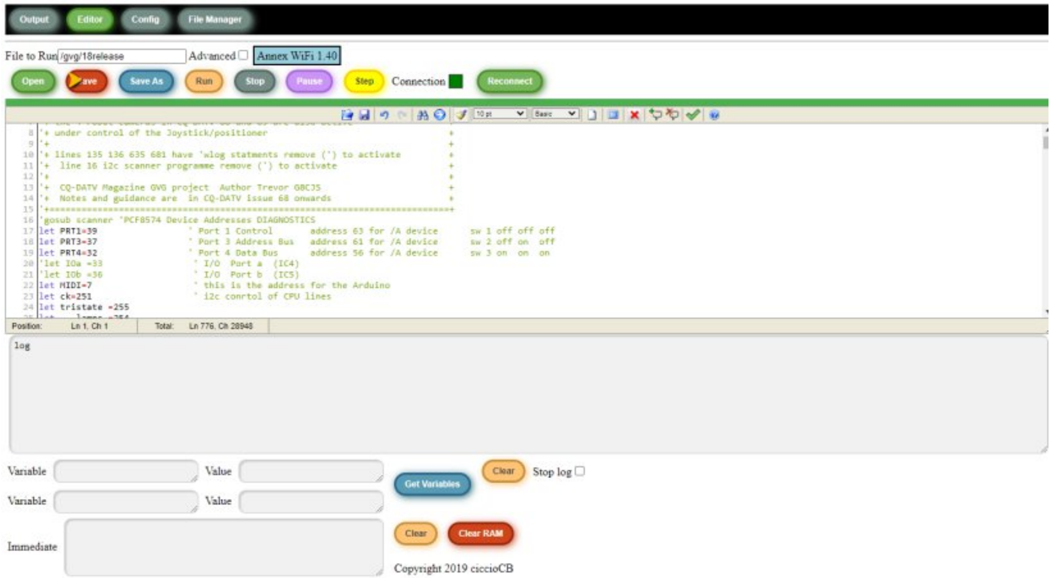
In the last issue we started trouble shooting GVG panel problems. The following notes have been compiled as a result of the work done by our beta testers and I hope they go somewhere to helping to track down and eliminate any hardware problems or software bugs that anyone may or may not have encountered. The latest GVG 18 download has diagrams of the panel and the online help manual, which we will keep updating as information becomes available. This Grass Valley technology might be old, but the panels were built to last and perhaps that's what gave them their well-deserved reputation for delivering not only production solutions, but well documented design, construction, and a build quality that also pleased the engineers.



Let's start by running the Annex software running in the browser, by entering the correct IP address. There are notes on this in the on-line help manual. Select Editor and open up 18 release. We can begin by scanning the port addresses with just the PCB powered up and connected to the PC, we do not need the J2 J3 connections to do this, nor do we need IC4 and IC5 fitted.

IC4 and IC5 are expansion chips for future additions if they are fitted it's not a problem. The first step was to remove the (') from the start of line 16 of the software. This puts the programme into I2C address display mode, (always remember to save any changes). If we now run the software, it will scan the I2C bus and list every address it finds - make a careful note of these addresses! The important ones will be the ports provided by the PCF 8574 chipset. They will most likely be 39, 37, 32. If this is the case, put back the (') at the start of line 16 and re-save the programme.

If the scanner does not deliver any addresses you have an I2C problem. Remove all the PCF 8574's and refit them one at a time, a faulty one can block the bus for other chips and devices.



If the Arduino Pro is fitted and programmed it will show up as Address 7 and if the OLED display is present it will show up as 60. If IC4 and IC5 are fitted they will be shown as 33 and 36. The Arduino pro is not essential to get the mixer functioning. If it is present it must be powered up or it will block the I2C bus. This is a typical screen produced by the I2C display routine.

```
log
You have I2C devices at 7
You have I2C devices at 32
You have I2C devices at 33
You have I2C devices at 36
You have I2C devices at 37
You have I2C devices at 39
You have I2C devices at 60
```

The ANNEX Editor running the scan software to check and display all the I2C devices on the bus (this requires vers 18 of the GVG software)

Now connect J2 and J3 power up the mixer, all the lights will bo on, press run in the editor and after less than one second the lights will go out leaving, PST 1, PGM 1, KEY 9 and MIX illuminated. If this does not happen then the +15V regulator will overload (depending on the heat sync size) and the lights will fade out. No damage will result, the +15V regulator will just shut down.

If you have the alternative set of PCF 8574 fitted then the scanned ports will come up as 63, 61 ,56 you will have to edit the programme lines 17, 18, and 19 to :-

```
17 let PRT1= 63
18 let PRT3= 61
19 let PRT 4= 56
```

Everything after the (‘) is just a comment to help human understanding of the programme and is not essential to getting the mixer software working, so keep line 17, 18, 19 as simple as the above example.

The PCF 8574’s I^{2}C address can be pre-set using the three external connections, on our PCB these are connected to the red switches for IC1, IC2 ,IC3. IC4 and IC5 are hard wired on the MK2 PCB as space was tight. The address bus also has part of its configuration fixed within the chip. This is set by the manufacturer in one of two ways, hence the two types of chips. The PCF 8574 can be set with the red switches to any number, between 32 and 39 and the PCF 8574A can be set to any number between 56 and 63. Either chipset can be used or even a mix of both, but you need to declare the address in lines 17, 18 and 19 of the programme, so the ANNEX BASIC software can connect to the chipset. The three PCF 8574 provide three different functions EG Control, Address and Data so it is important that the correct chip (or PORT) has the correct address associated with it.

If you have edited the programme, it will need saving. The (‘) in line 16 needs also needs putting back and this also needs to be followed by save to put the software back into GVG working mode. Power down, connect J2 and J3, power up and run the programme. If the lights do not default to PST 1, PGM1, KEY 9 and MIX only illuminated, then you have a problem. This maybe hardware related. The most common problems are the interconnect between our PCB and the GVG panel and some investigation will be required. Power down the panel remove the bottom plate of the GVG panel to provide access to the underside of the lower PCB. You will need to do some continuity testing. J2 on the GVG mixer can now be accessed. You need to check the J2 connections, the problem can often be the ribbon cable which in an ideal world is pressed into the connectors with a mandrill, but if we are making cables up at home these connections sometimes do not mate. If J2 on the panel does not connect to the correct PCF 8574 pin, then this could be the problem.

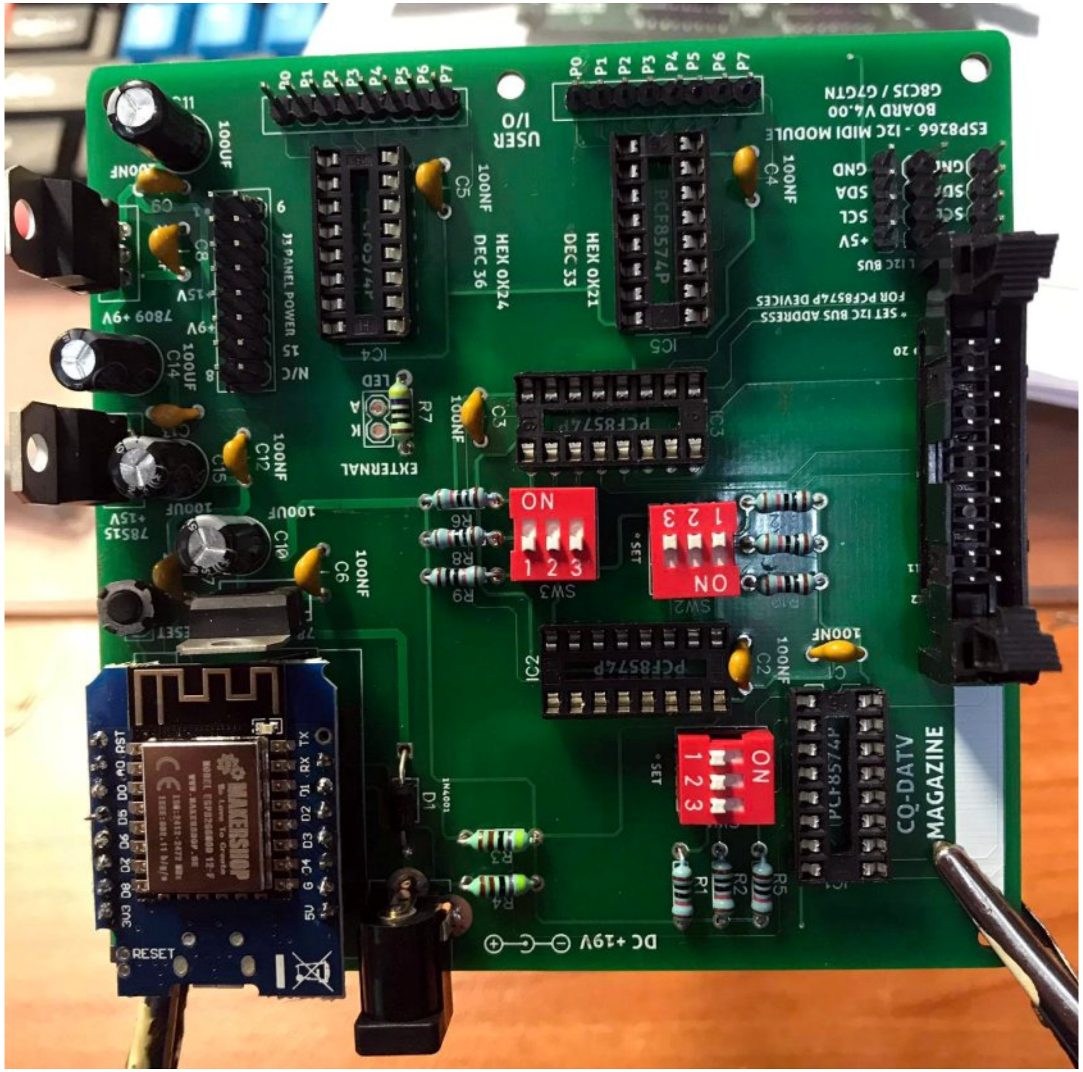
This needs testing using the chart below. Look for continuity between J2 on the panel and the PCF 8574 in the far-right column.

If you have continuity and software installed that has the correct ports addresses to match your chosen chipset and the (‘) at the start of line 16 back in place, you should be seeing the keys light up in the home position e.g.. PST 1, PGM 1, KEY 9 and MIX illuminated. The 15V regulator needs a good heat sync, as does the 9V one, but it should now cope with the reduced lamp load delivered by a working GVG panel under the control of the ANNEX BASIC software programme.

GVG Connector	Signal	PCB Connector	PCF 8574’s
J2-Pin 1	GND	PCB-1	N/C
J2-Pin 2	GND	PCB-2	N/C
J2-Pin 3	5	PCB-3	N/C
J2-Pin 4	D7	PCB-4	IC3-Pin 12
J2-Pin 5	RD ANALOGUE	PCB-5	IC1-Pin 9
J2-Pin 6	D6	PCB-6	IC3-Pin 11
J2-Pin 7	CONVERT	PCB-7	IC1-Pin 7
J2-Pin 8	D5	PCB-8	IC3-Pin 10
J2-Pin 9	DSPLY CLK	PCB-9	IC1-Pin 6
J2-Pin 10	D4	PCB-10	IC3-Pin 9
J2-Pin 11	A0	PCB-11	IC2-Pin 4
J2-Pin 12	A1	PCB-12	IC2-Pin 5
J2-Pin 13	A2	PCB-13	IC2-Pin 6
J2-Pin 14	A3	PCB-14	IC2-Pin 7
J2-Pin 15	D0	PCB-15	IC3-Pin 4
J2-Pin 16	D1	PCB-16	IC3-Pin 5
J2-Pin 17	D2	PCB-17	IC3-Pin 6
J2-Pin 18	WRITE LAMP	PCB-18	IC1-Pin 4
J2-Pin 19	D3	PCB-19	IC3-Pin 7
J2-Pin 20	READ BUTTON	PCB-20	IC1-Pin 5

GVG J2 to CQ-DATV PCB Interconnect table

Once you have the panel working the next stage is to connect it to Vmix, this will require the Arduino Pro, which is mounted under the D1 mini, a word of warning the mixer will work without this processor its only function is to convert GVG commands into MIDI commands, if it is not present the panel will function, just not connect to Vmix, but if it is present and not powered up it will inhibit the mixer by stopping I2C communication. This is easily detected by the I2C address scanner. It does not need to be programmed, but it must be powered if present or the bus is inhibited.



Other things that will stop the scanner producing addresses are faulty PCF 8574 port chips, these can be removed and inserted one at a time to detect a faulty chip. If the port chips show addresses but not the correct ones, then check you have the red switches set correctly.

When it is present and programmed the panel will talk to Vmix providing you import the MIDI file into Vmix short cuts. This file directs the MIDI commands to the correct key operation, again there is a detailed explanation in the online help manual.

We now have several boards out with beta testers and pictures are being sent back to the editorial office, this is from Tony in Greece. It looks a brilliant constructional effort Tony. I particularly like the full J2 connector with locks to keep the connector in place. Don't forget to set the red address switches.

At the time of CQ-DATV going to press Tony has it displaying port numbers and we have a conference call arranged to edit the software ports into programme line 17, 18, and 19 as it is displaying 63, 61 and 56 for his chip set.

Once we get that working it will be setting up the D1 mini–Auto Run as per the last issue. Then we can dispense with the D1 mini-USB lead.

The Arduino USB lead will still be required as this is how Vmix communicates with the panel.

Ian in New Zealand has also completed construction and his board has had a couple of modifications in that Ian's GVG has had an LED conversion done and does not require the regulators, everything runs from a 9V PSU.

Ian has the same chipset as Tony because it is scanning the same I2C device addresses. He has not yet reported a connection to Vmix as he is at present exploring using the PCB to control an ATEM. He has put a video clip on the CQ-DATV Facebook page of this working, and we hope that a full write up will arrive at the editorial desk.

This is something to look forward to in a future issue. He also mentioned problems with the Arduino Pro in that there is a 3V3 version around which uses an 8 MHz xtal, the 5V version uses a 16 MHz xtal and is the preferred option. I have not seen an 8 MHz version, both of mine are 16 MHz versions (its written on the Xtal, but you need a good magnifying glass to see it)

On the following page is my PCB, now mounted on the bottom panel, which is also performing the task of a heat sync. Perhaps I should have mounted it on the left-hand side, so as to put the regulators nearer the centre of the panel, but on the MK1 PCB the regulators were not present, and I wanted to avoid drilling additional holes in the panel. You do have to omit one of the GVG mounting pillars to make this

assembly work, but it is rather smart having it all contained in one unit, bar the lap top PSU.

I now have it running with just one USB connection to the Arduino via a slot I have cut in the backplate which is large enough to accommodate a USB connection to the D1 Mini too, but now I have conquered Auto Run is not necessary.

If I want to revise the software the Wi-Fi connection to the Annex editor does everything that I require.

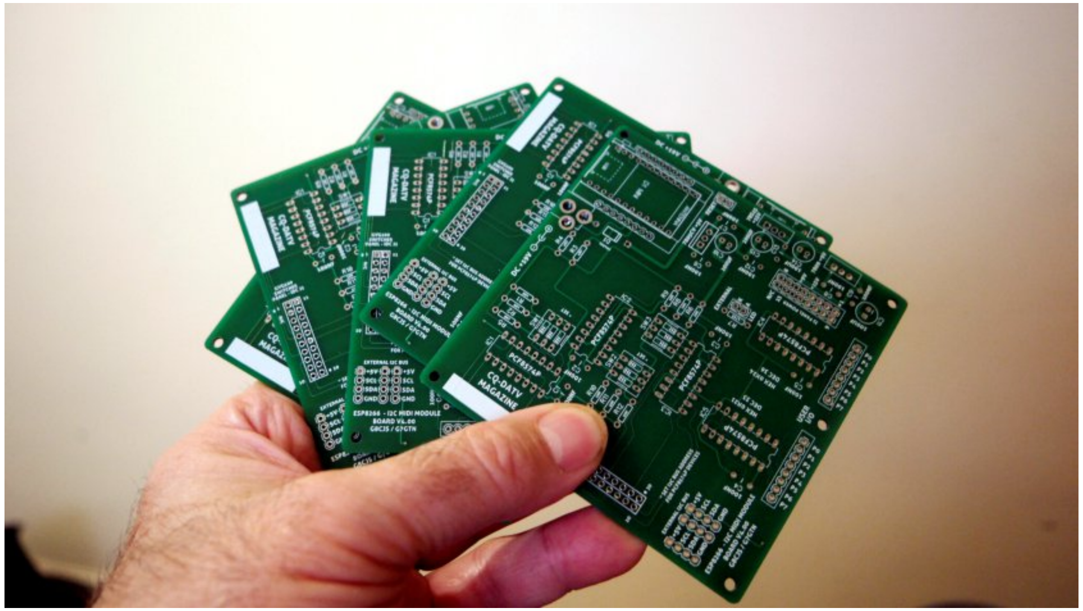
The picture also shows the panel with the PGM PST and mix light on EG the home position. The OLED display has been secured with blue tac behind the red screen which previously displayed the mix duration on a set of alpha numeric displays. I removed them (they were only plug-ins).

I have also fitted a chassis mount DB15 connector into that nice GVG cut-out and connected it to the I^2C bus so I can reconnect the robot camera which is controlled by the positioner on the GVG panel. It also means that if I want to add any future bright or not so bright ideas to the I^2C bus I don’t have to pull the mixer apart.

The black sticky tape obscures my metal work which I admit requires a revisit when the COVID lockdown has gone and I can visit a hardware store and buy a file to finish off the cut-out which was done with a junior hacksaw outside in the garden, stood in the snow (the things I do for CQ-DATV)

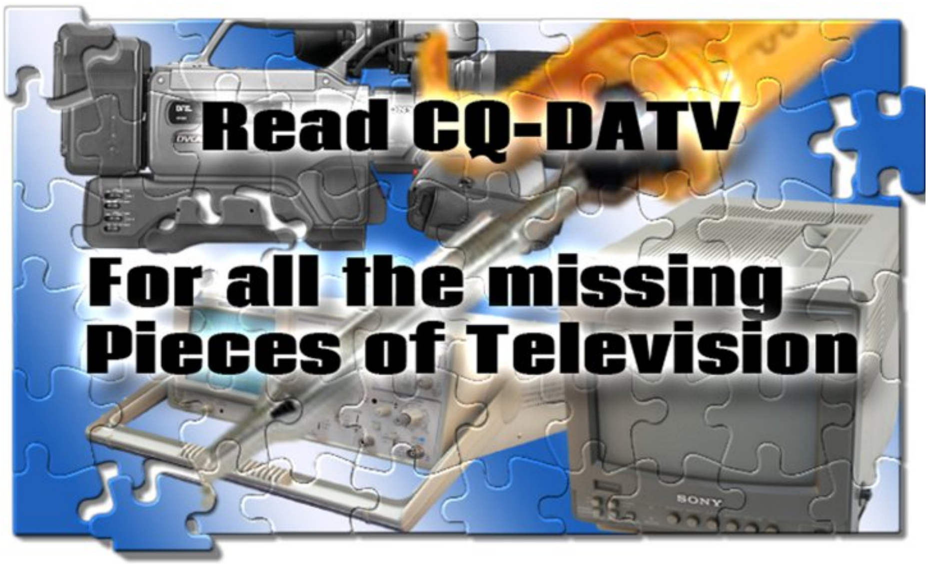
The GVG panels do seem to be a little thin on the ground. I constantly check eBay and put links for any I find on our CQ-DATV Facebook page. The last two were both in the USA, the postage to the UK almost doubled the price, but if you live in the USA its less of a problem.

I still have two PCBs should anyone want to join our beta testers. They are £5 +pp, all we ask is that you report back to CQ-DATV on your progress and in return we will help in any way that we can.



I am also not sure if we should call the PCB's a beta release now.

I have mine working and it looks like others are not far behind. My thanks to Mike G7GTN who designed both the MK1 and MK2 PCBs and also wrote the Arduino code to provide the Vmix Midi interface.



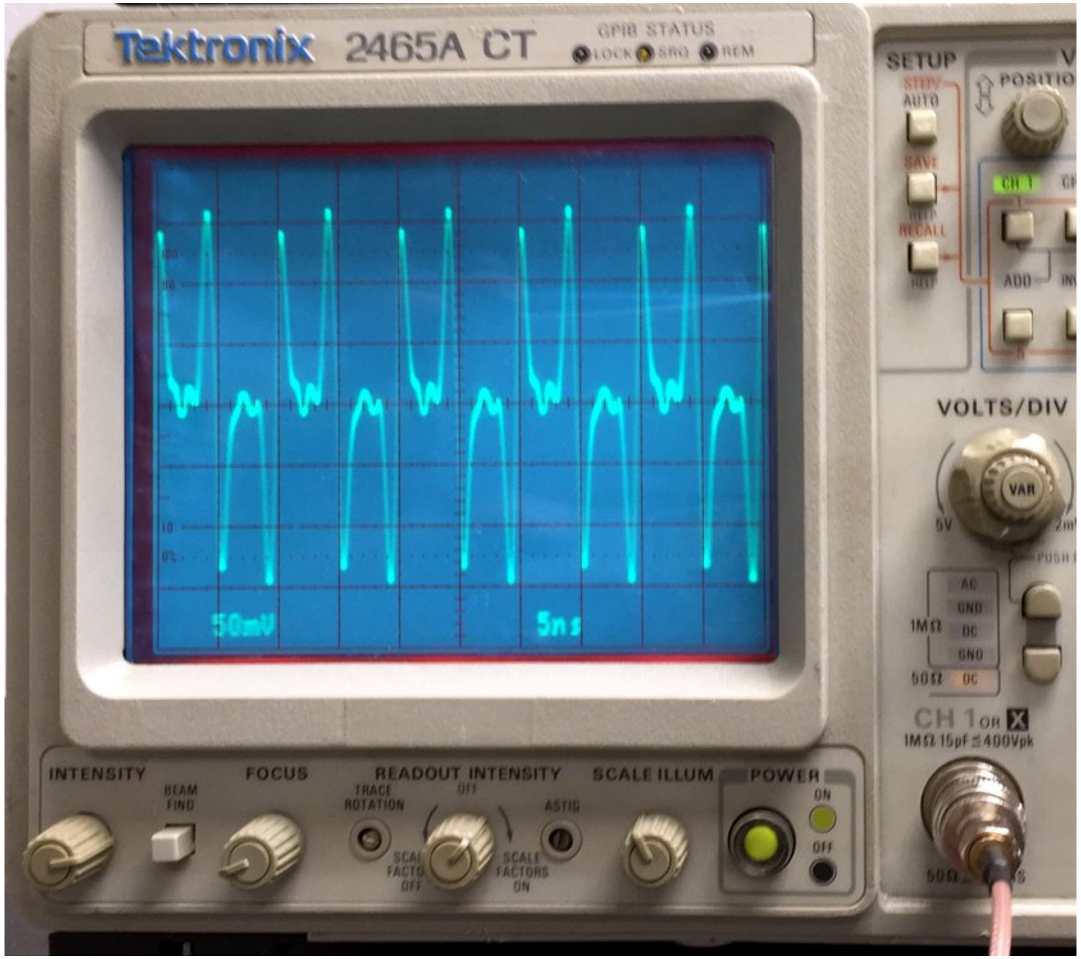
Phase Noise Issue Resolved for ADF-5355

Written by Jim Andrews, KH6HTV
Reproduced from Boulder Amateur Television Club TV Repeater's REPEATER March, 2021

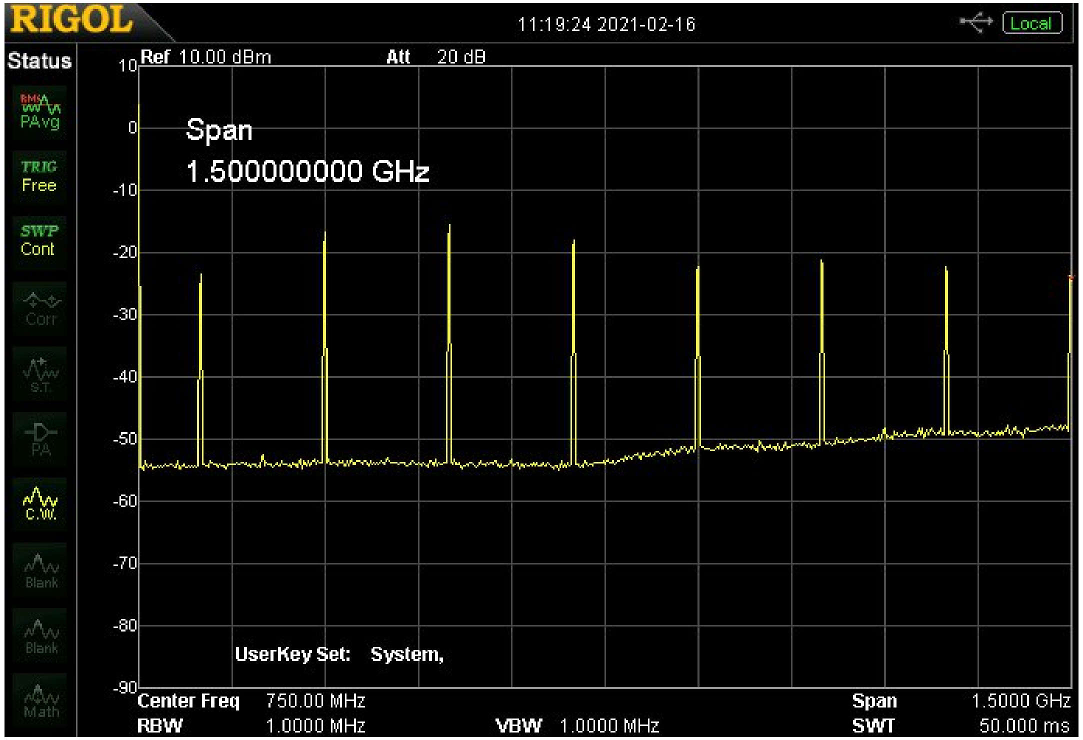
In the previous issue #69 newsletter, we reported that Pete, WB2DVS, was working on an improved version of the ADF5355 frequency synthesizer. Pete is designing his own Arduino controller, etc. to control an ADF5355 pc board. In particular, he reported improved phase noise performance with some modifications he made. This is now a follow on with more details.

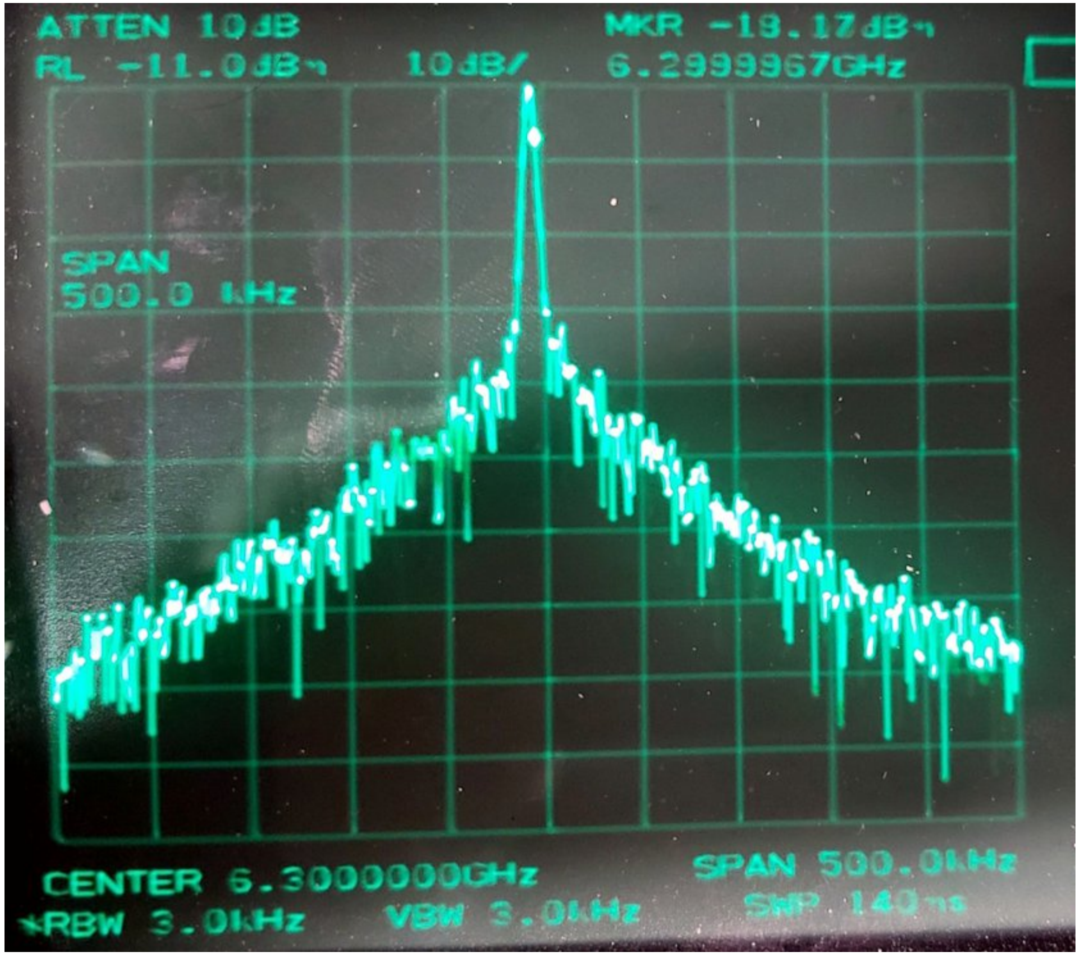
After Pete's inital report on our ATV net, I asked him to look at the ADF5355 signal generator I had purchased online. I originally had planned to use it as the local oscillator (LO) in my home-brew, 5.8 GHz Transverter. I gave up the idea because I found it had excessive phase noise which seriously degraded the receiver sensitivity, compared to using an old Frequency West brick oscillator.

The unit I purchased and Pete tested is pictured above. It was purchased from E-Bay for $159. There is no manufactuer's label, nor model number except for the ADF5355 label shown. These come from China. ADF5355 is an Analog Devices part number (*www.analog.com*) for a frequency synthezier IC.



ADF-5355, 100 MHz waveform at 5ns/div





and spectrum sweep to 1.5 GHz

The ADF5355 tunes from 54 MHz to 13.6 GHz. There are three SMA outputs on the rear panel. They are labeled A+, A-, & B. The frequency is programmed as FA shown on the lower line in the display. The five push buttons are for programming the frequency. They are from left to right. <--, up, enter, down, & --> The frequency FB (SMA output B) is then computed as a multiple of FA. To set frequency FB, enter

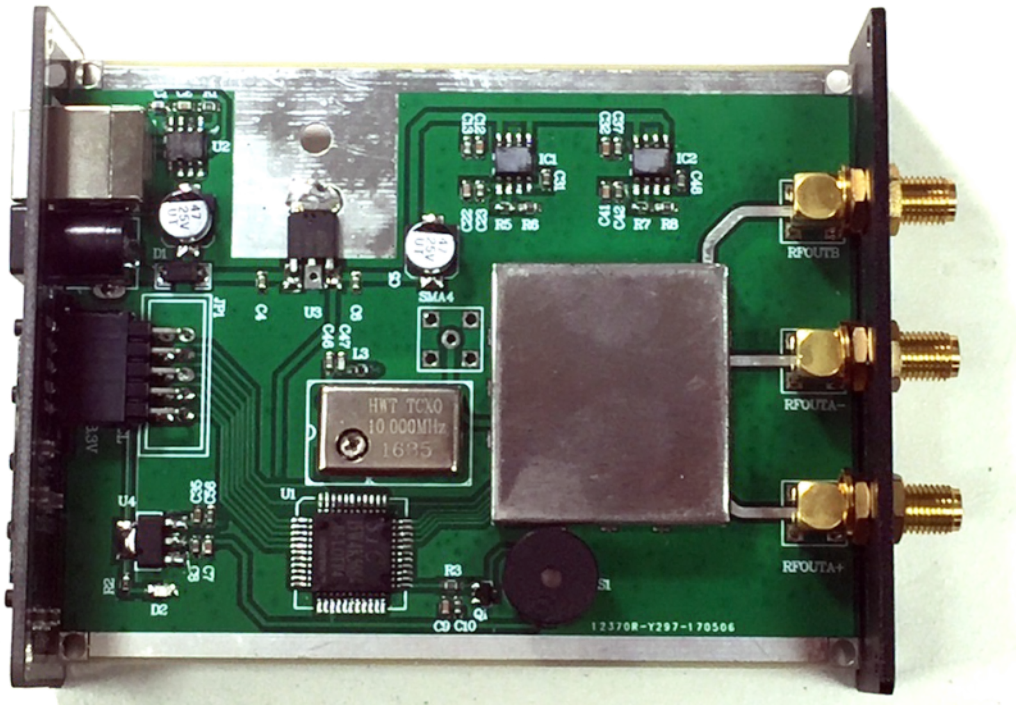
The SMA A output waveform is definitely not a sine wave, nor a square wave. It is a very sharp doublet as shown in the oscilloscope trace on the previous page with the synthesizer set to 100 MHz. It is very rich in odd harmonics as shown by the spectrum analyzer plot (top right).

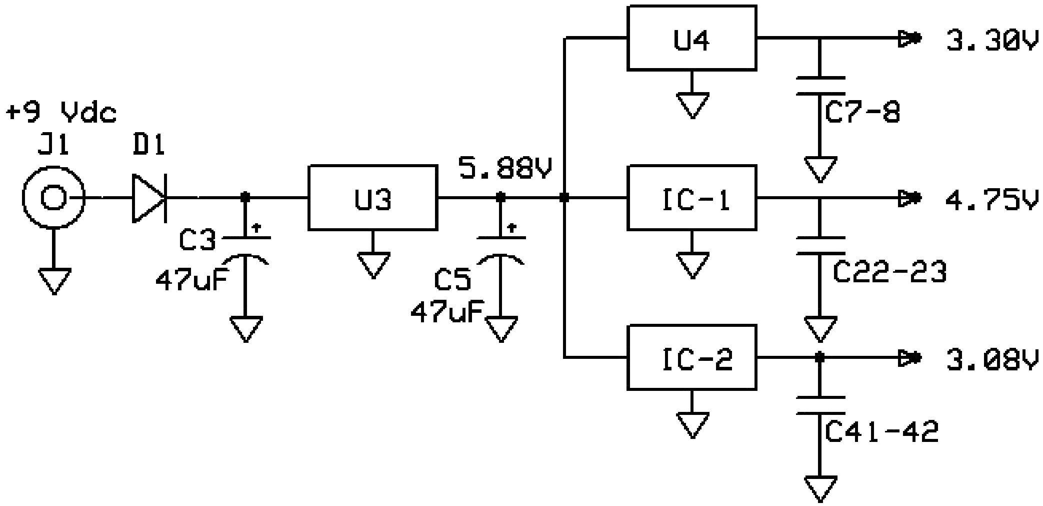
Pete, WB2DVS, studied this synthesizer at the high end of the FA frequency range at 6.3 GHz using his Hewlett-Packard model 8561E spectrum analyzer.

His test settings were using a span of 500 kHz with resolution and video bandwidths of 3 kHz. Here is what he saw on this ADF5355. Note the excessive phase noise sidebands which start to break away from the CW carrier about -35dB down.

Pete had studied carefully the Analog Devices spec. sheet for the ADF5355. He suspected that the culprit was excessive noise on the power supply lines. Pete then decided to investigate the power supplies within the ADF5355 box.

This schematic shows what he found. The pc board was well laid out and all components were labeled. The DC input is labeled for +9 to +12Vdc.





It is followed by a reverse polarity protection, series diode. This then goes to a first stage, linear voltage regulator, U3, whose output is 6 V (5.88V). The 6 V buss is then further regulated by three other linear regulators U4 (3.30V), IC1 (4.75V) and IC2 (3.08V). The ID marks on these regulator had all been ground off. But looking at the package details, Pete figures that the IC1 and IC2 regulators were probably low noise, Linear Technology LT-1763 ? Pete noted that the voltage regulators that seem to be LT1763 with the numbers sanded off have outputs that are out of spec for those parts. They are also just barely in spec for the ADF5355. The one that measures 3.08V should be 3.3V and the one that measures 4.76V should be 5V.

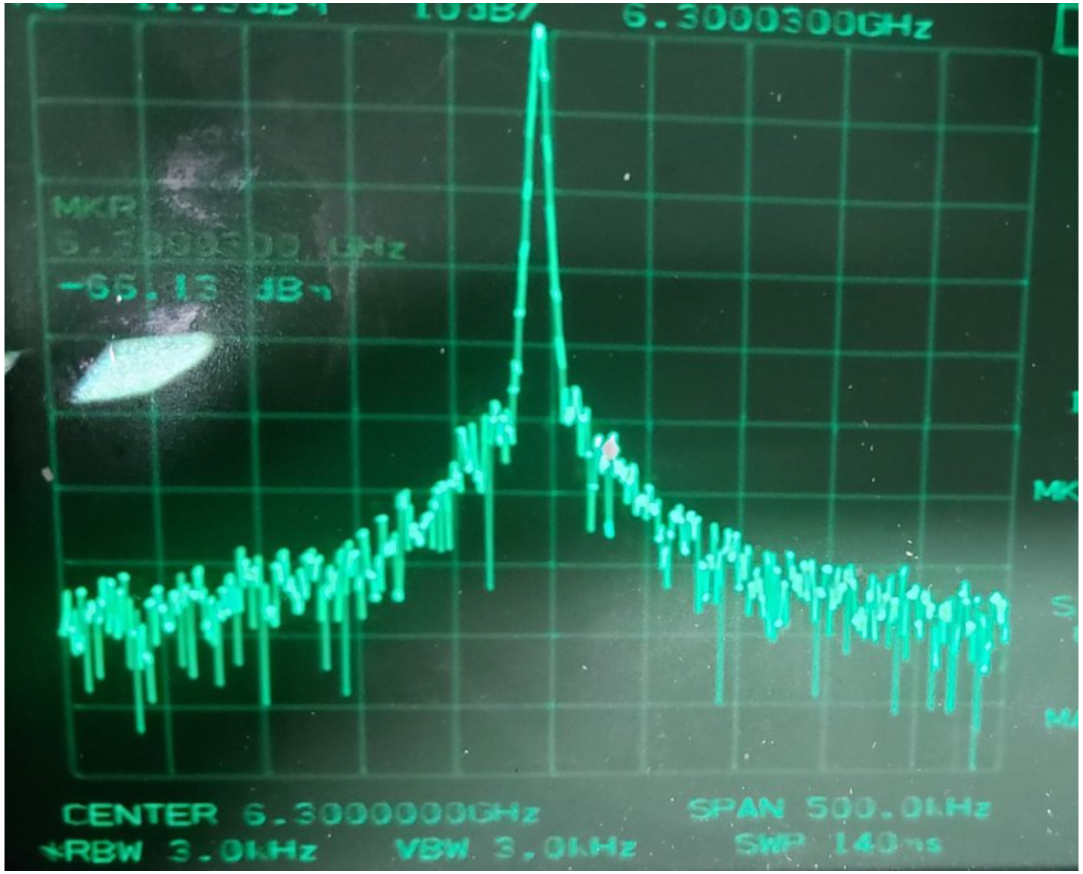
The input and output capacitors on U4, IC1 & IC2 were all very tiny SMD caps and thus probably did not have very large µF values. Pete then found that the 4.75 V output was the most responsible for causing the phase noise seen on the above 6.3 GHz spectrum.

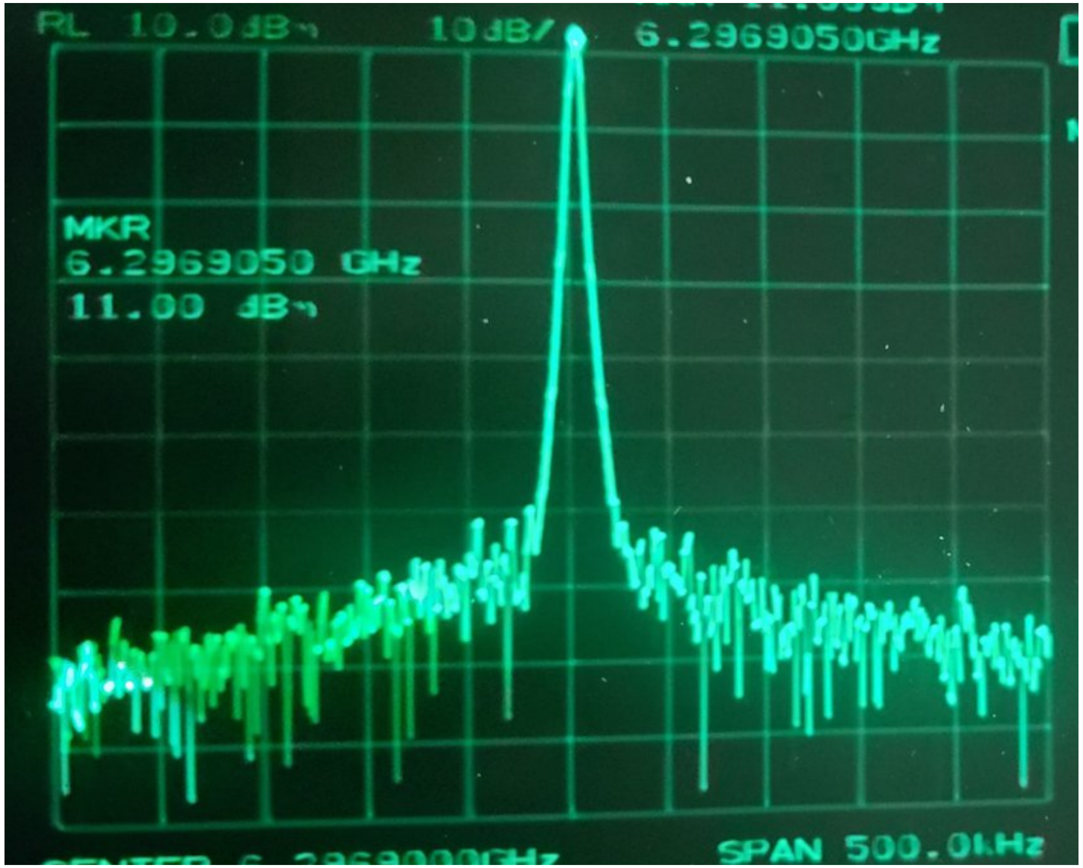
He found if he added a really large 1000 µF capacitor across IC1's output that the phase noise was greatly reduced as shown in the photo on the next page.

The phase noise has been greatly suppressed. It breaks away from the CW carrier now about -48dB down, as opposed to only -35dB before modification.

For comparison, Pete also measured an old, 6.3 GHz, California Microwave, brick oscillator. This is seen in the photo (top right - next page) to be exceptionally clean. The phase noise break point from the CW carrier is about -65dB down.

It should be noted that Pete also found these old brick oscillators to be very susceptible to power supply noise. The plot was measured using a very clean, -20Vdc from a linear regulator power supply. When Pete used a switching power supply for the -20Vdc, strong harmonics of the switcher's frequency were seen on the spectrum as sidebands about -50dB down. Pete also observed that the brick oscillator drifted with warm-up, whereas the ADF5355's frequency was quite stable.



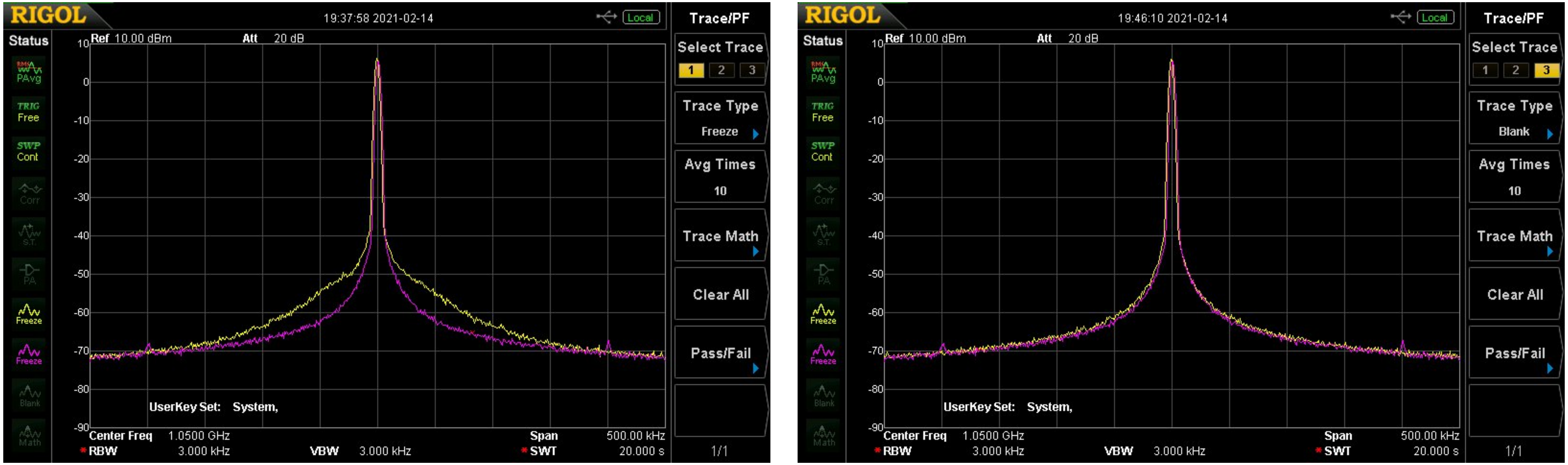


ADF5355 after adding the 1,000 µF cap to IC1 --- 6.3 GHz center freq. 500 kHz span, 3 kHz BW. The phase noise break point is about -48dB down.

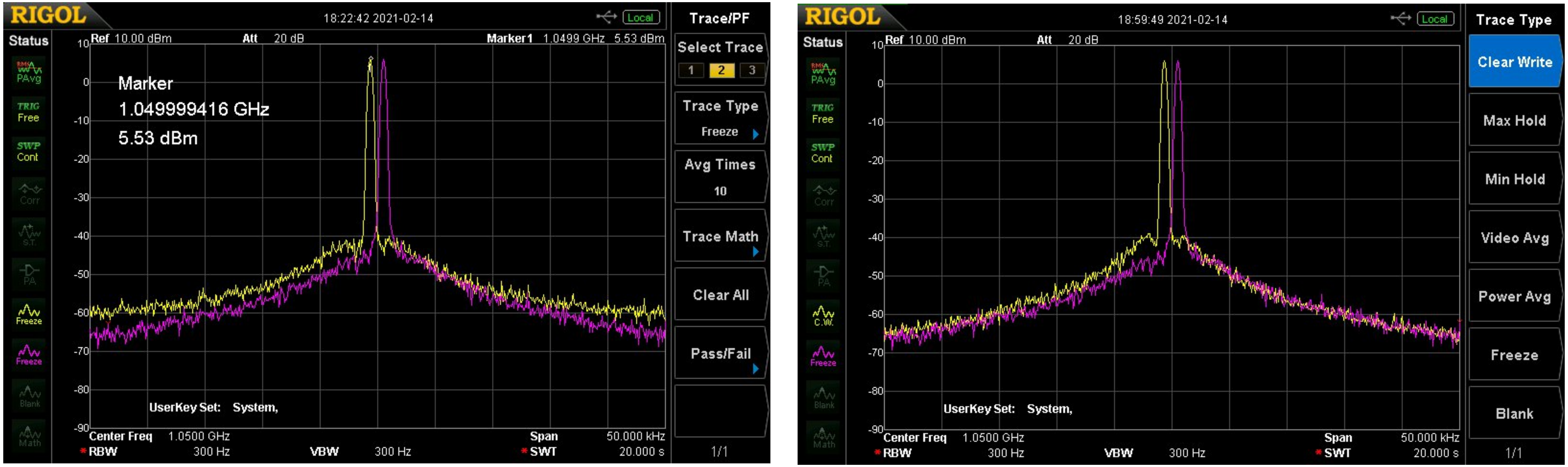
So, after Pete returned my ADF5355 signal generator to me, I was curious to see what I could also measure. I did not have a spectrum analyzer that would go up to 6 GHz. I own a Rigol DSA-815 spectrum analyzer which goes up to 1.5 GHz. I also have a Fluke 6060 B/K signal generator which goes up to 1050 MHz.

So, I set up my ADF5355 generator to 1050 MHz and compared before and after modification spectrums using Pete's same settings of 500 kHz span and 3 kHz bandwidth. The above photos show the ADF5355 compared to the Fluke signal generator. The right photo (next page - top) shows the trace of the modified ADF5355 is now identical to the high quality Fluke signal generator.

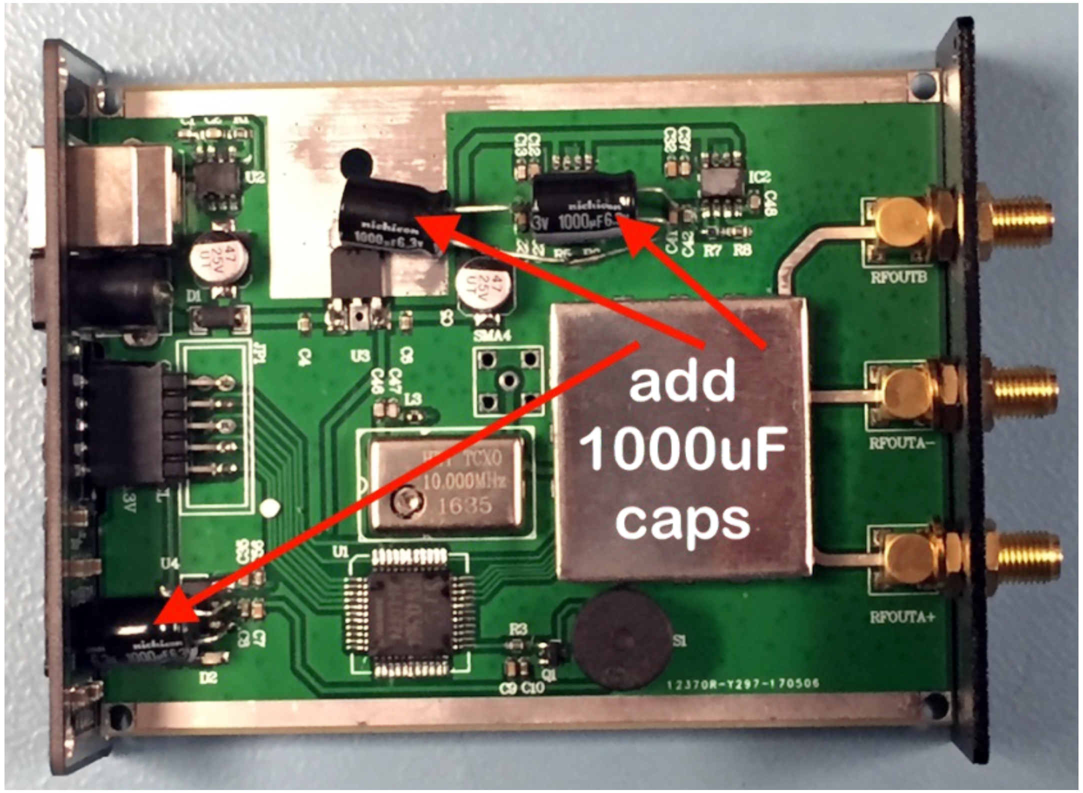
I also examined the really close in phase noise of the ADF5355 and the Fluke generator (next page - bottom). I did detect a bit higher phase noise on the ADF5355 compared to the Fluke within ± 5 kHz. I then decided to see if adding big, 1000 µF caps also on IC2 and U4 would help. They did help slightly by a couple of dB. The greatest improvement was the 1000 µF cap on the 4.75 V supply, IC1, as Pete had found. Note, the two traces are not exactly centered. This is just the slight frequency offset error in the two generators compared to the spectrum analyzer. They all do use internal TCXO, 10 MHz reference standards.



ADF5355 (yellow trace) & Fluke 6060 (magenta trace). 1050 MHz center freqency, 500kHz span, 3 kHz bandwidth. Left photo is unmodified ADF5355. Right photo is after modification.



ADF5355 (yellow trace) & Fluke 6060 (magenta trace). 1050 MHz center freqency, 50kHz span, 300 Hz bandwidth. Left photo is unmodified ADF5355. Right photo is after modification.



This photo shows the simple modification made to the ADF535 signal generator. It only consisted of adding three, 1000 µF, 20%, 6.3V, electrolytic capacitors on the outputs of U4, IC1 and IC2. The capacitors I used were made by Nichicon. The part number is: UVR0J102MPD. They are available from both Mouser and DigiKey.

Now for the acid test for the modified ADF5355. I tried it out in my 5.8 GHz Transverter. I measured the receiver sensitivity first with the existing Frequency West brick as the LO and then using the ADF5355. They were identical! Thus, the phase noise improvement was sufficient to allow use of a modified ADF5355 as the LO, rather than the older bricks.

Thank You Sir Peter, WB2DVS, for this break through! ! !

QO-100 All Modes Station Mixed Remote Station Based on SDR ADALM-PLUTO

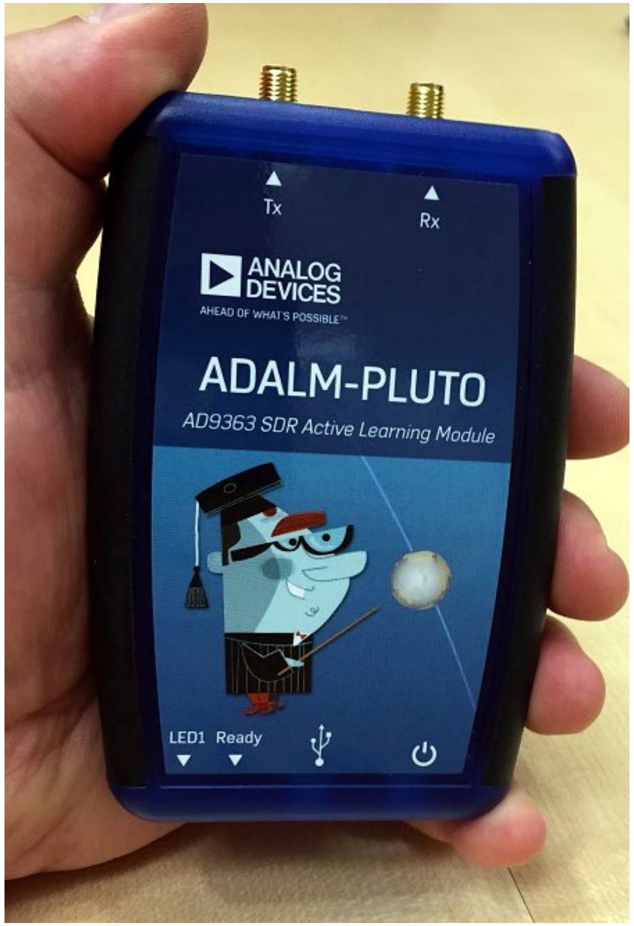
Written by Lucien Serrano, F1TE

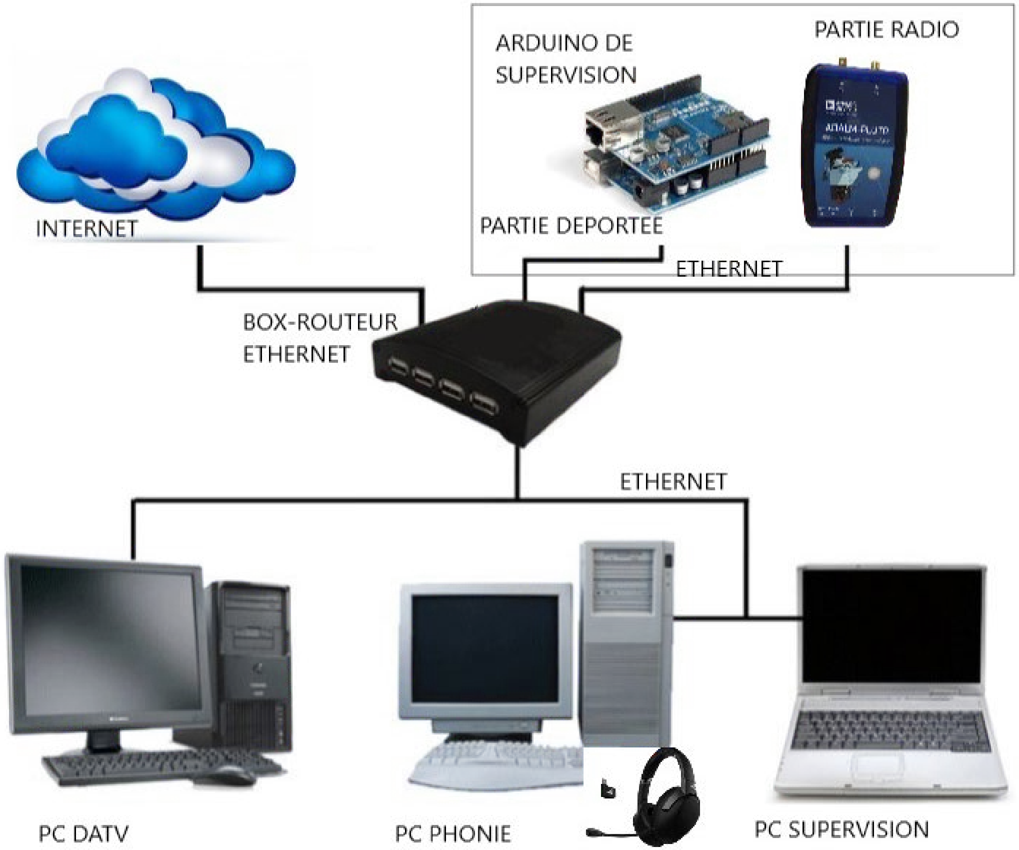
Originally published in the Radio-REF review, April 2021

The QO-100 geostationary satellite has two transponders, one "narrow band" for voice and digital and the other for "wide band" which is suitable for digital television. Both transponders have their inputs in the 2400 MHz band and their outputs is in the 10 GHz band. For digital modes a computer is essential. Radio amateurs have explored many communication systems, digital television being a prime example. DATV requires between ten and twenty times less spectrum space than older analogue transmissions. Radio has become "software" and the "genius" of amateur radio has moved to computer coding.

The engineers and technicians who used to make our transceivers have made room for others who now develop products using SDR platforms. Compared to a traditional radio, the signal received by the antenna is rapidly digitised, often involving a change of frequency using analog-to-digital converters. Numerous articles covering software radio have been published by F5NB. One thing that does not change is you will still need power amplifiers and antennas dedicated to the specific frequencies in use.

The goal is still to have a station that is as simple as possible and capable of transmitting to the QO-100 satellite. The "radio heart" of this dedicated QO-100 station is an ADALM-PLUTO SDR transceiver.





This simplified diagram shows that the radio section. Most of the kit need not be in the shack since data transmission (image, sound, etc.) is done by Ethernet cable, the length of which can easily reach 100 meters without any amplification or relay equipment.

This layout is useful for reducing the length of the coaxial between the AP and the 2.4 GHz source.

Several PCs are shown to accommodate the different programs, but in reality they can all be done on one PC since the traffic on the two transponders, narrow band or wide band DATV, are exclusive because the RF part is common.

Summary Description of each Module

The Ethernet router box is used to connect the various elements by 8-core shielded cable, and conventional RJ45 plugs. This allows among other things, remote access via the Web, both to the radio part and to the Arduino supervisor. Only RJ45 cable connections are used, the Wi-Fi connections turned out not to be good enough.

The DATV PC is equipped with a Minitiouner receiverPro2 (see CQ-DATV 92) this is connected by USB. Decoding and viewing of the images received is done with F6DZP software.
The PC also allows the generation of a video streaming using OBS or VMIX. This is the software that will stream images to the SDR transceiver IP ADALM-PLUTO where the 2.4 GHz the RF signal originates

The PC audio sends traffic on the transponders narrow band using SDR CONSOLE software from G4ELI. It arbitrates with the ADALM-PLUTO SDR in IP for the transmission and reception of sound or data.

The supervision PC is in fact a simple Internet browser that opens a web page that the ARDUINO module generates to ensure control of the voltages necessary for the radio part by means of relays controlled by this web page. This also allows feedback information on RF status, output power, SWR and other analogue measurements, as long as the sensors have been installed in the radio part. The ARDUINO supervision module is made up of made of three modules that can be found ready-made in the ARDUINO series:

1. *the ARDUINO itself, which is a programmable microprocessor supporting a web miniserver;*

2. *an "Ethernet shield" that connects to it and allows connection to the network by RJ45 cable;*

3. a relay card which allows control of the voltages necessary for the radio part, which can therefore be fully remotely controlled via the web.

The Radio part consists of:

1. an ADALM-PLUTO SDR;

2. a USB-Ethernet adapter for its connection to the network;

3. 2.4 GHz RF Power Amplifiers

4. a 12 V voltage injector on the reception channel ADALM-PLUTO for powering the 10 GHz LNB.

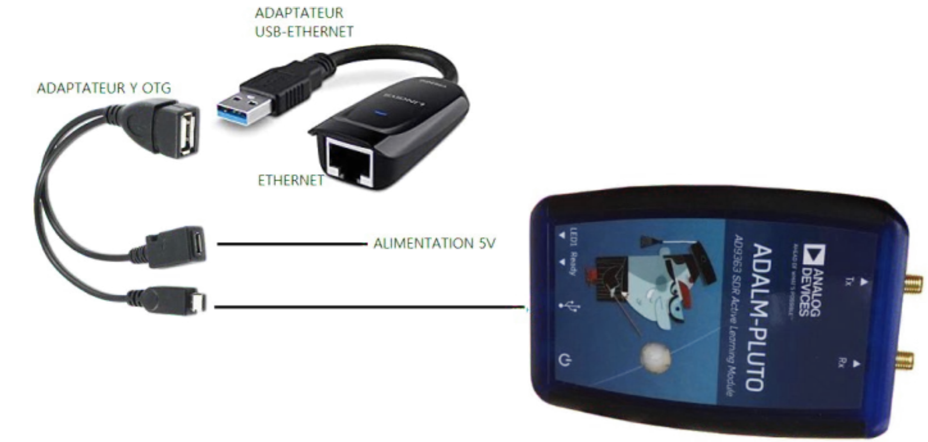
These are not shown on the diagram of the satellite dish(s) their sources are adapted to the frequencies used for the uplink and downlink, apart from the DATV Minitioune reception software which must run on the PC connected to the MinitiounerPro2 receiver, all other programs can run on any other PC connected to the network.

The Antenna and the Dual Source

This is a prime-focus 180 cm dish.

For the dual-band source, I adapted the LNB by clamping an Octagon with two outputs into the circular waveguide of the original source of the dish. The RX 10 GHz port is located in the centre of the 2,400 GHz helix’s reflector. The two outputs of the LNB allow Narrowband transponder independent reception to PLUTO through an injector and DATV to the MinitiounerPro2 receiver.

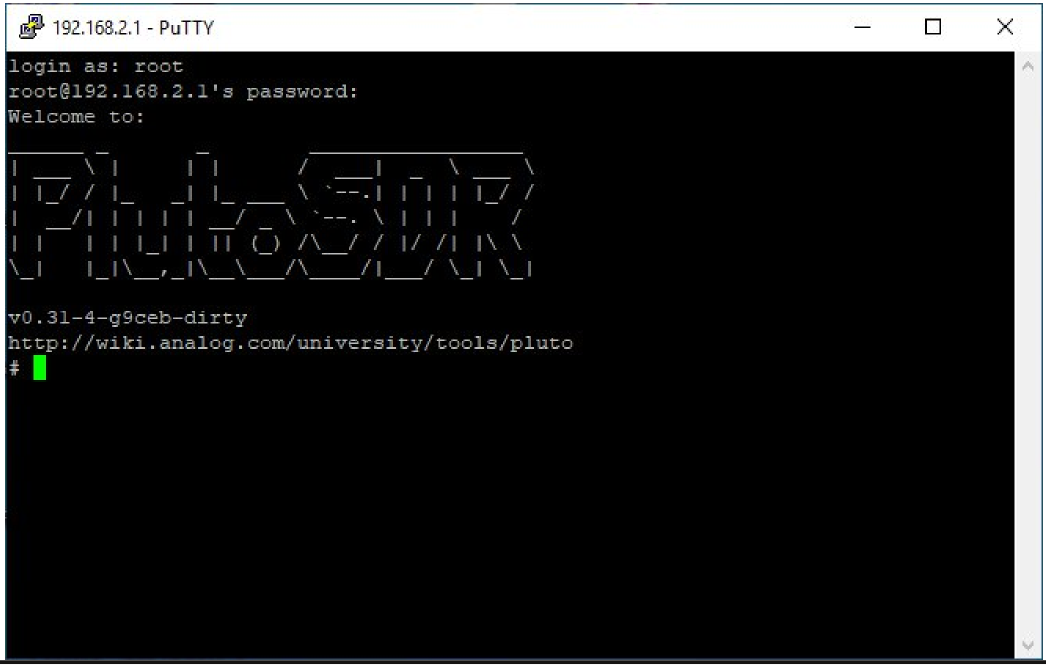
The ADALM-PLUTO SDR in IP Connection



We need to connect the PLUTO transceiver by IP over Ethernet using an adapter. I used a Linksys USB3GIG and a USB-OTG Y cable allowing an external power supply to power PLUTO. The adapter's RJ45 connector allows connection on the local network of your box, or directly or through the relay router.

Modification of Pluto

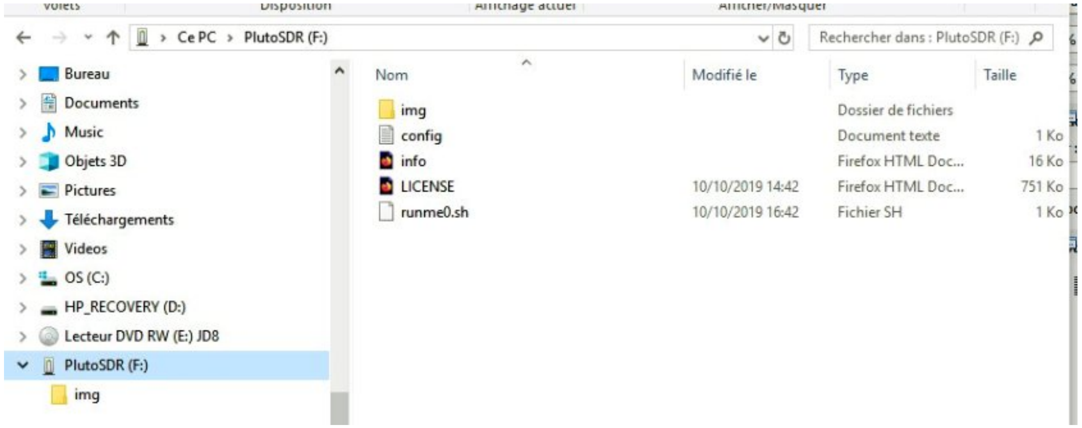
The PLUTO is a continuous coverage transceiver from 325 MHz to 3.8 GHz. It is therefore perfectly suited to frequencies from our satellite. Its hardware is minimum, and this is reflected in its price. Above all, it is designed as an educational tool for development. It is necessary to make some minor modifications to it to suite our traffic criteria. The first changes relate to stabilisation. Its internal clock and its external shielding to avoid firmware freezes and crashes in an RF environment. PLUTO has an embedded Linux OS and it is possible to connect to it in console mode via a SSH connection on its IP address. The default login is "Root" with the password "analog".

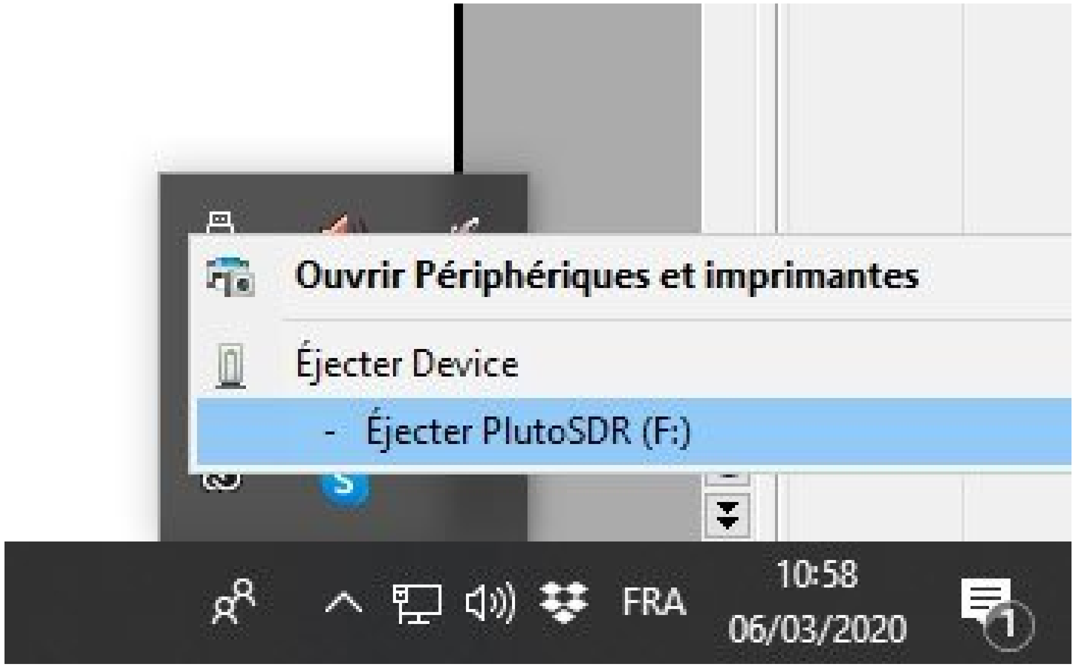


To use in DATV, it is necessary to install a specific firmware developed by F5OEO.

Flashing Procedure

You must retrieve the file provided by F5OEO at the address: *https://tinyurl.com/y6g7khv3* and copy it to the virtual drive mounted by Windows during login to the USB port, then when done, eject the device.





In particular, do not unplug the PLUTO when LED1, located on the left of the device flashes quickly, the flashing time lasts several minutes. Once the firmware is installed we will have installed on the PLUTO a PSK type modulation service from a "TS" stream which will be sent to it by the IP network on a specific UDP port.

Another flashing procedure is possible for Linux specialists.

```
login as: root
root@192.168.1.xxx's password:
Welcome to:
______ _       _        _____ ____________
| ___ \ |     | |      /  ___|  _  \ ___ \
| |_/ / |_   _| |_ ___ \ `--.| | | | |_/ /
|  __/| | | | | __/ _ \ `--. \ | | |    /
| |   | | |_| | || (_) /\__/ / |/ /| |\ \
\_|   |_|\__,_|\__\___/\____/|___/ \_| \_|

v0.31-4-g9ceb-dirty
http://wiki.analog.com/university/tools/pluto
#
# wget http://qra.f5oeo.fr:2080/pluto.frm
Connecting to qra.f5oeo.fr:2080 (86.254.181.124:2080)
pluto.frm            100% |********************************| 28.1M  0:00:00
ETA
# ls
autoudp.sh      luaradio        pluto.frm       radar           scream-raw
bigtspipe       makepatern.sh   pluto_dvb       rtmppluto.sh    tspipe
hacktv          patern.png      plutotx         rx2tx           udpts.sh
# pwd
/root
# mv pluto.frm /tmp
# cd /tmp
# update_frm.sh ./pluto.frm
```

You must connect to PLUTO in console mode as indicated above. The wget command is used to retrieve the file from the URL where the new firmware file is stored at F5OEO. We put this file in a temporary / tmp directory and we launch the update_frm.sh command which executes the flashing. This procedure should be left to specialists familiar with Linux.

Configuring the IP Network for use with SDR-Console.

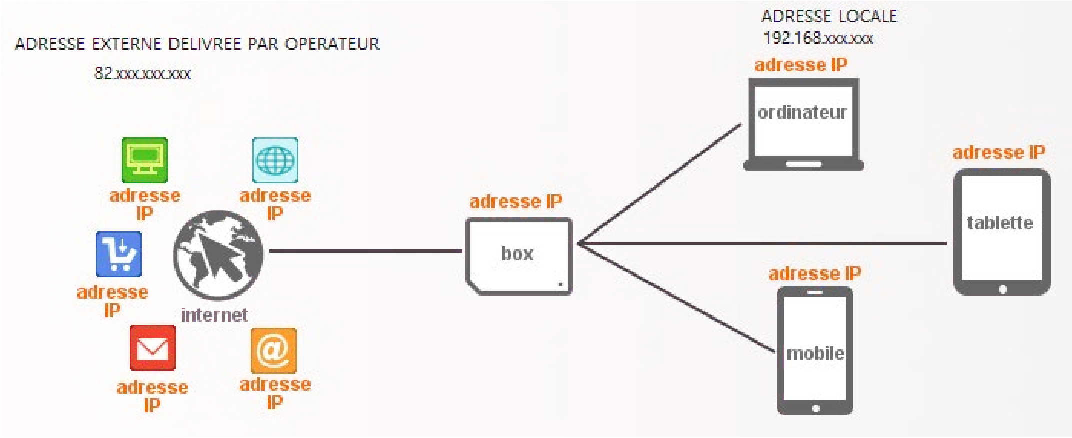
Here is the setting in the ADALM-PLUTO config.txt file.

```
# Analog Devices PLUTOSDR Rev.B (Z7010-AD9363)
# Device Configuration File
#   1. Open with an Editor
#   2. Edit this file
#   3. Save this file on the device USB drive
#   4. Eject the device USB Drive
# Doc:
https://wiki.analog.com/university/tools/pluto/users/customizing

[NETWORK]
hostname = pluto
ipaddr = 192.168.2.1
ipaddr_host = 192.168.2.10
netmask = 255.255.255.0

[WLAN]
ssid_wlan =
pwd_wlan =
ipaddr_wlan =

[USB_ETHERNET]
ipaddr_eth =
netmask_eth = 255.255.255.0

[SYSTEM]
xo_correction =
udc_handle_suspend = 0

[ACTIONS]
diagnostic_report = 0
dfu = 0
reset = 0
calibrate = 0
```

It can be found as an ASCII file in the virtual drive that is mounted when you connect ADALM-PLUTO via USB to your PC.

If you leave the ipaddr_eth = parameter blank, PLUTO will get an IP address from the DHCP server (Dynamic Host Configuration Protocol). Check your router for the IP address assigned to the PLUTO.

It is this address that should be used in the configuration of the SDR-CONSOLE software.

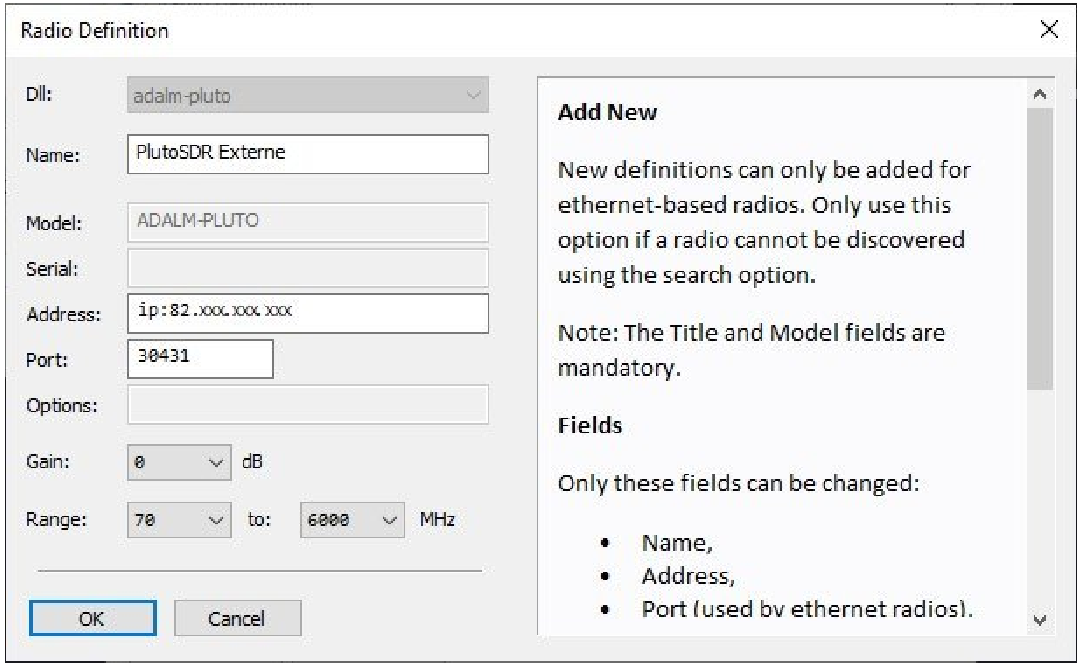


If like me you have opted for a local fixed address and not assigned by DHCP, it is this local address that you will then declare.

Each IP address has a number of software ports between 0 and 65535.

As indicated in the above setting, here port 0 is used my ISP (Free) offers me for the same price the possibility of having a fixed external address. By setting the router of the box by NAT functions (Network Address Translation) used to hide computers domestic workers behind a single public identification, it is possible to do a port routing of my external address to the same port of a local address. In these conditions, PLUTO port 30431 must be mapped to the local address assigned to it.

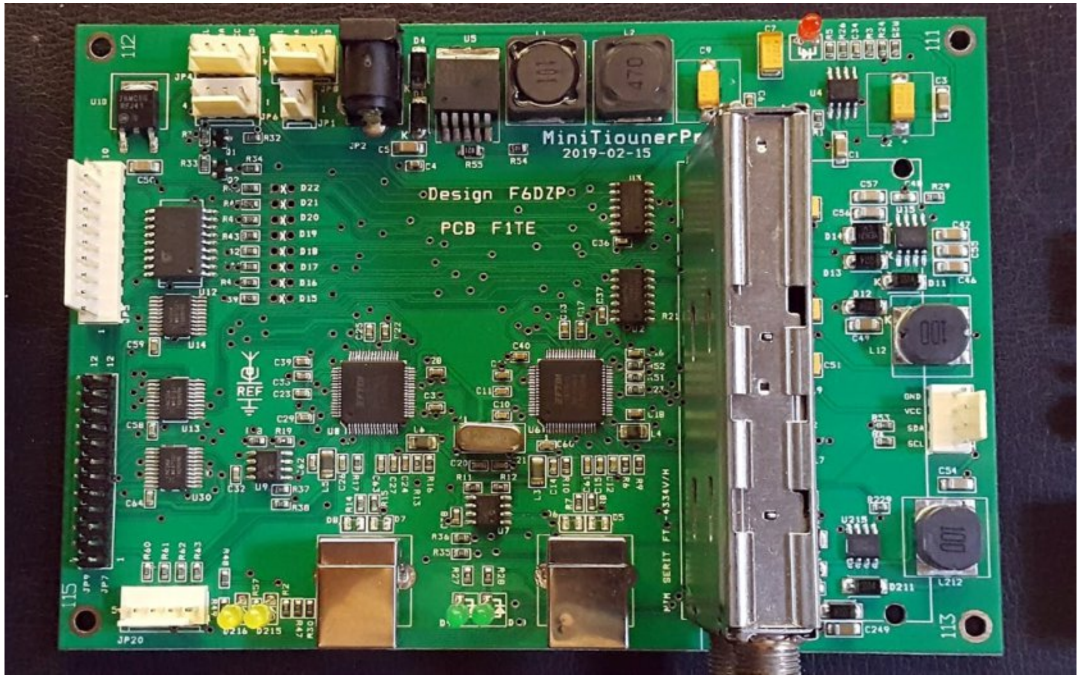
Indeed, port 0 is reserved for an external address to be used here.



If the routing is properly carried out in your box, your PLUTO will respond with the SDR-CONSOLE from anywhere on the web using the fixed IP that your ISP assigned to you, as long as the IP speed is sufficient. From experience, only fibre connections allow a correct operation in by this "remote".

Reception in DATV

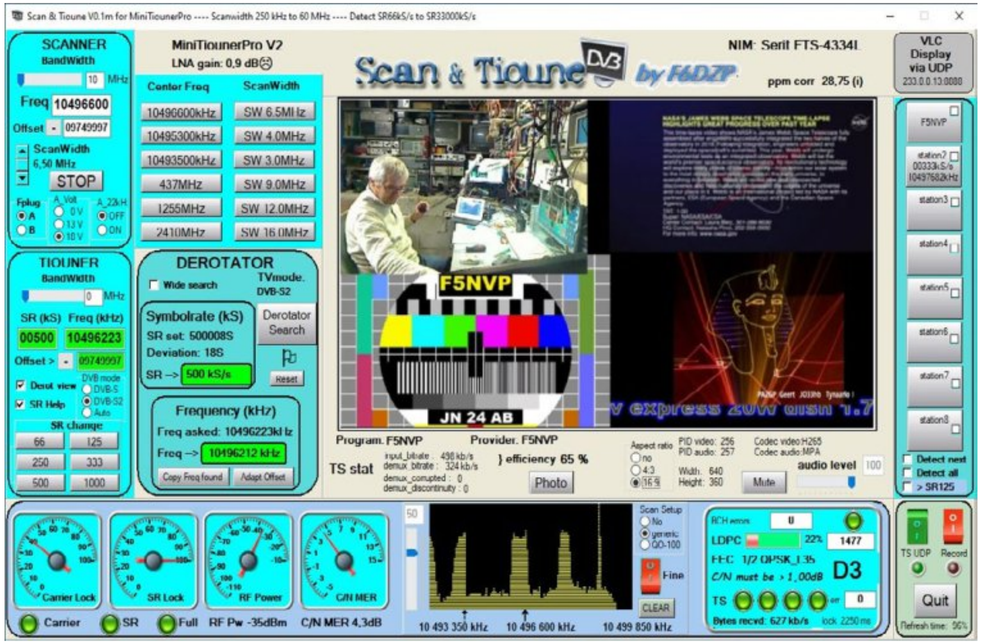
The MinitiounerPro2 receiver is used. It is available in a semi-kit at the REF store. This receiver is the result of collaboration with the original designer, F6DZP. It was described in the review (CQ-DATV 92) and to date more than 600 units have been distributed.



Here is the card fitted to the semi populated kit which includes the box. The receiver is directly connected to the PC which assigns functions by USB connection to set the LNB for reception on 10 GHz.

What is actually set up is the intermediate frequency. The LNB carries out a change of frequency with its local oscillator on 9750 MHz.

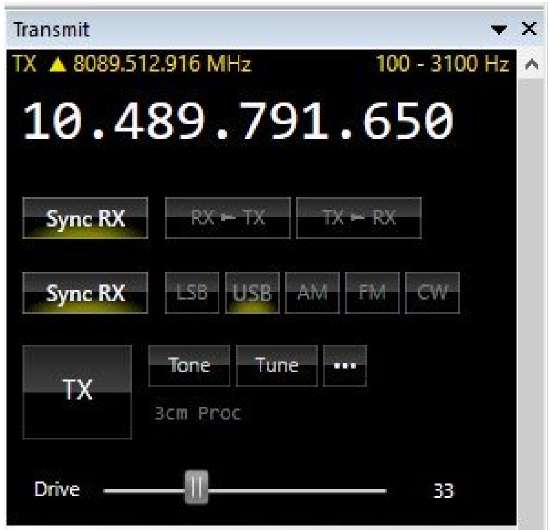
All this is managed by the different software suites of F6DZP's software which controls the 18 volt supply to the LNB to set it in vertical polarization mode required for the satellite's downlink.



Here first the beta test version of Scan & Tioune

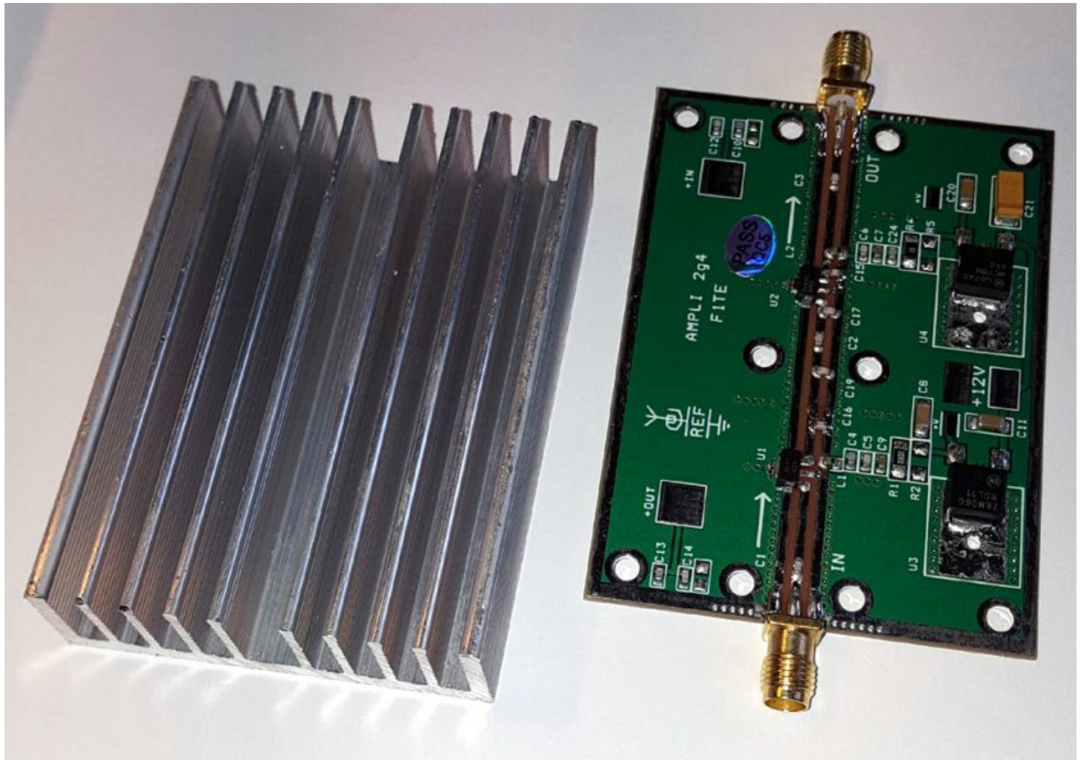
SDR-Console

Software used for speech must therefore adapt the output power of the PLUTO to avoid saturation of the satellite and a brutal call to order by the surveillance machine.



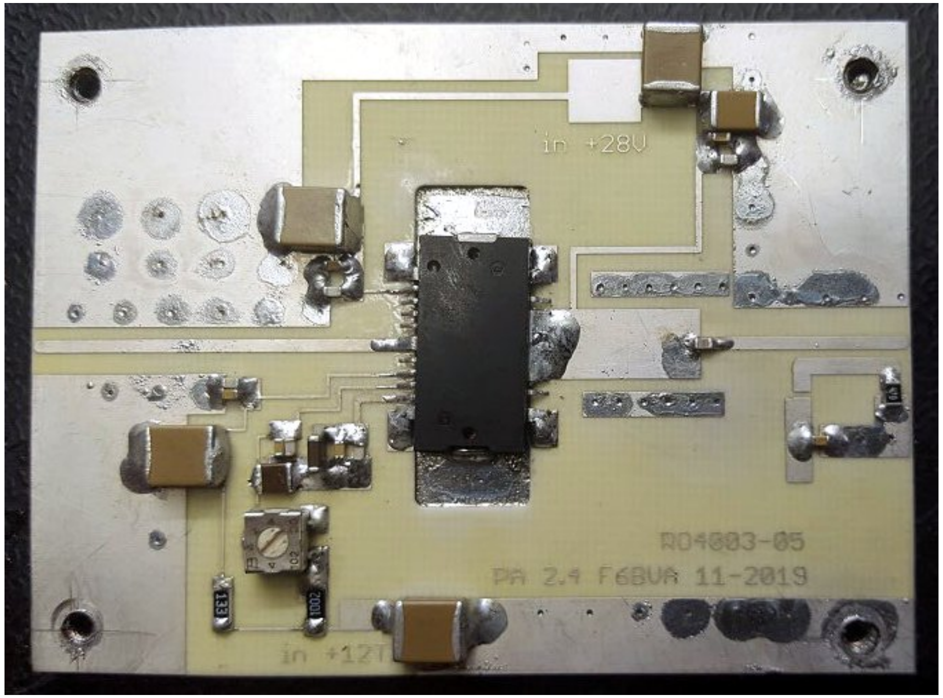
The Emission Amps

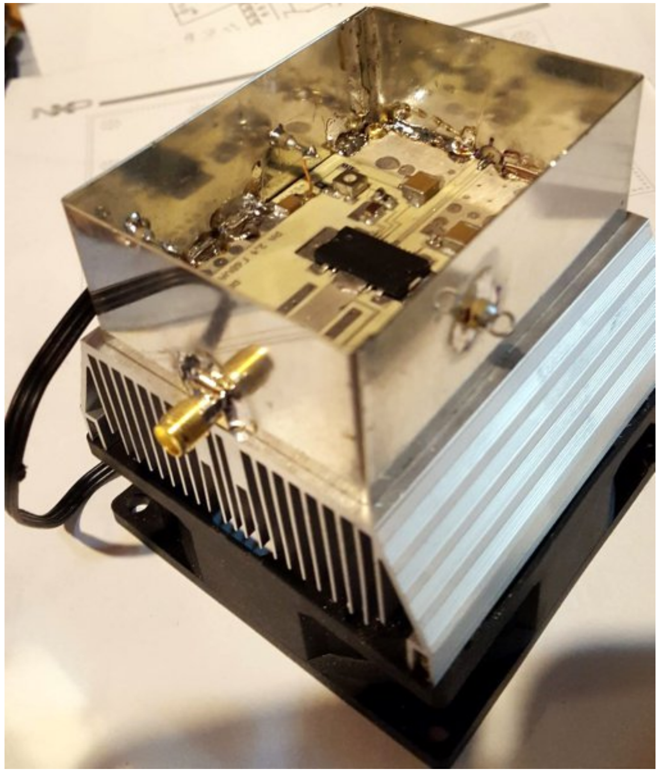
The ADALM-PLUTO transceiver delivers a maximum RF level of 0 dBm on 2.4 GHz. It therefore requires considerable amplification to achieve the required output power depending on the mode used. When using the narrow band transponder taking into account the gain of the dish used, a few watts are sufficient. For DATV on the broadband transponder, 20 watts minimum are required.



The first amplification stage uses a kit that will be shortly available at the REF store.

The gain of this two-stage amplifier is 30 dB and it allows maximum output of 1 W at 1 dB of compression, thus ensuring perfect linear amplification.

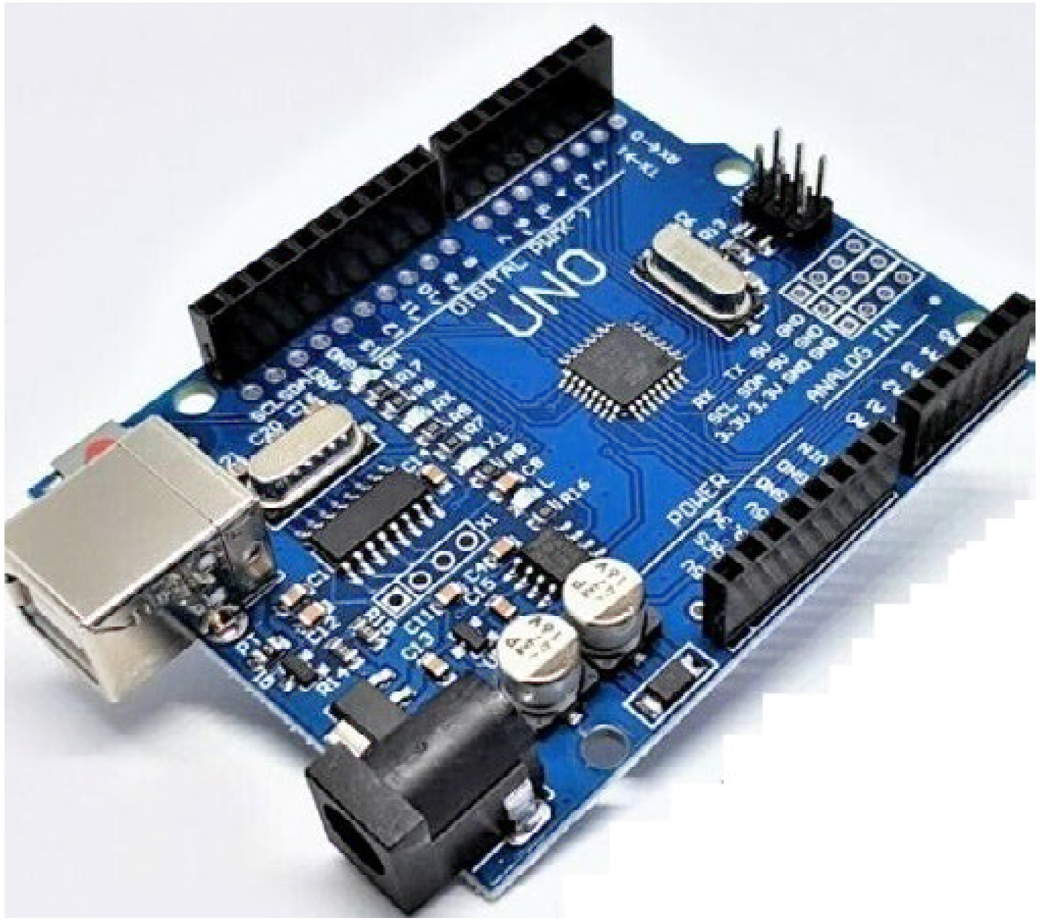


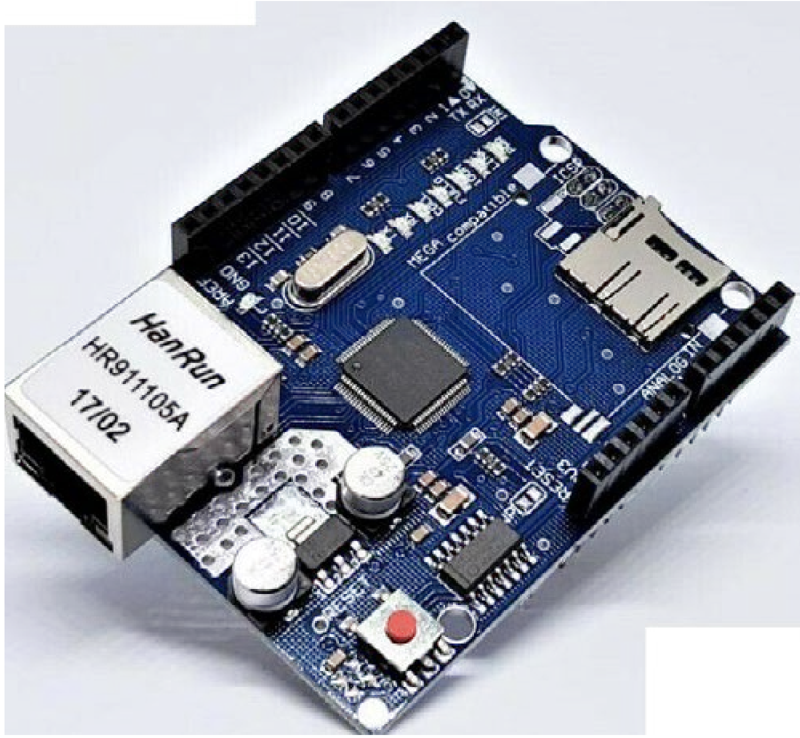


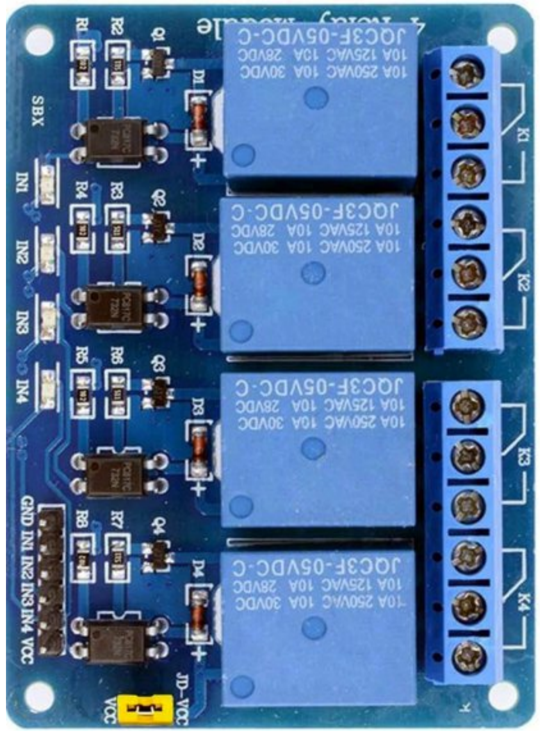
The final PA is an amplifier capable of outputting 20 W at 1 dB of compression. This is the result of the work of F6BVA. He uses an MMIC MW7IC2725N powered at 28 to 32 volts. The printed circuit board as well as the MMIC are completely welded to a 2.5 mm thick copper plate, with low temperature solder paste. Everything is then screwed onto a radiator-fan heat sync easily found on websites providing specialist online sales, eBay or Aliexpress for 4.5 €.

Control

Again, I shamelessly used the work of F6DZP who programmed an ARDUINO to control the supply voltages. The cards used are as follows:



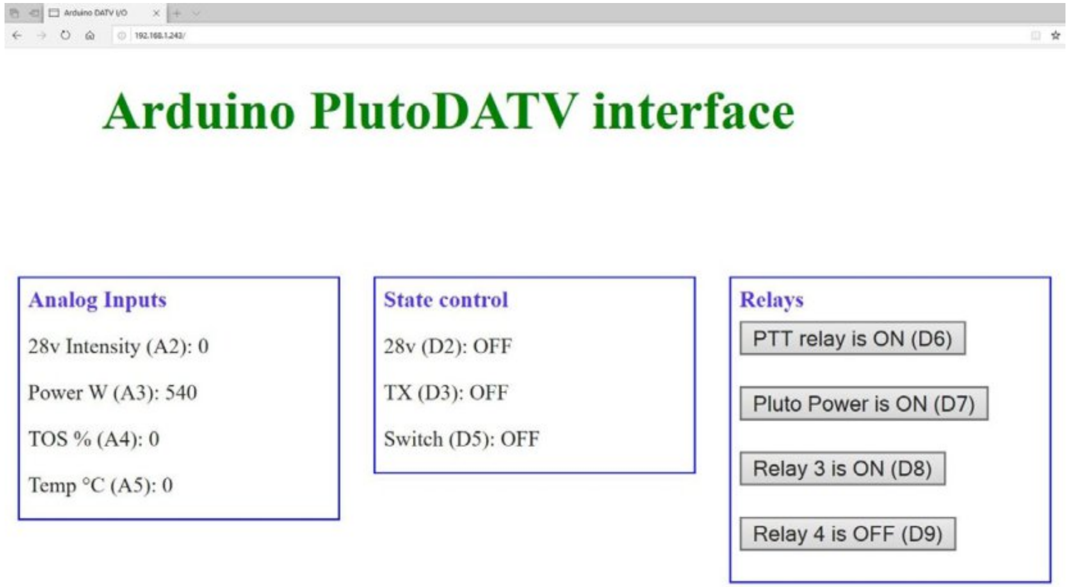




- *An ARDUINO UNO card.*
- *A Shield Ethernet card.*
- *A relay card.*

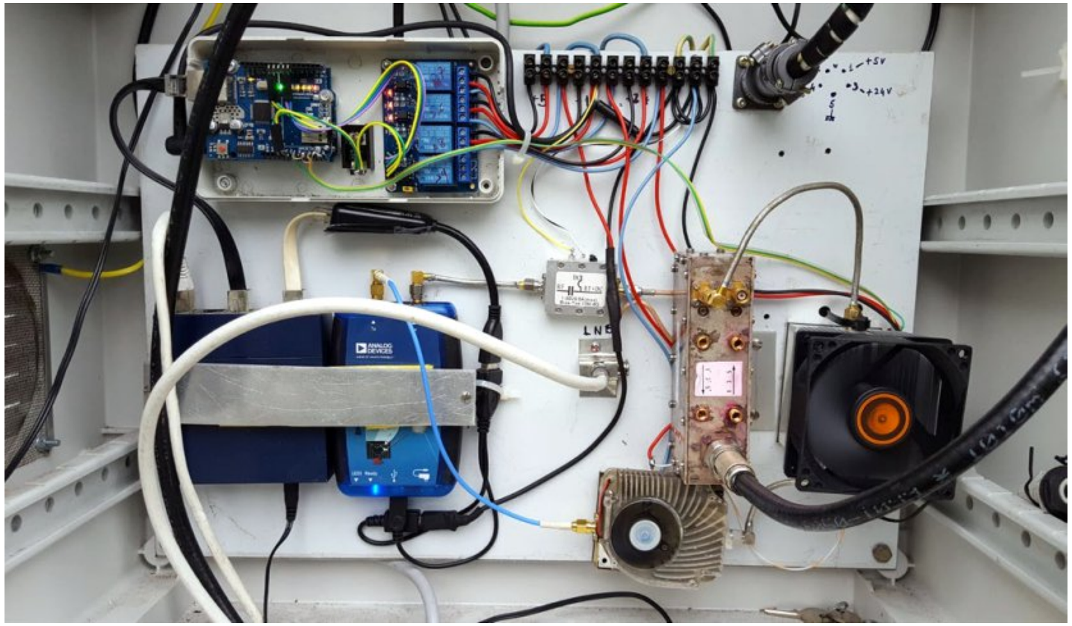
These modules are available on eBay.

The purpose of this set of cards is to have a mini local web server which will control all the voltages used by the different elements of the radio part from an accessible local URL through a simple Internet browser (see the appendix the links to the publication by F6DZP on this topic). Connected to the local network by an RJ45 connection, the locally accessible web page allows us to view and to switch on or switch off the different floors.



I have not used all the functions provided by F6DZP. Only the first three relays are wired. The PTT button applies 12 V to the first amp and PTT of the PA.

The relay 3 button energizes the +28 V of the PA.
The PLUTO power button is used to apply +5 V to the PLUTO. Only the analogue measurement of the relative power of output is wired and visible in the Analogue Input cartridge, Power (A3). Here the measurement indicates 540. These are not watts but an analogue measurement of the voltage detected by the small directional coupler integrated on the output line of the PA. A calibration in the Arduino code, for scaling this measurement, would display directly the output power, this is work in progress. The amplifier is installed in a well ventilated housing.



You can see in this photo the following building blocks.

- *All control and monitoring with the Arduino located at the top left.*
- *The relay card, which controls the various voltages grouped together on dominoes.*
- *Below, we find the PLUTO and its adapter USB-Ethernet, itself connected to a small router connected to the ADSL box of the QRA. The Arduino control module is also connected to it.*
- *On the RX input of PLUTO you can see the injector "T-bias"*

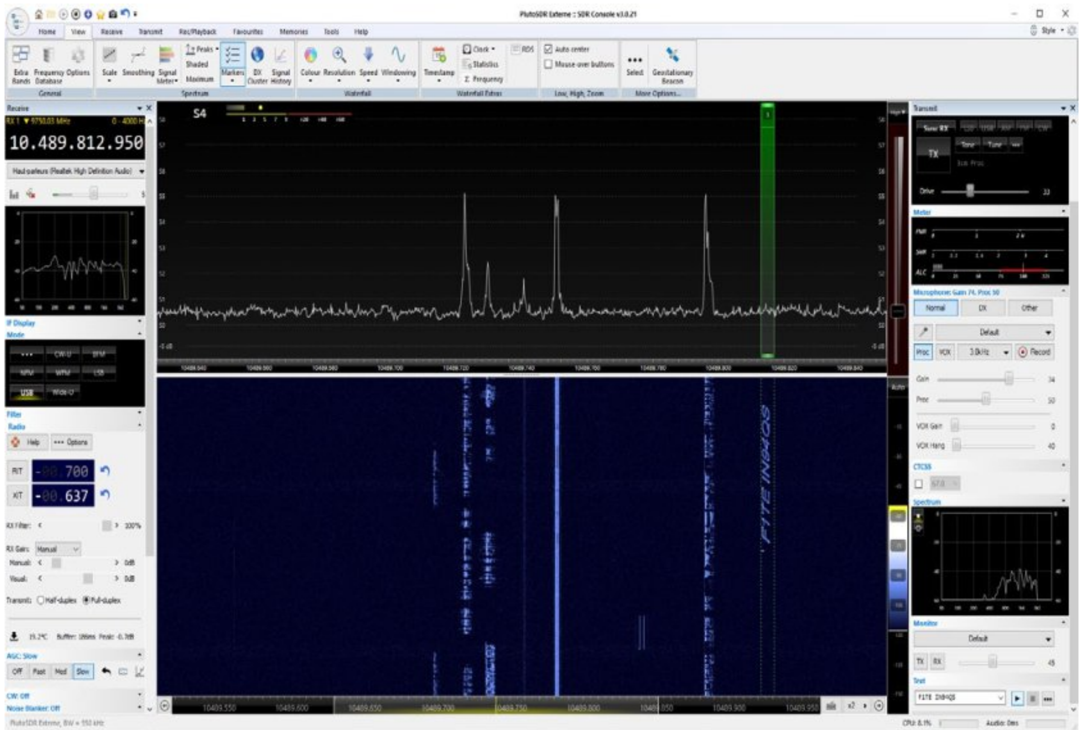
voltage which sends the +12 V to the output of the LNB.

• The first LNA is connected to the TX output of the PLUTO mounted in a ventilated box, followed by the PA 20 W F6BVA which also ventilated.

For safety, I added a 2.4 GHz filter. It came from a 1.5 GHz duplexer of recovery where one channel has been realigned to 2.4 GHz. The losses are of this are of the order of 0.2 dB.

Use of the Narrow Band Transponder (NB)

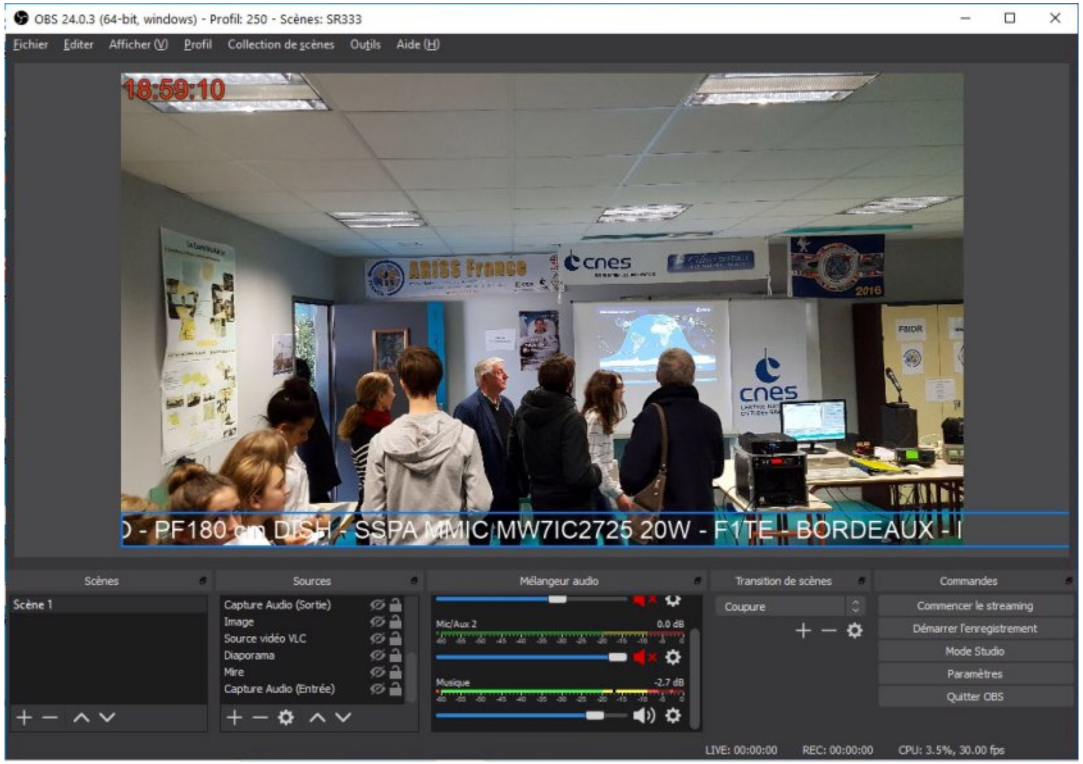
As already stated, it is the SDR-CONSOLE software that is used, by declaring it as indicated as an SDRPLUTO Radio in IP connection.



This program uses the audio resources of the PC on which it is installed, microphone and speaker. Reports from the online guide are helpful and efficient. As with other software of this type, stabilisation of the frequency to compensate for the drift of the LNB head is done by locking on to the digital beacon emitted by the satellite in the middle of the transponder band, on 10489.750 MHz. There is no need to modify the LNB head to stabilise it in frequency.

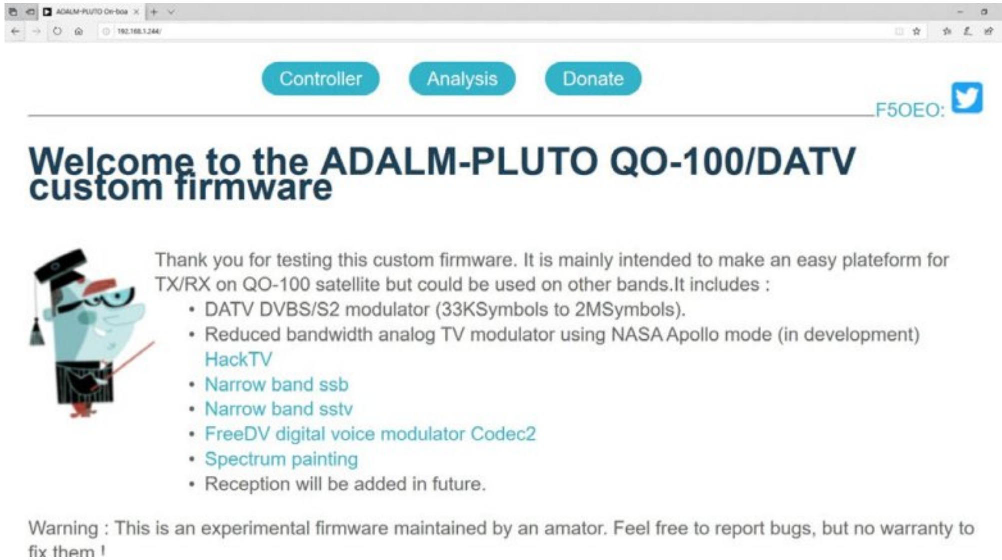
The DATV Program

We used OBS-Studio software suite to mix all the video picture images and sound. It also provides the coding according to the retained standard, DVBS1 (2), H264 or H265, and sends the digital stream to the appropriate service installed on the PLUTO transceiver, which will then select the type modulation PSK, QPSK, 8PSK, etc. The modulated signal from PLUTO will be amplified by the chain described above. The OBS-Studio suite used is excellent at mixing different sources, webcam, video, music tapes, microphone, etc and comes highly recommended



The software is based on an established service in the firmware of the PLUTO that we have already flashed with the code provided by Évariste F5OEO. It uses a single page accessible with your browser on the local IP address of PLUTO, by default 192.168.2.1.

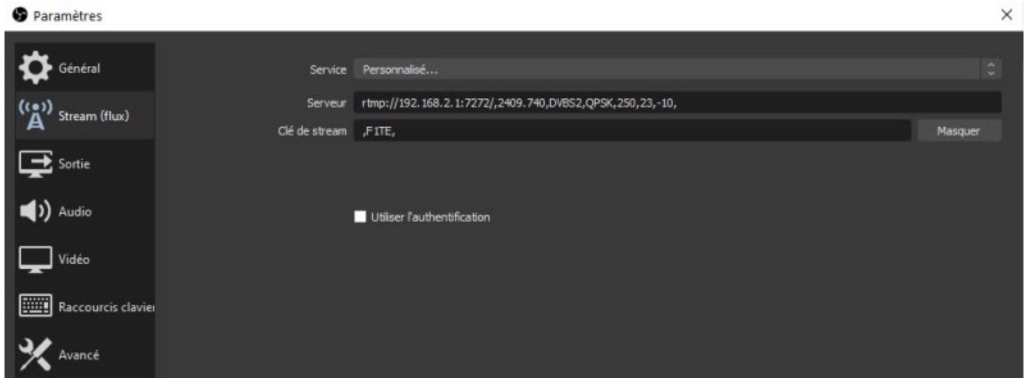
Évariste shows how to configure this video studio to generate the digital stream to the port's software associated with the IP address. Below is an excerpt from the explanation page online at the local Pluto address.



You must configure OBS to indicate where and how it is to send the stream to the PLUTO server.

This is done by a command line where it is indicated:

- *the local IP address of PLUTO as well as the software port associated with this service, here 7272; the transmission frequency, here 2409.740 MHz;*
- *DVBS2 mode;*
- *the type of modulation, here QPSK;*
- *the Serial Rate, here 250 kilo symbols per second;*
- *the FEC, here 2/3;*



- *the RF output level of the PLUTO, here -10 dB;*
- *the code used. Of course, other settings are necessary to ensure good fluidity of images and sound.*

It requires experimentation, and specialisation which is beyond this presentation which shows that with a few restrictions, it is possible to take full advantage of all the functions of this satellite. I hope this presentation will inspire many OM's to come and explore and test this satellite which covers a third of the globe.

Bibliography

Control by Arduino, F6DZP site:
https://tinyurl.com/y2m5bab7

2.4 GHz amplifiers: *https://tinyurl.com/y2xsdlw4* & *https://tinyurl.com/yylyt4rh*

OBS-Studio: *https://tinyurl.com/y3jpom43*

SDR-Console: *https://tinyurl.com/y4jrrhmg*

MinitiounerPro2: *https://tinyurl.com/yxg33alf* & *https://tinyurl.com/y3kf9nzc*

PLUTO F5OEO Firmware: *https://tinyurl.com/y6g7khv3*

ADALM-PLUTO modification: *https://tinyurl.com/y6nl8ama*

From the vault - BASIC

Written by Trevor Brown G8CJS

It's two years since I started digging around in the Grass Valley control panel, trying to map out all the bulbs and push buttons in order to adapt a surplus panel to do things other than drive the hardware it was originally designed to control.

The hardware interface was built on a prototype board, but interfacing a micro was a tricky and a little outside my comfort zone. I fell back on an I^2C bus which worked well for projects in a previous life, under the control of a Z80.

This time I wanted to work at a higher level than machine code or PIC and settled for an ESP8266 micro. The retro bit was to use BASIC to talk to the micro.

BASIC is old yes but we are in the Vault section of CQ-DATV and in my defence the version I used is actually very modern and is called Annex BASIC. I thought it worth a short trip down memory lane to the origins of this language.

In the late 70's we had home computers that encouraged owners to write their own software by using a resident language and at the time they all used a variant of BASIC (Beginners All Purpose Symbolic Instruction Code).

The machines themselves from ZX81's through BBC's including almost every fruit you can imagine from apple to tangerines appeared over a very short time span and put a lot of engineers on a learning curve they never saw coming.

The language technology was new, or was it.

John G. Kemeny and Thomas E. Kurtz designed the original BASIC language at Dartmouth College back in 1964 to try to enable people without a science or maths background to participate in computer programming…hands up, I am not a mathematician so we could chalk this up as a success at least for me.

The actual hardware we can probably trace back a little further one could argue the Colossus (the first programable computer designed to decode the Lorenzen Cypher in World War II was an early implementation of computing, we could wind back the clock further even further to the first mechanical computer designed by Charles Babbage in 1822, it's a big stretch to call this calculating engine a computer but it was a concept using the technology of the time…a little like conceding the first person to develop an aeroplane was George Cayley who designed first successful human glider, he discovered the four aerodynamic forces of flight: weight, lift, drag, thrust, the basis for the design of the modern aeroplane, but because the internal combustion engine had not been developed the Wright Brothers will always be remembered as the first person to fly and is the answer expected in any pub quiz.

There are those that like the more outlandish explanations such as alien technology and imagine them perhaps been discovered at Roswell or removed from some alien wreckage deep in the heart of area 51, got to admit it makes for a more exciting story.

The language was reworked to cope with some small memories E.G the ZX 81 only had 4k of memory and a lot of this development was attributed to Bill Gates and Microsoft, but the commercial development also led to the downfall of BASIC in that each computer developed their own dialect to avoid paying royalties to another company and by the 90's BASIC disappeared as newer machines with far greater capabilities came to market and other programming languages such as C were developed. I think I was inspired when what was described as a universal two-line programme was demonstrated

```
10 print "Hello World"
20 goto 10
```

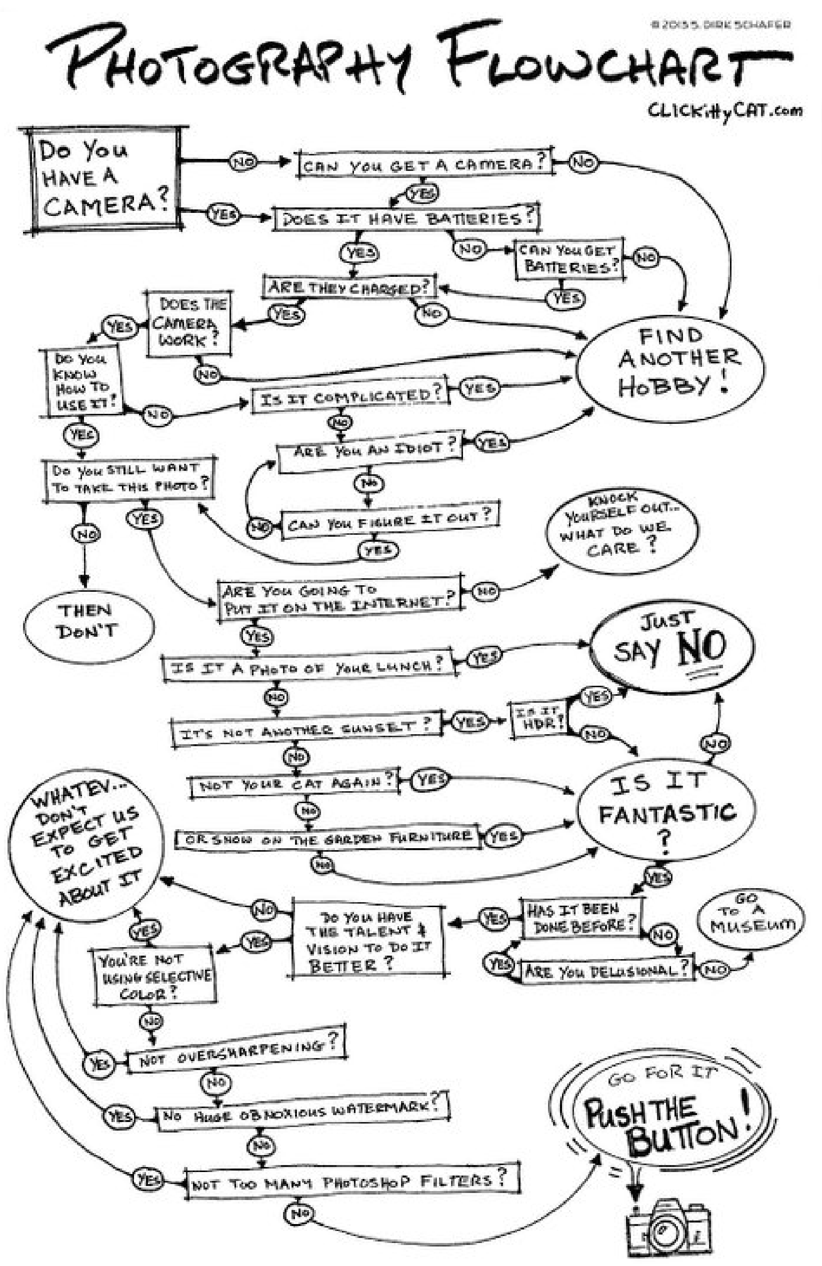
Note the line numbers. Early BASIC had line numbers, the programme would fill the screen by repeating Hello World Soon to be followed by the for next loop

```
10 for A = 1 to 5
20 print "Hello World"
20 next A
```

Ok, it was a little more algebra (something that always escaped me at school) but getting your head around it was not impossible

Understanding the hardware and the concept of an address bus and a data bus took a little more brain ache, but as an engineer that's what we signed up for.

But then it introduced the flow chart to our thinking.



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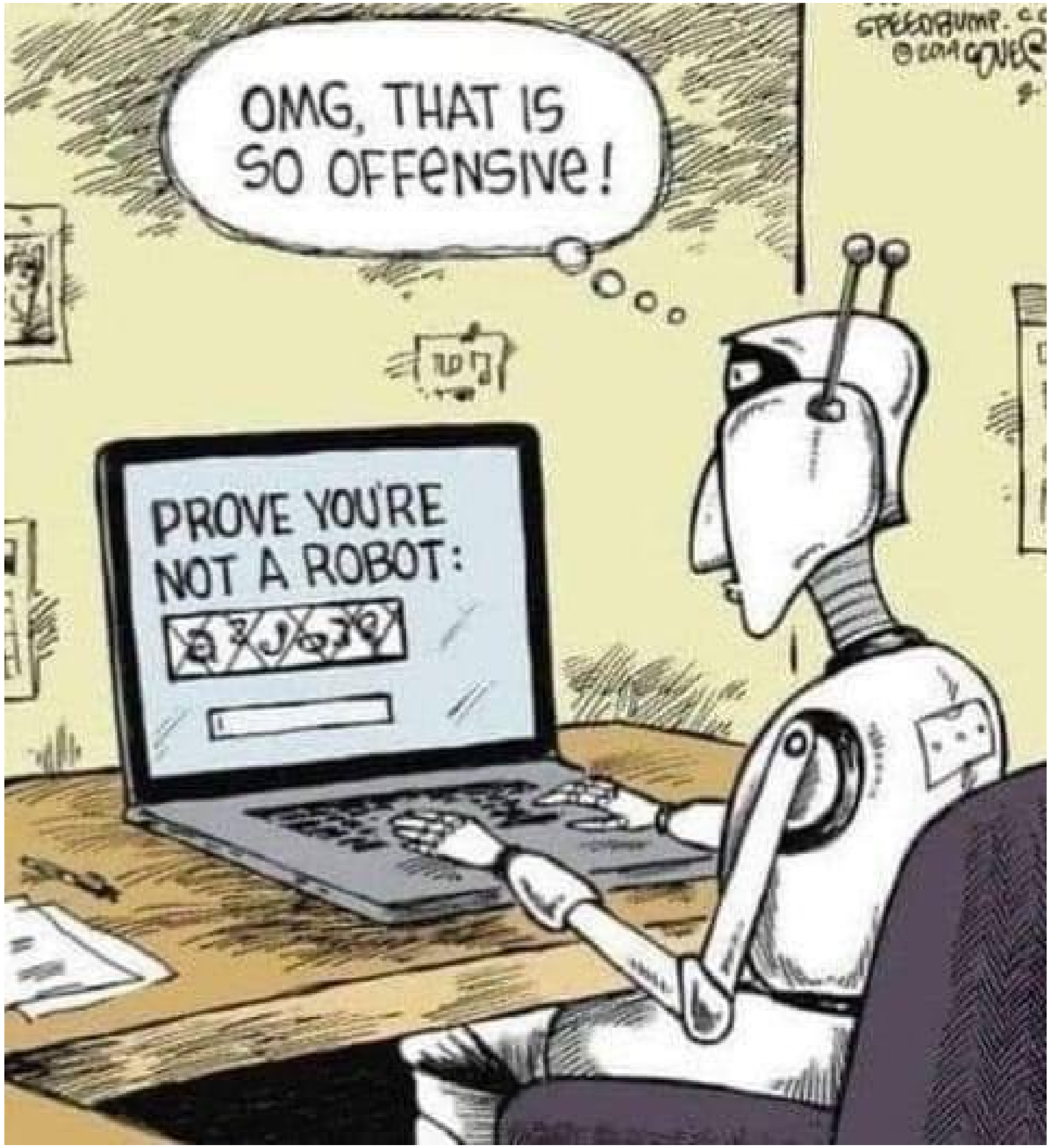

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