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 CQ-DATV 75

Lets start with worries over Galileo and for those of you that thought Galileo was an Italian astronomer, it is also the name of Europe's Global Navigation Satellite System (GNSS), providing improved positioning and timing information with significant positive implications for many European services and users. The downside is the impact that it may have on 23cms, particularly between 1240 and 1300MHz.

We suspect the problems may not be interference to the amateur TV repeater network, more so the other way around. Seems we are going to be plagued with these incursions and any arguments E.G. we were there first will hold little sway. Noel G8GTZ has the full story in the news section of this issue.

On a more positive note, Trevor has delivered the I/O for the GVG mixer project. At the moment it delivers the full PGM PST and Key banks and four of the transition commands. (see the CQ-DATV facebook page for the video).

In this series of articles, Trevor has taken us from the black art of demultiplexing the push buttons, via custom software, to lighting the appropriate the push-buttons and providing useful TTL commands. So we can all start interfacing to our individual projects.

The CQ-DATV software downloads log show a lot of interest in this project, so are you just curious about the code or have you a panel squirrelled away and are keeping quiet about it? Or perhaps you are living in the hope that one will turn up on e-Bay.

Jim Andrews, KH6HTV is looking at creating an in-band ATV repeater for 70cms using DVB-T.

Jim is using the Hi-Des model HV-110 Receiver, Hi-Des model HV-320E modulator and an Advanced Receiver Research, Pre-Amplifier. Jim has added a pair of HDMI components to provide an A/V output from the receiver, otherwise it is an almost off the shelf ATV repeater.

Doherty Amplifiers - What Are They? That's what we all said in the editorial office. Well they are not new and actually appeared about four years ago when 50 volt LDMOS push-pull FETs were introduced for RF amplifiers delivering improved gain, output power and better efficiency.

These new 50 volt LDMOS devices are used in the newest high-end power amplifiers.

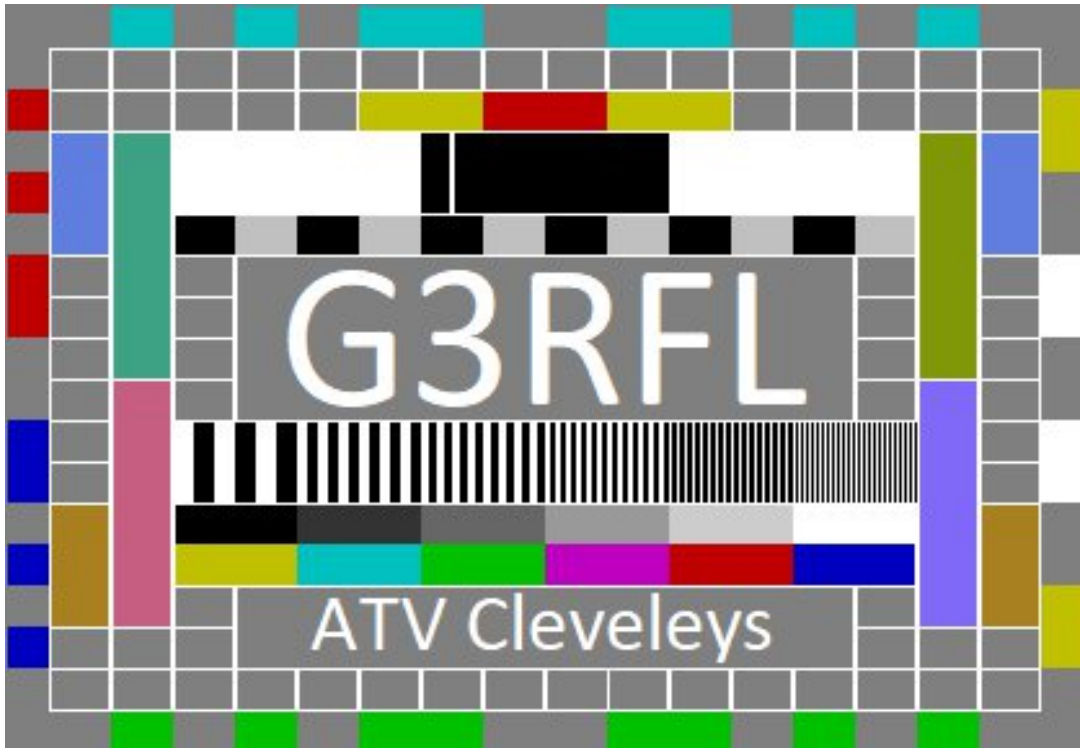
Interested? Well Mike Collis WA6SVT has the full story.

One from the vault is a look back on one of John Hudson G3RFL's projects and this time it's a microwave power meter.

This works by measuring the resistance of a thermistor that is heated by the power of the microwave source under test, but it also has a second thermistor that is not heated by the microwave power source to offset the ambient temperature. Seems John has thought it all through.

I know we have not heard from John for a while, but he is still developing circuits and at the moment is working on a video project to cut, fade and downstream key. Its still in the development stage, but when its working we will bring you the full story.

John has also developed a new test card and has sent in the picture, but unfortunately is so good it has been snapped up and used commercially so all we have is the picture.



So as we always say, sit back and enjoy CQ-DATV 75

CQ-DATV Production team

WELL READ THE WORLD OVER

CQ-DATV

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23cms and the threat from Galileo

This is not intended as a doom and gloom message but the worldwide ATV community should be aware of the potential threat to 23cms.

This headline is from a CEPT paper from France, Lithuania, Malta, Slovenia and the Netherlands which will be discussed at WRC19 with a view to making decisions at WRC23 (only 4 years away):

France, Lithuania, Malta, Slovenia, The Netherlands say:
A WRC-23 agenda item is necessary to address this issue because:
1-Unregulated use of the band 1240-1300 MHz by the amateur service is a serious source of harmful interference to RNSS receivers. This is demonstrated by experience.
2-The number of Galileo receivers in 1260-1300 MHz will increase dramatically, and interference cases will multiply if not addressed timely.
3-Galileo and other RNSS systems will deploy at global scale, and interference scenario between amateur emissions and RNSS receivers include cross-border cases. The issue is therefore of international nature and is to be addressed in the ITU framework.
4-Galileo is a major European asset, and a decision at WRC-23 is essential to be compatible with the roadmap of deployment of Galileo receivers in this band.

Our friends at IARU and RSGB are well aware of the issue and planning / making responses but in the worst case this could have a serious impact on 23cms between 1240 and 1300MHz, especially for wide band modes such as ATV, and we have already seen several TV repeaters in Germany shut down.

In the UK we are more fortunate in that we have 1300 - 1325MHz but this certainly mean a reshuffle of the band plan with potentialy all ATV activity focussed in the 25MHz - it could present some interesting challenges for 23cms repeater keepers with inputs and oiutputs in the same band!
Please lobby and support your national society as they continue to fight our corner.

73 Noel - G8GTZ

Ref:
https://rsgb.org/main/blog/news/gb2rs/headlines/2019/08/16/iaru-prepares-for-key-cept-meeting/

GB3EY on air

GB3EY was switched for the first time from its new site and using DATV at 1700 today the 22nd August 2019. It is running in 'beacon' mode only and there are no active inputs. The site is at Cave Wold Radio Station with QTH locator IO93RS37ME about 9 miles WNW of Hull in East Yorkshire. It is running just over 4.5 watts RMS to a temporary Alford Slot antenna 6M AGL and the site is 155m ASL. Symbol rate is 4MS/s, FEC 3/4 and the frequency is unchanged at 1308MHz.

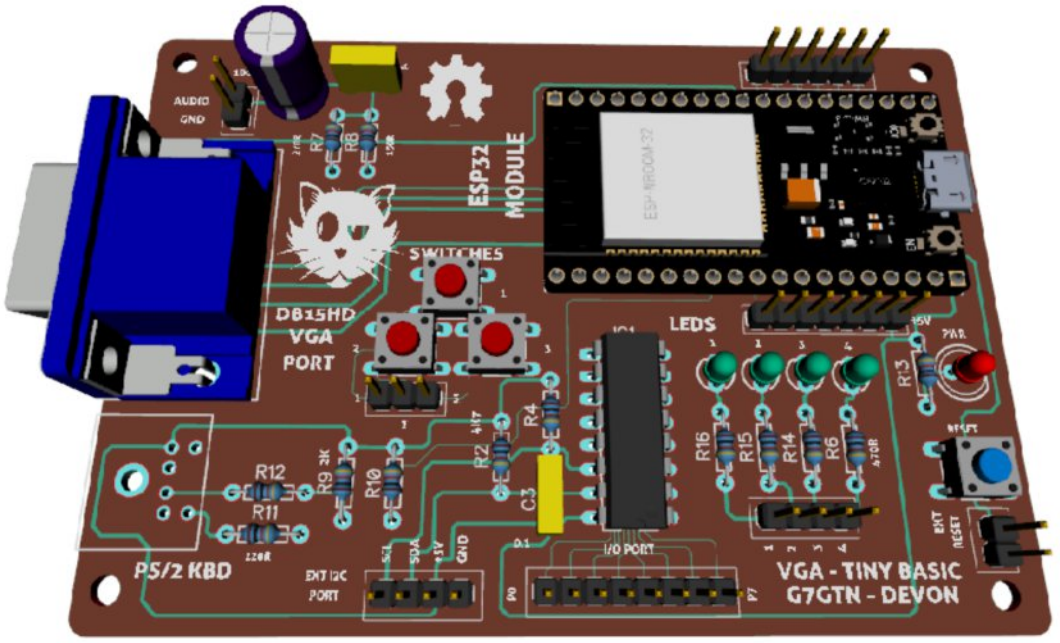
Reports would be welcomed via email to clive (AT) hesh.co.uk or richard (AT) guttridge.karoo.co.uk

Richard G4YTV, GB3EY NoV holder / keeper. Clive G3GJA, East Yorkshire Repeater Group Chairman

Source: *https://forum.batc.org.uk/viewtopic.php?t=6265*

Micro Corner

When you publish an ATV magazine every month, sometimes there is not enough time to design build and test all the projects for that issue. Its not just manhours, but we do order components from sources that can best be described as distant and well we have all heard the song slow boat to china, well things have not improved since Bing Crosby and Peggy Lee sang those lyrics. And not only is it slow boat to china, but the reciprocal of that "slow boat from china" is also a problem. As a result one of the components for a project for this column, a multipurpose VGA processor board has at the time of closing this issue not arrived.



The PCB is with us and is now populated and awaiting the PCB mounted VGA connector, let hope for issue 76 that the connector is with us and that the board delivers.

All ATV interested parties

Each Tuesday night @9:00PM I host a net on 147.48MHz simplex for the purpose of ATV topic discussion.

There is no need to belong to ATCO to participate, only a genuine interest in ATV. All are invited. We have not had a large group lately so check in if you can, even if you don't have much to say.

For those who check in, the general rules are as follows:

Out-of-town and video check-ins have priority.

After all participants are heard, I will give status and news if any followed by late check-in requests or comments.

We usually chat for about ½ hour so join us locally or via internet.

We stream the discussion on the internet so out of town ATVers can participate. It is interactive. Go to https://batc.org.uk/live/wr8atv to see the video and audio direct.

If you are a BATC member, log in first then go to https://batc.org.uk/live/wr8atv to see your name and call automatically displayed in the side bar. To send a message to the group type it in the space provided then enter.

Also, transmissions are repeated on 446.350MHz originating in downtown Columbus so you don't have to reposition your antenna to listen to each one. Transmit toward downtown Columbus on 147.48MHz and receive the audio from downtown Columbus on 446.350MHz.

If the group is large, I may have a joke or two to share at the end of the session so don't leave early! (clean ones of course)

See you on Tuesday, Art WA8RMC

Grass Valley Mixer Conversions - Part 8

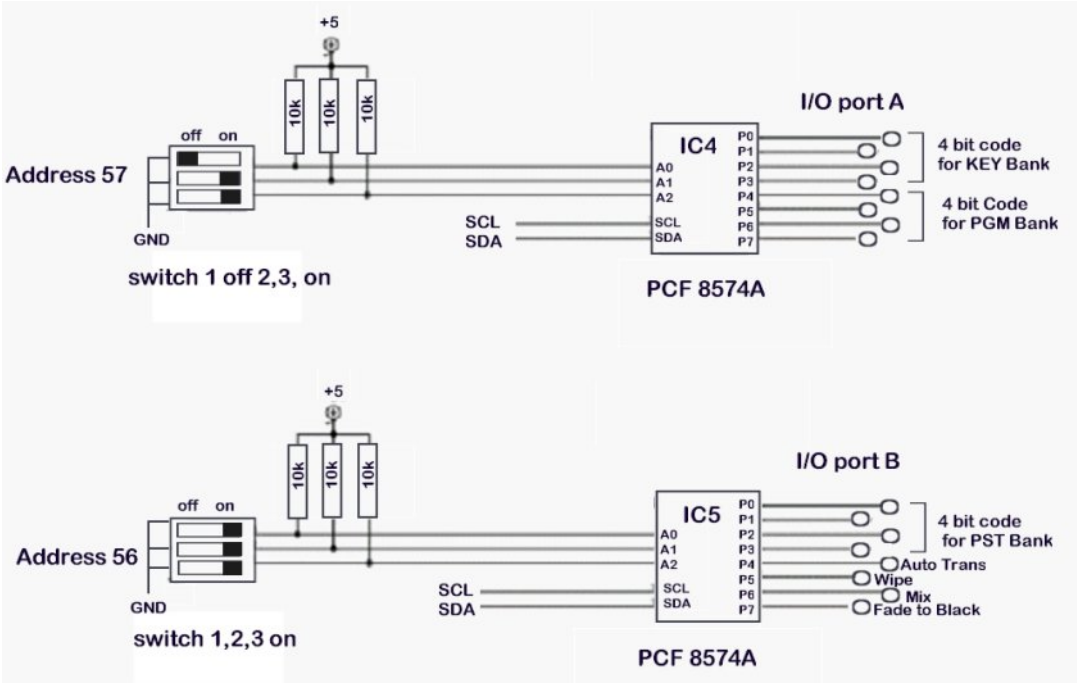
Written By Trevor Brown G8CJS

Ok I promised some I/O, well more output than input, but that's what the panel was designed for.

I added a further 2 PCF8574 Port chips, above and beyond the original 3 chips exploratory dongle in CQ-DATV 68. These chips are both on the PCB designed and built by Mike G7GTN and shown in CQ-DATV 73. They provide two 8-bit ports called IC4 and IC5 a notation that Mike has silk screen printed on the PCB. The port pins are brought onto to external connectors with the PCB printed with User I/O

I have written the software to divide both 8-bit ports into two 4-bit ports. The two 4-bit ports of IC4 carry a 4-bit code that indicates which of the KEY Bank and PGM bank buttons have been selected. A little tricky having to have two independent banks sharing the same chip as each time one is updated it will clear the other. This is taken care of in software by storing the Key Bank and PGM banks as a variables X and W and adding them together and refreshing the latch with this 8-bit word when the selection of either Key or PGM is made. A little bit fiddly but I/O is precious and needs to be used sparingly.

Flushed with success I have applied the same software to IC5, and it now carries a 4-bit word that indicates the PST Bank selection. The other 4 bits carry some of the commands controlled by following push buttons "Fade to Black", "Mix", "Wipe" and "Auto Transition". I have not encoded the commands each one has an I/O port bit to itself and will be at Logic 1 when the command is selected on the panel.



I/O and the default connections the software delivers

Mike has included on his PCB switches that enable the PCF 8574 I/O chips to have the address that they are located with in the I/O map adjusted. It goes without saying that no two I2C devices can share the same address and the three user pre-set address lines limit the number of PCF 8574 devices to 7 per I2c bus. Inside the PCF 8574 are three additional address lines that are not user presentable. There is another set of 8574 Chips that have these non-user pre-settable address lines set to different setting creating a different range of addresses and have the designation 8274A. This enables another 7 chips to be added to the I2c bus making 14 in all.

I have put a declaration table at the head of the software showing the decimal address of all the chips. The 8574 chips have an address that is 24 higher than the 8574A. Apologies in advance I have used a mixed chip-set, all that was available in my junk box.

Please edit the header if you have used a different combinations of these two chip sets.

```
let PRT1=39        ' Port 1 Control      address 63 For PCF
8574
let PRT3=37        ' Port 3 Address Bus  address 63 For PCF
8574
let PRT4=32        ' Port 4 Data Bus     address 63 For PCF
8574
let IOa= 57       ' I/O  Port a        address 33  For PCF
8574A
let IOb =56       ' I/O  Port b       address 33  For PCF 8574A
```

Declaration table at the top of the programme

I have also added an I2c LCD display at address 63, this just displays "Grass Valley CQ-DATV Project" but once we have the software fully functioning we can improve on this. If in doubt about I2c addresses run the I2C scanner software. This will indicate the address of every functioning device on the I2c bus. You do not have to use my address notation, but it is important that if you change the position of any of the devices that you correct the table at the head of the software.

```
i2c.setup 4, 5
serial2.mode 115200, 13,15
print "Scanning for I2C devices" + serial.chr$ + " "
goto i2cscanner
i2cscanner:
wlog " "
wlog "Scanning for I2C devices..."
wlog " "
for c = 1 to 127
 i2c.begin c
 if i2c.end = 0 then
 wlog "Device Found " + str$(c) + " Decimal" + " ----->" +
string$(2," ") + hex$(c) + " Hexadecimal"
 pause 55
 end if
next c
wlog " "
wlog "Scan Finished"
print "Scan Finished" + serial.chr$ + " "
end
return
```

I2C scanner Programme

This will deliver a report:-

```
Scanning for I2C devices...
Device Found 32 Decimal ----->  20 Hexadecimal
Device Found 37 Decimal ----->  25 Hexadecimal
Device Found 39 Decimal ----->  27 Hexadecimal
Device Found 56 Decimal ----->  38 Hexadecimal
Device Found 57 Decimal ----->  39 Hexadecimal
Device found 63 Decimal ----->  3F Hexadecimal
Scan Finished
```

I have used two PCF 8574A and three PCF 8574 chips (sorry working with my junk box). Address 63 is the LCD Panel and for my device it is fixed.

The truth table shows the logic delivered and for the PGM, PCF and PST banks. It delivers active low.

Sorry, I was using LEDS to indicate the state of the port. The LEDS are connected via a current limiting pull up resistor to VCC (the ports sink current better than sourcing current) light an LED and it gives you brain ache to count the lights not lit in binary.

The I/O is clearly indicated in the comments in the software. Please feel free to edit the table if it does not interface for you.

IC4 Port Connections

Key Buttons	P4	P5	P6	P7	PGM Buttons	P0	P1	P2	P3
0	L	H	H	H	0	L	H	H	H
1	H	L	H	H	1	H	L	H	H
2	L	L	H	H	2	L	L	H	H
3	H	H	L	H	3	H	H	L	H
4	L	H	L	H	4	L	H	L	H
5	H	L	L	H	5	H	L	L	H
6	L	L	L	H	6	L	L	L	H
7	H	H	H	L	7	H	H	H	L
8	L	H	H	L	8	L	H	H	L
9	H	L	H	L	9	H	L	H	L

IC5 Port Connections

PST Buttons	P0	P1	P2	P3	P4	P5	P6	P7
0	L	H	H	H	Auto Trans			
1	H	L	H	H				
2	L	L	H	H		Wipe		
3	H	H	L	H				
4	L	H	L	H			Mix	
5	H	L	L	H				
6	L	L	L	H				Fade to Black
7	H	H	H	L				
8	L	H	H	L				
9	H	L	H	L				

I have also revised the Annex BASIC code to implement the mixer coming up with key 0, PGM 0 and PST 0 illuminated after reset. This removed the invalid state of no buttons being pressed which was making it a little difficult to programme the I/O and, to be honest, it looks much more professional.

The code uses separate sub routines for the Key bank and for the PGM bank, followed by a few gosub IOa calls added to the key routines in the programme. I won't bore you with too much code as you can download the full revised version from the CQ-DATV web site and look at it in a text editor or revise it in the free Annex editor. This is much better as it provides line numbers and enables customising of any requirements. The two sub routines I have produced bellow:-

```
IOkey: 'I/O routine for key bank

if B=1 and e=254 then let w=14    'if key 0 pressed turn on
if B=1 and e=253 then let w=13    'if key 1 pressed turn on
if B=1 and e=251 then let w=12    'if key 2 pressed turn on
if B=1 and e=247 then let w=11    'if key 3 pressed turn on
if B=1 and e=239 then let w=10    'if key 4 pressed turn on
if B=1 and e=223 then let w=9    'if key 5 pressed turn on
if B=1 and e=191 then let w=8    'if key 6 pressed turn on
if B=1 and e=127 then let w=7    'if key 7 pressed turn on
if B=4 and e=251 then let w=6    'if key 8 pressed turn on
if B=4 and e=247 then let w=5    'if key 9 pressed turn on
i2c.begin IOa    'I/O port a'
i2c.write w+x     'key bank to I/O
i2c.end
return
```

```
IOpgm: 'I/O routine for PGM bank

if B=2 and e=254 then  let x= 224   'if PGM 0 pressed turn
on
if B=2 and e=253 then  let x= 208   'if PGM 1 pressed turn
on
if B=2 and e=251 then  let x= 192   'if PGM 2 pressed turn
on
if B=2 and e=247 then  let x= 176   'if PGM 3 pressed turn
on
 if B=2 and e=239 then  let x= 160   'if PGM 4 pressed turn
on
if B=2 and e=223 then  let x= 144   'if PGM 5 pressed turn
on
if B=2 and e=191 then  let x= 128   'if PGM 6 pressed turn
on
if B=2 and e=127 then  let x= 112   'If PGM 7 pressed turn
on
if b=4 and e=254 then  let x= 96   'if PGM 8  pressed turn on

if b=4 and e=253 then  let x= 80   'if PGM 9  pressed turn on

i2c.begin IOa    'I/O port a'
i2c.write x+w     'PGM bank to I/O
i2c.end
return
```

Continued next page...

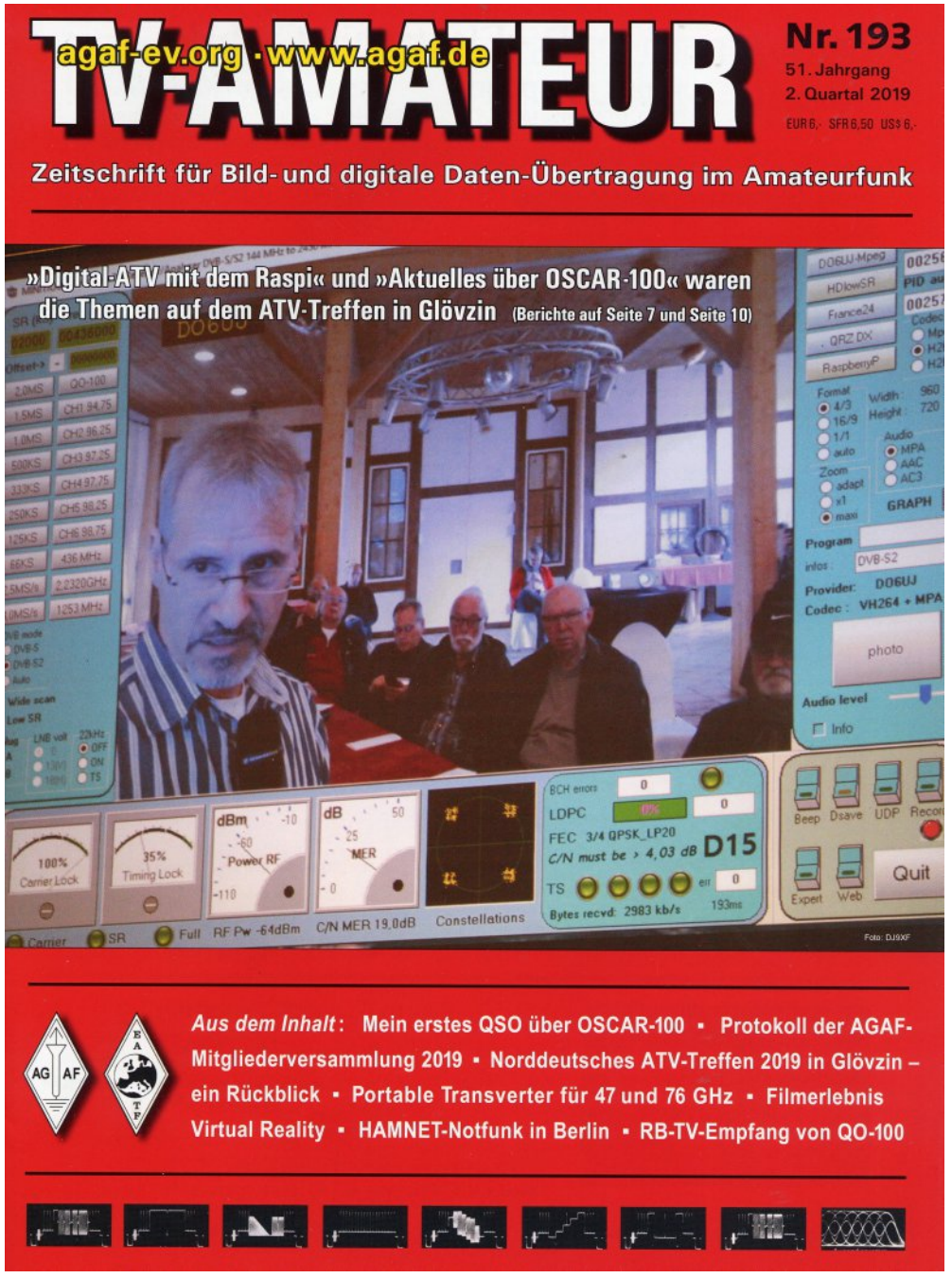
I have also implemented the port IC5 and again split it in software to produce two 4-bit ports. The lower the 4-bit code indicates the choice of PST selection and the 4 higher bits carry the commands "Fade to Black", "Mix", "Wipe", and "Auto Transition". These are not multiplexed commands. They are active high so selection is indicated by a Logic 1 (again you can edit the software if you need something different). The software will only allow the selection of one of these commands at once.

Auto Transition on the original GVG mixer enabled you to mix or wipe at a rate set in the window at the top of the panel. I have not implemented any way of setting the speed of transition as this small PCB on my panel is faulty and disconnected. Something for me to investigate at a future date, although the circuit diagram of this small panel is missing from my manual - rather like buying a detective novel from a charity shop to find the last page has been removed, leaving you to wonder who the guilty party was.

I have been checking E-bay and no other GVG panels have changed hands, although I did get an email from a panel owner in Switzerland who has a panel he may, or may not, part with. Perhaps he is waiting to see if my work will increase the value of his investment.

Previous to this investigation of the panel workings, several months back, they were appearing quite frequently on E-bay! Next time I will be looking at the analogue side of the panel and how we can utilise the Joysticks, T-Bar and all the Pots.

This is your free ATV magazine.
Please consider contributing an article!



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Building a Basic, 70 cm, DVB-T, Television Repeater

Written by Jim Andrews, KH6HTV
(Application Note AN-48)

Fig. 1 A basic, 70cm, 10 Watt, DVB-T, Television Repeater

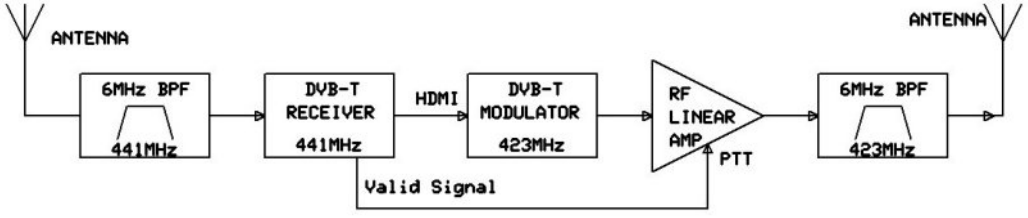


Fig. 2 Basic, 70 cm, Digital TV Repeater, block diagram

Application Note, AN-23 [1], has previously discussed the basics of what is required to build a Digital TV (DTV) repeater. Fig. 1 in AN-23, and Fig. 2 above, shows the typical method of constructing a basic 70 cm DTV repeater. It consists of using two, separate antennas, one for receive and one for transmitting. The isolation between the antennas, plus the sharp skirts of the band-pass filters (BPF) allow the receiver to hear (see) a weak incoming TV signal on one TV channel while transmitting a high power TV signal on a nearby TV channel.

Fig. 1 is a photo of an actual 70cm, DVB-T repeater built in the summer of 2019 by KH6HTV for the Pueblo, Colorado Amateur Radio Club (W0PHC). It is a basic TV repeater using the block diagram of Fig. 1. Fig. 3 below is the actual block diagram of the W0PHC-TV repeater. The only added items were a low noise, preamplifier and a pair of HDMI components to provide an A/V output from the receiver to be viewed on an external video monitor. It does not have any added fancy "bells & whistles".

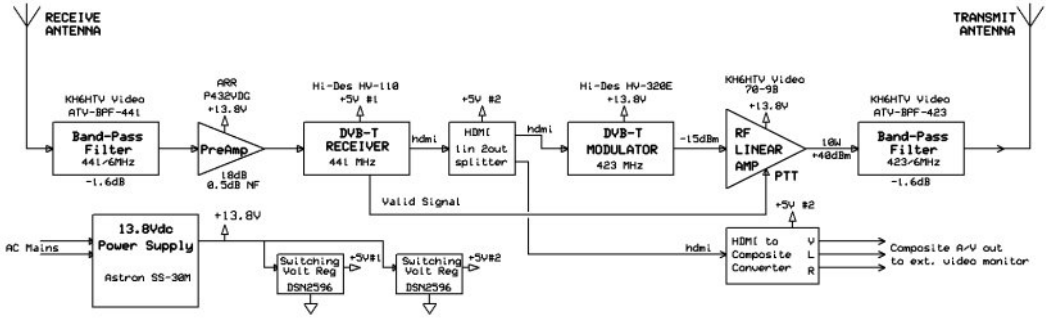


Fig. 3 Block Diagram of the Pueblo, W0PHC-TV repeater

The major components used in the repeater were: Hi-Des model HV-110 Receiver, Hi-Des model HV-320E Modulator, Advanced Receiver Research, model P432VDG Pre-Amplifier. KH6HTV Video supplied the pair of band-pass filters, models ATV-BPF-423 & ATV-BPF-441, plus the RF Linear Power Amplifier, model 70-9B. +13.8Vdc power was supplied by an

Fig. 4 Close up view of the TV repeater's front panel

Astron model SS-30M. The complete TV repeater was assembled on a 19" rack mount, 2U, open shelf (14 1/2" deep).

Fig. 4 shows the front panel operating controls. The repeater is very simple to operate. First connect the antennas. The DC power supply is turned on.

The RF Power Amplifier's RF Power Level rotary knob is set to HIGH and it's toggle switch is set to Ext. PTT. The HV-110 receiver is set to Ch 04 (i.e. 441 MHz). The HV-320E modulator is set to Ch 57 (i.e. 423 MHz).

From this point on, the repeater is ready to function automatically.

When a valid, DVB-T signal is received, the receiver's LED turns from red to green. This keys the PTT logic line and turns on the RF Power Amplifier.

The amplifier's LED turns from stand-by (yellow) to transmitter on (red). The cooling fan starts running and the power supply's amp meter jumps up to 10 Amps. Approx. 1.5 amps, stand-by.

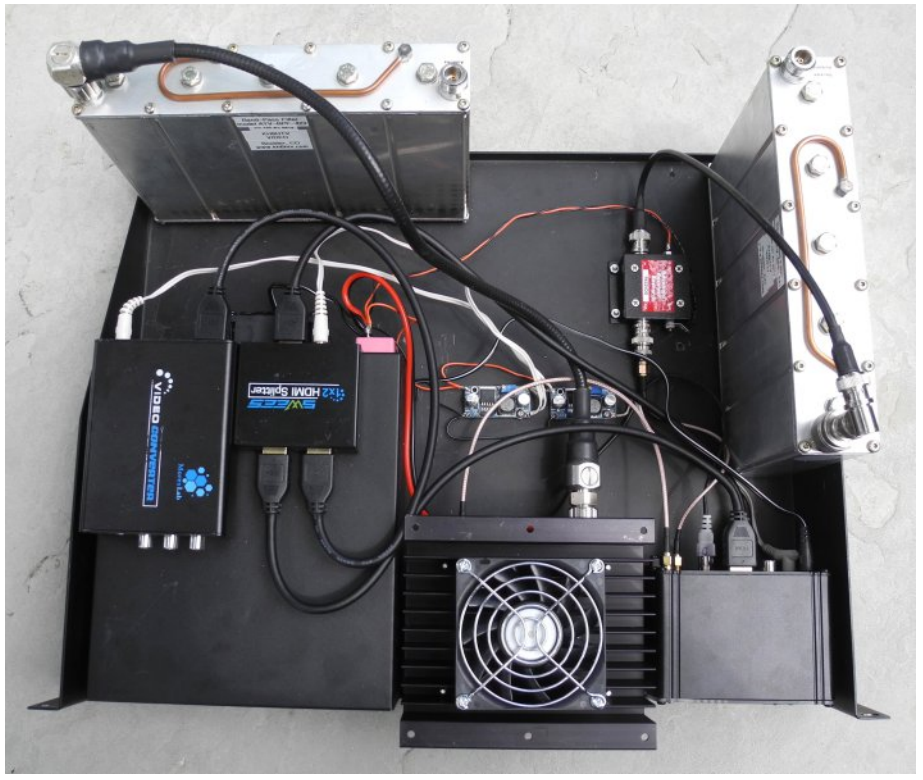


Fig. 5 Top view of the W0PHC-TV repeater

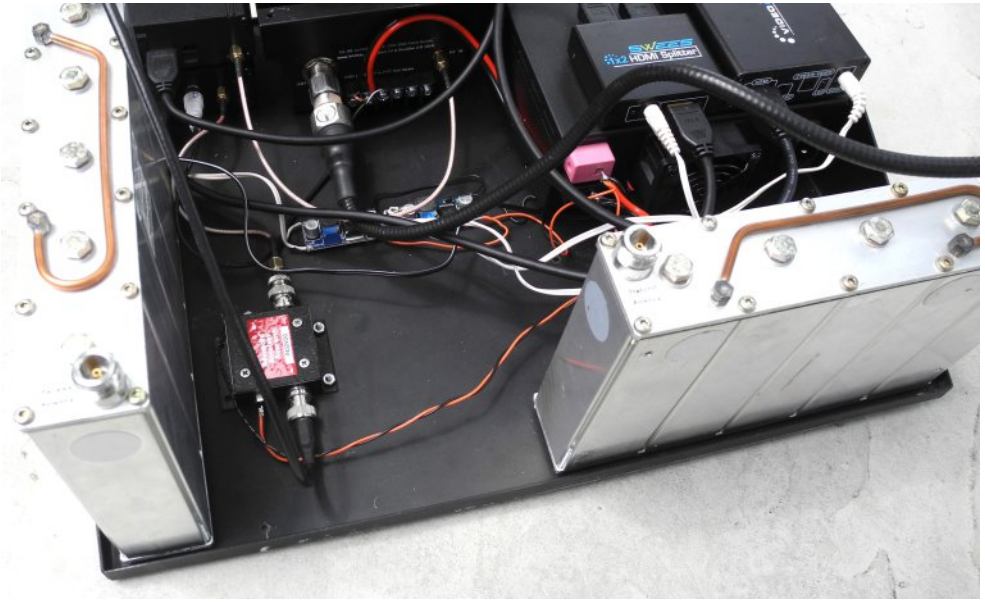


Fig. 6 Rear view of the W0PHC-TV repeater

Basic performance tests were performed on the finished repeater.

Transmitter Tests

The transmitter was set up to transmit QPSK, DVB-T signals on a center frequency of 423 MHz with 6 MHz bandwidth. The rf output power was measured using an HP-432A Power Meter with an HP-8478B Thermistor power head. This allowed the rf power to be measured in true RMS. The repeater's rf output was attenuated using a high power (150W), 30dB attenuator. It was a Narda model 769-30. This was followed by precision 10.0dB, 2 W, N attenuator.

The repeater's RF output power was: 9.3 Watts (rms) (+39.7dBm)

The repeater's rf spectrum was measured using the 150W, 30dB power attenuator and a Rigol model DSA-815 Spectrum Analyzer. Figs. 7 & 8 show the rf output from the rf power amplifier and also the repeater's output from the transmit BPF.

Fig. 7 TV Repeater's Output Spectrum: Yellow trace is output from rf power amplifier. (shoulder break-point is -29dB, Pout = 12.6 W, +41dBm) Magenta trace is the power amp output after passing through the 423 BPF (shoulder break-point is -34dB, Pout = 9.3 W, +39.7dBm). This is the output to the transmit antenna. 10dB/div & 2MHz/div. center freq. = 423MHz

Fig. 8 Pueblo DVB-T Repeater's rf output spectrum. Center Freq = 423MHz, 10dB/div & 2MHz/div. Pout = 9.3 Watts (rms) = +39.7dBm. Shoulder break-point is -34dB down (+3.2MHz from center). Spectrum is attenuated by -40dB (-4MHz), -53dB (-5MHz), -47dB (+4Mz) & -58dB (+5MHz)

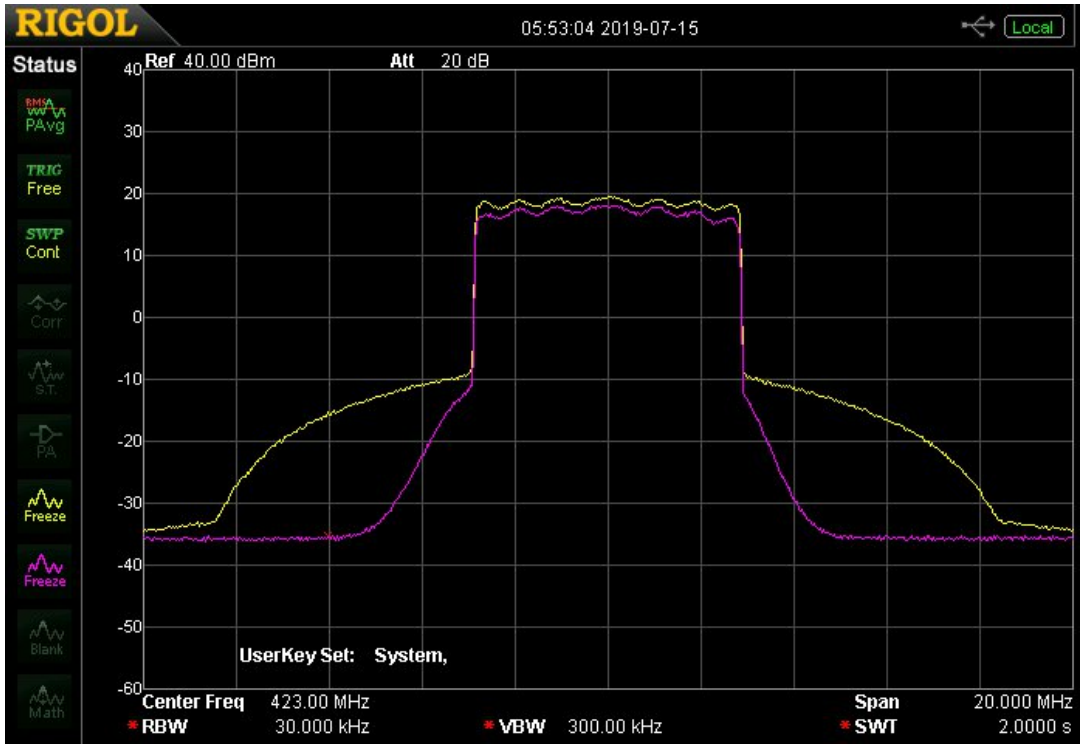
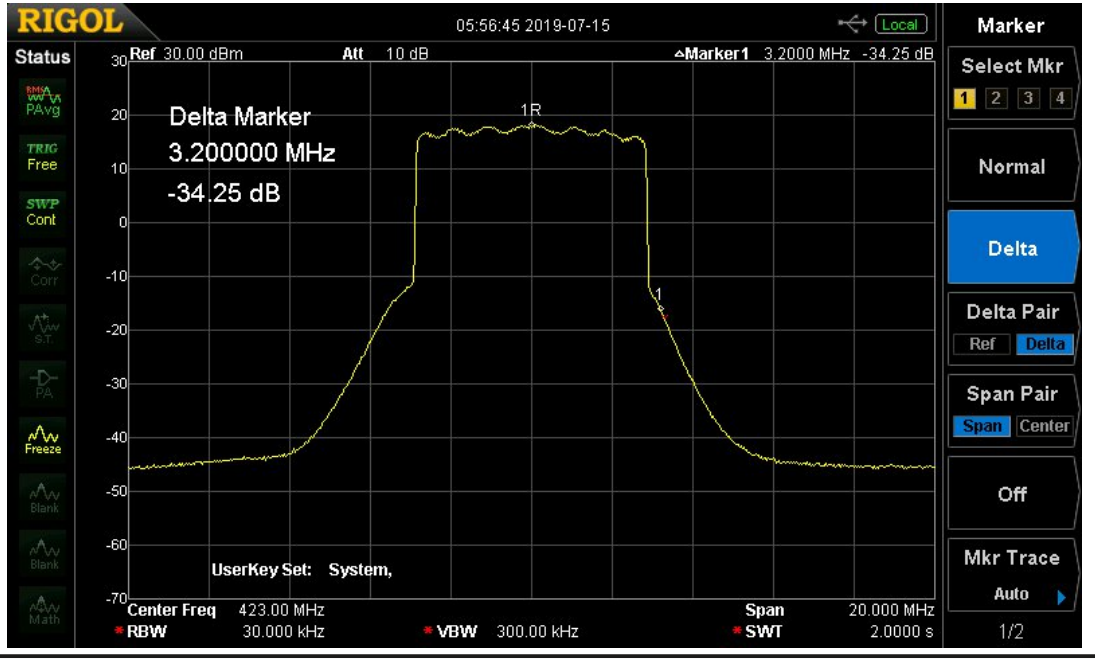


Fig 7 above, Fig 8 below. See text for description.



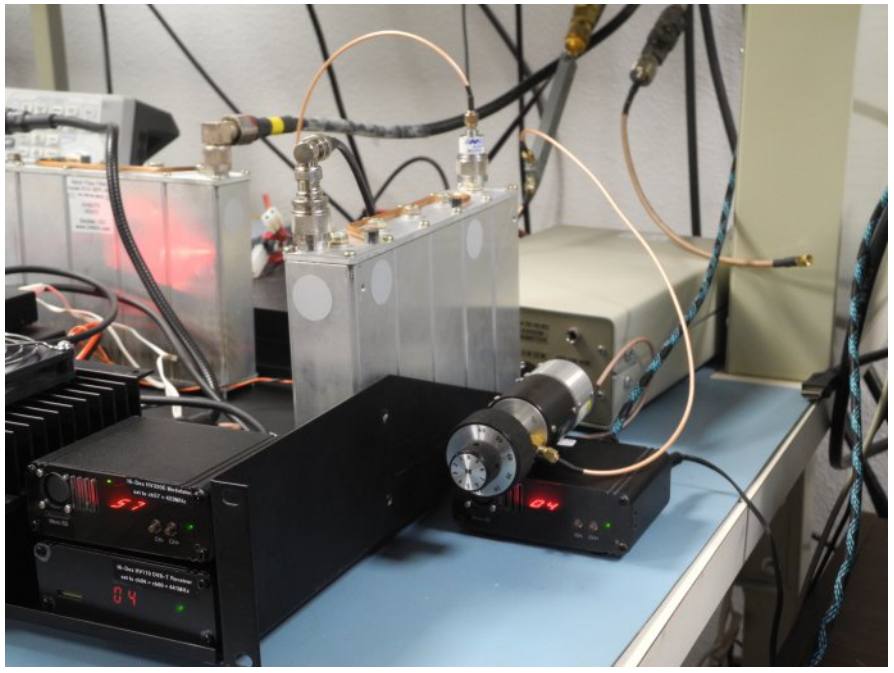


Fig. 9 Test setup for receiver

Fig. 10 Monitor showing OSD

Receiver Sensitivity Tests

The TV repeater's receiver was tested using normal, amateur, DVB-T, live video signals. The test signal's various parameters were: 441 MHz, 6 MHz bandwidth, QPSK modulation, 1080P resolution, H-264, 8K FFT, 1/2 FEC (code rate) & 1/16 Guard.

The test signal was generated using a Hi-Des model HV-320E. Live video was furnished by a Blu-Ray DVD player playing a continuous looping Blu-Ray disc complete with constant motion and live audio.

The +7dBm rf output from the HV-320E was attenuated using 20dB and 30dB SMA attenuators along with a Weinschel SMA rotary step attenuator (0-69dB, 1dB steps). See Fig. 9.

The digital threshold was determined when the received video was just above pixelization and the video was solid with no breakups. Also the receiver's LED glowed steadily green with no blinking. At this level, the receiver's on-screen-display (OSD) indicated a s/n of 8dB. See Fig. 10.

Initial Bench Tests of Receiver

- *Test 1: Test signal directly into the HV-110 receiver. Sensitivity = -94dBm - no signal OSD = -98dBm, 0dB s/n – with signal OSD = -92dB, 8dB s/n - i.e. for weak signals, the OSD power meter reads +2dB high.*
- *Test 2: Test signal into Pre-Amp and then the receiver. Sensitivity = -98dBm - no signal OSD = -85dBm, 0dB s/n – with signal OSD = -77dB, 8dB s/n*
- *Test 3: Test signal into repeater's receive antenna connector. Sensitivity = -95dBm (i.e. BPF -> PreAmp -> Rcvr) no signal OSD = -85dBm, 0dB s/n – with signal OSD = -75dB, 9dB s/n*
- *Test 4: Strong signal into the receive antenna connector to*

calibrate the OSD. Pin = -73dBm, OSD reads -55dBm, 23dB s/n. delta = +18dB - The OSD power meter has an offset of +18dB due to the preamp in the system. For higher power levels the OSD power meter is accurate within ±1dB as long as this offset is accounted for.

The above results were the same with or without the transmitter being turned on.

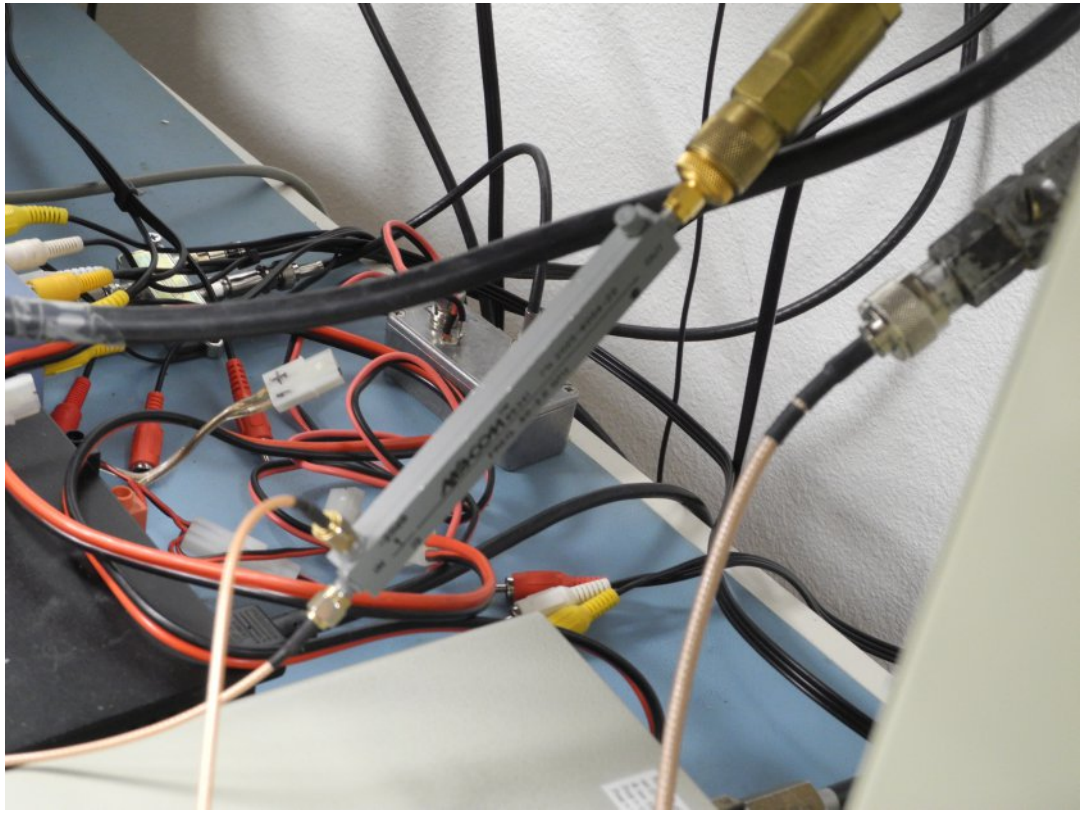


Fig. 12 20dB coupler in receive line

Real World Final Test

The final acid test was to connect the repeater to outside antennas and verify it still performed properly. It was connected to a pair of antennas on KH6HTV's 50 ft. antenna tower. See Fig. 11.

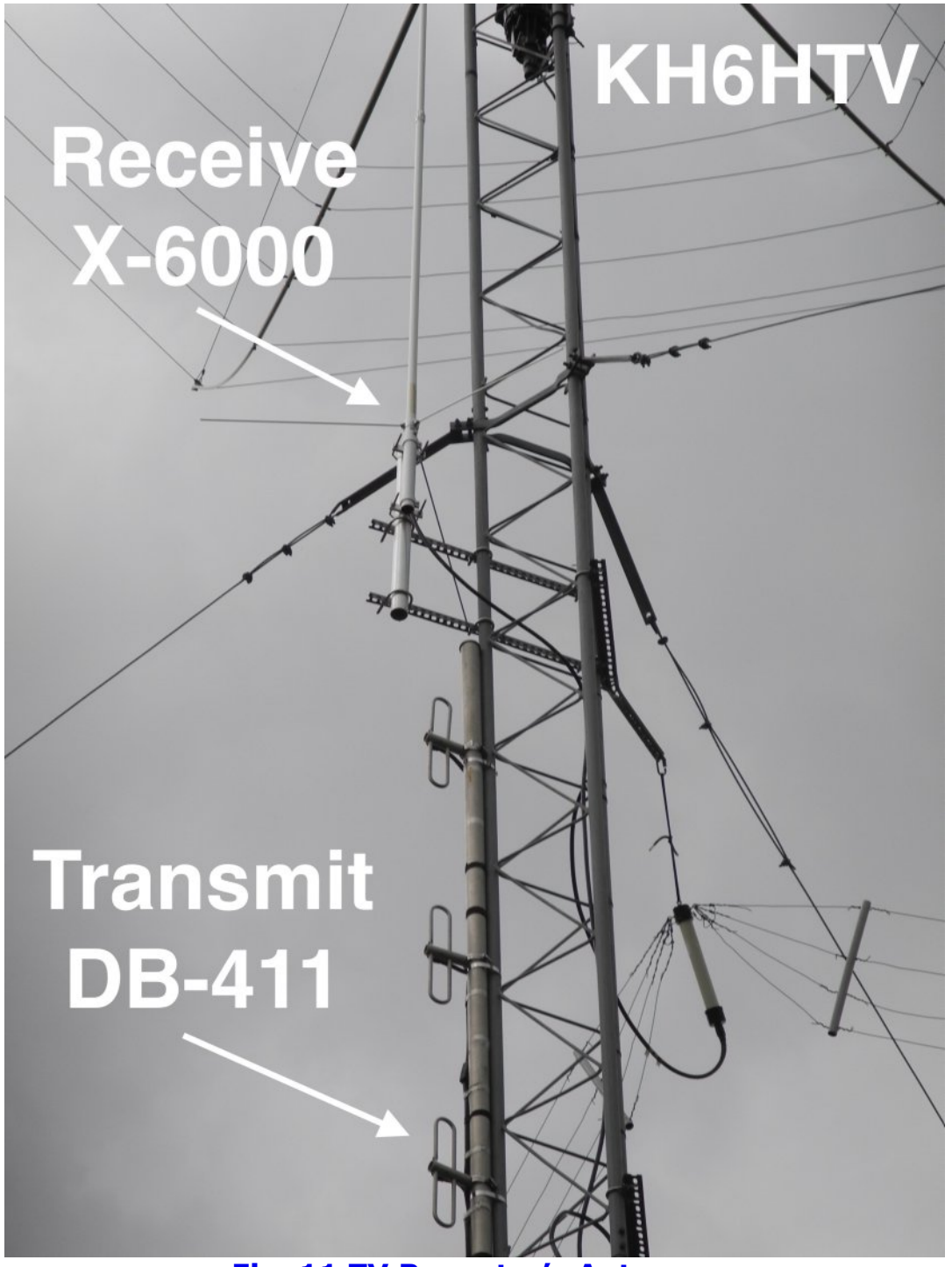


Fig. 11 TV Repeater's Antennas

These antennas have been used successfully in the past when the Boulder ATV repeater was temporarily at KH6HTV's QTH. The receive antenna was a Diamond X-6000 (2m/70cm/23cm) at 45 ft. The transmit antenna was a DB Products DB-411, four element, co-linear.

The Pueblo TV repeater performed flawlessly when using these antennas. The initial test was performed with Don, N0YE, transmitting through the repeater from his QTH about 5 miles away.

Sensitivity tests were again performed on the receiver while the repeater was operational and connected to the antennas. To perform this test an SMA, 20dB directional coupler (Macom 96341, 0.5-2GHz) was inserted into the receive antenna line at the repeater's input. See Fig. 12. The DVB-T test signal from the HV-320E and the step attenuator was injected into the receiver's antenna input via this 20dB directional coupler. Similar sensitivity tests were again run with this setup.

The conclusions were:

1. No desensing of the receiver when the transmitter was on.2.

2. Ambient background rf level on Ch 60 (438-444) raised the indicated OSD power level from -85dBm up to about -80dBm.4.

3. The receiver's threshold sensitivity when connected to an outside antenna was approximately -93dBm. Thus, the ambient, background rf degraded the effective threshold by about -2dB.

Reference

[1] *https://kh6htv.com/application-notes/*

Doherty Amplifiers - What Are They?

Written by Mike Collis WA6SVT

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Background

For years ATV power amplifiers have been class A for low level stages used for least amount of distortion and class AB for low distortion and better efficiency as PAs. In the analog days, most ATV stations used off the shelf linear amplifiers that were typically used for SSB, CW and FM modes based on land mobile UHF transistors that were designed for class C use but biased to try and move the transistor into class AB. They were OK for analog but still had some objectional distortion because their power curve was not linear enough. When digital ATV came on board, these amplifiers would not reproduce a digital ATV signal properly.

Some of the class AB bipolar RF power modules would work at greatly backed off power levels but the newer MOS or LDMOS power modules worked better due to the LDMOS FET's ability to better handle the short duration peaks in the RF envelope. For broadcast TV service, analog RF power amplifiers worked well for the transition to DTV. Most of these UHF amplifiers were IOT tubes with solid state IPA drivers. Solid State transmitters at the time had poor efficiency and were usually limited to low and medium power. About ten years ago LDMOS 32 volt transistors became the transistor of choice allowing their use in broadcast amplifiers to obtain 25 percent efficiency. Many of the older broadcast UHF RF amplifier modules and pallets were now surplus. Many ATVers have used these for DATV. In the case of broadcast TV service, the AC power to RF power efficiency with solid state with its poor efficiency and resulting large electric bills, broadcasters still favored the use of IOT and tetrode final amplifiers.

About four years ago 50 volt LDMOS push-pull FETs were introduced that improved gain, output power and efficiency to the 35 % range. These new 50 volt LDMOS devices are used in the newest high-end power amplifiers made by W6PQL and others for high power ham radio UHF and VHF amplifiers. In order to reach or surpass IOT or tetrode amplifier efficiency a new amplifier was designed. The Doherty amplifier greatly improved efficiency surpassing the IOT and tetrode amplifier.

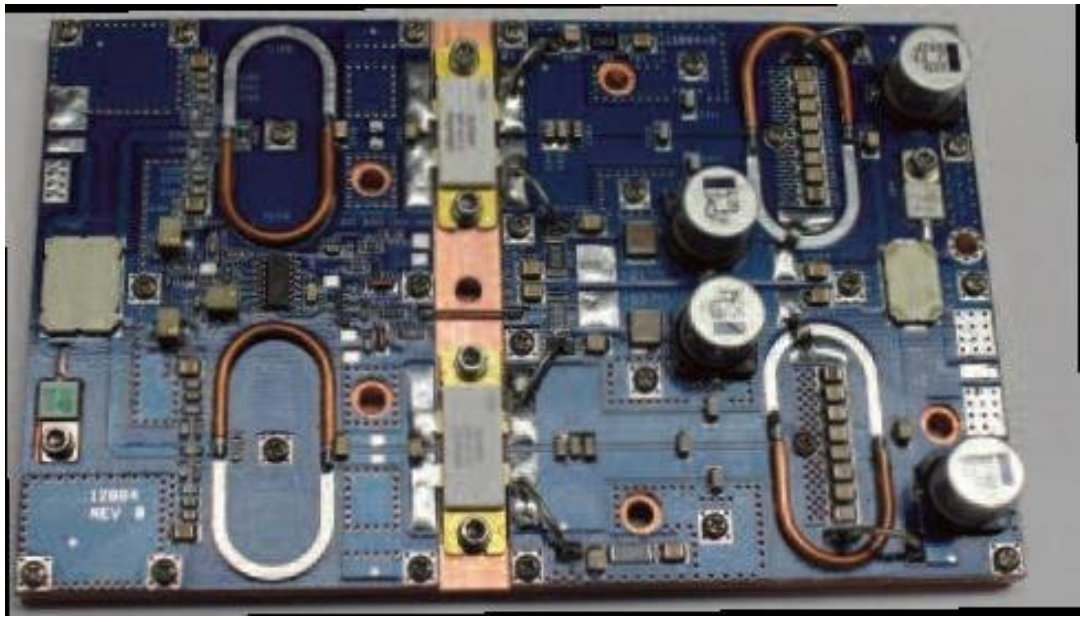
How they work

First let's review existing push pull solid state UHF power amplifier technology. The amplifier stage is usually a push pull, that is, it's a balanced set of FETs or bipolar transistors with one amplifying the positive half of the of the RF cycle and the other the negative half. Each transistor is biased for class AB mode so the transistor is turned on enough so no RF envelope transition distortion takes place.

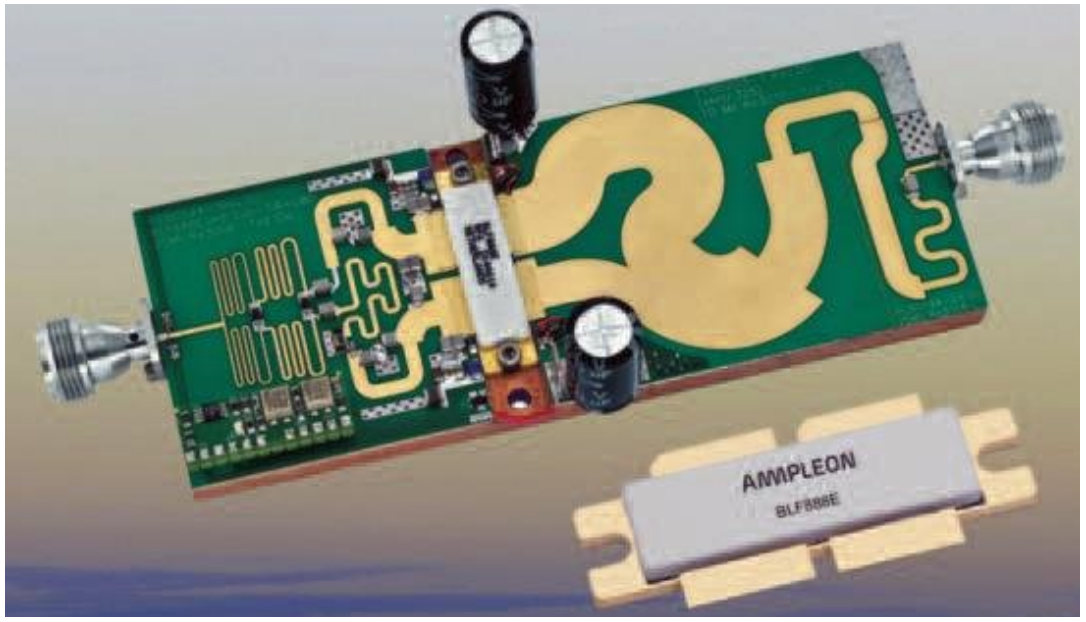
Push-pull is how most audio power amplifiers work and give fair to good efficiency. In the case of DTV modes there is a high peak to average level difference usually in the 6 to 8 dB range and is why an amplifier rated for 100 watts in SSB or CW will only achieve about 15 to 20 watts average digital power.

This backed off power gives about 30 percent efficiency while at saturation efficiency is near 65 percent. The UHF push pull amplifier has a great amount of symmetry when looking at the amplifier board as seen in the pic on the next page.

Doherty amplifiers on the other hand look asymmetrical. They still employ two transistors, but each is optimized and biased for different parts of the power curve. The main or carrier transistor is biased class AB as a single ended amplifier and is used to amplify the lower level or average power level of the DTV signal.



Push Pull UHF RF Pallet



Doherty UHF Amplifier Pallet

The other transistor known as the peak transistor is biased class C and its bias is set to keep the transistor turned off until the peak part of the signal starts. This level is about 6 to 7 dB below amplifier saturation.

This greatly improves efficiency. Doherty amplifiers only amplify the positive half of the RF waveform. The resulting negative clipping causes harmonic distortion and a low pass filter is required to reduce harmonic distortion.

The filter also restores the negative half of the waveform.

One more enhancement to discuss, the carrier transistor will saturate at about 25 percent of full pallet saturated power. What is needed is a way to pull the carrier transistor into peak amplifier mode only during the peak part of the signal but remain as class AB during the bottom 25 percent of the power curve.

The peak transistor when in conduction during peak RF drive is used to pull up the carrier transistor into peak mode allowing more power to be generated as well as power sharing between FETs. This is done by placing a quarter wave strip line (transmission line) between the carrier and peak transistor.

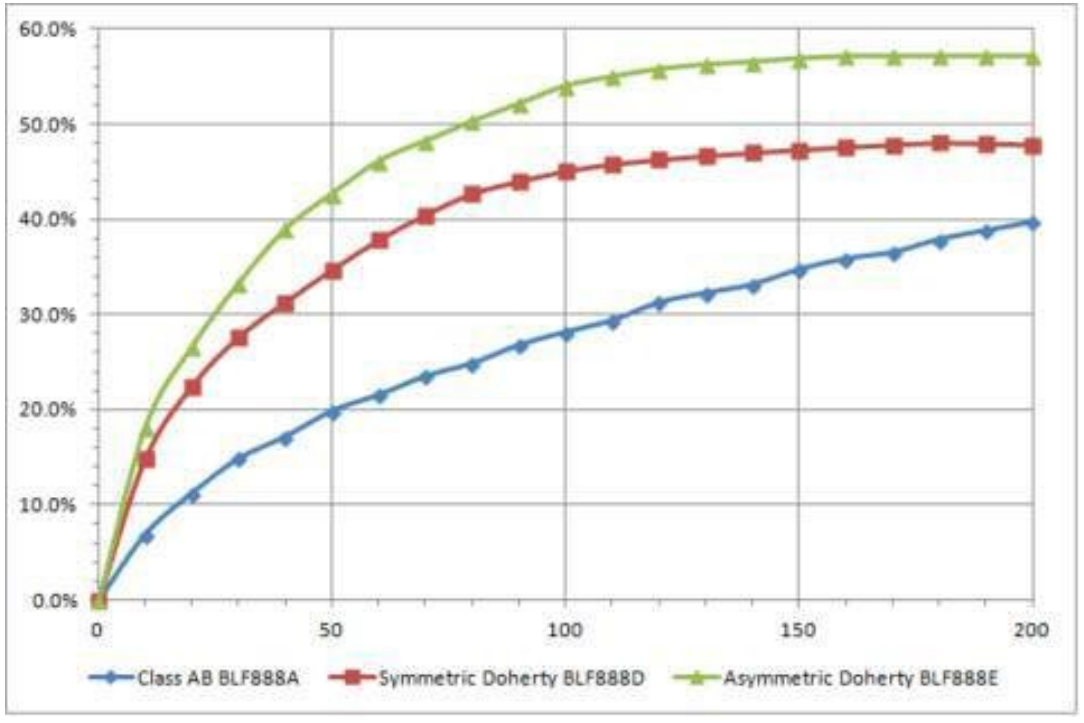
This is due to the quarter wave line inverting the load impedance to a lower level to the carrier transistor (like adding more loading to your HF amplifier). The lowering of this impedance allows the carrier transistor to supply more RF current thus its saturation level has been raised to match the saturation level of the peak transistor.

The quarter wave phase inverter on the output of the carrier transistor delays the signal 90 degrees so another 1/4 wave line is needed on the input stage of the peak transistor or a 3 dB (0 and 90 degree outputs) hybrid splitter is used so the signal at the T junction is back in phase.

Some Doherty designs use a dual transistor with the peak side having 1.5 times higher power rating for even better efficiency.

Note the difference in efficiency between class AB push pull and Doherty using balanced transistors (symmetrical) and transistors with the peak transistor rated for higher power (asymmetrical).

It is possible to convert an existing push pull RF pallet that has two push pull stages in parallel into a narrow bandwidth Doherty amplifier by removing the output 3 dB hybrid and



placing a simple tee connection in its place.

Because the quarter wave lines are now far away from the transistor output tabs, off frequency use from the quarter wave lines and hybrids will cause faster phase shifting.

Bias modifications: The transistor used for the peak amplifier will need to have its bias adjusted for class C.
This allows the use of an existing pallet to be converted to a Doherty high efficient amplifier. A harmonic filter would need to be added as well.

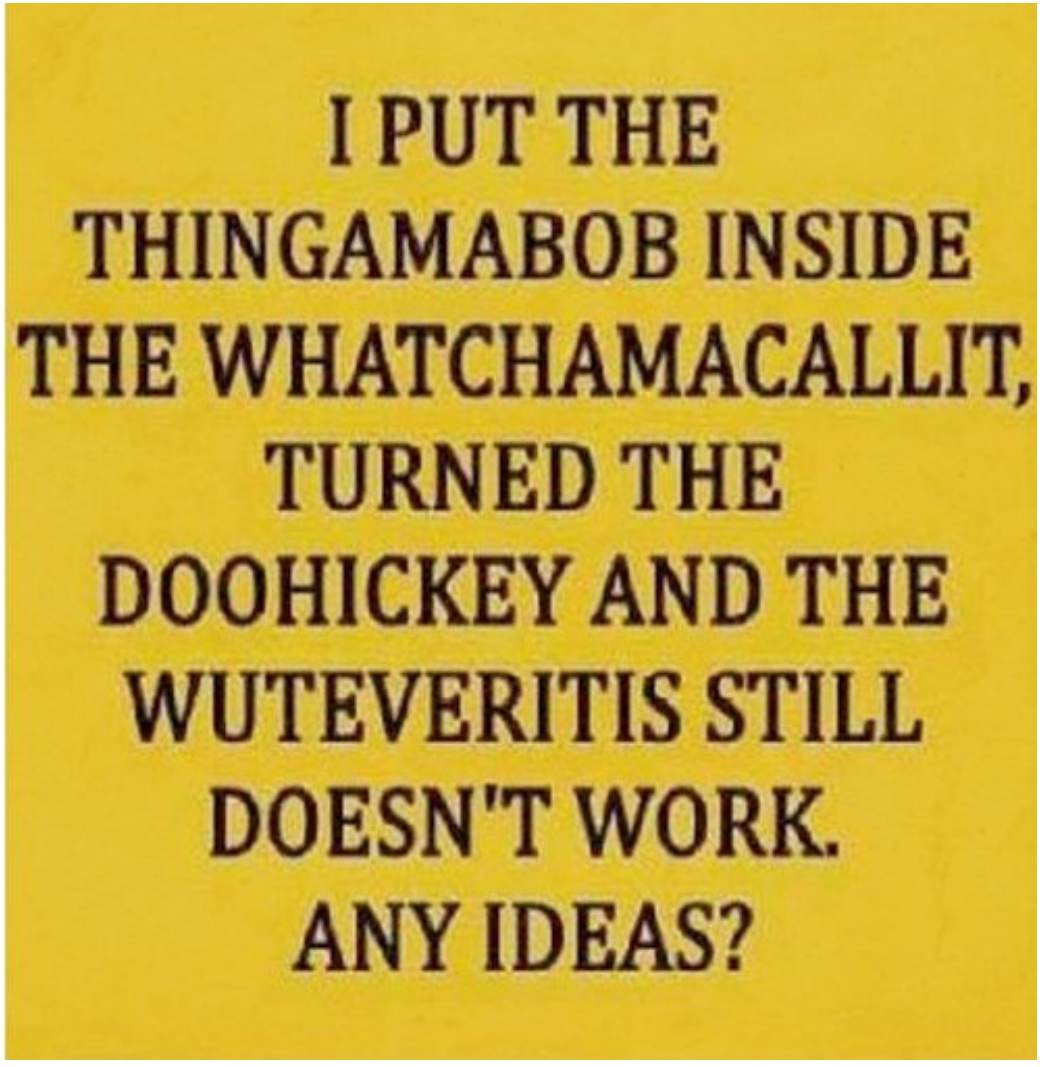
It should be noted that for most DATV use, class AB push pull amplifiers run backed off. It's still the easier way to go as pre-distortion is not needed for the lower power levels typically used.

For DATV DXing and a high-power repeater output, Doherty amplifiers may be worth looking into. An exciter with adaptive pre-distortion is recommended when using Doherty amplifiers to make best use of the added efficiency at the higher drive levels used due to some increased distortion as compared with class AB push pull amplifiers.

...73 Mike WA6SVT

Sorry as explained in the News section, the #%@$ part needed to complete part 2 hasn't arrived, so no article this month.

In the meantime, how about you lot get off your backsides and submit an article or two instead of leaving it to the regular few.



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Simple Microwave Power Meter

By John Hudson G3RFL

First published in issue 8

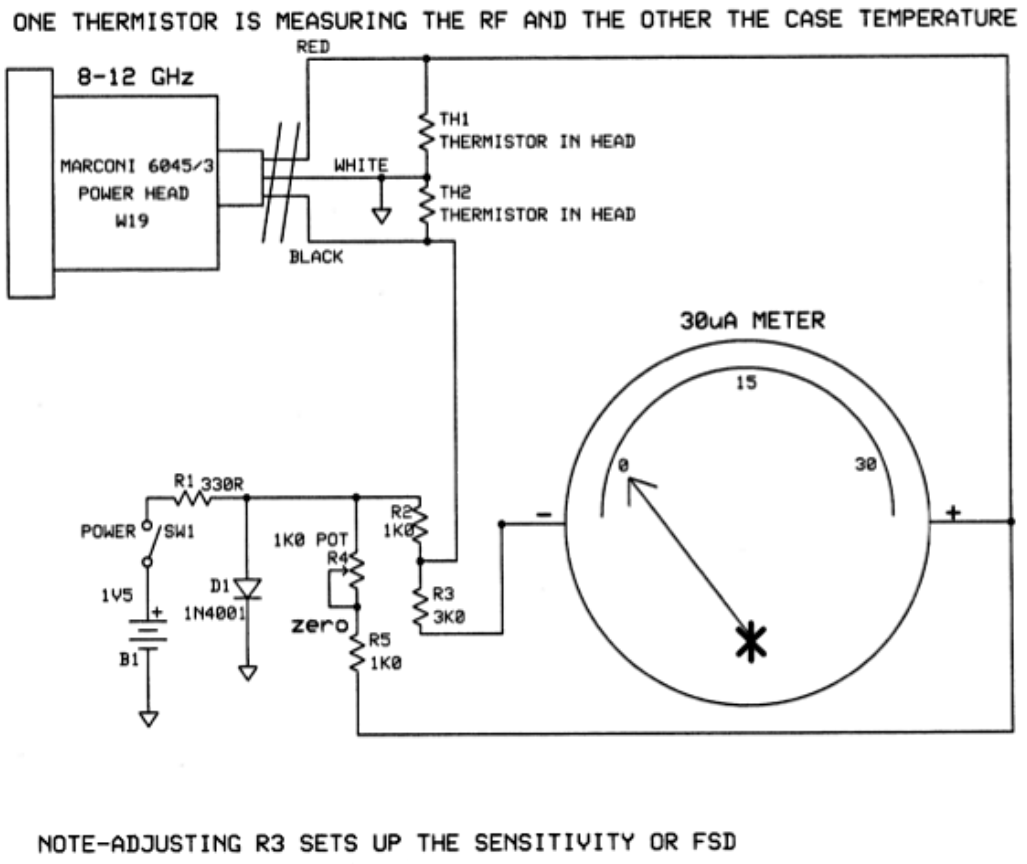
The original unit used a Marconi waveguide and transition to coax via a probe. The probe was removed and a thermistor put in its place at the focal point.

The second thermistor is mounted in the power meter case to measure the ambient air temperature. The RF will only warm the waveguide thermistor, so the resistance difference is proportional to the RF. This needs some initial calibration for the temperature offset and this is the purpose of the POT R4 which should be used to zero the 30µA meter, before the RF is applied. R3 can be varied to set the sensitivity or FSD (full scale defection) of the meter.

Apply the RF and the head thermistor will reduce in value and produce an increased current flow and change the balance of the two thermistors and this change in balance will result in current flowing through the µA meter, current that is proportional to the amount of RF entering the waveguide.

The unit is not calibrated so it is difficult to use if for power measurements, but it is useful for tuning up 10GHz transmitters and proved valuable for setting GB3FY up.

I did try using the Wife's hair dryer and a can of freezer to check for stability in various conditions and the unit does track the temperature changes via the case mounted thermocouple which cancels out these violent temperate changes.



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