In this issue

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All issues of CQ-DATV magazine are available for free download at *https://cq-datv.mobi/ebooks.php*

Editorial

Welcome to CQ-DATV 64. Publishing a monthly magazine is a double edged sword in that it provides an opportunity to update you on what is happening on the ATV scene with news that would start to look stale if we had stayed as a quarterly publication.

The down side is the pressure it puts on our volunteer workforce to source and edit the material into the multi formats we publish. The material is the most difficult to source or to ask our staff writers to create, so we have yet again to say - **if you want this magazine to continue we need your input!** It does not have to be a heavy constructional article, even though these are most welcome, but just a report on the activity where you live and perhaps a picture of your kit.

CQ-DATV was launched as a platform for exchanging ideas from enthusiasts around the world. Like all platforms it has had its highs and lows. The logic of producing this magazine free of charge may have been revolutionary at the time, but it is hard to justify anything but, in the world of electronic publishing and volunteers that work without any remuneration.

So please remember it takes only a few minutes to sit down and write a few words and take an accompanying picture, but it is the life blood of this magazine.

In this issue our news department have cast their net far and wide with stories from Jim KH6HTV about an ATV repeater in Boulder County, Ken W6HCC has sent in his updates to DATV Express and we have an interesting story about equipping a sub-orbital rocket with TV cameras and a link so you can see the launch, along with a story about live streaming a TV production from the Ross Revenge all about Radio Caroline (Ok most of the production team grew up in the age of Pirate Radio ships, if you didn't ask your parents or perhaps grandparents).

Moving on from news to articles, we start with a report by Rudi Pavlič s58ru about the first 10GHz DVB-T ATV contact in Slovenia.

Richard, VK4XRL, has written another addition of digital world looking at domestic kit for DVB-S2 reception of ATV.

Trevor has been looking back on the story behind a story we published in CQ-DATV 63 about the Ampex sign coming down in Redwood City.

Jim, KH6HT, has been investigating RF amplifier output power for various modulations including DATV.

John G3RFL has found a DIY PCB toner transfer (no heat!) and Etching method. It would seem that photosensitive coated PCB materials are getting too expensive and John has a quick and easy solution for avoiding the light box, film and the expensive coated PCB.

The team have also added a long lost SSTV book to our library. We hope to expand the Archive section in the coming weeks by including other long lost publications.

So please keep checking *https://www.cq-datv.mobi/ebooks.php#vintage*.

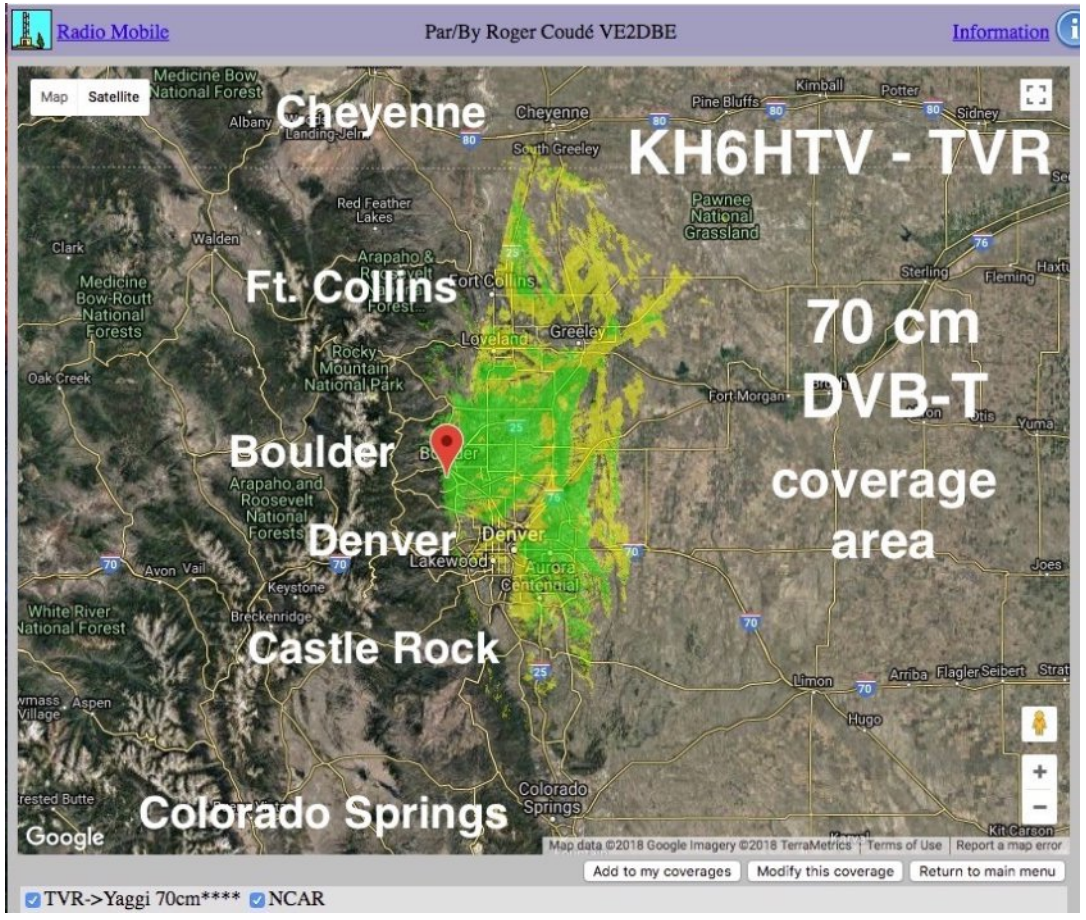
Something that did not make it into this issue is the Ancona ATV contest so please, if you took part, we would love a report so we can bring you the full story in the next issue.

So as we always say sit back and enjoy CQ-DATV 64.

CQ-DATV Production team

TV Amateur is a German Language ATV Magazine. It is published 4 times a year and if you would like to subscribe go to *http://agaf-ev.org/*

BOULDER TV Repeater's REPEATER



The above map is the predicted coverage area of our TV repeater. This assumes the remote station is using a 6 element (11dBi) yagi antenna at 30ft height. On 70cm, the remote staion also needs to be using a 10 watt (rms, avg) DVB-T transmitter. The on-line, RF propagation prediction program called Radio Mobile *http://www.ve2dbe.com/rmonline.html* was used to calculate this map. More detailed maps are available at *www.kh6htv.com* in App. Note AN-43c. Very detailed point-to-point RF path predictions can also be provided upon request.

ATV from Wyoming to Boulder Jim Andrews, KH6HTV

The Boulder ATV Repeater, from it's new location, reaches out a really long distance. Plus the repeater is a true QRP repeater, running only 5 Watts on DTV. On 70cm, it's transmitter shares a common antenna with the BARC 70cm FM voice repeater. Computer predictions said we should be able to reach into southern Wyoming. The computer said a good site to test was just south of Cheyenne on I-25 where there are several microwave towers and also the Cheyenne TV tower. It is 77 air miles from the repeater.

On July 19th, Jim, KH6HTV and Don, AA6TV made a DXpedition to Cheyenne to see if in fact they could both receive and transmit into the repeater. The DXpediton was timed to co-inside with the Thursday afternoon ATV net. The above photo is confirmation that it works ! This photo was taken by Don, N0YE, ATV net control. It was the TV image he saw on his home TV screen after being repeated by our TV repeater.

Jim & Don received the 70cm, DTV signal from Boulder on a 6 element yagi antenna with a 10dB margin. They were also able to transmit a 70cm, 10 watt DTV signal back to the repeater, again with a 10dB margin (exactly as predicted by the computer program, Radio Mobile).

On 23cm, they used a 3 watt, DVB-T transmitter and a 24 element, loop yaggi. Again,, they had a 10dB margin. The last test was on 23cm with a 30 watt, FM-TV transmitter. They again got a P5 picture into the repeater. Dropping the power down to 1/2 watt degraded the FM picture to P3.

While driving up to Cheyenne, Don and Jim monitored in the car transmissions from the tv repeater. Don, N0YE, had the repeater turned on and transmitting a continuous DVD with "live" video and audio. Driving from Boulder east on Baseline Road and then north on I-25, we were able to verify the good and bad areas as predicted by Radio Mobile.

To maximize the chances of success, the DVB-T digital parameters were set for a lower 720P resolution, QPSK modulation and very aggressive Forward Error Correction of 1/2 Code Rate. These parameters are used on the TV repeater's transmitter and were also used for the Cheyenne transmitter.

For more details on these parameters, see my application note, AN-39. (*www.kh6htv.com*)

As a side note, the BARC 2 meter (146.70MHz), FM voice repeater was used to communicate between Cheyenne and Boulder. Running 50 watts, mobile, voice communication was far worse than the DTV communication. The audio both ways over DVB-T was perfect CD quality. The FM voice signals were very scratchy and difficult to understand.

73 de Jim Andrews, KH6HTV

DATV-Express Project

Art WA8RMC reports that there was a steady stream of orders during August for MiniTiouner-Express receivers. Many of the orders are for customers in the European Union…..and Charles is now waiting for more units to arrive from Art (that is clear customs), in order to resume shipping to EU orders.

Charles G4GUO has fixed one bug for PLUTO units and has prepared a zip of v1.25LP10 for Ken to test,
Ken W6HHC reports he has just received a v1.25LP10 zip file from Charles for the Windows DATV-Express software.

This software corrects a small (code-wise) bug in the PLUTO support that allowed an RF-carrier to be produced in RECEIVE mode after the PTT button was released from TRANSMIT. Ken plans to begin testing the new software version on PLUTO, and LimeSDR-mini, and DATV-Express hardware units before uploading to the *www.DATV-Express.com* web site on the DOWNLOADS page.

Charles G4GUO also reports he has been spending time lately working on "pre-distortion" software for the DATV-Express software, that lower the distortion "shoulders" on the hardware RF output. The status is that he has sorted out a non-obvious math problem and is now moving in a positive direction for this new DATV feature.

Just a note that the v1.25LP10 software (DATV-Express DVB Transmitter software for Windows) is available for download. This build of software fixes the PLUTO problem where an RF carrier is sent out when clicking PTT to go back to STANDBY. This software now supports four hardware exciter boards:

- *DATV-Express (USB-2)*
- *LimeSDR (USB-3 or -2)*
- *LimeSDR-mini (USB-3 or -2)*
- *PLUTO (USB-2)*

The software can be downloaded from the project web-site at *www.DATV-Express.com*. Go to the DOWNLOADs page. A stand alone NOTES file (aka README) can also be downloaded from the same DOWNLOADs page.

Many thanks to Charles G4GUO for correcting the PLUTO "unexpected carrier" bug…de Ken W6HHC

Project Speed is set to slow….de Ken W6HHC

Copenhagen Suborbitals

Copenhagen Suborbitals is the world's only manned, amateur, crowd funded space programme. Since its beginning in 2008, Copenhagen Suborbitals has flown five home built rockets and two mock-up space capsules. Their stated goal is to have one of the members fly into space (above 100 km), on a sub-orbital spaceflight, in a space capsule on the Spica rocket.

The company is planning to launch its Nexø II rocket in summer 2018.

As an amateur organisation, the 55 members use their spare time on the project, while at the same time having regular dayjobs. At the annual general assembly, they elect a chairman and boardmembers. Currently (2017), the chairman is Kristian Elof Sørensen, who also leads the Copenhagen Suborbitals maritime group.

On August 4th 2018 we successfully launched the Nexø II rocket. Nexø II is Copenhagen Suborbitals most advanced rocket to date. In this video we show you the complete story will all the highlights of the mission. Enjoy!

The IBA Archive channel

Liam Mustapha has made available a collection of TV Engineering Announcements broadcast on ITV and Channel 4 in the 1970's and 80's

This YouTube channel is dedicated to the Independent Broadcasting Authority's (IBA) 'Engineering Announcements for the Radio and Television Trade' programmes broadcast on ITV, and latterly on Channel 4, during the 1970s and 1980s. This channel is non-profit and is for archival purposes only. If you have any enquiries, please message me on our Google+ page. Many thanks for stopping by and I hope you enjoy these nostalgic programmes from the past!

Liam Mustapha
Owner of the Channel

The IBA Archive
https://www.youtube.com/channel/UC6oDtfnkkKgYKk0BId3f38w/

Source Southgate ARC News

This Week in Radio Tech

So a little video challenge for me on Thursday evening at 2200 UK. There's a Radio Industry technical webcast called This Week In Radio Tech which I've watched for years and years. It's hosted by Kirk A. Harnack, and we're going to do a live video link via Skype to his live webcast from the Radio Caroline ship, Ross Revenge.

Kirk works for the Telos Alliance, home to Axia audio over IP radio mixers and Omnia audio processors, both very well respected products.

He is also a very accomplished radio engineer, radio station owner, and a pretty darn good weather presenter at his local TV station, and a great host of the webcast.
It'll be at 2200 UK time on Thursday evening.

Hoping the 4G technology behaves. We did a test today with the whole chain, Canon XA25 Camera, through the Magewell SDI to USB, into my MBP, and out to the Vodaphone 4G USB dongle via and active USB cable that's about 10m long, so we can go into the bowels of the ship, slightly under the waterline and surrounded by steel, but keep the dongle up on deck. I have a 25m SDI cable on the camera too, so can then move around the transmitter and generator rooms, but most of it will come from the studio.

I'll do a new post at the time. Should be fun. I've done a Facebook live from the ship on my phone, which is also Vodaphone so the 4G should be ok.
https://www.facebook.com/154534786156/posts/10155347572356157/

Join Kirk Harnack,for episode 413 with guest Rob Ashard.
https://www.facebook.com/guysfromqueens/videos/1881534318601889/UzpfSTQxMTI0ODg0OTA4MDU1Mzo4OTE0NTA4NTEwNjAzNDg/?multi_permalinks=891450851060348%2C890934547778645&notif_id=1537429129151077&notif_t=group_activity

P4-A ground segment system integration

Since Friday morning, we have been finalizing the individual components for the Es'hail-2 / P4-A ground station in Qatar and final testing. The equipment will later be installed in the Es'hailSat control station (SCC). Another plant will be back up at QARS in Doha. Furthermore, we will install the third ground station at AMSAT-DL in Bochum. The ground equipment consists among other things of the LEILA system for the narrow band transponder (NB), the DATV receiving and transmitting device for DVB-S2 or digital amateur radio television over the wide band transponder (WB), transceiver for SSB operation and redundant units for the SCC.

The AMSAT-DL team:

Tilman Glötzner, DG2TG	Peter Gülzow, DB2OS
Thomas Kleffel, DG5NGI	Michael Lengrüßer, DD5ER
Mario Lorenz, DL5MLO	Stefan Reimann, DG8FAC
Jens Schoon, DH6BB	Achim Vollhardt, DH2VA

Source: *http://amsat-dl.org/p4-a-bodensegment-system-integration*

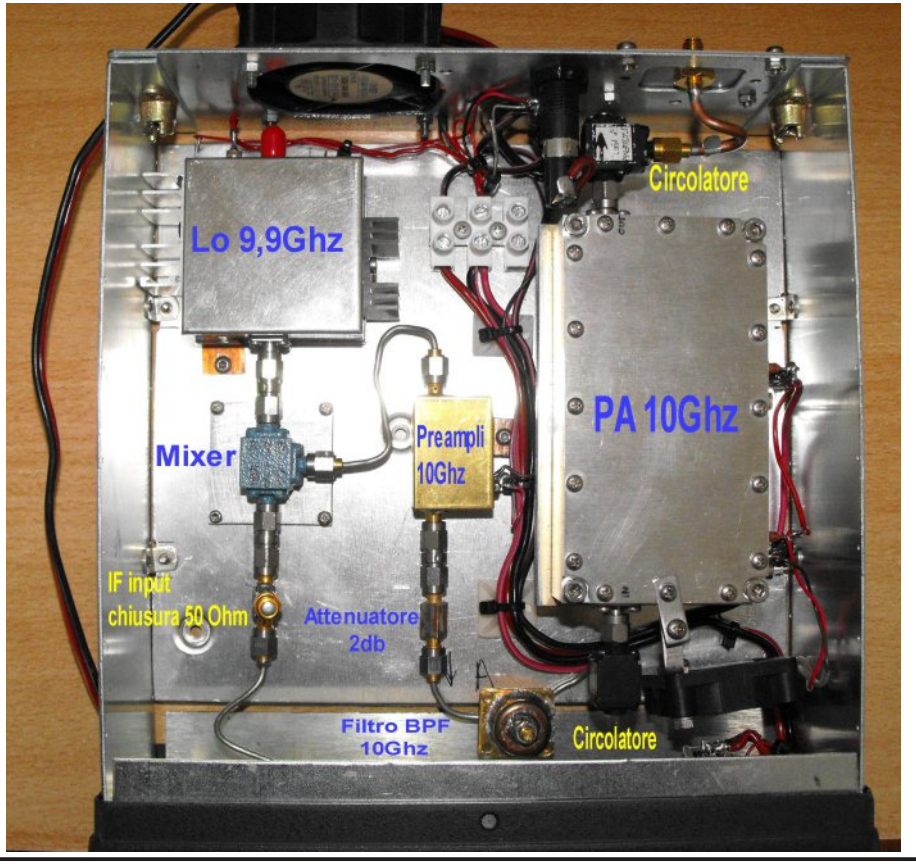
Conquering 10 GHz DVB-T in S5 - Slovenia

Rudi Pavlič s58ru reports

Graziano S50J has recently acquired an up converter for work on 10 GHz DVB-T.

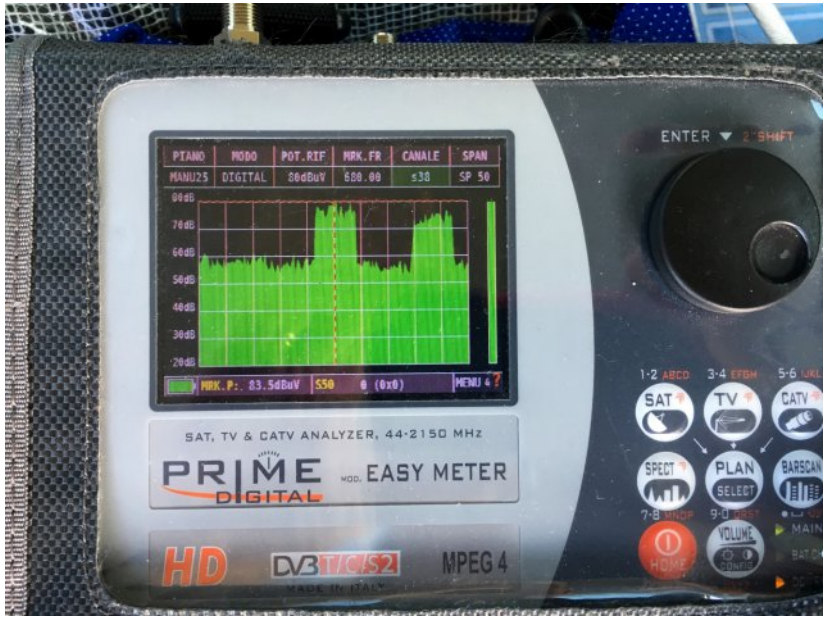
The converter has an oscillator that is set at 9900 MHz, controlled by a low phase noise PLL and locked to a 10MHz TCXO which provides a very precise internal reference - as it should be:-

- *Using the modulators we have (HV-100, HV200, HV-320), for an input of 550 MHz 0db, the Output produced is 10450 MHz 80mW.*
- *For an input 500 MHz will be transmitted at 10400 MHz (9900 + 500 = 10400 MHz)*



Graziano pressed a HiDes modulator into service for the driver, which was left over from his first experiments on 13 cm DVB-T.

We set the link up with me at the receive end and failed! 10GHz DVB-T, was not going to happen for me.



The next day, Mauro IV3WSJ joined us. I tried first in a last ditch attempt to receive Graziano and again failured! Mauro then "took over" control - it became the Mauro experiment.

Mauro immediately received the Grazian signal on 10GHz DVB-T. To make matters worse, Mauro showed Graziano that the link was successful. This was, if I'm not mistaken, the first 10GHz DVB-T connection in Slovenia. I am not expecting a QSL card.

2018-09-14 - 10:31 S50J - JN65VO - S5 / IV3WSJ - JN65VN - 5 km - 10 GHz DVB-T

- *Grazian transmitting power was 80 mW using a 60 cms parabola, receiving using an OFF-SET 40cm parabola. Transmission frequency 10.430 MHz, QRA locator JN65VO Hrvatini.*
- *Mauro transmitting power 450 mW - OFF-SET parabola of 80 cm for both RX and TX. Transmission frequency 10.450 MHz, QRA locator JN65VN Tinjan.*

When they were happy with the link, Mauro pointed the antenna towards me and began transmitting 10 GHz DVB-T. I received his signal straight away, but I could not return the transmission because I had not set my TX to this frequency.

Again I went down the route of "hunting" Grazian's signal and this time I was lucky and received it! The problem is that Graziano has a chimney stack in front of his parabola, which blocks the signals towards my QTH.

A problem we now understand and nothing I could have done at the time to be the first DVB-T contact for this link.

73 s58ru

New Satellite Receiver for 23cm and Repeaters Using DVB-S/S2

Written by Richard Carden - VK4XRL

Digital ATV receivers are the backbone into the world of DATV, everybody has to start somewhere and there are at times some interesting kit around at some very good prices.

The first one I played with was introduced through Peter Cossins VK3BFG from the Melbourne ATV group. It was available at I price that I couldn't resist buying one to try it out.

This was the KOQIT K1 mini unit and is quite small measuring about 120mm x 70mm. The front panel has two USB inputs which could be used for Wi-Fi and media (record or replay). The rear panel has a +12v input from a power pack, a A/V socket, a socket for the LED remote screen, plus an HDMI output socket and a F connector for RF input.

The above photos show the RPi PortsDown being received by the receiver. One added advantage is that when the information button is clicked twice it will show the Transmission parameters of the received signal including signal strength, Quality and BER which could prove to be very useful.

The Melbourne group are working on a way to allow a signal receive indication which can then be interfaced to the repeater control unit. (It is hoped that this will be available when completed).

Not quite as small, but never the less popular with DATV operators in Australia is another receiver that's worth a mention and this is the STRONG Model SRT 4950E.

This one maybe not as elegant, but is ideal for DATV repeater operation complete with signal indicator which is not available on the KOQIT. It only requires interfacing from the signal indicator to the repeater controller.

Both units are capable of receiving both DVB-S/S2 (especially useful if using the PortsDown which can use both MPEG2 and MPEG4) and will tune the amateur bands at least in Australia so check if you're intending to use one in a different country. Sensitivity is on par with other receivers like this but no real tests have been done at this stage.

Normal caution is required if used direct to the antenna as power is fed to the F connector for supplying a preamp or LNB if required.

Both these receivers can be found on EBay.

White Christmas to White Powder

Written By Trevor Brown G8CJS

Ampex sign Redwood city

In last month's issue we reported on the removal of the Ampex sign form Highway 101 of Redwood City. I thought we ought to look back on the company and their contribution to Broadcast Television which was of course Video Tape Recording.

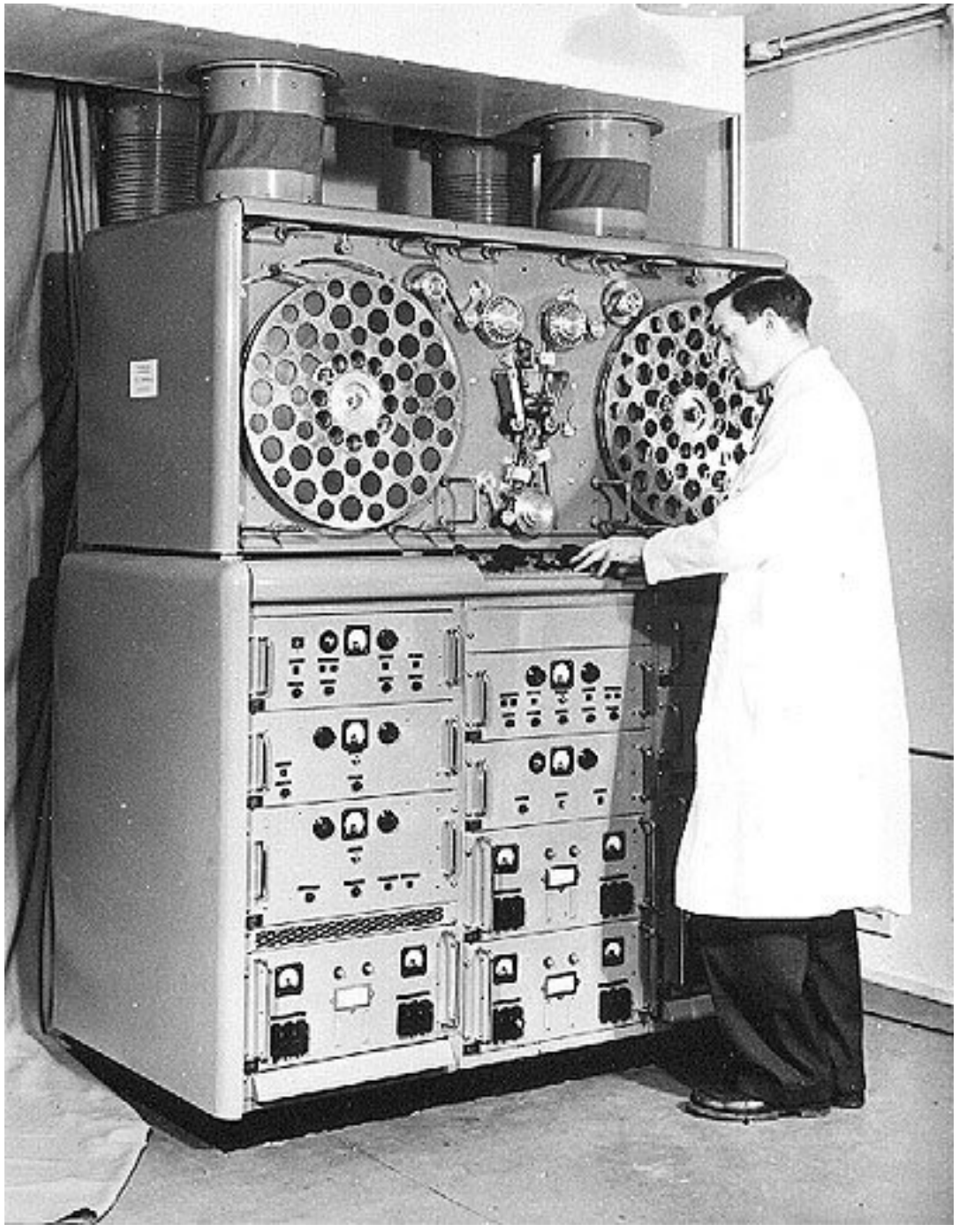
Ampex was founded by a Russian-American inventor Alexander Matthew Poniatoff. The company name was composed of his initials AMP, the EX was added as there already was a company called AMP.

The company was established in 1944 and started by manufacturing high quality motors for use in Radar equipment during World War II. The company later diversified into tape recording based on equipment developed by German companies before and during World War II, there were patents, but these were effectively voided after Germany's 1945 surrender.

The equipment Ampex produced had far reaching results. Bing Crosby, then a radio star had a dislike for live broadcasts and a preference for pre recording his shows. This met with resistance because the quality of the recordings at the time and often shows were performed twice, once for the east coast and once for the west coast.

There had to be a better solution and when Ampex developed its 200 tape recorder, ABC agreed to allow Crosby to pre-record his shows onto tape using the 200. Crosby immediately placed an order for $50,000 worth of the new recorders so that Ampex (then a small six-man concern) could develop a commercial production model.

Alexander M. Poniatoff (r) and Harold Lindsay, his chief engineer, in 1948 with the first Ampex 200 recorder



BBC VERA video recorder

The path from Audio recorders to video recorders was one other companies had looked at, perhaps the most famous was VERA (Vision Electronic Recording Apparatus) developed by the BBC. This machine had fixed heads and a tape speed of 200 inches per second to deal with the TV bandwidth.

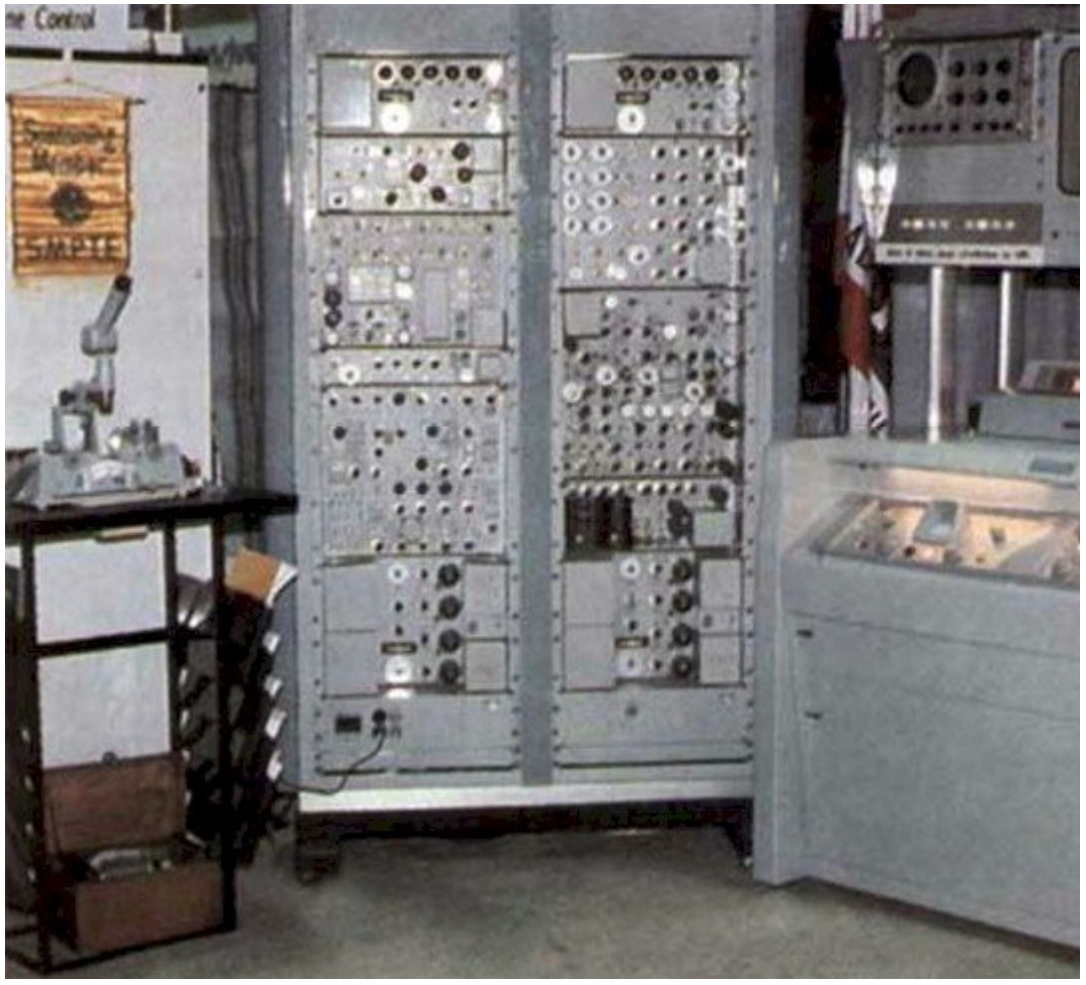
These tape speeds and fixed heads were unworkable and produced very poor results. Bing Crosby or rather his company BCE (Bing Crosby Enterprises) experimented with a multi track machine and found the problem was not only the head to tape speed used to deal with television bandwidths, but the current head designs were also a problem.

New designs delivered 1MHz bandwidths, but were still not adequate. BCE and Ampex worked together to come up with a practical solution that could deal with TV bandwidths and use a manageable tape speed.

The result was the Ampex VR-1000, the world's first commercially successful videotape recorder that appeared in 1956. It uses the 2" quadruplex format, using two-inch (5.1 cm) tape.

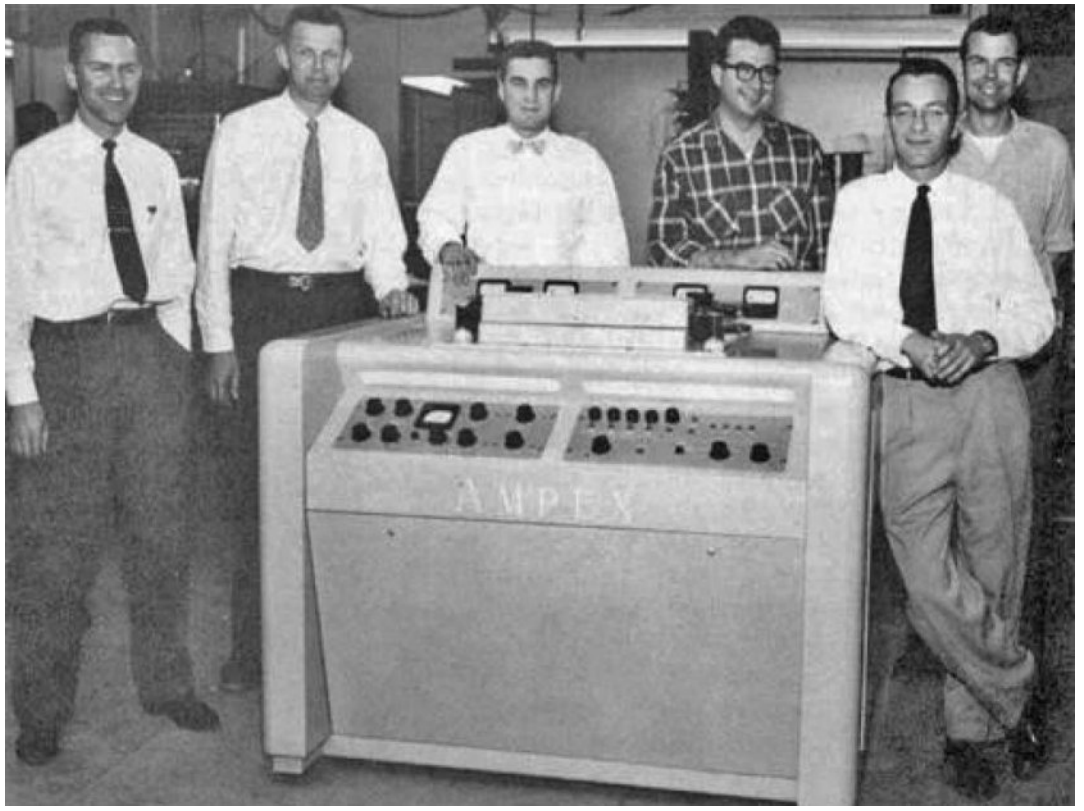
The development team behind this first video recorder are also worth acknowledging. It might not have been the first recorder, but it was the most practical and the format it used lived on well into the 1980's. It did have its problems most noticeably no pictures in wind, no freeze frames and no slow motion.

It was originally designed as a way of time shifting TV programmes. The format was editable, but with difficulty as it entailed cutting the tape physically with a razor blade at a point that was determine by developing the video tracks with a solution of Iron powder and searching through them with a microscope, before cutting and joining the parts together.



Ampex VR 1000 video tape recorder, note the two external racks, which are part of the machine

The product launch was in April 1956 at NAB, but two days before the convention the machine was demonstrated to 300 CBS affiliates at the Conrad Hilton Hotel. The demonstration started with a speech by Bill Lodge VP of CBS. When this was over, 20 monitors around the room showed the speech being replayed, before the curtains were drawn back to reveal the source of this replay. There was about 10 seconds of silence until they realised what was happening, followed by clapping and cheering, remember this was the first time anyone outside Amex had seen instantaneous replay of any event.



Fred Pfost, Shelby Henderson, Ray Dolby, Alex Maxey, Charles Ginsburg, Charley Anderson - The Team behind the development of the VR1000

It's rumoured that at NBC the orders came so fast that they were written on table napkins, by the sales staff.

Ampex won an Oscar, several Emmys and a Grammy. In 2008, Ampex declared Chapter 11 bankruptcy and was acquired by Delta Information Systems. Sad end to the company that invented video recording.

Ray Dolby is a house hold name, these days for his work on audio systems that carry is name, I always thought it a fitting tribute when in the 1980's when I installed Dolby sound modules to a much later Ampex video recorder (VPR2) but that's another story.

There were also unsubstantiated rumours that part way thought the development process Ray Dolby was inducted into the services and still thinking about the VR 1000 rang Ginsburgh to say he though they ought to change from AM to FM and introduce a control track. But again these are only rumours.

Why the title well White Christmas is a reference to Bing Crosby's famous song, which incidentally was used on the radio to signal the American withdrawal from Vietnam . White powder, as video tape evolved and tape improved and improved Memorex Chroma 90 developed a problem with the tape backing collapsing and delivering white powder that clogged the machine and stopped the recordings being recovered, the same problem also happened to the 3M tape 420 some months later.

Video recording rescued from 1964
https://www.dcvideo.com/news/2018/8/23/dc-video-restores-rare-1964-color-tonight-show

Diary of a POM in Western Australia

August 31
Just got transferred with work from Leeds UK to our new home in Karratha, Western Australia .
Now this is a town that knows how to live!
Beautiful, sunny days and warm, balmy evenings.
I watched the sunset from a deckchair by our pool yesterday.
It was beautiful. I've finally found my new home.
I love it here.

September 13
Really heating up now.
It got to 31 today.
No problem though.
Living in air-conditioned home, driving air-conditioned car.
What a pleasure to see the sun every day like this.
I'm turning into a sun-worshipper - no blasted rain like back in Leeds !!

September 30
Had the back yard landscaped with tropical plants today.
Lots of palms and rocks.
No more mowing lawns for me!
Another scorcher today, but I love it here.
It's Paradise !

October 10
The temperature hasn't been below 35 all week.
How do people get used to this kind of heat?
At least today it's windy though.
Keeps the flies off a bit.
Acclimatizing is taking longer than we expected.

October 15
Fell asleep by the pool yesterday.
Got third degree burns over 60% of my body.
Missed three days off work.
What a dumb thing to do..
Got to respect the old sun in a climate like this!

October 20
Didn't notice Kitty (our cat) sneaking into the car before I left for work this morning.
By the time I got back to the car after work, Kitty had died and swollen up to the size of a shopping bag and stuck to the upholstery.
The car now smells like Whiskettes and cat shit.
I've learned my lesson though: no more pets in this heat.

October 25
This wind is a bastard.
It feels like a giant *?@#ing blow dryer.
And it's hot as hell!

The home air conditioner is on the blink and the repair man charged $200 just to drive over and tell me he needs to order parts from *?@#!ing Perth .....The wife & the kids are complaining.

October 30
The temperature's up around 40 and the parts still haven't arrived for the *?@#ing air conditioner.
House is an oven so we've all been sleeping outside by the pool for 3 nights now.
Bloody $600,000 house and we can't even go inside.
Why the hell did I ever come here?

November 4
Finally got the *?@#ing air-conditioner fixed. It cost $1,500 and gets the temperature down to around
25 degrees, but the humidity makes it feel about 35.
Stupid repairman. *?@#ing thief.

November 8
If one more smart bastard says 'Hot enough for you today?' I'm going to *?@#ing throttle him.
*?@#ing heat!
By the time I get to work, the car radiator is boiling over, my *?@#ing clothes are soaking *?@#!ing wet and I smell like baked cat. *?@#ing place is the end of the Earth.

November 9
Tried to run some errands after work, wore shorts, and sat on the black leather upholstery in my car.
I thought my *?@#ing arse was on fire.
I lost 2 layers of flesh, all the hair on the backs of my legs and off my *?@#ing arse.
Now the car smells like burnt hair, fried arse and baked cat.

November 10
The Weather report might as well be a *?@#ing recording..
Hot and sunny.
Hot and sunny, Hot and *?@#ing sunny.
It never *?@#ing changes!
It's been too hot to do anything for 2 *?@#ing months and the weatherman says it might really warm
up next week. *?@#!.

November 15
Doesn't it ever rain in this damn *?@#ing place?
Water restrictions will be next, so my $5,000 worth of palms might just dry up and blow into the *?@#ing pool.
The only things that thrive in this *?@#ing hell-hole are the *?@#ing flies.
You don't dare open your mouth for fear of swallowing half a dozen of the little bastards!

November 20
Welcome to HELL!
It got to 45 *?@#ing degrees today.
Now the air conditioners gone in my car.
The repair man came to fix it and said, 'Hot enough for you today?'
I wanted to shove the *?@#!ing car up his *?@#ing arse.
Anyway, had to spend the $2,500 mortgage payment to bail me out of jail for assaulting the stupid prick.
*?@#ing Karratha!
What kind of sick, demented *?@#ing idiot would want to live here!

December 1
WHAT!!!! The FIRST day of Summer!!!!
You are *?@#ing kidding me!

(Anonymous)

Amplifier Output Power for Various Modulations

Written by Jim Andrews, KH6HTV.
Reprinted by permission.

The question often arises, for a typical class A-B, linear, RF power amplifier, how much power can I get for various types of modulation ? A set of tests were performed on a KH6HTV Video model 70-9B, 70cm, amplifier to obtain some representative values. The tests were all performed on TV channel 60 (438-444MHz) with a center frequency of 441 MHz, or 439.25MHz for VUSB-TV.

The table below summarizes the results.

Details on the measurements are on the following pages.

Model 70-9B Amplifier Output Powers

MODULATION	P(out) dBm	P(out) Watts	Power type	notes
CW	49	80	rms	
FM	49	80	rms	
AM	41	12.5	rms	
AM	47	50	PEP	@99% mod.
SSB	47	50	PEP	@ -1dB
VUSB-TV	44.5	28	PEP	
QPSK - DTV	39	8	rms	
16QAM - DTV	38.5	7	rms	
64QAM - DTV	37.8	6	rms	

CW/FM: For FM/CW service a very non-linear, class C amplifier suffices and provides the best efficiency. For all other classes of service a linear amplifier is required [1]. All measurements for this report were made on a KH6HTV Video model 70-9B RF Linear Power Amplifier, S/N 123.

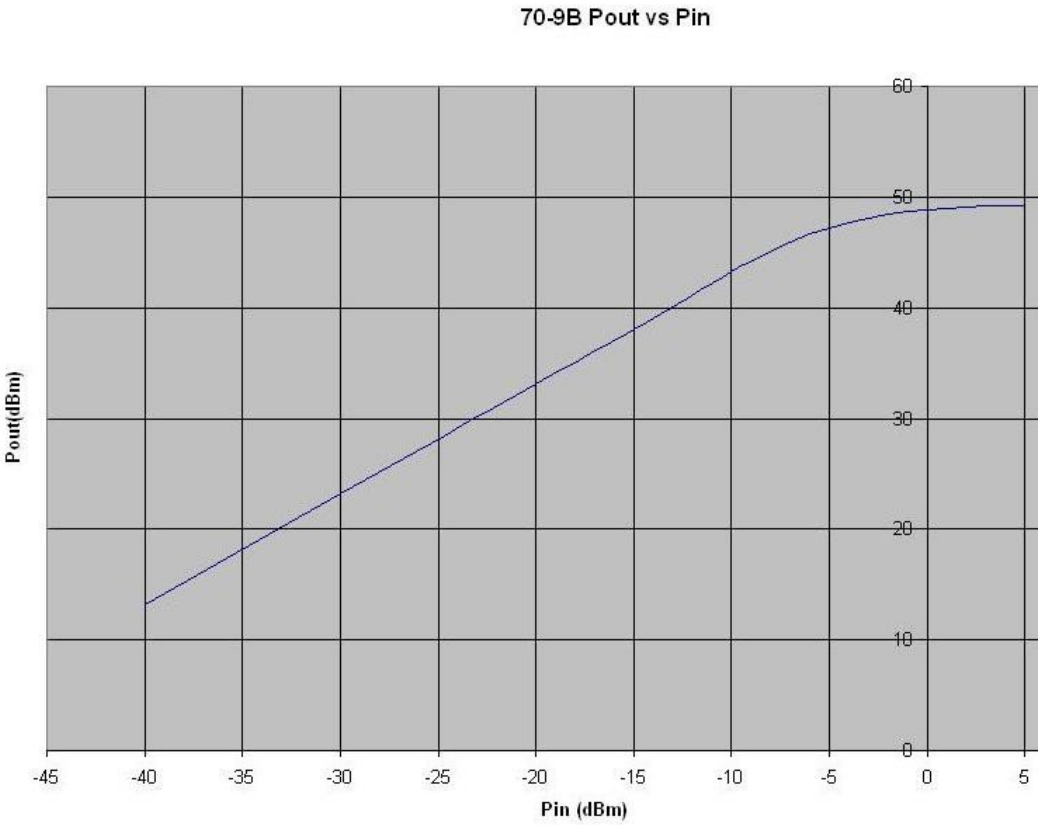


Fig. 1 Model 70-9B Amplifier Pout vs. Pin.

Most all measurements were done at 441 MHz.
Fig. 1 above shows a CW measurement of the output power vs. the input power. The signal source was a Fluke model 6060B/AK rf signal generator. The output was measured using a Rigol model DSA-815 spectrum analyzer. A 30dB, 150 Watt attenuator, plus a 10dB, 2 Watt attenuator were used on the output of the amplifier.

The amplifier is seen to be very linear. Like all good linear amplifiers, it eventually saturates at it's max. output, but in a smooth, controlled fashion. The small signal gain was 53dB. The saturated output power was +49dBm = 80 watts. The -1dB gain compression occurred at +47.2dBm = 52.5 watts. Below 20 watts (+43dBm), the amplifier is extremely linear.

At low drive levels, the amplifier is in class A mode. It draws 7.9 Amps at a supply voltage of +13.8Vdc. Thus the quiescent dc input power is about 109 watts. At higher drive levels, it starts to draw more current and enters class A-B. When fully saturated, it draws 12.8 Amps. Thus, P(dc) = 177 watts. At max. saturated rf power output, the efficiency is 45%.

Fig. 2 shows the amplifier's spectrums with FM modulation at max. output of 80W and low power of 2 watts. They are identical, except for level.

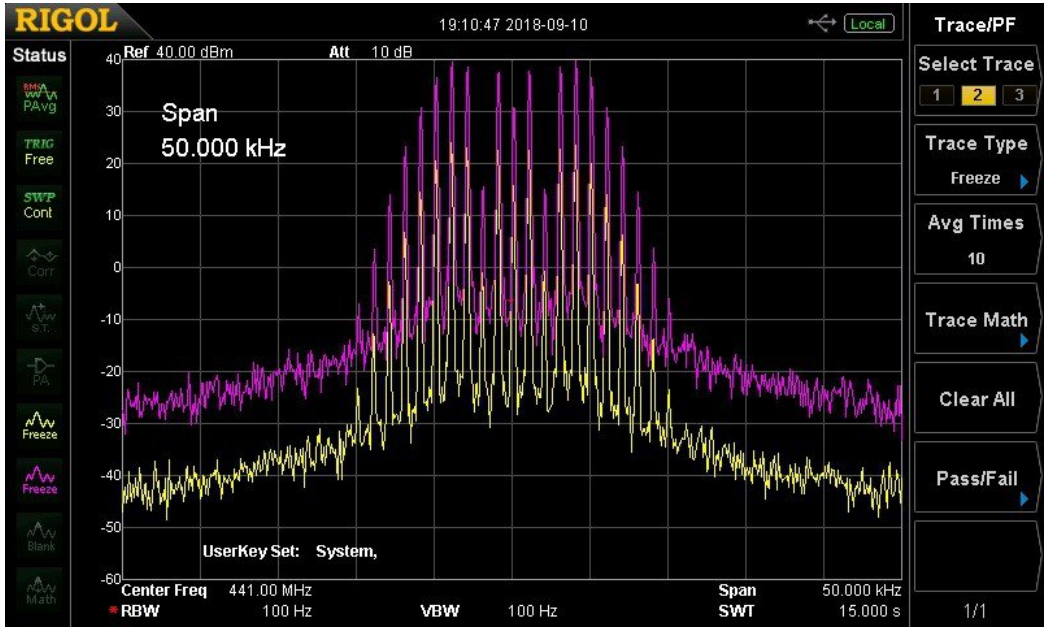


Fig. 2 70-9B Amplifier operating as an FM voice transmitter. FM spectrum with 1kHz tone and 5kHz deviation. Magenta = max. output of 80 watts. Yellow = low power of 2 watts. Spectrum analyzer settings: 10dB/div & 5kHz/div, 50kHz span, BW = 100Hz, VBW = 100Hz.

AM: For AM modulation, it is important to not overdrive the amplifier to maintain the fidelity of the waveform up to 100% modulation.

With 100% modulation, the peaks of the modulated output waveform are 2 X in voltage and 4 X in power of the un-modulated carrier. To avoid compression of the peaks, they should not extend beyond the -1dB gain compression level. For this amplifier, it means the Peak Envelope Power (PEP) should be no more than 50 watts (47dBm). Figs. 3 & 4 show the resultant time domain waveform and frequency spectrums for a 1 kHz modulation tone when the amplifier is working at it's optimum setting of 12.5 watts power. The Fluke 6060B was the signal source for this test and the Rigol DSA-815 was used for the measurement.

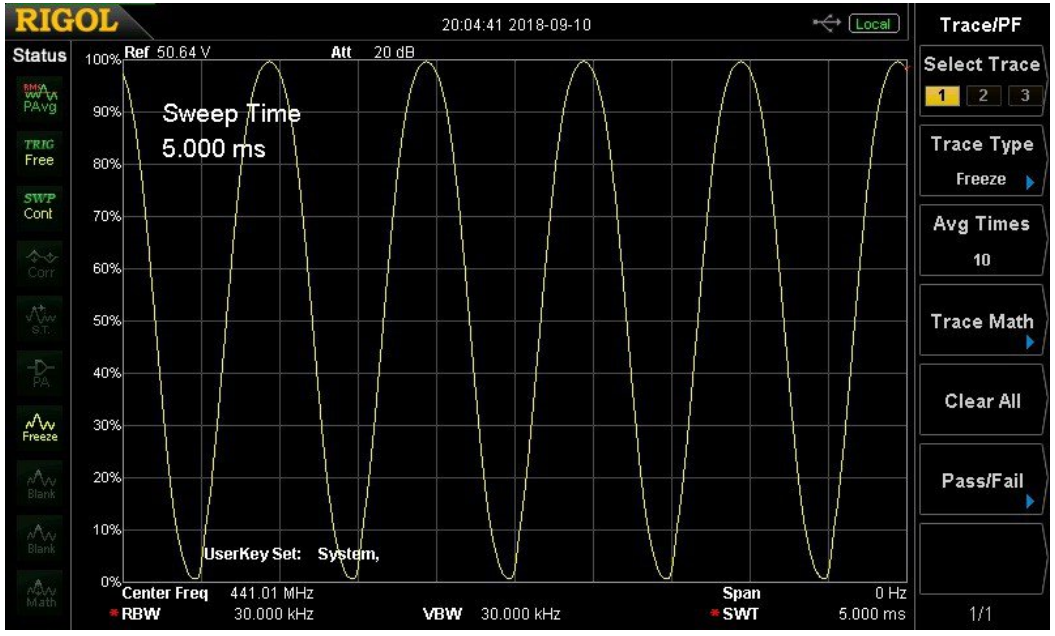


Fig. 3 70-9B Amplifier acting as an AM voice transmitter. This is the output RF voltage waveform for a 1KHz tone at 99% modulation. Spectrum Analyzer settings: Vert = linear detector, 100% = 50V = 50 watts (PEP). span = 0, horiz. sweep = 5ms, BW = 30kHz, VBW = 30kHz. Pavg = 12.5 watts = 41dBm

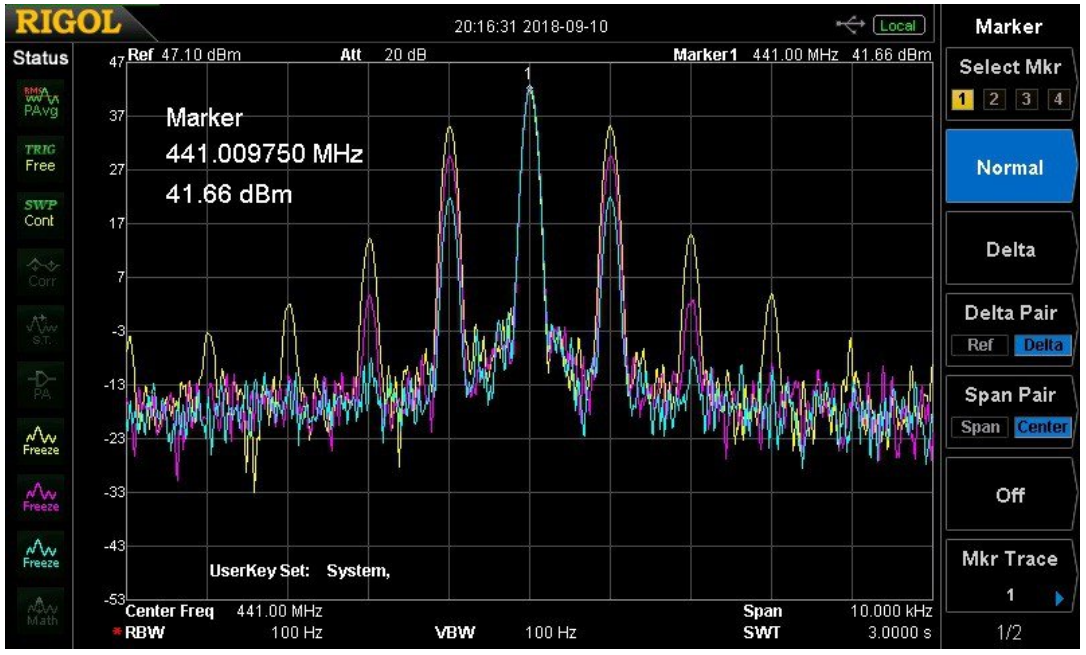


Fig. 4 70-9B Amplifier acting as an AM voice transmitter. These are the output spectrums for a 1kHz tone at 20% (cyan), 50% (magenta) and 99% (yellow) modulation. Carrier power = 12.5 watts = 41dBm Spectrum Analyzer settings: 10dB/div & 1kHz/div. BW = 100Hz, VBW = 100Hz

SSB: For Single Side Band (SSB) service, to maintain linearity, the max. peak output (PEP) should also be limited to the -1dB gain compression point. Thus, for the 70-9B, it should be rated at 50 watts (PEP) (47dBm).

SSB tests were performed using a Yaesu FT- 817 SSB transmitter. This transmitter is capable of 2.5 watts (PEP) when working on it's internal battery. The output was attenuated with a 30dB, 20 watt attenuator, plus an adjustable step attenuator and used as the test signal input to the 70-9B amplifier.

The transmitter was set to 441.000 MHz, upper side-band, and modulated with a 1 kHz tone.

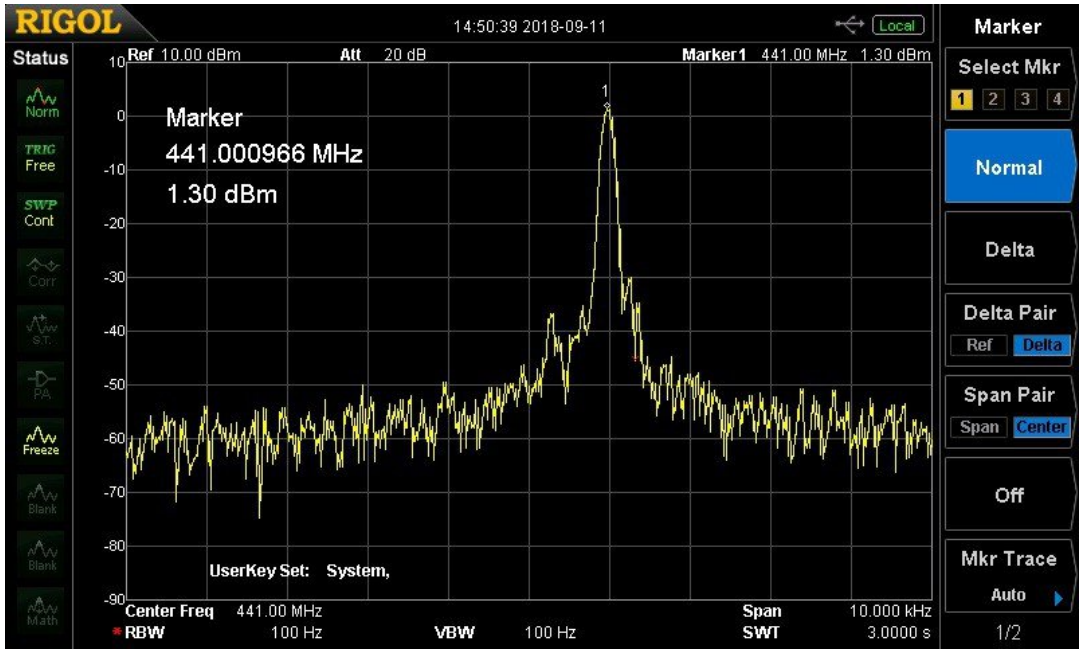


Fig. 5 Spectrum from the Yaesu FT-817, USB transmitter, putting out a 1 watt (PEP), 1 kHz tone. Attenuated by 30dB for measurement and use as the input to the 70-9B amplifier. Spectrum analyzer settings are: 10dB/div & 1kHz/div. 10kHz span, BW = 100Hz, VBW = 100Hz. Center Freq. = 441.000 MHz

Fig. 5 shows the spectrum of the FT-817 transmitter when putting out a 1 watt (PEP) (30dBm) signal.

Fig. 6 (next page) shows the 50 watt (PEP) output from the 70-9B Amplifier.

Continued next page...

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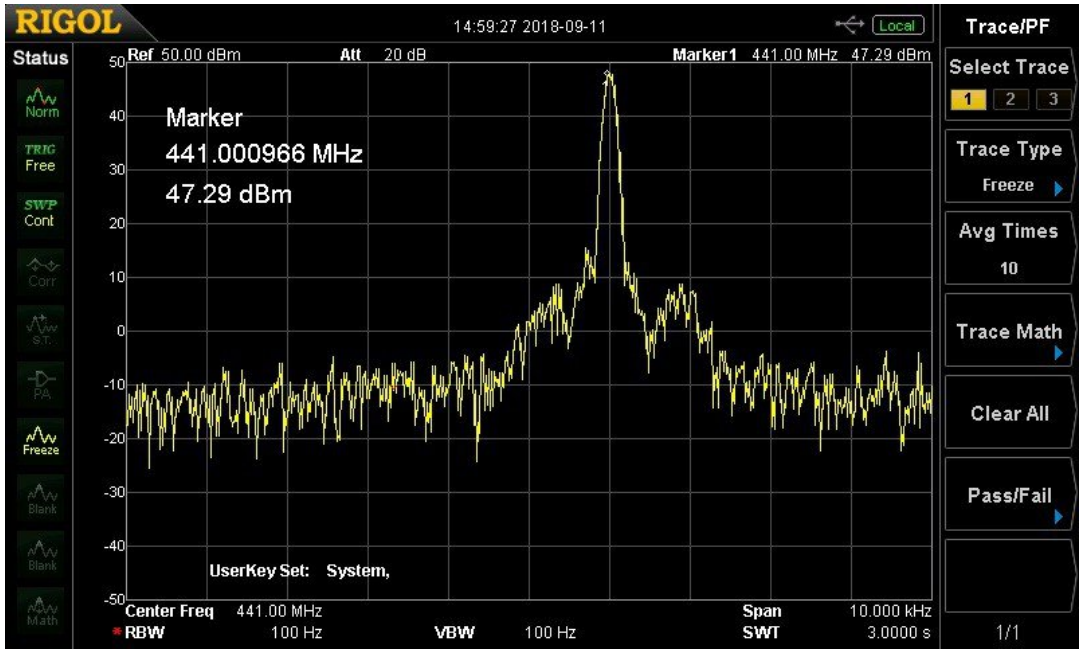


Fig. 6 SSB output from the 70-9B Amplifier when driven to 50 watts (PEP) (47dBm) output power by a 1 kHz, USB test signal. 10dB/div. & 1kHz/div.

VUSB-TV: For NTSC, analog TV, the linearity requirements are more severe than for AM or SSB voice. A 6 MHz wide, analog TV signal uses Vestigial Upper SideBand (VUSB). It is essentially an AM modulated signal with the video carrier present and all of the upper sideband, but only 3/4 MHz of the lower sideband present. To maintain the 6 MHz channel purity, the rest of the lower sideband must be suppressed. If a TV amplifier is driven too hard the sync pulse will be compressed and the non- linearities in the amplifier will then generate out of channel signals. On an analog TV signal, this is most evident by the re-appearance on the lower sideband of the mirror image of the 4.5 MHz Sound Sub-Carrier (SSC) and the 3.58 MHz Color Sub-Carrier (CSC). For amateur TV service, we have found an acceptable point is to limit the lower SSC non-linearity to be no greater than -20dB below the upper sideband SSC.

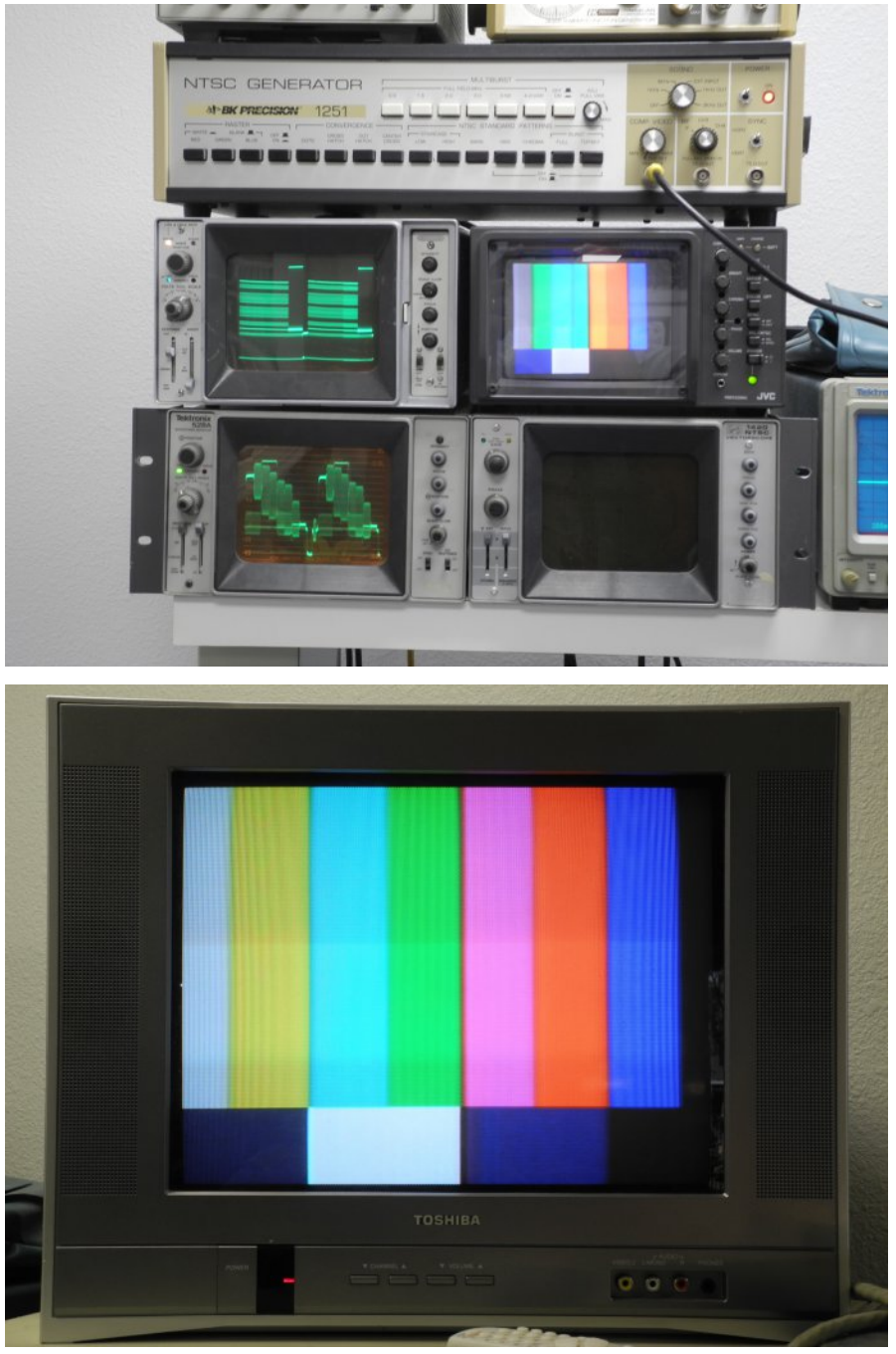


Fig. 7 NTSC signal generator and Tektronix waveform monitors (top) and Toshiba video monitor (above) showing color bar test signal.

Analog TV transmitters are rated by the peak power of the highest feature of the video waveform, namely the sync pulse. They are thus rated in a similar fashion to SSB transmitters, with a PEP rating. Average (rms) power measurements on an analog TV transmitter are relatively meaningless.

The average power varies depending upon the video content and thus will wander around considerably as the program material changes. Going from a totally white to totally black screen results in almost a 4dB variation.

For these VUSB-TV tests, a Blonder-Tongue model ACM-806 CATV modulator was used as the rf signal source. It was set to Ch 60 (439.25MHz), 0dBm (PEP) and -20dBc for the SSC. It was modulated using standard NTSC test signals from a B&K model 1251 TV signal generator.

A Drake model DMM-806 CATV receiver was used to de-modulate the resultant rf TV signals from the 70-9B amplifier under test. The baseband video output from the Drake receiver was viewed and measured on a Tektronix model 528A, TV Waveform Monitor. It was also viewed on JVC and Toshiba video monitors. The standard test signal used was color bars, see Fig. 7.

Fig. 8 shows the rf spectrum from the CATV modulator, while Fig. 9 shows the rf spectrum of the 70-9B amplifier's output. The video test signal was standard color bars.

The rf drive level was adjusted up to the point at which the spurious SSC on the lower sideband had risen to be -20dB below the SSC on the upper sideband. At this point, the sync pulse peak power is 28 watts (PEP) (44.5dBm).

Note: that the spurious CSC on the lower sideband has come up to about -30dB below the CSC on the upper sideband.

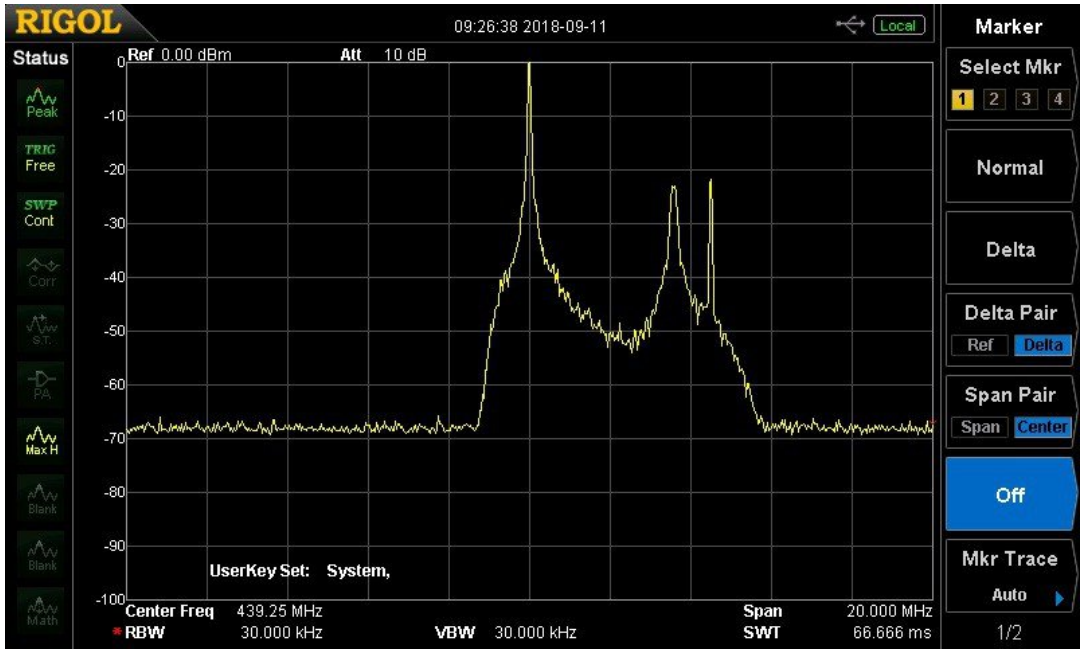
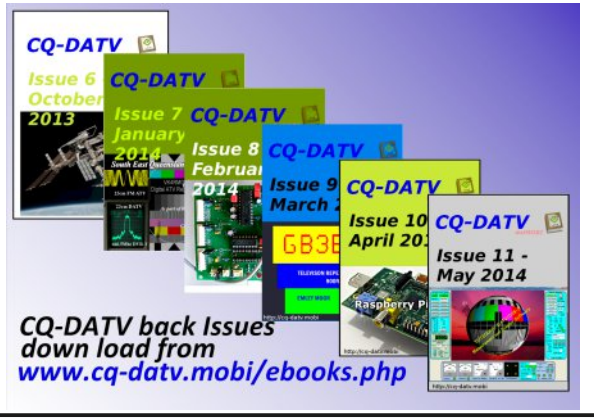


Fig. 8 RF spectrum of NTSC, VUSB-TV signal from CATV modulator. Test signal is color bars. Spectrum Analyzer settings are: 10dB/div, 2MHz/div. 20MHz span, IF BW = 30kHz, VBW = 30kHz. Detector = Pos Peak, Display = max. hold sweep = auto The video carrier is in the center at 439.25MHz. The color sub-carrier is the peak, 3.58MHz above the video carrier. The sound sub-carrier is the spike, 4.5MHz above the video carrier. Note that most of the lower sideband is severely attenuated.



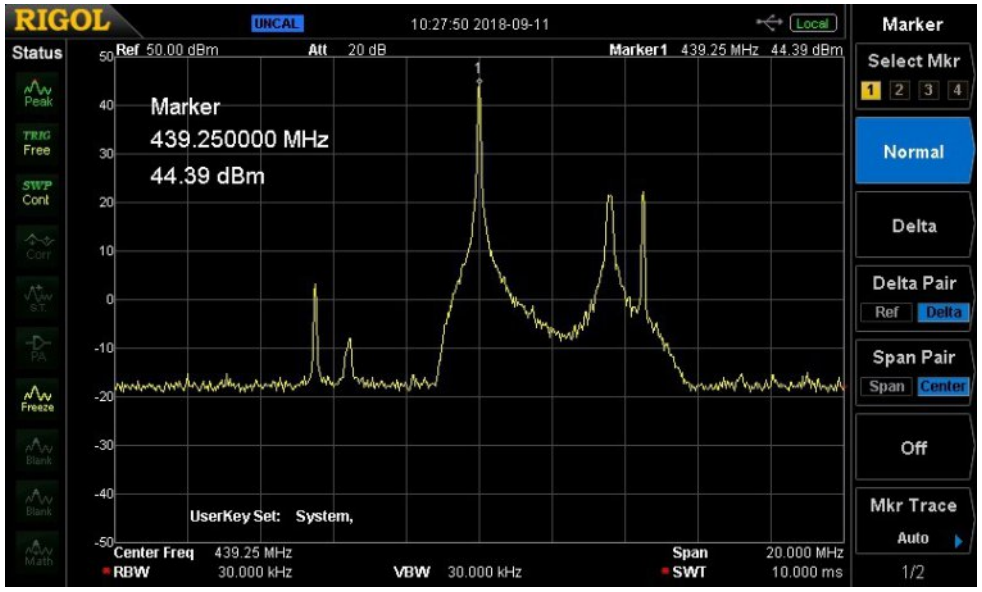


Fig. 9 RF spectrum of NTSC, VUSB-TV signal output from 70-9B Amplifier. Pout = 28 watts (PEP) (44.5dBm). Note presence of undesired SSC & CSC on lower sideband.

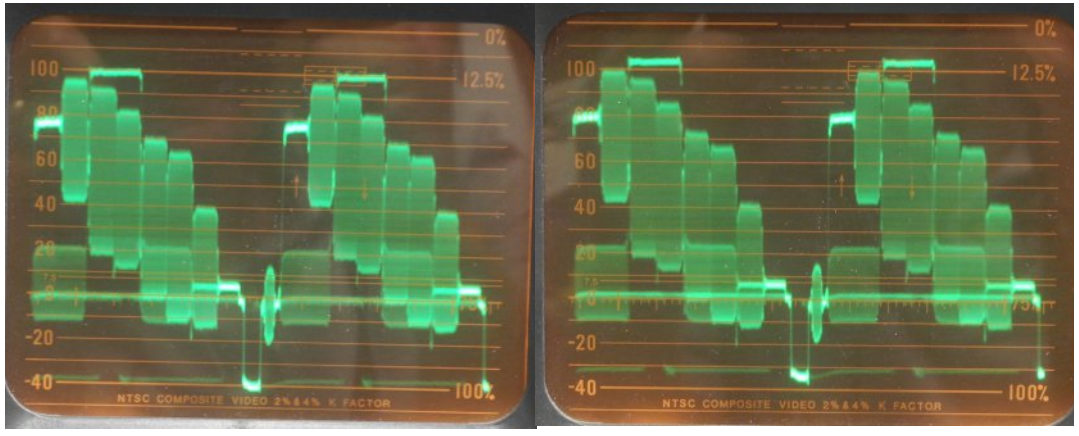


Fig. 10 Demodulated TV signal video, color bars, waveform as displayed on Tek 528A TV waveform monitor. Left photo is the test signal from the B-T ACM-806 CATV modulator. Right photo is the resultant output after the signal on the left was amplified by a model 70-9B rf linear power amplifier to 28 watts (PEP).

Fig. 10 shows the demodulated TV signals from both the CATV modulator and also after amplification by the 70-9B amplifier. The test signal displayed is the standard color bar test pattern. TV standards call for the video signal to be exactly 1.0 V ptp into 75 ohms, with the sync pulse being -40 IRE units in height and the white level being 100 IRE units above the black reference level. The CATV modulator's waveform meets this spec. After amplification, there is some distortion. The sync pulse is now compressed from 40 to 36 IRE units. The white to black is expanded from 100 to 103 IRE units.

Fig. 11 (next page) shows the actual RF envelope as measured by the spectrum analyzer. The video test signal was a standard B&W staircase. TV standards call for the tip of the sync pulse to be at the 100% (i.e. max.) level. The black, back-porch reference level is to be at the 75% level and the white level is to be at the 12% level. The rf output from the B-T CATV modulator meets these specs. (left photo). After amplification to the 28 watt (PEP) level, the rf envelope waveform has been distorted by a small amount. Due to compression of the sync pulse, the reference black level has shifted up from 75% to 78% and the white level has shifted up from 12% to 13%.

DIGITAL TV: Digital TV (DTV) utilizes extremely complex modulation waveforms consisting typically of many COFDM sub-carriers.

Unlike an AM or VUSB- TV signal, there is no truly distinguishable major feature, such as a sync pulse, to lock onto for observation.

The DTV signal instead resembles a random noise source. This can be confirmed by tuning in a DTV signal on an AM or SSB receiver. It sounds just like background, random noise, except that the signal strength, S meter reads the presence of extra rf power.

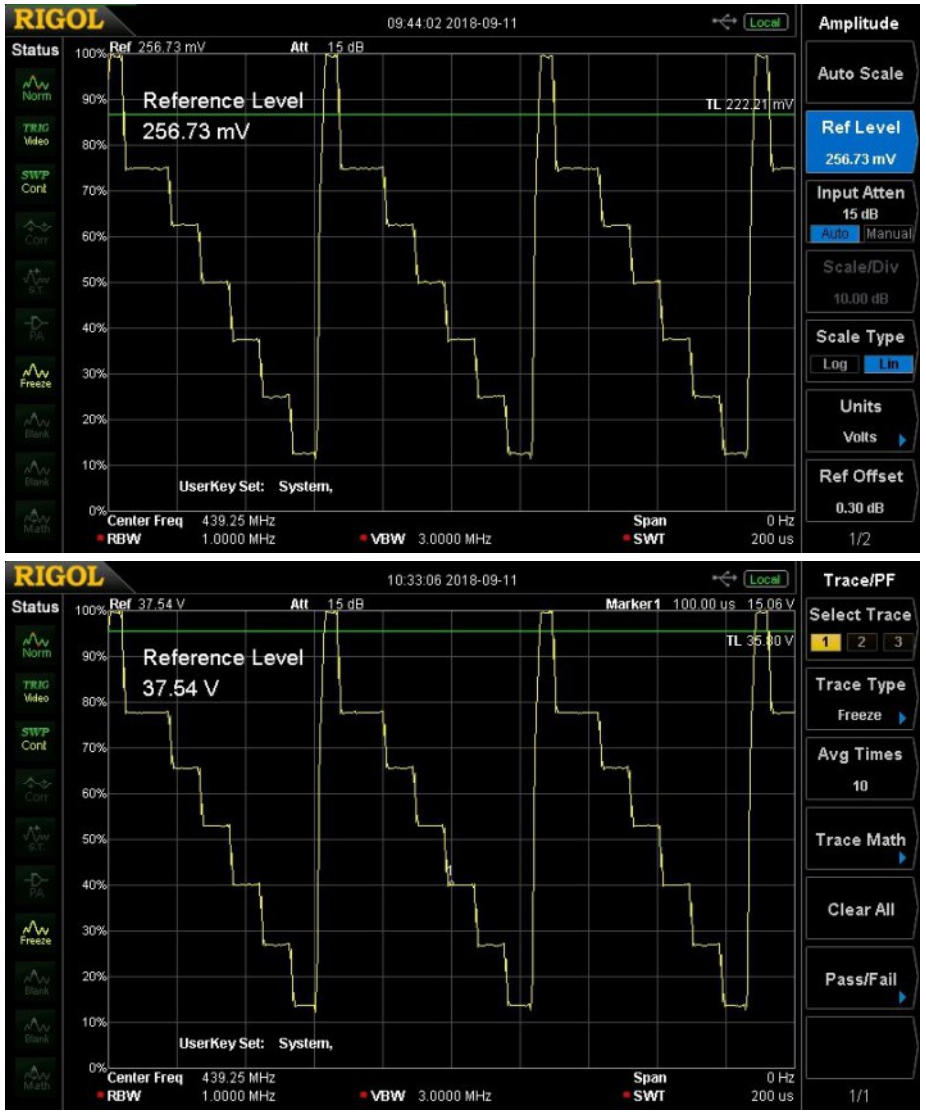


Fig. 11 B&W Staircase Video Test Signal. Detected RF waveforms from B-T CATV modulator (top) and after amplification by 70-9B rf linear power amplifier (above) to 28 watt (PEP). Measured by Rigol DSA-815 spectrum analyzer. Settings were: center freq. = 439.25MHz, 0 Hz span, BW = 1MHz, VBW = 3MHz, detector = normal, freeze display, vert = linear display, Ref. level (top) = 37.5 V = 44.5dBm = 28 watts, horiz = time display, 200µs.

Thus, for characterizing DTV transmitters, they are not rated in terms of peak power like an analog TV transmitter, but instead in terms of RMS, average power of the noise like signal. A DTV transmitter does need to provide considerable head room to accommodate peaks in the DTV signal many dB above the RMS average power.

Caution must be exercised in the selection of a power meter to accurately characterize a DTV transmitter. The power meter must measure true RMS power. Most inexpensive power meters use a simple semiconductor diode detector which actually measures the peak voltage. The meter readout is then calibrated in equivalent rms power assuming the signal was a true sine wave. This is obviously not the case for a DTV transmitter. A thermistor type power meter head will give a true rms reading.

Many TV amateurs in the USA that are experimenting with DTV are using the European terrestrial, digital broadcast TV standard of DVB-T. DVB-T supports three different types of modulation. They are: QPSK, 16QAM and 64QAM. Fig. 20.6 [2,3] below shows the constellation I-Q diagrams for these modulations. Each dot represents a particular amplitude/phase vector and a unique logic state. The more complex QAM modulations can support higher data rates within a fixed bandwidth channel, but at the expense of reduced receiver sensitivity.

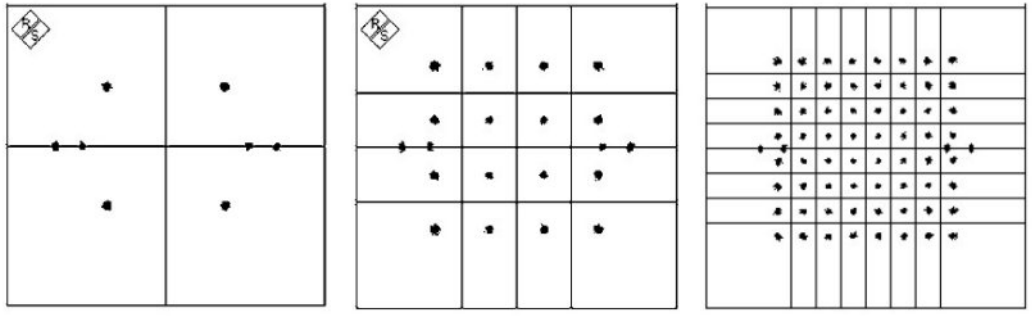


Fig. 20.6. DVB-T constellation diagrams for QPSK, 16QAM and 64QAM

Careful examination of the I-Q diagrams in Fig. 20.6 will reveal the presence of four additional dots on the horizontal, I line. These are identified in Fig. 20.3. [3] They are additional pilot carriers used to carry data for receiver initialization and synchronization, and for channel distortion measurement and correction.

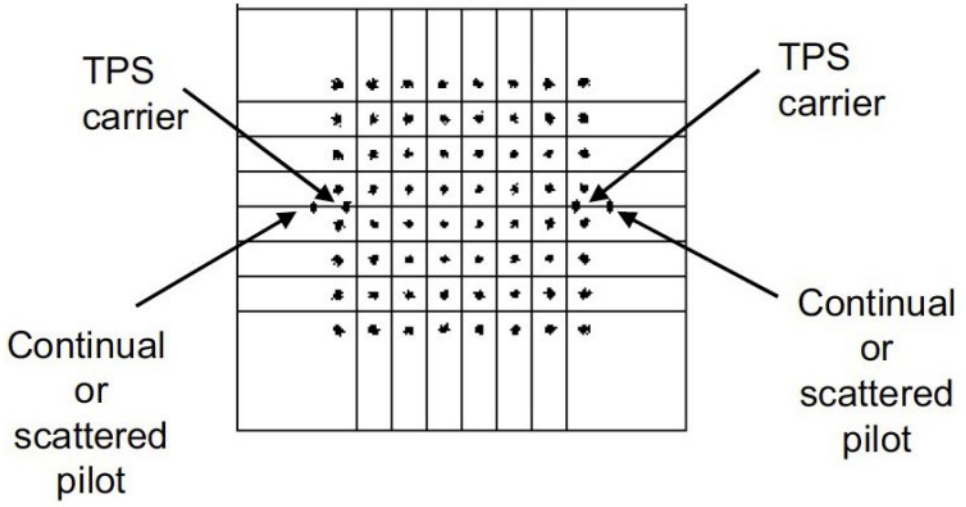


Fig. 20.3. DVB-T carriers: payload carriers, Continual and Scattered Pilots, TPS carriers

QPSK is the simplest of the three modulations. QPSK stands for Q uadrature P hase S hift K eying. It is related to BPSK-31 which is commonly used by radio amateurs for digital text communications on the HF band.

BPSK is simple binary phase modulation in which the phase of the transmitted signal is either 0o or 180o , which is the equivalent of simply turning a sine wave upside down..

For QPSK, the phase is rotated in 90o increments from 45o to 135o to 225o to 315o . The signal amplitude always remains the same, much like a CW or FM signal. QPSK is the most robust form of DTV modulation as it does not require any amplitude changes, much like FM in this regard.

16QAM is the next higher level of modulation used in DVB-T. It stands for sixteen state Q uadrature A mplitude M odulation. Each quadrant of the QPSK, I-Q diagram is now divided further into four more sectors, for a total of 16 sectors. There now are three distinct amplitude levels. Because different amplitudes represent different logic values, 16QAM is thus more susceptible to degradation than QPSK, more like AM vs. FM.

64QAM is the highest level of complexity allowed in DVB-T. As seen in Fig. 20.6, each of the 16QAM sectors is again divided by four, for a total of 64 sectors. It is even more susceptible to amplitude degradatin than 16QAM.

DTV Transmitter Measurements: A transmitter is obviously characterized by it's output power. See above discussion. For a DTV transmitter, another important parameter is the MER, or M odulation E rror R atio. However, MER is a very complex parameter and requires a sophisticated measurement instrument, not typically found in an amateur ham shack.

Most DTV receivers, even the cheapest ones, give some indication of the signal strength and also quality. The quality rating is a relative measure of the decoded S/N ratio. On most cheap receivers, it is simply an uncalibrated bar graph, but this can still be a useful indicator. If you transmitter shows anything less than 100% quality, then it is distorting the rf signal and you need to back off on the drive level. On the Hi-Des receivers, they actually give an on screen display of the actual received signal strength in dBm and also the S/N in dB. For QPSK, the best S/N = 23dB. For 16QAM, the best S/N = 26dB. For 64QAM, the best S/N = 32dB.

Another measurement that can be easily performed, if one has access to a spectrum analyzer is the Shoulder Attenuation. It is a good indicator of the amount of non-linearity present in the transmitter's rf signal.

The ideal DVB-T spectrum looks like white noise riding on top of a rectangular pedestal. The output from a good quality DVB-T modulator is a good example. See Fig. 14. Anything observed outside of the channel bandwidth other than the receiver noise floor is an undesired artifact created by non-linearites. Fig. 14 shows a minimal amount of shoulder energy well below -40dB outside of the 6 MHz channel. The DVB-T standards [4] specify that the shoulder attenuation is to be measured ± 200 kHz beyond the channel edges. For the example in Fig. 14, the shoulder attenuation was measured to be -45dB. The analyzer's noise floor in this example is at -77dBm.

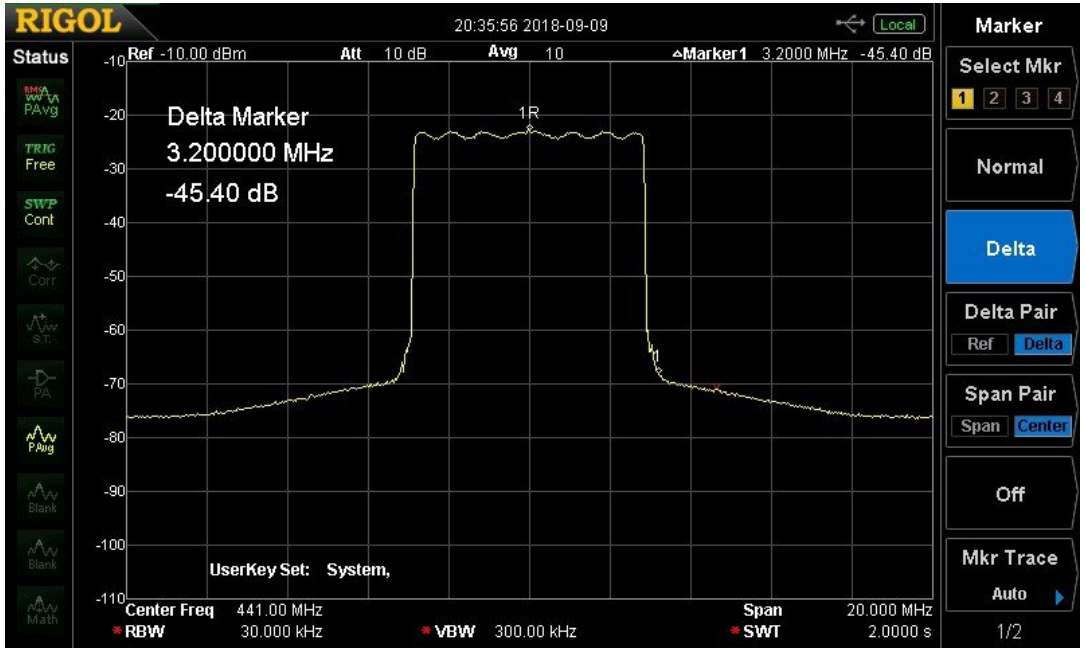


Fig. 14 QPSK spectrum from Hi-Des model HV-100EH, DVB-T Modulator. Measured by Rigol DSA-815 spectrum analyzer. Analyzer settings were: 10dB/div & 2MHz/div, 20MHz span, 2 second scan rate, BW = 30kHz, VBW = 300kHz, rms detector, plus signal averaging. Shoulder attenuation measured 200kHz beyond channel edge. Value of -45dB shown for a 6 MHz channel.

When a DTV signal is amplified by a power amplifier, as the drive level is increased, the undesired, out of channel, shoulders will be seen to rise more rapidly than the actual power of the input drive signal. These shoulders are undesirable for two reasons.

The first is distortion and worse MER for the transmitted DTV signal. The second is spectrum contamination. To avoid interference with other services on frequencies outside of our assigned channel, our transmitters must be clean and not put signals into adjacent channels.

Commercial, broadcast TV transmitters have extremely stringent out of channel requirements for the shoulders to be suppressed > 50dB.

A typical broadcast DTV transmitter's shoulders will be at about -28dB. Then expensive, digital, predistortion is applied to the drive signal reducing the shoulders to -38dB. Finally a sharp cutoff, channel band-pass filter is used on the amplifier's output to further reduce the shoulders to -52dB [5].

For the amateur TV service, we do not have the big bucks $$$ to implement digital pre-distortion. We do however, often use, especially for our TV repeaters, sharp cut-off, band-pass, channel filters.

For the typical, ham DTV station, a good compromise in terms of maximizing output power, minimizing adjacent channel RFI, and maintaining good MER is to set the drive level so that the amplifier's shoulder attenuation is about -30dB.

Fig. 15 shows the resultant spectrum for a model 70-9B amplifier with -30dB shoulders.

Fig. 15 Model 70-9B Amplifier output spectrum for optimum drive level resulting in -30dB shoulders. Pout = +39dBm = 8 watts rms

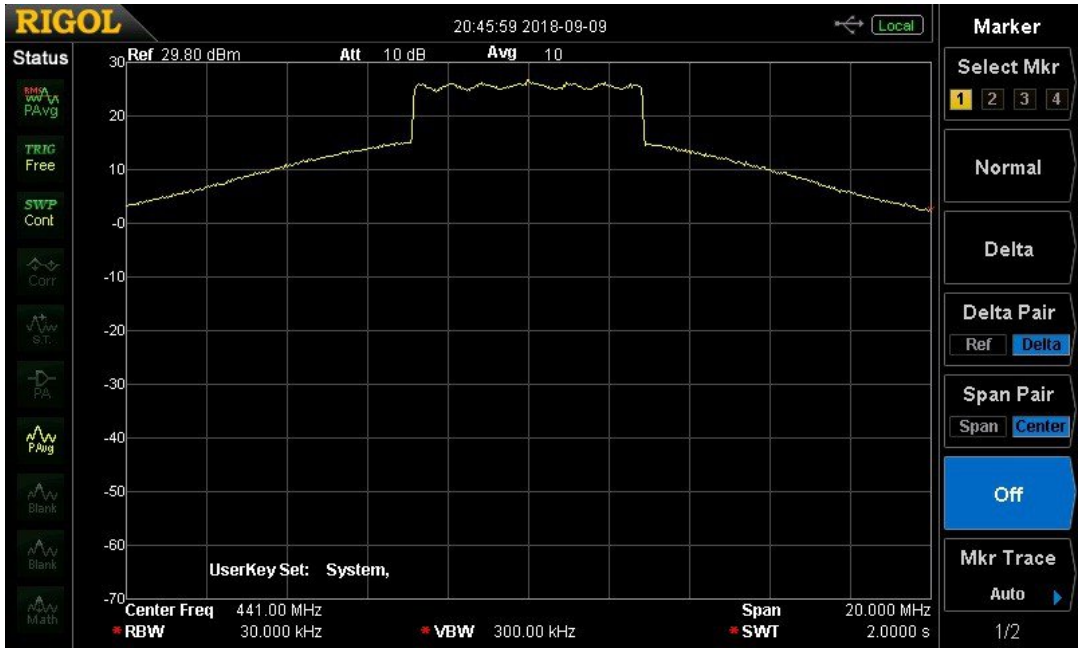


Fig. 16 Model 70-9B Ampler output spectrum for max. drive level resulting in -12dB shoulders. Pout = +47.5dBm = 56 watts rms Totally unacceptable spectrum contamination.

Tests were also run on increasing the rf drive power and observing the shoulder attenuation and also the S/N as measured on a Hi-Des model HV-110 receiver. For QPSK, when the output power was increased to +42dBm (16W), the S/N started to degrade and the shoulder dropped to -25dB.

Driving the amplifier very hard to get maximum output power resulted in the totally unacceptable spectrum shown in Fig. 16. At this level of severe compression of the QPSK signal, the receiver's S/N dropped to 9dB, but the receiver was still able to decode the images.

This demonstrated that QPSK is very resilient to amplitude compression, much like the results with FM.

The same tests were performed using 16QAM and 64QAM. For 16QAM, when the output power was increased to +41.1dBm (13W), the S/N started to degrade and the shoulder dropped to -25dB. Further increasing the drive power, the S/N dropped to 14dB and the receiver locked up. At this level, the output power was 45.3dBm (34W) and the shoulder was -16dB.

For 64QAM, when the output power was increased to +37.9dBm (6.2W), the S/N started to degrade and the shoulder dropped to -32dB. Further increasing the drive power, the S/N dropped to 20dB and the receiver locked up.

At this level, the output power was 42.7dBm (19W) and the shoulder was -21dB. Thus for 64QAM, the shoulder requirement is even more stringent and should be set no higher than -33dB.

These above tests show the necessity of providing considerable "head room" in a DTV transmitter. The head-room is the difference between the acceptable rms output power and the amplifier's max. saturated output power. From the final results reported in the table on page 1, the minumum head rooms required are: QPSK = 10dB, 16QAM = 10.5dB and 64QAM = 11.2dB

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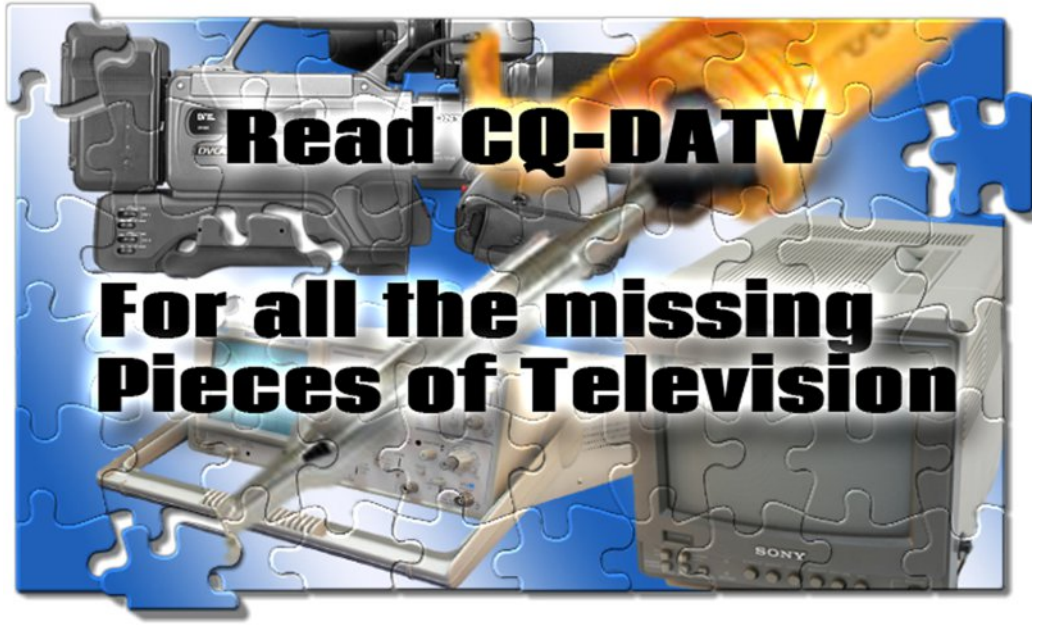
1. "Linear Amplifiers - Buyer Beware", Jim Andrews, KH6HTV Video application note, AN-8, Sept. 2011, 2 pages

2. "Digital Video & Audio Broadcasting Technology", W. Fischer, Springer, Heidelberg, New York, 2010, 811 pages

3. Figs. 20.3 & 20.6 come from Ref. [2] pages 373 & 378

4. See Ref [2], section 21.2, pages 425-428

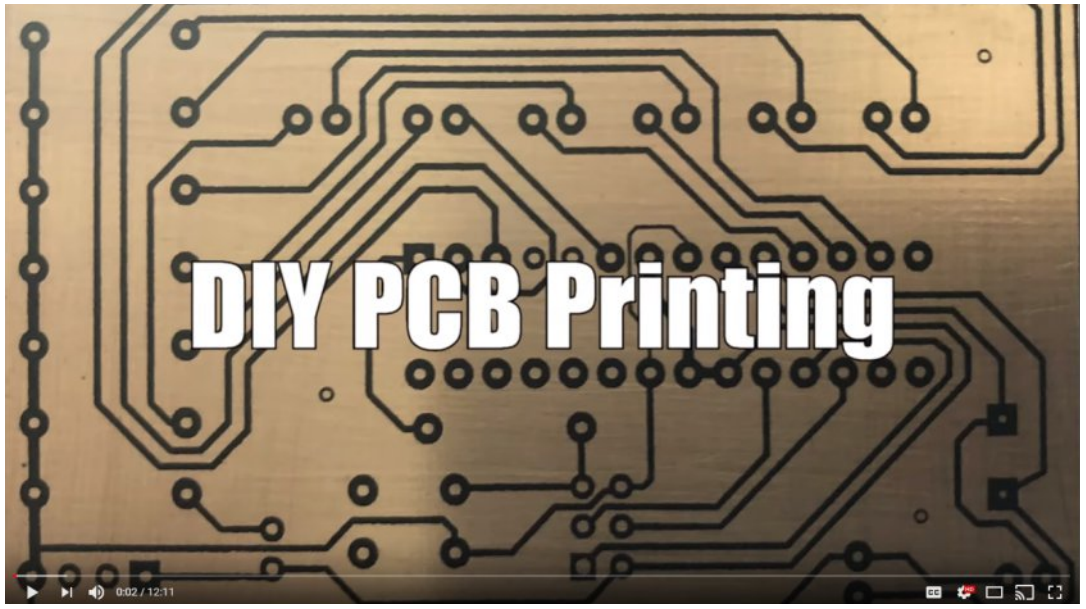
5. See Ref [2], section 21.7, pages 446-450



Check out the DKARS website at:-
http://dkars.nl/

Printing Artwork onto PCB's without UV

Written by John Hudson G3RFL



DIY PCB Toner Transfer (No Heat) & Etching. No need to use an Iron, transfer easily and fast!

For some time now I have been photo etching PCB's using boards pre coated with a UV sensitive varnish. The process works well, but the cost of the pre coated board has been getting more and more expensive and I wondered if there was an alternative. The solution came as most solutions do these days from the internet. The link is at the end of the article.

The layout was generated from a CAD programme, where would we be without CAD there are many design packages and all of them will print out the copper work to paper, if only we could get the PCB into the printer instead of the paper, alas that is not possible *(Ed. - This is possible, see end of article),* but the video comes up with the next best thing a simple transfer, that does not involve printing onto film and then the UV transfer process.

The artwork still needs printing, but onto art work paper the sort used for magazine covers. No it does not have to be blank, just print on top of the cover artwork. There is a BUT, it has to be a laser printer, I tried ink jet and failed. I resorted to a Brother HL-1210W Laser Mono Printer which I definitely paid only £29 for as a "special" about 3 years ago from Staples and still using the same toner cartridge. Pleased I did not throw that out in the last shack clearance.

This printer has never produced ink-black prints (except on paper) but I've just found out (after a firmware and software update) that the contrast can now be altered.

Various mono laser printers out there but they appear to be around £60 at the cheapest (search, search and search again!). For example:
https://www.currys.co.uk/gbuk/computing-accessories/printers-scanners-and-ink/printers/brother-hl1212w-monochrome-wireless-laser-printer-10028088-pdt.html

As always, the toners cost a fortune! Often more than the original printer + the first toner cartridge, I think that's why we all moved to ink jet.

The next step is to contact print the artwork onto the copper board and in the video this is done by using nail polish remover, the paper is secured to the copper board by folding it over the edges and sticking down with masking tape, other tape will I am sure do the trick as it is not an integral part of the process. The artwork is soaked through with nail polish remover and finger pressed and allowed to dry, this effectively transfers the artwork from the glossy magazine cover to the PCB and yes it works.

Nail polish remover is Acetone based and pure Acetone – is MUCH cheaper and doesn't contain stuff like Aloe Vera, distilled water etc.

Make sure the PCB is as clean as you can get it. Acetone (and its fumes) will attack a LOT of plastics (that's how this system works – laser toner is basically a plasticised powder that turns into a VERY thin layer of plastic with modest heat that will not stick to glossy paper!). Use in a well ventilated area – nasty stuff!

Once you have a transfer you can etch in the conventional way, my favourite is a Ferric Chloride solution which works well with my bubble bath, but the author in the video has a preference for plastic forks to agitate the solution.

Will it save money, Yes a Wi-Fi connected printer from ARGOS is just £59

This process does not need special PCB at £8 a go and the savings will it will soon pay for the printer!

My thanks to Ted G4MXR and Dave G3ZGZ. who have also tried the process and Gareth Burrows for the original idea.
https://www.youtube.com/watch?v=cVhSCEPINpM

Editors note: For those that want try direct printing to pcb material here is but one of many articles for using an inkjet printer, but be warned, it is not for the feint-hearted:

https://www.instructables.com/id/Converting-an-Inkjet-Printer-to-Print-PCBs/

And one for using a laser printer:

https://www.instructables.com/id/Modification-of-the-Lexmark-E260-for-Direct-Laser--1/

An internet search with the words 'inkjet pcb print' or 'laser printer pcb print' will turn up plenty more results.

One from the Vault

Originally published in our first issue 5 and a half years ago!!

Inexpensive home constructed dummy load

Written by John Hudson G3RFL

In a senior moment, I managed to damage my RF dummy Load, by using it on a 13cms transmitter that was more than capable of delivering 120W. So it was time to consider a replacement and an upgrade to cope with the higher power Levels.

I started by purchasing a 50ohm 250W surface mount resistor. The resistor I chose has a specification (see data sheets below) that will enable it to be used up to at least 2GHz,and cost £7. I have seen some on eBay for about the same price, but only 150W versions.

I was fortunate to find suitable heatsink in my junk box, something I suspect was left over from a computer upgrade.

It was a simple task to drill the heat sink and mount the resistor applying a liberal dosage of heat transfer compound. I folded the TAB back over itself onto its top and filed an "N" type connector plug, filing the centre pin down as much as possible as this goes over the resistor and compression touches the resistor tab, carefully not over tightening it or you will break the resistor.

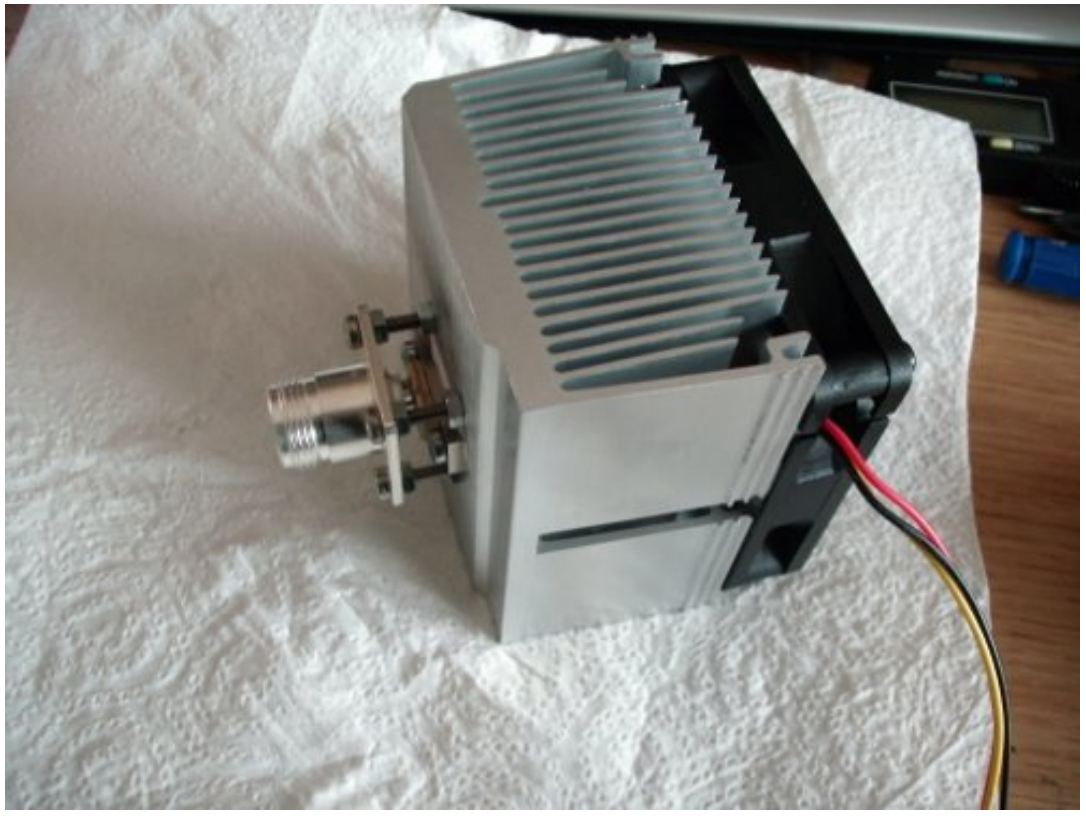
In theory the unit should work up to 2GHz, but my first test was on 2m with just 50w, the heatsink soon got too hot to hold, after only a few minutes.

So I decided to add a fan, a quick search of my junk box and I failed to come up with a suitable fan for the heat sink, probably why the heat sink was in my junk box, so it was time to invest some of my children's inheritance in a commercial product.

The 12V fan I chose came from CPC and was designed for use on PCu/P and cost just over £7.

When the fan arrived I fitted it and repeated the experiment with the two meter source, once the heat sink became to hot to hold, I powered up the fan, and after only a few minutes the temperature dropped to just a few deg above room temperature.

I was well pleased with my £7 investment, in what proved to be a very quiet fan, well worth the £7. The fan also has the third wire which provides pulses to indicate the fan is spinning, this might be useful for the future when I develop the unit further, but my first addition will be a Voltage detector interfaced to a PIC so I can read out the POWER via a USB lead.....watch this space.



Completed unit ....so far

See next page for Data sheets.

Anaren

RF Power

Model RFP-250-50RM

Flanged Resistors

250 Watts, 50 Ω

Features

- DC - 2.0 GHz
- 250 Watts
- BeO Ceramic
- Welded Silver Leads
- Non-Nichrome Resistive Element
- 100% Tested

General Specifications

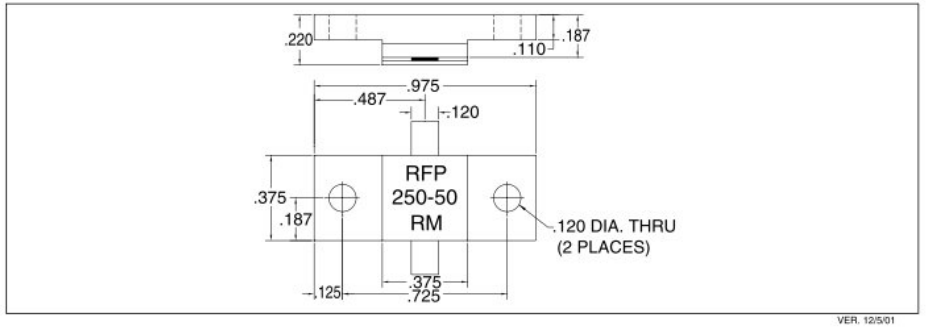
Resistive Element:	Thick film
Substrate:	Beryllium oxide ceramic
Cover:	Alumina ceramic
Mounting Flange:	Copper, nickel plated per QQ-N-290
Lead(s):	99.99% pure silver (.005" thk)

Electrical Specifications

Resistance Value:	50 ohms, ±5%
Frequency Range:	DC - 2.0 GHz
Power:	250 Watts
Capacitance:	3.3 pF

Notes: Tolerance is ±.010, unless otherwise specified. Operating temperature is -55°C to +150°C (see chart). Designed to meet or exceed applicable portions of MIL-E-5400. All dimensions are in inches. Lead length 0.15" minimum.
Specifications subject to change without notice.

Outline Drawing



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Model RFP-250-50RM

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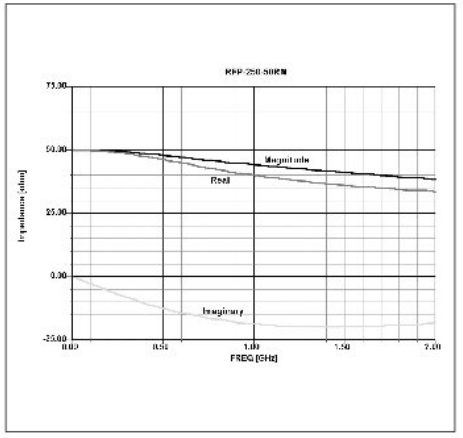
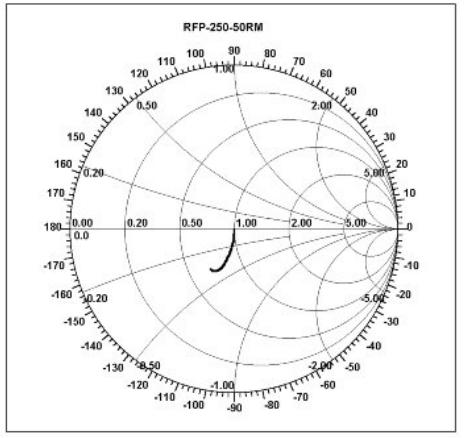
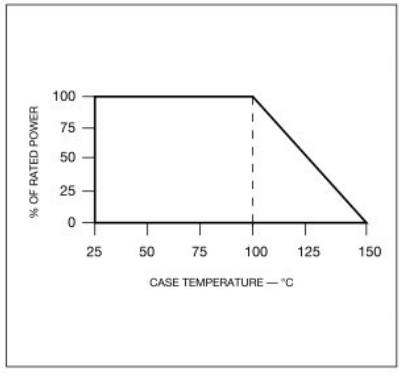
RF Power

Typical Performance

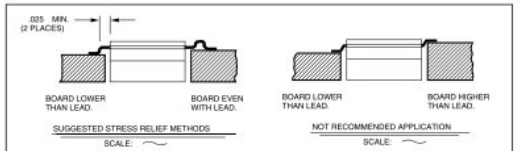




Power Derating



Suggested Mounting Procedures



1. Make sure that the devices are mounted on flat surfaces (.001" under the device) to optimize the heat transfer.
2. Drill & tap the heatsink for the appropriate thread size to be used.
3. Coat heatsink with a minimum amount of high quality silicone grease (.001" max. thickness).
4. Position device on mounting surface and secure using socket head screws, flat & split washers. Torque screws to the appropriate value. Make sure that the device is flat against the heatsink. (Care should be taken to avoid upward pressure of the leads towards the lid).
5. Solder leads in place using an SN63 type solder with a controlled temperature iron (210°C).

Anaren What'll we think of next?™

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