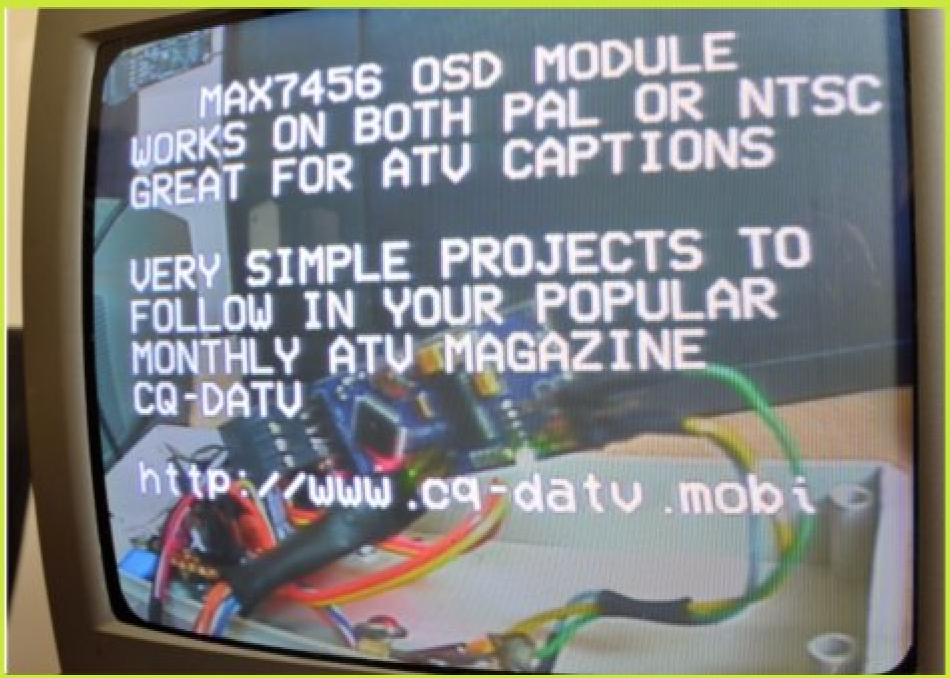
CQ-DATV

dotMOBI

Issue 12 - June 2014



http://cq-datv.mobi

In this issue

The team

- Ian Pawson - G8IQU
- Trevor Brown - G8CJS
- Mike Berry - G1LWX
- Ted Bottomley
- Richard Carden - VK4XRL
- John Hudson - G3RFL
- Dave Kenward G8AJN
- Ken Konechy - W6HHC
- Klaus Kramer - DL4KCK
- John Lukey - VK2ZUH
- Terry Mowles - VK5TM
- Clive Reynolds G3GJA / G8EQZ
- Mike Stevens - G7GTN
- Paul Wade - W1GHZ

Younger radio hams disappearing

The Radio Society of Great Britain has released the figure for the number of members aged under 25

Given that RSGB membership is completely free for UK radio amateurs aged 25 and under in full time education, you would expect every youngster interested in the hobby to be a member of the Society, so it provides a good proxy for the national figure for amateurs in that age group.

The figure released may come as a shock to some, just 295 are aged under 25. Take almost any radio club and you will find many members who have been licenced for 40, 50 or 60 years, having first taken up the hobby in their teens or early twenties.

The figure suggests we are sitting on a demographic time-bomb which could see amateur radio all but wiped out in 20 years time.

All is not doom and gloom, there are some glimmers of light. This year the RSGB has decided to take part for the first time in the annual IARU Region 1 Youngsters On The Air event and the Society also intends to run a separate event for youngsters called YOTA UK in Wolverhampton on July 19-20.

Importantly many amateurs at grassroots level are now becoming involved in attracting younger-blood into the hobby, both Camb-Hams and Essex Hams have been doing a great job in promoting amateur radio to a new generation.

Source - Southgate amateur radio news

EMDRC

The Eastern and Mountain Districts Radio Club will be the first Club in Melbourne to have a permanent DATV Transmitter. The transmitter design is based around the German SR Systems DATV exciter and was built by Damian VK3KQ.

The transmitter, transmit and receive monitors and Set Top Box is all housed in a 19 inch rack. (Which turns out to be not quite 19 inches, but that is another story). The project was partially funded by a grant from the WIA and the installation work has been carried out by Damian, VK3KQ, Ralph VK3LL, Jack VK3WWW and Bob VK3AIC amongst others.

The Club has permanent rooms in the basement of a two story building, the top room being a shared facility with the local scouts (I think ?). Video, audio and control cables have been run up to the top room to facilitate operations from either floor.

It is expected that next Friday will be the first formal transmissions from VK3ER on VK3RTV1 with a lecture from Len Steel, VK3FB on Super Light Antennas for SOTA operations (starting at about 8 PM) . VK3RTV will stream on the British Amateur TV Web Site for those who cannot receive the Melbourne ATV Repeater.

Also ….at about 10 PM (every Friday night) Clint VK3CSJ will be up on VK3RTV2 with the very entertaining Astronomical Society weekly broadcast. This is simulcast on 80 metres and streamed on the BATC website of course. Friday looks like being a big night for ATV and an opportunity to tune Set Top Boxes and new antennas with known transmission times.

Peter VK3PB has a DATV Express system and is also planning some regular broadcasts with content of interest to amateurs.

Peter Cossins

Newbury Radio Rally

We are pleased to announce that this year is the 27th anniversary of the Newbury Radio Rally.

It takes place on Sunday 15th June at the Newbury Showground next to junction 13 of the M4 motorway in Berkshire.

In addition to the usual very large (120+) sellers area, we have a demonstration marquee with displays of amateur radio stations on air (SSB, CW, & DATA), air traffic control radar, Vulcan to the Sky stand, heritage Police Command Radio Control Truck with Support Car, plus clubs and national society stands. We also have new and expanded hot food caterers.

Are you interested in selling something (old or new)?

ADVANCE BOOKINGS are now possible via the web site www.nadars.org.uk/rally.asp and we invite you to secure your space, and save money and time at the gate, by making your booking now

We look forward to welcoming you again this year

Phill Morris, G6EES

Astronaut co-hosts Hamvention live webstream

The live webcast of the Dayton Hamvention has been and gone for 2014.

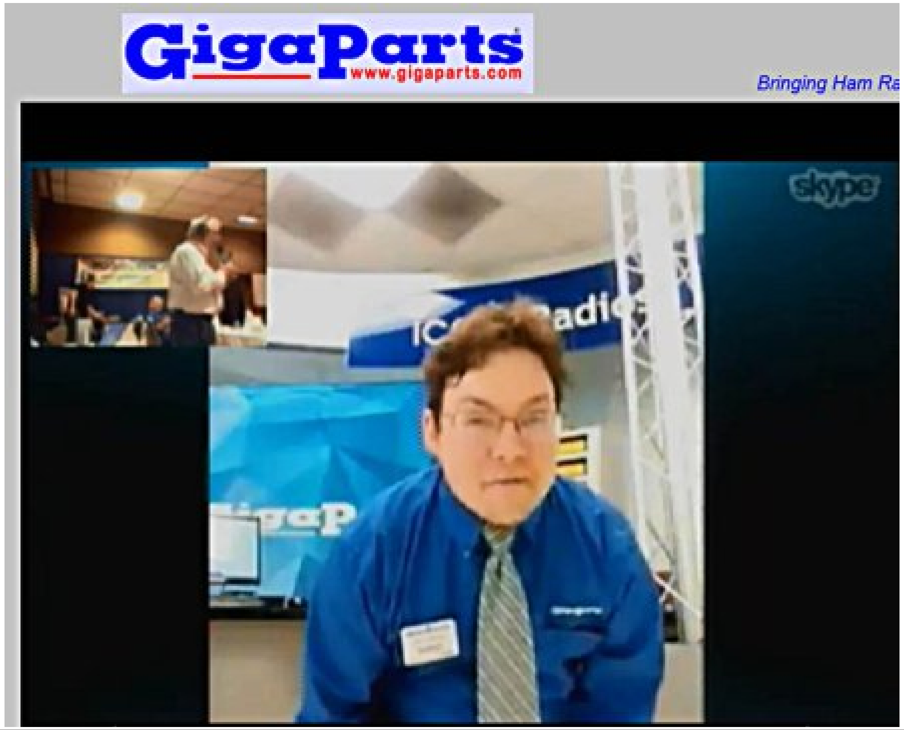
w5kub.com went live on Wed May 14 as they drove the 500 miles from Memphis, TN, to Dayton OH.

They had the video stream up on Thursday during set up, and then of course during the show on Fri, Sat, and Sun the 16, 17 18th.

Last year during hamvention, we had 47,300 viewers follow us during the live 5 day webcast. They were in over 100 countries. This year I had a special guest, Astronaut Douglas Wheelock who joined us all day on Friday and Sat morning to co-host our show.

There were many prizes given out to lucky viewers such as antenna tuners, radios, antennas, weather stations, antenna analyzers, microphones, qsl cards, 24 hr clocks etc.

Ken, W6HHC, found one truly "iconic" screen-capture of the crowd scene at Dayton this year. Courtesy of K0NEB on Youtube.



Right: Here is W5KUB (upper left of picture) raffling off a Yaesu FTdx1200 high-end rig donated by GigaParts at Dayton on Saturday

Editorial

Well CQ-DATV 12 is in print, so the concept of a free ATV monthly publication is still alive and well We did have a small wobble with DATV 11 in that Ian our editor had health problems and was rushed into hospital and spent considerable time in ICU, so Terry our deputy editor stepped up to the mark and produced CQ-DATV 11, sorry it appeared on a different website and in PDF format only, but we did our best. Ian is now behind his desk and CQ-DATV 12 is back on the normal website and all the usually eBook formats for CQ-DATV 11 have been created, a big thanks to Terry VK5TM you were dropped in the at the deep end.

We have also published CQ-DATV on a new public website http://issuu.com/cq-datv which is a free magazine publishing site for pilot magazines that want to lure you into buying additional issues...well we had to be different, as we have no plans to charge for CQ-DATV. What we would ask is that you down load from the normal site
http://www.cq-datv.mobi/ebooks.php
if possible as we do record statistics, just to keep a check on our popularity. The most popular issue was CQ-DATV 7 with over 5000 down loads. We don't track where you all are we just need to know that we are producing something you enjoy reading, but if you would like to subscribe please go to http://cq-datv.mobi/lists and when CQ-DATV is available we notify you.

In this issue Ted reviews of all thing a Lidl Bike stand, but you have guessed it, it never sees a push bike. Dave G8AGN produces a PCB using the humble domestic iron, let's not ask how he got the practice needed to wield this implement. Richard VK4XRL has produced Digital World 5 and looks at an array of ATV kit from digital to analogue. Ken W6HCC keeps us up to date with DATV express and in his DATVtalk09, provides an overview of the DVB-T protocol. VHF communications has kindly permitted us to reprint a 10GHz power amplifier. Mike G7GTN has delivered part 2 of his on screen display and Trevor G8CJS looks back at linearity measurements in the video domain. Dave VK5RDC has put together a new DATV repeater in Australia.

Add to this all the ATV news and we have a bumper read. Thanks for taking the time to download and read this edition of CQ-DATV and if you enjoy it, let others know.

- **Do you belong to an active Amateur Televison club?**
- **Want to promote your club to a wider audience?**
- **Have an interesting article or project about Amateur Televsion that you think might interest others?**
- **Contact editor@cq-datv.mobi and let us know.**
- **Your club, article or project could appear in the pages of CQ-DATV.**
- **Guidelines for contributions to CQ-DATV magazine can be found on the Information page.**

DATVtalk09 DigitalATV - Understanding DVB-T Protocol

by Ken Konechy W6HHC

Reproduced from the Orange County Amateur Radio Club newsletter. www.W6ZE.org

[Please Note – This is the eighth article in a series of DATVtalk articles to introduce Digital-ATV to hams and to explain various aspects of this new area of ham radio. In the CQ-DATV5 issue, the DATVtalk02 article was the beginning of this series and presented an introduction article about Digital-ATV.]

Many of the earlier DATVtalk articles about Digital-ATV have provided details about how DVB-S modulation works. DVB-S is currently the most popular modulation standard being used by hams for DATV. This month I will look at some of the technical details of DVB-T protocol/modulation.

The "T" in DVB-T protocol means that it is designed to work well for terrestrial transmissions to your commercial DTV set at home. Fig 1 shows a typical home terrestrial broadcast receiving station using a Set-Top-Box (STB).

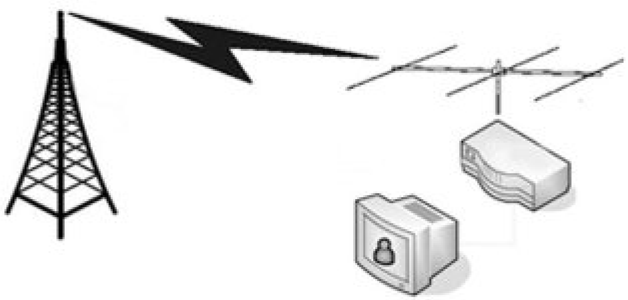


Figure 1 - Terrestrial Reception using a Commercial Set-Top-Box (STB)

DVB-T is used for home terrestrial reception of commercial television in much of the world (Europe, Asia, and Pacific). In the United States and Canada, the competing DTV broadcast standard for terrestrial reception is called ATSC. A comparison table for the PROs and CONs between DVB-T and ATSC and DVB-S technologies can be found near the end of this article.

Typical Transmitter Block Diagram

Groups and clubs of DATV enthusiasts have shown that DVB-T digital technology is possible for hams. Fig 2 is a block diagram of a basic DVB-T transmitter used by several groups in Europe and Australia for DATV. The analog camera and video is compressed by a MPEG-2 encoder board. The TransportStream (TS) digital data is fed to the exciter board that does a lot of complicated data processing and then converts the digital data directly to modulated RF at a desired frequency. The small RF output signal of the exciter board is typically amplified by two stages of very linear RF amplifiers.

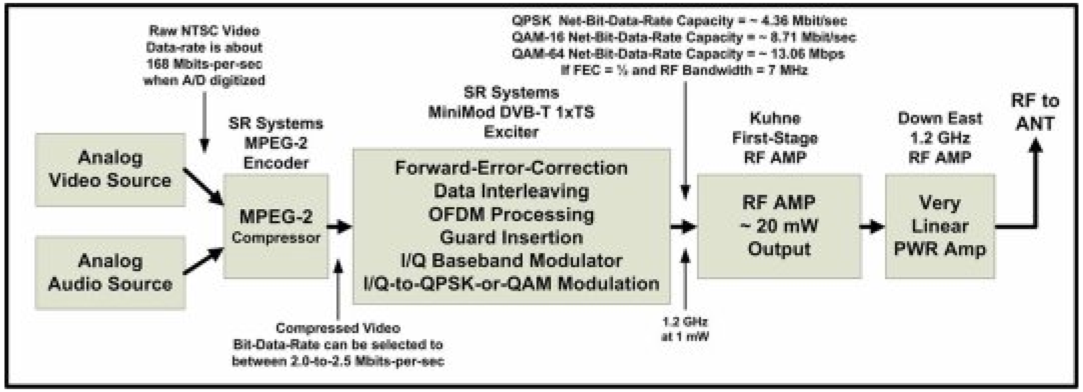


Figure 2 – Block Diagram of Typical DVB-T Transmitter for DATV)

Video Data-Rate and Compression

For DATV, the analog camera output is first digitized by the MPEG-2 Encoder board shown in Fig 2, and then compressed by the MPEG-2 algorithm. The reason the compressed video data rate varies in Table 1 is that the small value means little

motion in the video scene and the larger value means a lot of motion. MPEG-2 encoding can be used in two modes: (a) constant output mode per frame with null packets inserted as needed and (b) variable data per frame. Below are two uses for these two modes of encoding:
a) Encoding for DVB-T uses constant data rate with null inserts as needed
b) Encoding for DVD burning uses variable data per frame

Table 1 – Camera Video Data Streams and MPEG-2 Data Streams

Video Data Stream	Data-Rate	Notes
Analog NTSC camera	168 Mbits/sec	A/D digitized, uncompressed
NTSC MPEG-2	2-3 Mbits/sec	compressed
VHS MPEG-2	1-2 Mbits/sec	compressed
Analog Pal Camera	216 Mbits/sec	A/D digitized, uncompressed
PAL MPEG-2	2.5 -6 Mbits/sec	compressed
HDTV camera	1-1.5 Gbits/sec	uncompressed
HDTV MPEG-2	15-60 Mbits/sec	compressed
HDTV MPEG-4	12-20 Mbits/sec	compressed

Notice in Table 1 that the digitized NTSC camera video data-bit-stream is 168 Mbits/sec before compression, and MPEG-2 encoding (compression) will reduce this to a Net-Bit-Data-Rate between 1 and 3 Mbps, which is quite a reduction.

The MPEG-2 encoder I use makes a direct measurement of the compressed video rate not practical. Discussions with many hams in Europe reveal that they plan for the MPEG-2 output payload data-rate to be set typically between 2.0 and 2.5 Mbits/sec for PAL with excellent results for D1 video resolution. My own DATV tests show that settings of either 2.0 or 2.1 Mbps provide excellent video quality for NTSC. [As a note: the TechTalk85 article in the OCARC DATV library (URL is listed at the end) provided a detailed look at how the MPEG-2 processing works.]

FEC Inflation of Payload Data Stream Data-Rate

Forward Error Correction (FEC) is a technology that not only can detect errors on the received signal, but adds enough redundancy of the data so that it can correct several wrong bits. But, there is a trade-off when choosing the amount of redundancy. Since redundancy inflates the data-rate of the output stream, the trade-off is between more redundancy or keeping the inflated data-rate smaller. As we will see a little later in this article, the larger the inflated output data-rate, the higher the required symbol rate. Higher symbol rates may force you to a wider-bandwidth or a more noise-sensitive modulation scheme. So at some point the FEC algorithm will not have enough redundancy to correct too many errors, and the DATV receiver screen will go blank or freeze.

The DVB-T commercial television standard uses a combination of two different Forward-Error-Correction (FEC) algorithms together in order to provide protection against noise errors and multipath errors. The first FEC algorithm is called the inner-Punctured-Convolutional-Code by the DVB-T specification (and typically called Viterbi in DVB-S articles). The second FEC algorithm is called Reed-Solomon. These two algorithms are the same as those used in DVB-S technology.

Convolutional encoding with Viterbi decoding is a FEC technique that is well suited to a channel in which the transmitted signal has been corrupted by Gaussian noise. The inner-Punctured-Convolutional-Code FEC algorithm can be configured for different levels of error correction. These different Puncture-Table redundancy settings are usually called: 1/2, 2/3, 3/4, 5/6 and 7/8….where the first number ("1" in the case of con-figuration 1/2) is the number of input bits. The second number ("2" in the case of configuration 1/2) is the number of output bits from this FEC algorithm.

So the MPEG2 output data stream is "inflated" 100% by this FECviterbi algorithm configured for 1/2. That is...for every bit going into the FEC engine, two bits come out. A FECviterbi algorithm configured for 3/4, for example, would inflate the MPEG-2 output data stream by 33%. So FEC levels can really inflate the data-bit-rate going to the RF modulator; the MPEG-2 algorithm compresses the video stream, but the FEC algorithms start to expand the required data-bit-rates again.

The second algorithm that is used, the Reed-Solomon FEC algorithm, has a fixed configuration. Its data stream "inflation rate" is 188/204. So for every 188 bits going into the FECreed-solomon algorithm, 204 bits come out...an additional FEC inflation of 8.5%.

Digital Modulation Symbols and Symbol-Rates

Digital modulation technology like BPSK (for example PSK-31), QPSK (Quad Phase Shift Keying – like DVB-S and DVB-T) and QAM-256 (Quadrature Amplitude Modulation with 256 "constellation points") have the ability to put more information into a more narrow frequency spectrum than analog modulation. The complexity of the digital modulation scheme, allows us to pack more "data bits" into each SYMBOL. Table 2 lists out how many data bits can be packed into a symbol for several well known digital modulation technologies.

DVB-T technology users can choose between QPSK, QAM-16, or QAM-64 modulation schemes (shown in BLUE) for the COFDM sub-carriers discussed latter.

The higher-order modulations schemes, like QAM-16 and QAM-64) can "pack" more bits into the symbol rate than QPSK. But, the complexities for QAM-16 and QAM-64 modulation make them more susceptible to noise and

Table 2 – Symbol Bit-Packing for Various Digital Modulation Technologies Modulations in BLUE can be selected for DVB-T

Modulation scheme	Data Bits per Symbol (Me)
BPSK	1
QPSK	2
8-VSB	3
QAM 16	4
QAM 64	6
QAM 256	8

interference. Fig 3, Fig 4, and Fig 5 are intended to give an appreciation of the increasing complexities for these three modulation schemes.

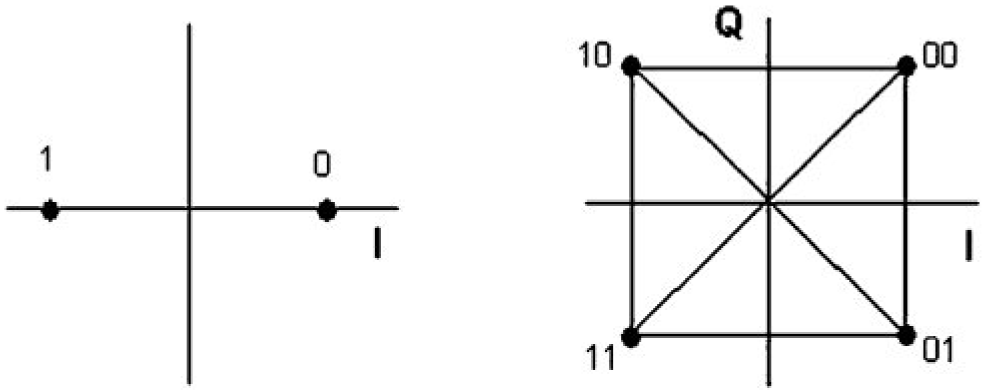


Figure 3 – The constellations of BPSK (on the left) with two states and by QPSK with four states.

Notice in Fig 4 that not only is the angle from the origin to the state important, but the amplitude from the origin is critical, also. The I-axis amplitude of the signal can have four different values. The Q-axis (shown as the R-axis in this drawing) can also have four amplitude values.

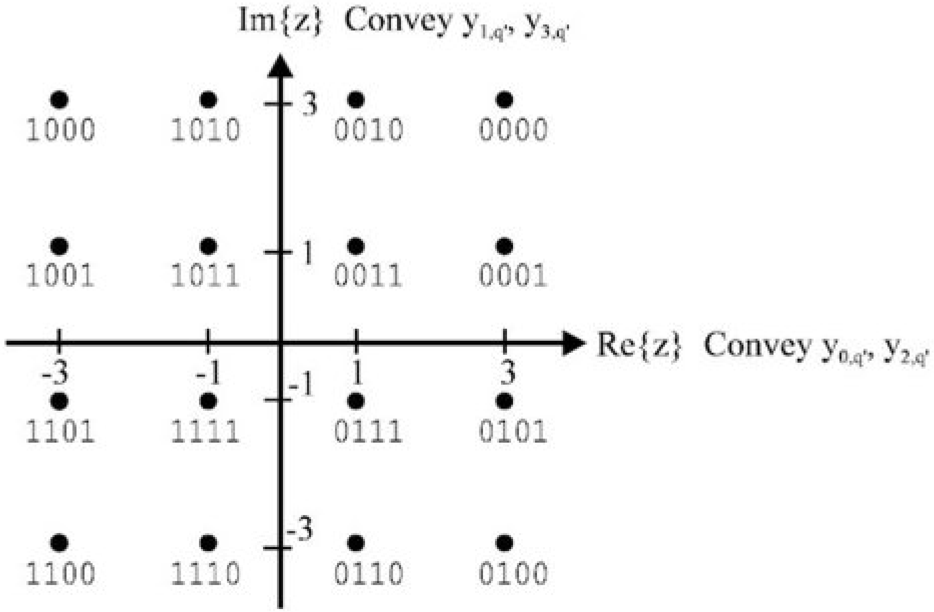


Figure 4 – The constellation for QAM-16 modulation contains 16 states. Each state defines four bits of data.

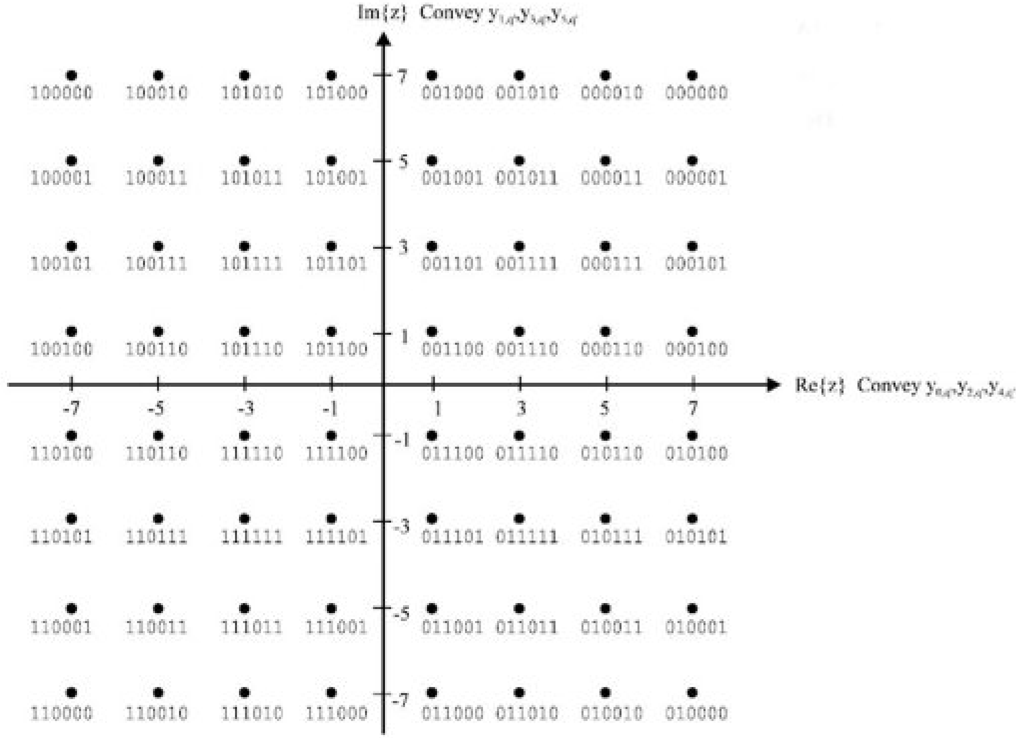


Figure 5 – The constellation for QAM-64 modulation contains 64 states. Each state defines six bits of data.

I use Fig 3 and 4 and 5 to help me to visualize the differences between the complexities of QPSK, QAM-16 and QAM-64 modulation technologies. There is a balance between the rate at which data can be transmitted and the signal-to-noise ratio that can be tolerated. The lower order modulation schemes like QPSK do not transmit data as fast as the higher modulation formats such as QAM-64, but they can be received better when signal strengths are weaker (that is QPSK is more robust).

COFDM

The DVB-T technology adds a process to the modulation of the RF signal that is very different from either DVB-S or ATSC modulations. The negative effects of multipath reflections can be reduced, by using 16QAM modulation with a low effective bitrate per carrier. To reduce the effective bitrate per carrier, DVB-T spreads out the bitrate over a large amount of carriers. This spreading out will result in 1,705 closely spaced sub-carriers (using COFDM.....aka Coded Orthogonal Frequency Division Multiplexing) to create a bandwidth that can be chosen to 6MHz or 7MHz or 8MHz wide. Fig 6 shows an example where there 1,705 sub-carriers spaced at about 3.906 KHz apart...to create a 7MHz bandwidth signal.

Normally these sub-carrier signals would be expected to interfere with each other, but by making the signals orthogonal to each another there is no mutual interference. This is achieved by having the carrier spacing equal to the reciprocal of the symbol period. This means that when the signals are demodulated they will have a whole number of cycles in the symbol period and their contribution will sum to zero - in other words there is no interference contribution.

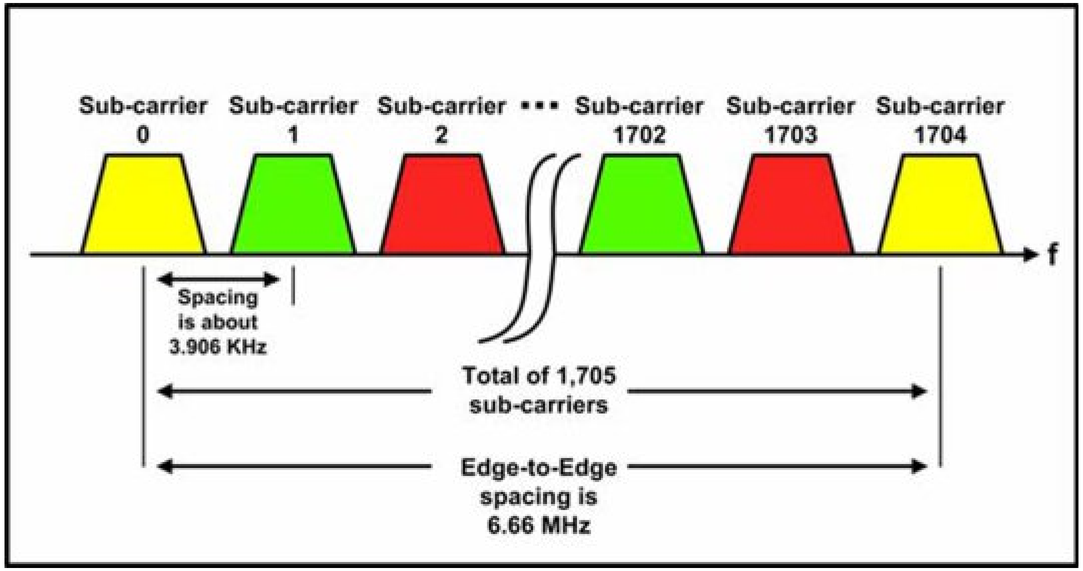


Figure 6 – COFDM spreads the DATV signal over 1705 sub-carriers (7 MHz bandwidth is shown)

When I read different articles on DVB-T technology, I observed that some articles use the term COFDM, and other articles use the term OFDM. What is the difference?? Wikipedia just says "they are the same" for DVB-T articles?? Hans Hass DC8UE was kind enough to dig up a better explanation for the difference between COFDM and OFDM. He found the following information

COFDM
Coded Orthogonal Frequency Division Multiplex
C=Coded – means it uses FEC
O=Orthogonal -means no cross talk between sub-carriers
FDM=Frequency Division Multiplex – means distribution of datastream over a lot of sub-carriers

So OFDM just is a similar communication protocol that does NOT use Forward-Error-Correction (FEC). In a way, Wikipedia is correct, the use of FEC does not affect the number of sub-carriers or the frequency bandwidth...FEC just changes the amount of data overhead added to the datastream. So many technical details stay the same between COFDM and OFDM.

Actually, COFDM can be chosen for 1,705 sub-carriers called the 2K mode, or for 6,816 sub-carriers, called the 8K mode. Stefan Reimann DG8FAC of SR-System explained that ham radio DATV only uses the 2K mode of DVB-T. Stefan DG8FAC detailed that the 8K mode is only used in commercial DTV broadcasts to create Single-Frequency-Networks (SFN) where two or more transmitters carrying the same data operate on the same frequency (to provided geographically overlap-ping coverage) without causing interference to each other. This SFN concept is too complex for ham radio applications and also the size of the FPGA needed for the 8K mode becomes larger and more expensive than the current SR-Systems MiniMod board design.

A final point about COFDM in DVB-T is that the sub-carriers, as shown in Fig 6, can all be modulated with either QPSK or with QAM-16 or with QAM-64.

The Role of the DVB-T Guard Insertion

Wikipedia explains that the purpose of the guard interval is to introduce immunity to propagation delays, echoes and reflections, to which digital data is normally very sensitive. In COFDM, the beginning of each symbol is preceded by a guard interval. As long as the echoes fall within this interval, they will not affect the receiver's ability to safely decode the actual data, as data is only interpreted outside the guard interval.

Longer guard periods allow more distant echoes to be tolerated. However, longer guard intervals reduce the channel efficiency. With DVB-T, four guard intervals are available (given as fractions of a symbol period):

1/32   1/16   1/8   1/4

Therefore, choosing a guard interval of 1/32 gives lowest protection from long echoes and the highest data rate. A guard interval of 1/4 results in the best protection but the lowest data rate. Table 3 provides details of Guard Interval delay times for 6 MHz and 7 MHz configurations.

	6 MHz - 2K Mode				7 MHz - 2K Mode			
Guard Interval	1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32
Duration of Symbol w/o padding	2048 x T 298.67 uSec				2048 x T 256 uSec			
Duration of Guard Interval	74.67 uSec	37.33 uSec	18.67 uSec	9.33 uSec	64 uSec	32 uSec	16 uSec	8 uSec
Guarded Symbol Duration	373.3 uSec	336.0 uSec	317.3 uSec	308.0 uSec	320 uSec	288 uSec	272 uSec	264 uSec

Table 3 – Details of Guard Interval timing for 6 MHz and 7 MHz Bandwidths

Modulation and RF Bandwidth with DVB-T

As discussed earlier, DVB-T transmissions can be chosen to use QPSK, QAM-16, or QAM-64 for modulation. In addition, the transmitter can be chosen for 6 MHz, 7 MHz or 8 MHz bandwidth. Recently, receivers (such as the HiDes Model UT-100B) have finally become available for hams to receive 2 MHz or 3 MHz DVB-T signals. The choice of the modulation does not affect the RF bandwidth because the carrier has been divided into so many evenly-spaced sub-carriers (1,705 sub-carriers for DATV). Fig 7 shows the typical spectrum analyzer view of a DVB-T transmission with 8 MHz bandwidth.

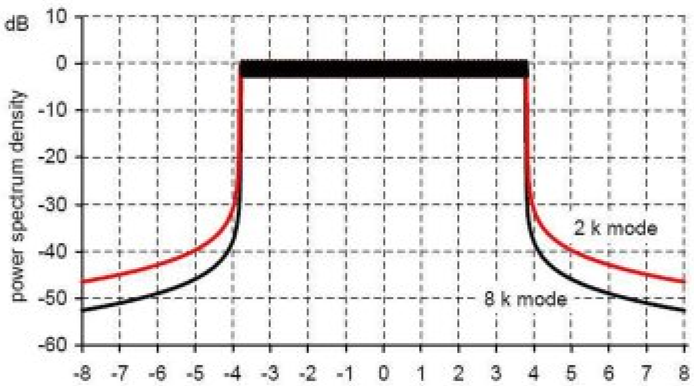


Figure 7 – Theoretical spectrum for an 8 MHz wide DVB-T signal (NOTE: bottom axis is labelled in MHz)

The only difference in the choice of modulation is the amount of payload for Net-Data-Bit-Rate that is available in the transmission, for a given bandwidth. The Net-Data-Rate that the transmission can provide is shown in Table 4. For a given bandwidth, the efficiency that is available is affected by the FEC setting and the Guard Interval setting. Notice that QAM-64 modulation in Table 4 provides approximately 50% more payload (NDBR) than the same settings for QAM-16 modulation. Also, QPSK modulation provides approximately 50% less payload than QAM-16 modulation.

Modulation	FEC Coderate	Channel bandwidth/Kanalbandbreite (MBit/sec)															
		8 MHz				7 MHz				6 MHz				5 MHz			
		Schutzintervall/Guard				Schutzintervall/Guard				Schutzintervall/Guard				Schutzintervall/Guard			
		1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32
QPSK	1/2	4,98	5,53	5,85	6,03	4,36	4,84	5,12	5,28	3,74	4,15	4,39	4,52	3,11	3,46	3,66	3,77
	2/3	6,64	7,37	7,81	8,04	5,81	6,45	6,83	7,04	4,98	5,53	5,86	6,03	4,15	4,61	4,88	5,03
	3/4	7,46	8,29	8,78	9,05	6,53	7,25	7,68	7,92	5,60	6,22	6,59	6,79	4,66	5,18	5,49	5,66
	5/6	8,29	9,22	9,76	10,05	7,25	8,07	8,54	8,79	6,22	6,92	7,32	7,54	5,18	5,76	6,10	6,28
	7/8	8,71	9,68	10,25	10,56	7,62	8,47	8,97	9,24	6,53	7,26	7,69	7,92	5,44	6,05	6,41	6,60
16-QAM	1/2	9,95	11,06	11,71	12,06	8,71	9,68	10,25	10,55	7,46	8,30	8,78	9,05	6,22	6,91	7,32	7,54
	2/3	13,27	14,75	15,61	16,09	11,61	12,91	13,66	14,08	9,95	11,06	11,71	12,07	8,29	9,22	9,76	10,06
	3/4	14,93	16,59	17,56	18,10	13,06	14,52	15,37	15,84	11,20	12,44	13,17	13,58	9,33	10,37	10,98	11,31
	5/6	16,59	18,43	19,52	20,11	14,52	16,13	17,08	17,60	12,44	13,82	14,64	15,08	10,37	11,52	12,20	12,57
	7/8	17,42	19,35	20,49	21,11	15,24	16,93	17,93	18,47	13,07	14,51	15,37	15,83	10,89	12,09	12,81	13,19
64-QAM	1/2	14,93	16,59	17,56	18,10	13,06	14,52	15,37	15,84	11,20	12,44	13,17	13,58	9,33	10,37	10,98	11,31
	2/3	19,91	22,12	23,42	24,13	17,42	19,36	20,49	21,11	14,93	16,59	17,57	18,10	12,44	13,83	14,64	15,08
	3/4	22,39	24,88	26,35	27,14	19,59	21,77	23,06	23,75	16,79	18,66	19,76	20,36	13,99	15,55	16,47	19,96
	5/6	24,88	27,65	29,27	30,16	21,77	24,19	25,61	26,39	18,66	20,74	21,95	22,62	15,55	17,28	18,29	18,85
	7/8	26,13	29,03	30,74	31,67	22,86	25,40	26,90	27,71	19,60	21,77	23,06	23,75	16,33	18,14	19,21	19,79

The specified data rates are valid for 8k, 4k and 2k modes and apply for 188 byte DVB packets

Table 4 – Net-Data-Rate for a Chosen RF Bandwidth and Modulation Scheme (Table courtesy of SR-Systems)

Table 6 is a sample of "payloads" (NDBR) for different modulation schemes using same FEC setting and same Guard Intervals. If you remember that NTSC MPEG2 TS can be selected to be around 2.0 Mbps NDBR (see Table 1), then you can see that two video streams can be carried by a single QPSK 7 MHz carrier. Also, Table 6 illustrates that a QPSK 2 MHz BW signal does NOT provide enough NDBR "payload" to support a good quality NTSC or PAL video stream. QAM-16

Modulation	FEC Coderate	Channel bandwidth/Kanalbandbreite (MBit/sec)															
		4 MHz				3 MHz				2 MHz				1 MHz			
		Schutzintervall/Guard				Schutzintervall/Guard				Schutzintervall/Guard				Schutzintervall/Guard			
		1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32	1/4	1/8	1/16	1/32
QPSK	1/2	2,49	2,7	2,93	3,02	1,87	2,07	2,19	2,26	1,25	1,38	1,46	1,51	0,62	0,69	0,73	0,75
	2/3	3,32	3,69	3,91	4,02	2,49	2,76	2,93	3,02	1,66	1,84	1,95	2,01	0,83	0,92	0,98	1,01
	3/4	3,73	4,15	4,39	4,53	2,80	3,11	3,29	3,39	1,87	2,07	2,20	2,26	0,93	1,04	1,10	1,13
	5/6	4,15	4,61	4,88	5,03	3,11	3,46	3,66	3,77	2,07	2,31	2,44	2,51	1,04	1,15	1,22	1,26
	7/8	4,36	4,84	5,13	5,28	3,27	3,63	3,84	3,96	2,18	2,42	2,56	2,64	1,09	1,21	1,28	1,32
16-QAM	1/2	4,98	5,53	5,86	6,03	3,73	4,15	4,39	4,52	2,49	2,77	2,93	3,02	1,24	1,38	1,46	1,51
	2/3	6,64	7,38	7,81	8,05	4,98	5,53	5,85	6,03	3,32	3,69	3,90	4,02	1,66	1,84	1,95	2,01
	3/4	7,47	8,30	8,78	9,05	5,60	6,22	6,59	6,79	3,73	4,15	4,39	4,53	1,87	2,07	2,20	2,26
	5/6	8,30	9,22	9,76	10,06	6,22	6,91	7,32	7,54	4,15	4,61	4,88	5,03	2,07	2,30	2,44	2,51
	7/8	8,71	9,68	10,25	10,56	6,53	7,26	7,68	7,92	4,36	4,84	5,12	5,28	2,18	2,42	2,56	2,64
64-QAM	1/2	7,47	8,30	8,78	9,05	5,60	6,22	6,59	6,79	3,73	4,15	4,39	4,53	1,87	2,07	2,20	2,26
	2/3	9,96	11,06	11,71	12,07	7,47	8,30	8,78	9,05	4,98	5,53	5,86	6,03	2,49	2,77	2,93	3,02
	3/4	11,20	12,44	13,18	13,57	8,40	9,33	9,88	10,18	5,60	6,22	6,59	6,79	2,80	3,11	3,29	3,39
	5/6	12,44	13,83	14,64	15,08	9,33	10,37	10,98	11,31	6,22	6,91	7,32	7,54	3,11	3,46	3,66	3,77
	7/8	13,07	14,52	15,37	15,84	9,80	10,89	11,53	11,88	6,53	7,26	7,69	7,92	3,27	3,63	3,84	3,96

The specified data rates are valid for 8k, 4k and 2k modes and apply for 188 byte DVB packets

Table 5 – Net-Data-Rate for a RF Bandwidth of 2 MHz , 3 MHz (Table courtesy of SR-Systems)

	Net-Data-Bit-Rate for FEC=1/2 Guard = 1/4		
Modulation	**2 MHz BW**	**6 MHz BW**	**7 MHz BW**
QPSK	**1.25 Mbps**	**3.74 Mbps**	**4.36 Mbps**
QAM-16	**2.49 Mbps**	**7.46 Mbps**	**8.71 Mbps**
QAM-64	**3.73 Mbps**	**11.20 Mbps**	**13.06 Mbps**

Table 6 – Example of DVB-T Transmission "Payload" for different Modulation Schemes

and QAM-64 at 6 MHz , 7 MHz and 8 MHz bandwidths can carry even more than one TS videos at the same time. Essentially, this is how commercial DTV broadcast stations can carry six DTV "sub-channels" on the same transmitted signal.

I wondered why wider bandwidths provided a higher payload data-rate, if each bandwidth used exactly the same number of sub-carriers?? Then, I remembered that the Symbol-rate for each bandwidth is adjusted based on the spacing of the sub-carriers to provide the orthogonal interference protection. So, narrower bandwidths do require the use of slower Symbol-rates.

An interesting note about DVB-T RF Bandwidth is that SR-Systems has designed their MiniMOD exciter boards to allow for selection of DVB-T transmission bandwidths of 8, 7 ,6, 5, 4, 3 MHz and down to only 2 MHz BW. These narrow bandwidths of 5 –to– 2 MHz are not covered by the commercial DVB-T standard. But, as Stefan DG8FAC explains "...we transmit on 70cm with 2MHz in QAM-16, 1/2FEC and 1/4 Guard, and this works perfectly." The NIM receiver boards that are available from SR-Systems, have modified firmware used with the DiBcom7000 chip used in the NIM DVB-T board to receive the 2 MHz BW. But, this "not-normal" bandwidth choice will not work with commercially available SetTopBoxes that were not intended to be used with a 2 MHz bandwidth.

Fig 8 shows a DVB-T transmission spectrum produced at the output of a MiniMOD exciter board. This picture shows the direct resemblance to the theoretical DVB-T spectrum shown in Fig 7. Fig 9 shows a similar output for the DATV-Express board.

The spectrum display in Fig 10 looks quite different than the theoretical shown in Fig 7. Peter Cossins VK3BFG who has contributed much to the VK3RTV repeater DATV progress explains "...The DVB-T spectrum from the final amp sampled via a directional coupler to a dummy load is quite rectangular. This spectrum [Fig 10] tapers off with increasing frequency ....it should be fairly flat on the top! The spectrum photo I have provided is live off a 49 element J beam ....I checked a local com-mercial UHF on the same antenna which

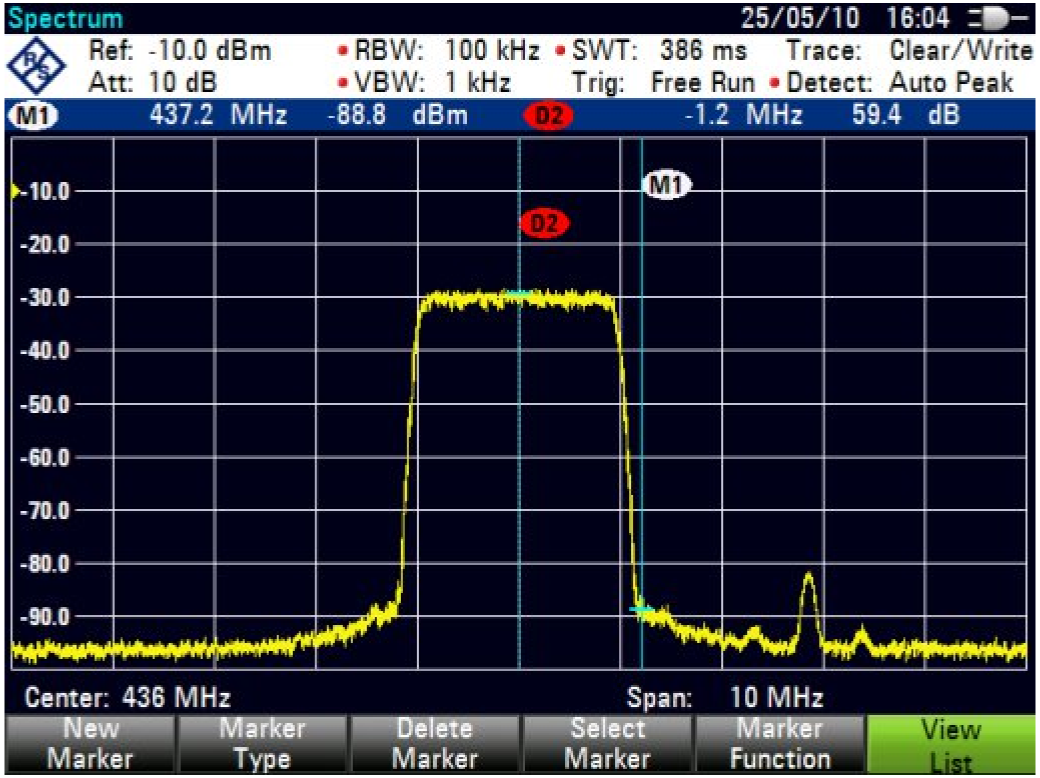


Figure 8 – A DVB-T MiniMOD exciter output transmission of 2 MHz BW is seen on a Spectrum Analyzer (Courtesy of Stefan DG8FAC)

is very close in freq and it looks somewhat similar, but a bit more rectangular as it should be. The repeater antenna up the hill is the original analogue one optimized for 444.25 MHz, not 446.5 Mhz. This seems to be confirmed as 'performance' is better at the bottom end rather than the top end. The repeater antenna is quite OK to about 4 MHz+ so it was satisfactory for the analogue system.

I think what you are seeing is the variations in gain performance of both antennas over the bandwidth... "

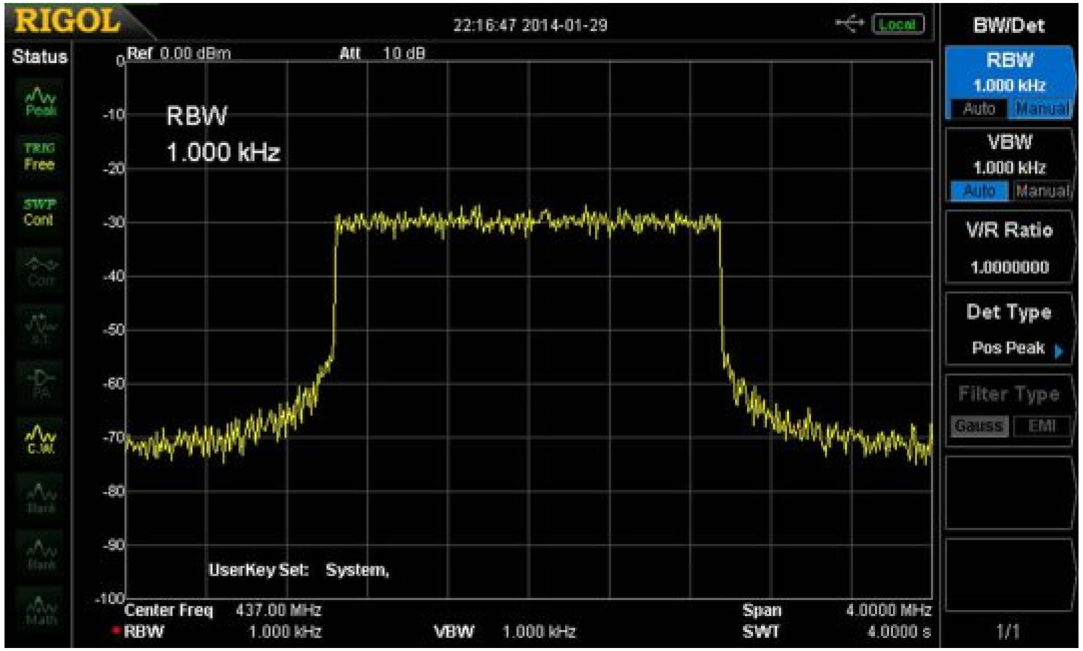


Figure 9 – A DVB-T DATV-Express exciter output transmission of 2 MHz BW is seen on a Spectrum Analyzer (Courtesy of Charles G4GUO)

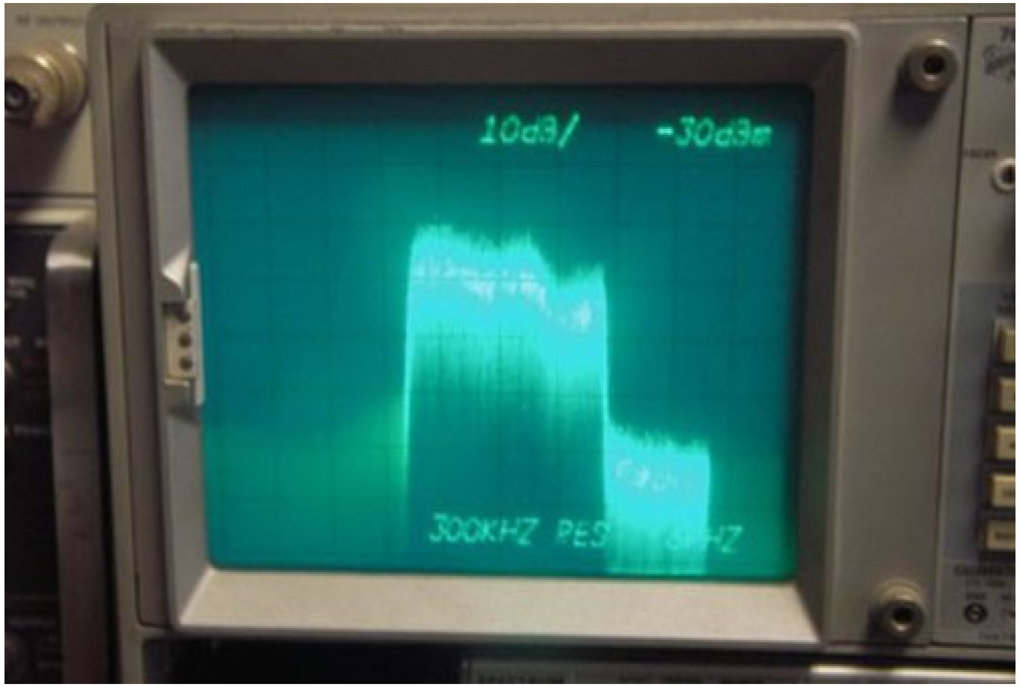


Figure 10 – DVB-T transmission as seen on a Receiving Station shows effects of VK3RTV Transmit Antenna tuned off-frequency (Courtesy of Peter VK3BFG)

De-rating the RF Power Amp Output

It is finally worth noting that DVB-T is more sensitive to non-linearity of a power amplifier than DVB-S technology. This is because the COFDM modulations have a very large "Peak-to-Average Ratio" called PAR. The graph in Fig 11 shows that OFDM/COFDM is very much worse than QPSK. This is because you can not allow "flat-topping" the power peaks to create distortion, therefore the average power out of the amplifier will be set lower.

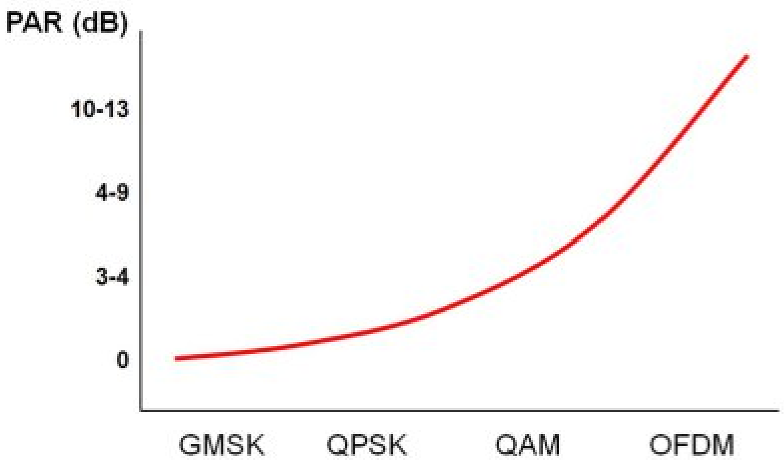


Fig 11 – PAR for amplifier output power when processing signals with various digital modulation technologies (Graph courtesy of Robert Green – Keithley Instruments, Inc.)

Peter VK3BFG confirms by explaining "...Digital television [DVB-T] requires extremely linear RF amplifiers and hence it was necessary to bias the module close to Class A. This is an extremely inefficient mode with a maximum efficiency of 50%. The actual efficiency obtained for DVB-T was about 14 % !!!.

Driving the amp is extremely non-linear and the spectrum growth occurs at an alarmingly fast rate after a certain point has been reached....".

Hans Hass DC8UE has experience as a satellite communications engineer at a commercial TV station and has access to good communications instrumentation. Hans explains that "...On measurements with my own DATV DVB-T transmitter, I can operate the linear 6 Watt PA (FM rating) only at 300mW (in QAM-16 mode). That is 13db below saturation or 5% from the possible FM-power (not DC-input power). If I increase the power, the MER [digital Modulation Error Ratio] will get poor values."

Stefan DG8FAC wrote: The exciter power output settings in DVB-T mode with a 6W (FM rating) Power Amplifier are made with ETL measuring equipment as follows:

- *GAIN = 08   yields MER 40dB [good] at 100mW OUT*
- *GAIN = 10   yields MER 39dB [acceptable] at 250mW OUT*
- *GAIN = 13   yields MER 34dB [poor] at 500mW OUT*

On the RF Amplifiers web site from Alberto (DGØVE) you can read (in German): All amplifiers can also be used for DVB-S and DVB-T with reduced power. You will notice that in the DVB-S mode only about 20% to 25% of the maximal power (P-1dB) can be achieved. Working in the DVB-T mode you will get only approximately 8% to 10% of the P–1dB power level.

Comparing DVB-T with DVB-S and ATSC

Table 7 goes through an exercise of PROs and CONs for each of the primary technologies considered for ham DATV. Many hams see the primary disadvantage of DVB-T for DATV as squeezing the fixed bandwidth of normally 6 MHz or wider into crowded band plans. However, recent new ham equipment now provides receivers capable down to 2 MHz bandwidth. But, on the opposite side of the coin is the DVB-T capability to easily carry more than one video picture simultaneously on the same carrier. Choosing a DATV technology really depends on your requirements.

Conclusion

DVB-T technology offers many interesting concepts and capabilities for ham DATV. There can be no doubt that its design to deal with multi-path noise is impressive. My main reason for selecting DVB-S for my home station was to take advantage of the narrow bandwidth offered for DATV. However, I made that decision before 2 MHz BW receivers were available for DVB-T. But still, I enjoy studying the competing DATV technologies and understanding how they work. My philosophy in this DATVtalk article is that it is good to know the strengths and weaknesses of each DATV technology.

	DVB-S	DVB-T	ATSC
PROs	Bandwidth can be as small as 2 or 3 MHz Cheap FTA Set Top Boxes (STB) on eBay Wide-spread experience and knowledge is provided by European hams on the Internet	Excellent multipath interference immunity Cheap Set Top Boxes (STB) on eBay 6 MHz bandwidth can support multiple video streams	Excellent multipath interference immunity Cheap Set Top Boxes (STB) in USA 6 MHz bandwidth can support multiple video streams
CONs	Multipath interference immunity not as strong as DVB-T or ATSC, but plenty of FEC correction is available	Standard 6, 7, or 8 MHz fixed bandwidth is no advantage over analog-ATV High Peak-to-Average of power for QAM modulation requires very linear power amps and large de-rating of average output power. Typically DVB-T exciter board is 100% more expensive than DVB-S	6 MHz fixed bandwidth is no advantage over analog-ATV Dolby audio AC3 encoder licensing issue unfeasible for hams Current ham transmitter boards for ATSC cannot provide AC3 audio (Dolby) Use of substitute MPEG-2 audio does not work with ATSC STBs, but can (may?) work with cable-ready DTV receivers

Table 7 – Comparing PROs and CONs between DVB-S, DVB-T and ATSC DATV Technologies

Contact Info

The author may be contacted at W6HHC@ARRL.net

Useful URLs

- British ATV Club – Digital/DigiLite/DTX1 forums – see www.BATC.org.UK/forum/
- BATC info site for DTX1 DVB-S exciter – see www.DTX1.info
- DATV-Express Project web site (SDR-based exciter) – see www.DATV-Express.com
- DigiLite Project for DATV (derivative of the "Poor Man's DATV") – see www.G8AJN.tv/dlindex.html
- Digital Video Broadcasting standard for DVB-T – see ETSI EN 300 744 V1.6.1 specification
- Melbourne DATV Repeater VK3RTV – see www.VK3RTV.com/latest.html
- Orange County ARC entire series of newsletter DATV articles – see www.W6ZE.org/DATV/
- HiDes DVB-T receivers and transmitters – see www.HiDes.com.tw/product_eng.html
- SR-Systems D-ATV components (Boards) – see www.SR-systems.de
- Yahoo Group for Digital ATV – see groups.yahoo.com/group/DigitalATV/

Lidl bike stand

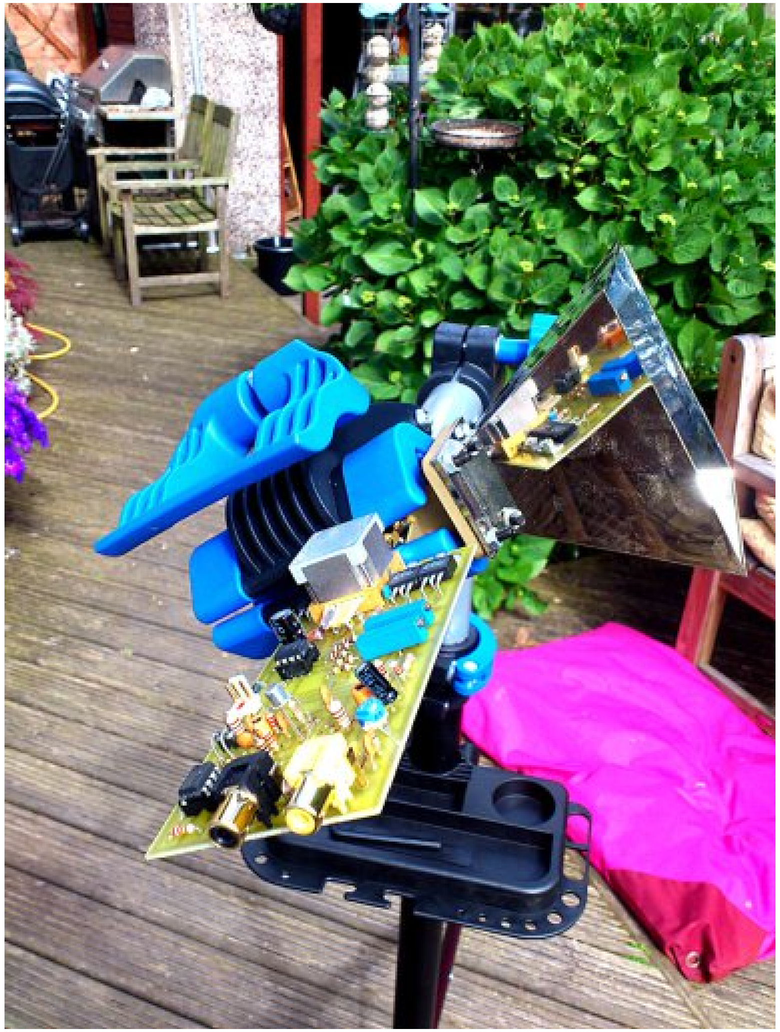
By Ted Bottomley

Every now and then, Lidl comes up trumps!

This time, it's a little "quadpod" (four legged) stand that is actually marketed as a bicycle work station. Manufactured in Germany under the name "Powerflex", it is very sturdy, has an adjustable head clamp that will hold just about anything

and a handy little tool tray that will easily hold a 10Ah SLAB amongst other things: tuning tools, adaptors and a magnetic compartment that will hold tight the only tool you (rarely) need for the stand so you don't lose it – a 5mm Allen key (included with the stand)!

The whole thing collapses right down into something a lot smaller than my old thumping great tripod! Approx 4 feet long by 5 inches dia to be precise – should fit most car boots or just slide across the back seat or footwell.

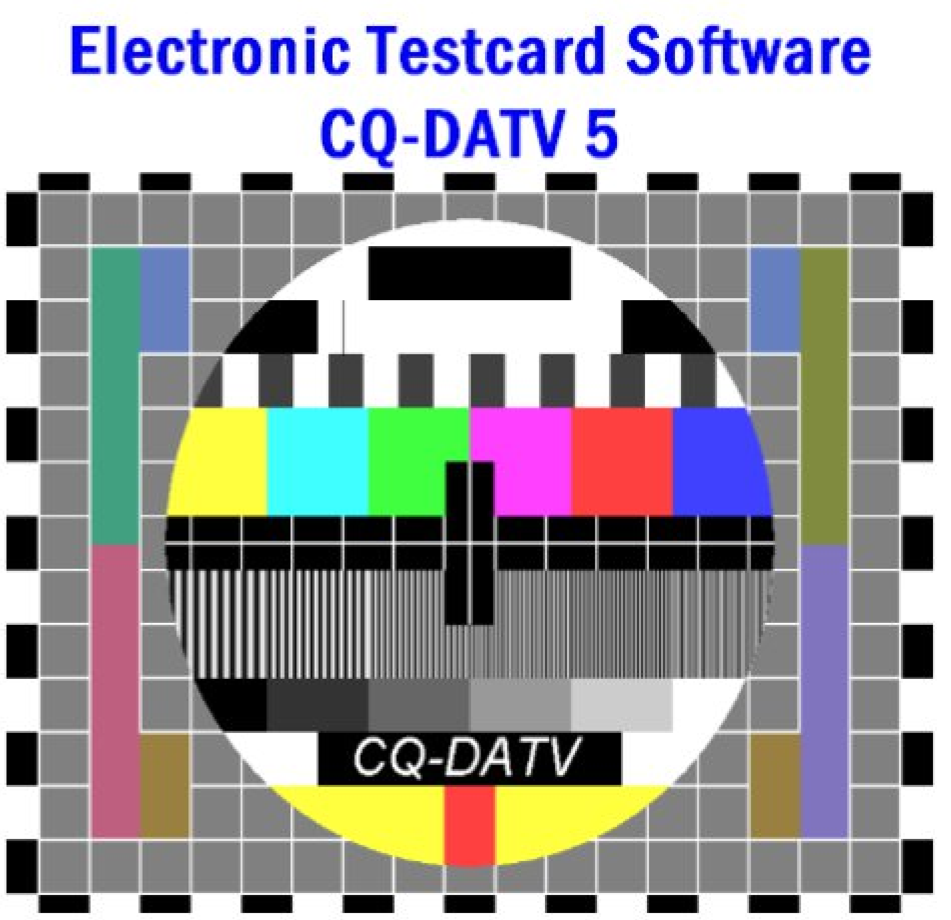


About 7 foot high fully extended, there is very little “sway” or wobble and the fold-out footpads on the 4 stable wide spread legs have convenient holes to allow the stand to be screwed (say to your deck) or simply pegged on grass; I’m going to drill mine out (there is plenty of material) to allow rock-pegs to be used in out-of-the-way car parks that use gravel or crushed rocks for the surface!

So far, I have tried the soft-jawed clamp with LNBs, waveguide to SMA adaptors, round aluminium tube up to 1.5”, square aluminium tube, a mini-dish and even a VHF/UHF vertical co-linear. Az/El? No problems! Release the simple clamp and twist the upper tube for Azimuth, loosen the LARGE hand-screw and rotate the horizontal tube for Elevation...

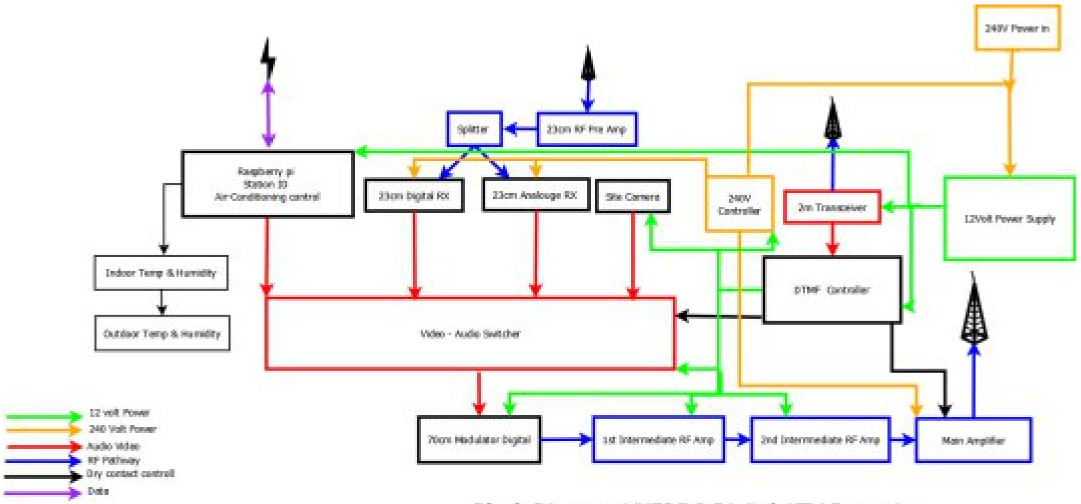
Lidl - £29.99.

PS – I have no connections with Lidl whatsoever and will receive no benefits in cash or otherwise – maybe I should ask them...



New DATV Repeater in Australia

VK5RDC is situated on the Buff at 2000' above sea level, and some 15Km east of Port Pirie on Spencer Gulf, it shares the transmitter hut of Trax FM our local community radio station. It is intended to cover Port Pirie and Whyalla to the west, Port Augusta to the north Kadina in the south and towns in-between.



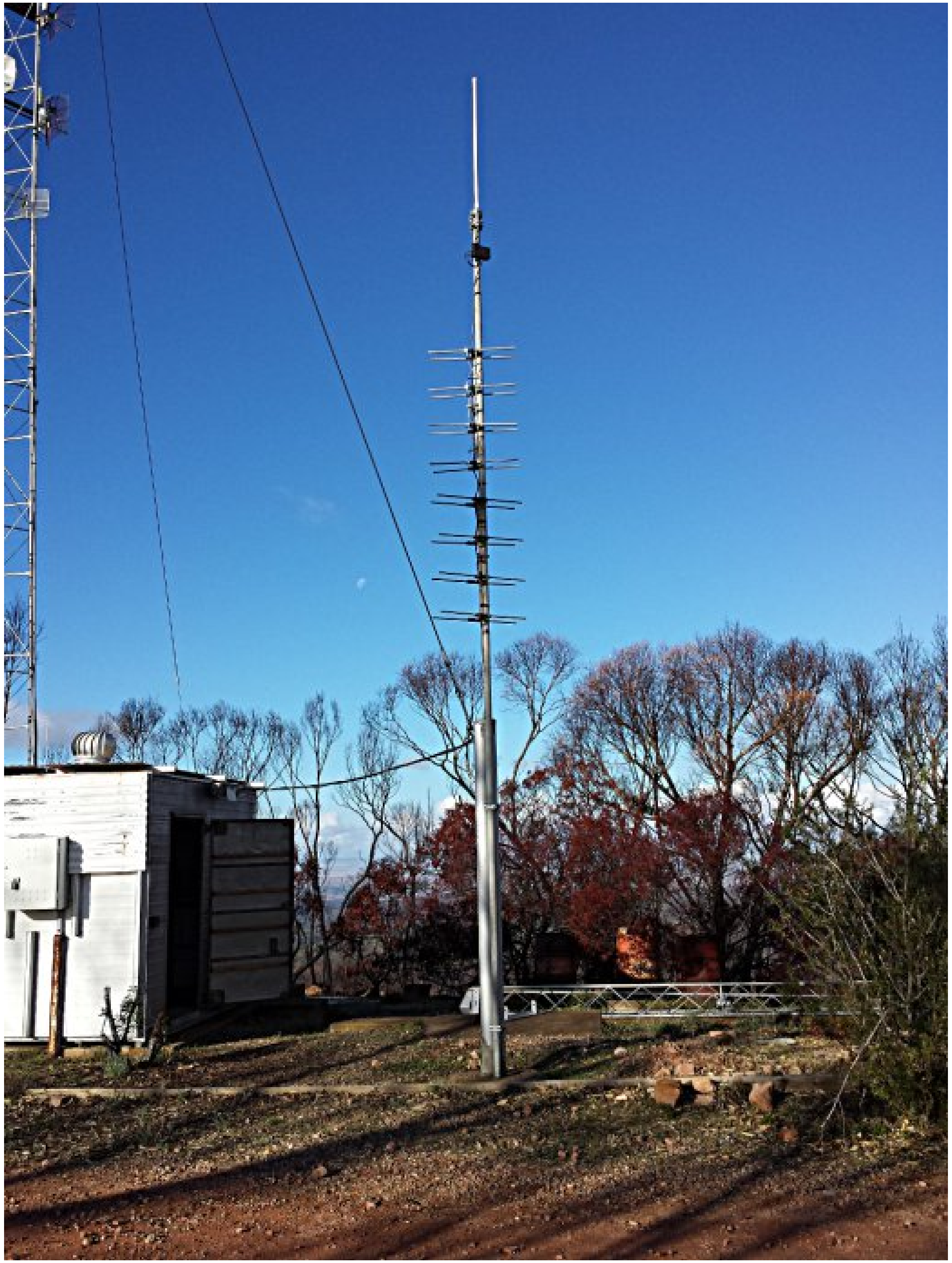
Block Diagram VK5RDC Digital ATV Repeater

The digital receiver is 1290.000 MHz DVB-S and the output is on 446.500 MHz DVB-T at 100 Watts.

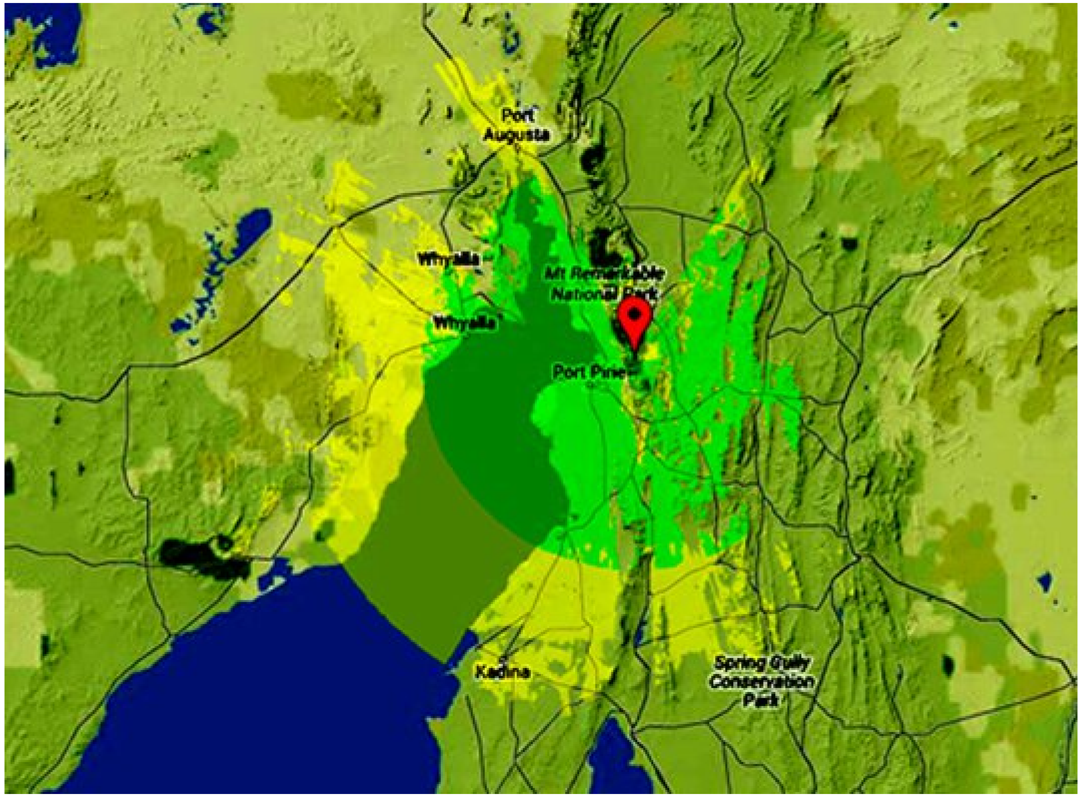
I have included some pictures and the following is, a description of the repeater:- On the top of the repeater there is an orange box that is the DTMF 240V interface below that is the Analogue 23cm receiver, then the Digital 23cm receiver, the 2meter DTMF receiver and video switcher, DTMF controller, below that is the 70cm ATV modulator two intermediate RF amplifiers and SWR/Power meter, then the 600w linear RF power amplifier, the black box is the power supply, below that is the TRAX FM transmitter equipment.

The antennas are temporary at the moment, once they have proved themselves they will be installed on the tower you can see laying on the ground in the background, on top of the pole is the 23cm receive antenna and below are the two CA16 type 70cm transmit antennas.
Many improvements are planned, but the first step is complete, it is licensed and on the air.

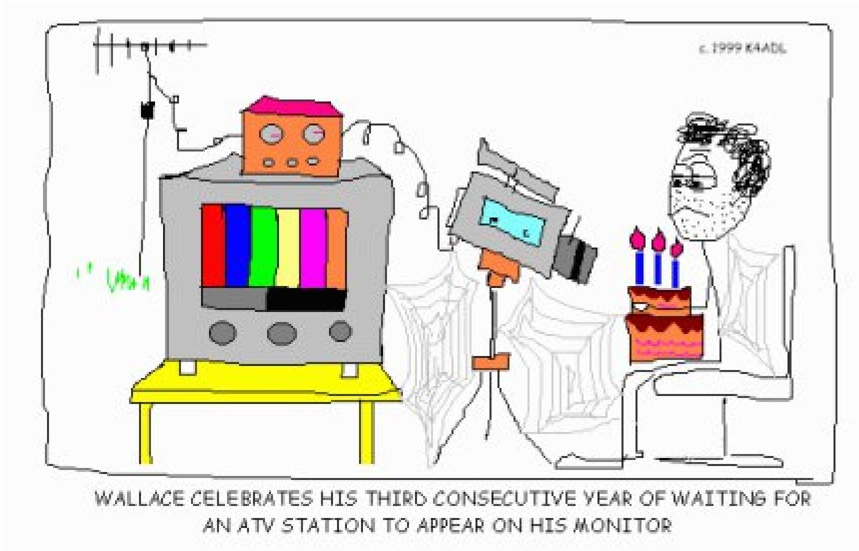
Dave VK5DMC



Temporary antenna setup. The permanent tower is laying down in the background



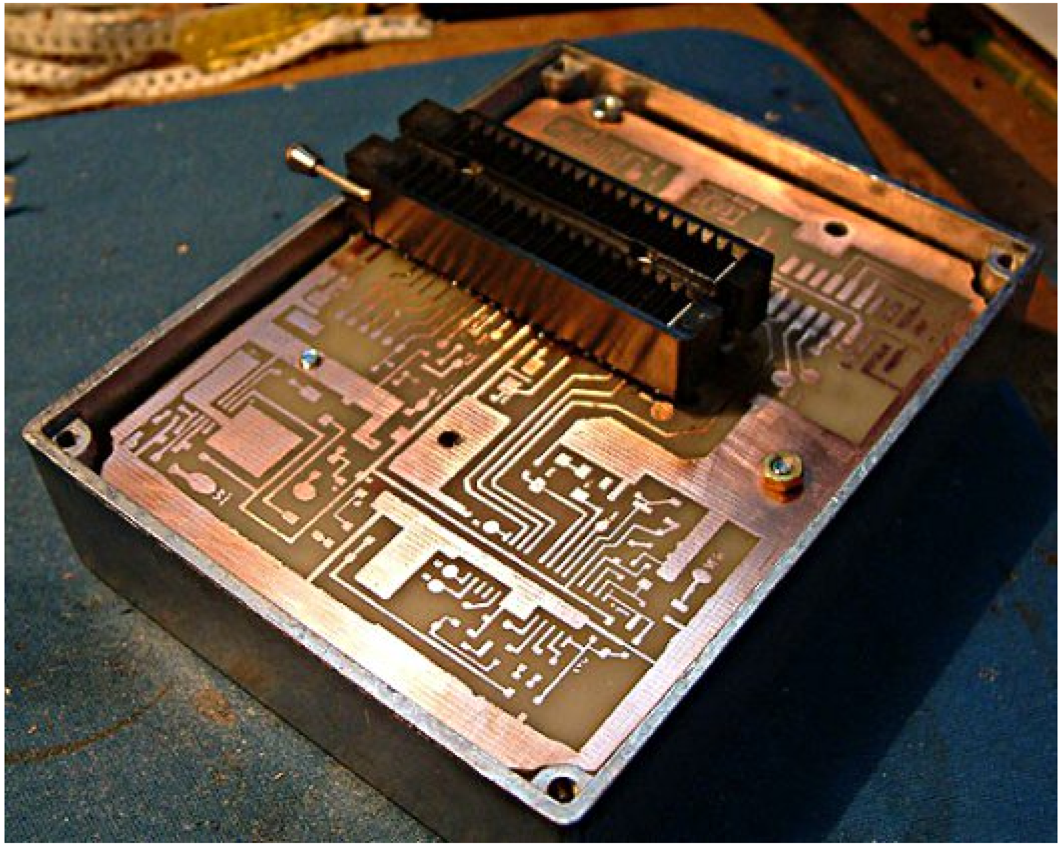
VK5RDC Coverage map



Cartoon courtesy www.qsl.net/k4adl

Making Your Own Prototype Printed Circuit Boards

by Dave Kenward G8AJN



Looking back over some past copies of CQTV I was struck by the number of constructional items that were still being built with strip-board pcb. This is an obvious way to quickly prototype designs, but can be rather cumbersome and obviously will be tricky as more and more ICs go over to surface mount packages. One of the worst jobs in my view for the home constructor is the drilling of boards. Even quite simple boards can require dozens of holes, so the attraction of SMD components all soldered onto the one side of the pcb requiring no drilling at all is clear.

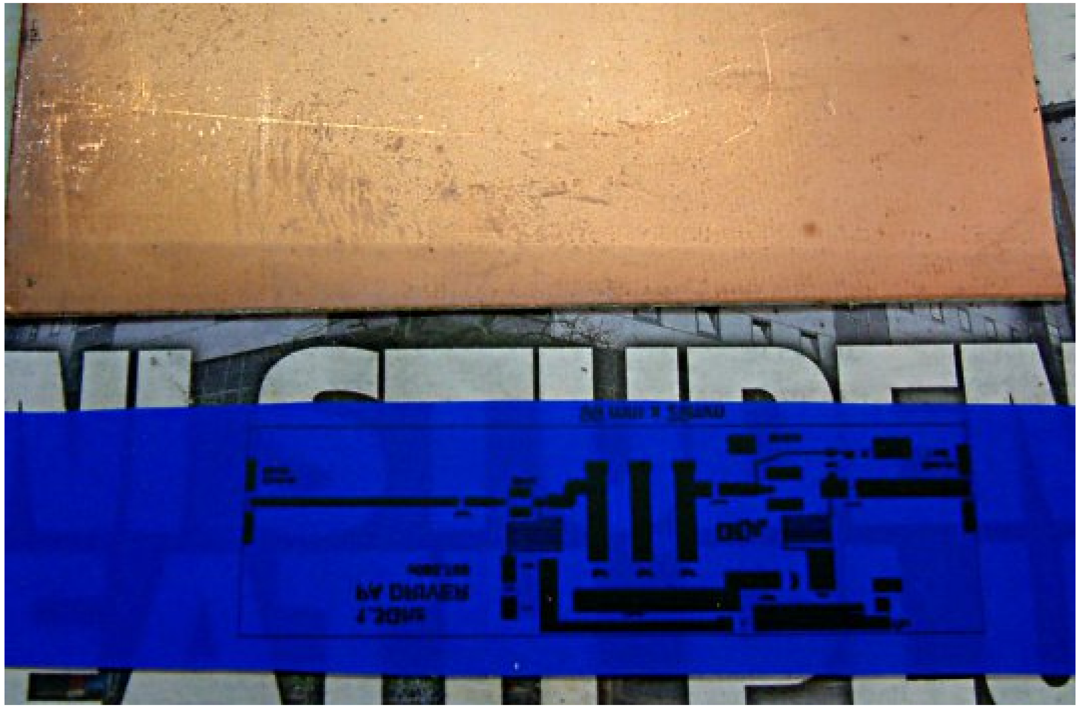
PCB manufacturers are not interested in small runs and charge nearly as much for a couple of boards as for twenty. So what other options are there? Photo-resist requires a negative sheet with a photographic surface painted onto a copper pcb. The process then requires a light-box and careful timing of exposure followed by a developing and then removal of unwanted material leaves a pcb ready for etching. Quite a few tricky processes and opportunities to fail.

I discovered a couple of years ago another option using an iron-on system. Discussing the product with some local operators I realised that many had never even heard of this way of producing boards. At first I was rather sceptical, particularly when it came to fine tracking, but I decided to give it a try and have found that Press N Peel is ideal for anyone with access to a laser printer or photocopier. Armed with a vector based computer drawing programme such as CorelDraw a simple circuit can be quickly prototyped. Of course a CAD program such as Eagle will do much of the work for you, but takes a lot of patience in learning your way around the software. The example shown here was entirely produced using CorelDraw . A 1:1 scale picture in a magazine can be scanned into your pc but only if the quality of the original is good enough. Settings for the printout can be checked on paper first. The settings for the printer should be 'print colours as black' and 'mirror'. (selected on the printing options via the drawing program).

BLUE MEANIES

Press N Peel Sheets are available at several suppliers such as Maplin, CPC and on Ebay*. The sheets come in packs of five A4 size and work out to about £3 each sheet. Of course you can get quite a few designs on one sheet, then when printed out they can be cut by a pair of scissors to make individual boards.

By way of a demonstration I will briefly take you through the process of the making of a circuit board for the local ATV repeater GB3SQ quite a few years ago using the PressNPeel sheet method.

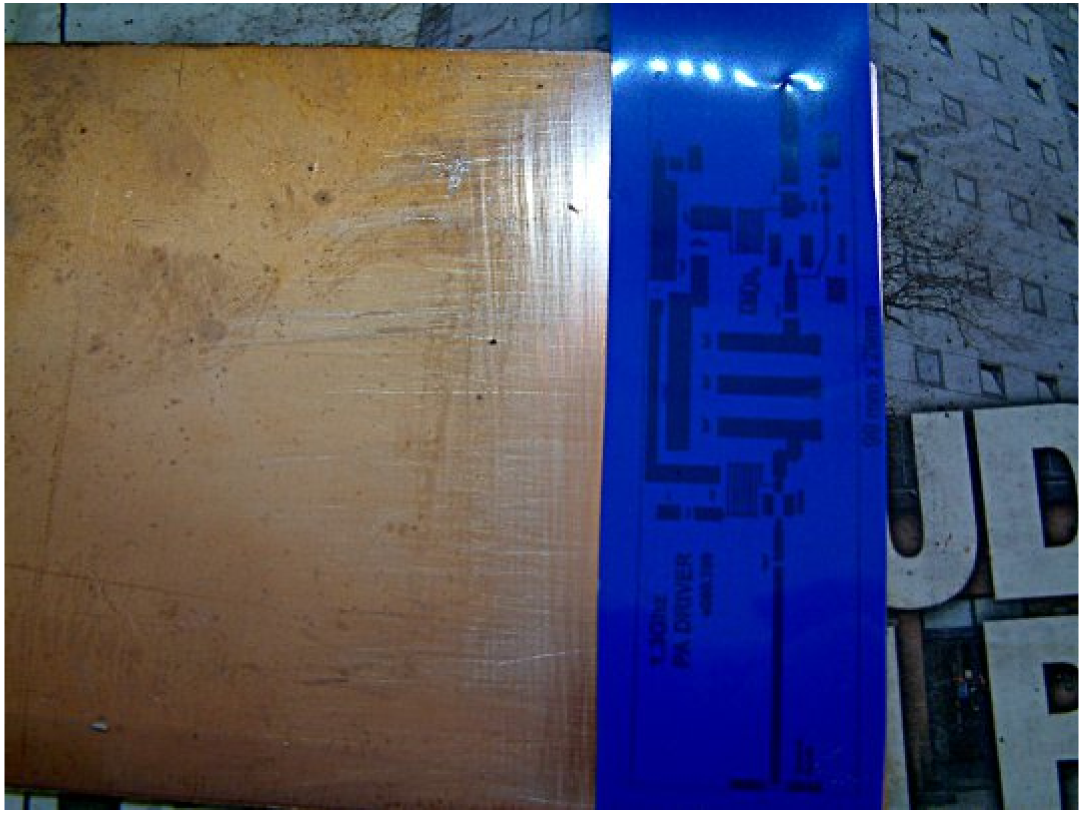


The blue sheets have a shiny side and a dull, coated side. It is this coated side that is printed onto with a mirror image of the track layout. from vector drawing programs such as CorelDraw . Each block of track will be a separate layer. Use the printer options Set all colours as black and mirrored. Don't use scale to fit as you need the sizes to remain unchanged at 1:1.

Always do a test print onto white paper first to check sizes to avoid wasting a blue sheet.

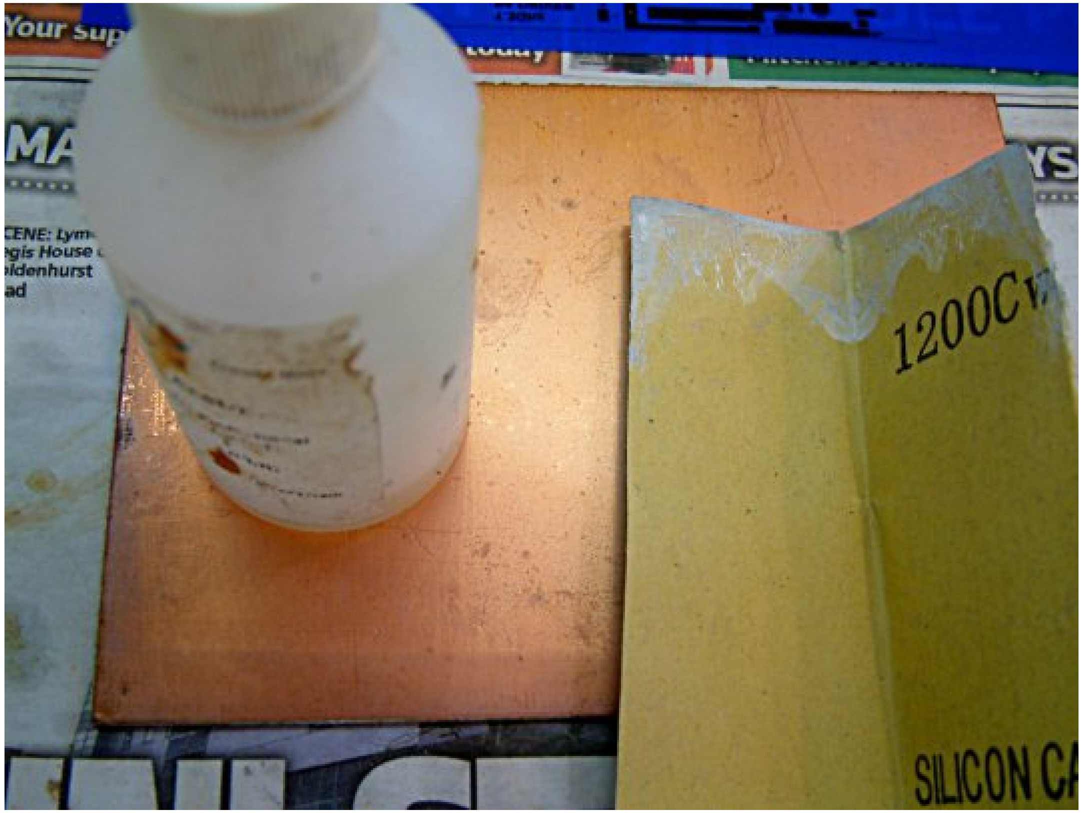
This printing cannot be done with an inkjet printer, but either a laser printer or a photocopier will work. The toner has to be fused with heat onto the sheet to mix with the impregnated chemicals. It is not necessary to etch from the whole sheet at once, a sharp knife or scissors can be used to cut out a single image. Store the remnants in a air-tight plastic bag.

IRONING THINGS OUT



Acetone (nail varnish remover) wiped over the surface of the copper sheet should clear any grease/fingerprints etc. As you can see in the pictures I have deliberately selected a grotty piece of board to demonstrate this process and it in no way reflects the fact that I am trying to save money by using up old offcuts. Badly marked copper can be treated with some wetted very fine wet/dry paper (1200 or finer) and by using light pressure (*see picture next page*). Don't use any cleaning liquids.

The very clean pcb copper board is then laid flat with the dull (printed) side of the sheet touching the copper and use a smoothing iron (set temperature to around 'silk' setting) is gently wiped across the area of the design until the copper is heated to a point where the chemicals on the sheet deposit



the toner onto the board rather like using an iron-on transfer. It takes quite a while if using a lot of copper as it acts as a heat sink. If the temperature is too high the blue plastic sheet will start to crinkle. If the plastic sheet does begin to crease remove the iron and drop its temperature setting down a notch.

Don't over-press, keep the pressure to about the weight of the iron itself and concentrate on any large ground areas, edges and corners.

It can take about five minutes to get all the black tracking to leave the blue sheet and adhere to the copper. During this time I recommend an interlude of nagging to pass the time. My wife seems to find it therapeutic whilst ironing.

Allow about 5-6 minutes ironing for a board of about 100mm x 100mm, less if smaller. Usually 8 minutes for a larger sheet. Ensure that there is a fairly even heat across the board but there is no need to press hard as that will tend to make the finer tracks splay wider.

After ironing for five minutes, allow to cool a few minutes and gently peel back the transfer sheet from a corner, looking for any tracks that may not have transferred fully. If there are any, simply let the sheet back down and iron for a few more minutes then repeat.

Cool the board gently with cold water, or by waiting, down to room temperature then gently peel off the sheet. Look for any spots missing, especially on ground planes.

An etch resist pen can be used for any odd spots that need attention in large ground areas for example. Nail varnish is ideal for large areas such as ground tracks. If there are pieces of track missing it is usually either because of unclean areas of the copper or finger marks on the blue sheet. Old stock sheets loose their adhesiveness if not stored properly.

If you are using double sided board you can cover the lower side with nail varnish at this stage. If you feel uncomfortable asking for nail varnish in Boots I suggest asking the wife to find you an unwanted colour of nail-varnish, but be ready for that long-suffering look that says 'he gets worse as he gets older'.

COME UP AND SEE MY ETCHINGS

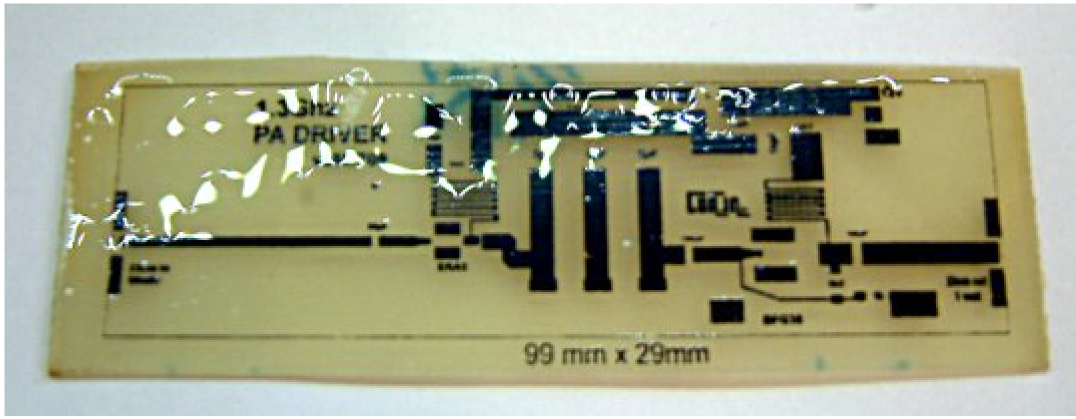
Etch as usual with ferric chloride crystals (about a heaped tablespoon to 1/2pint [300ml] depending on area of exposed copper to deal with) and quite hot, but not boiling water (dangerous chlorine fumes), sufficient to submerge the board. Ferric Chloride stains skin and clothes and metal objects. Mind those piercings.

Wear old clothing as F.C. stains permanently. Use latex gloves and a fairly deep plastic tray (such as those use in supermarkets for meat), cover it with cling film to protect clothes from staining splashes and agitate the mixture vigorously to get air bubbles into the ferric chloride and to prevent any etched copper settling back onto the board. The copper will turn pink initially as the etching process is under way.

After 10-15 minutes or so the board will be etched. If it is going a bit slowly because the liquid has cooled, you can remove the board, rinse it under cold water tap and place the etchant tray in the microwave on high for 10 seconds or so to re-warm the liquid. When all unwanted copper is gone,rinse the board under cold water.

The etch resist can be removed with Jif cream and wire wool or wet/dry paper. If not being assembled that day the resist should be left on to protect the copper tracks and removed when needed. Keep the board in a airtight plastic bag.

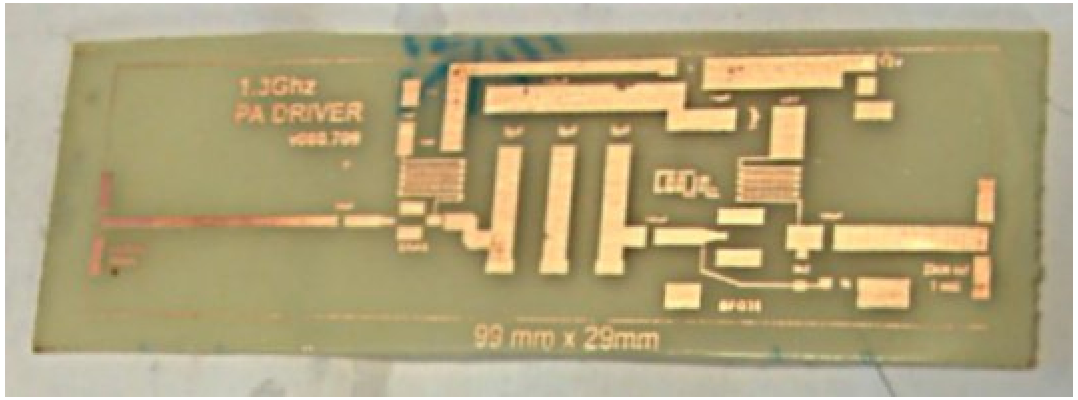
If you want to tin the entire board you will need a small artwork brush (~10mm) and some solder paste which should be stored in a cool place. When buying, ensure that it is solder paste not soldering flux which some Ebay sellers seem to confuse . Brush it over the tracks and use a hot air blower to flow the solder. YouTube has some examples of this to watch.



AVOID A LINGERING DEATH

I would advise against doing this work while the wife is around. When disposing of used Ferric Chloride remember it will stain clothes, worktops and metals including the wifes best cutlery if it splashes, so take care and deny everything. Always use a folded newspaper under the etching tray. When finished place the etchant tray in to the sink. Allow the cold tap to gently run into the tray and it will gradually weaken the mixture and let it drain away.

Double sided boards are achievable with care, you will need to varnish the unprinted side to avoid etching it away. If you wish to try double sided tracking then you will need to varnish the etched side while the other side is printed and etched. Quite tricky, but it can be done.



You can place a number of different (or even the same) designs on an A4 sheet. Most CAD programs allow you to fit as many as possible on to a sheet using the 'Panelise' option.

* Depending upon where you get your sheets from you may find some of the imported sheets are slightly smaller and a fraction thinner. If the sheets snag inside your printer as they pass the heated rollers, try placing the sealed plastic bag with the sheets inside into a fridge for 20 to 30 minutes before using them. Never buy sheets from anywhere unless you are sure that they are 'fresh' stock as results will be poor and rather patchy unless the chemicals on the blue sheet are fresh. Ensure you store unused sheets in a cool dry place. Tin snips are easier for cutting small board areas than metal saws.

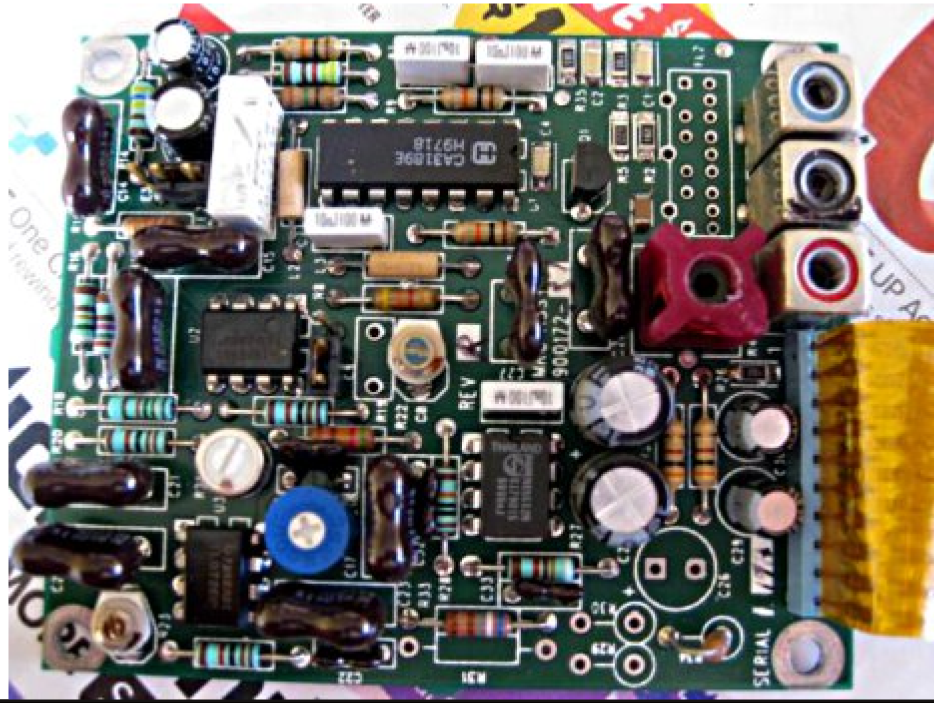
Richard Carden VK4XRL

Well there has been much written in CQ-DATV about the digital approach to ATV with Express, the BATC DATV-DTx1 and others. I do believe that we need to get these PC type approaches into a separate PC arrangement so it becomes a standalone unit and can go portable if required. Unfortunately it's not in my area of expertise so I will have to leave that up to those that know how. Maybe some more articles on the use of the Raspberry Pi even for just supplying idents and test-cards would be of interest especially for those that are not up to speed in this area. An article by Grant ZL1WTT on his web site re his digital concept is worth a read and maybe it's one way to go in the future:
http://www.qsl.net/zl1wtt/page1.html

I have been toying also with the idea of providing an OSD unit for our repeater but again it's not my domain when using PIC's and programming etc. If anyone has some articles regarding OSD or the like then drop the editor a note so all can benefit from it. Grant Zl1wtt has a unit featured on his web site, so have a look, it can be found here:
http://www.qsl.net/zl1wtt/page6.html.

The article in the latest issue of CQ-DATV by Mike G7GTN on the minimOSD could also be a real inner. With it interfaced maybe with a Raspberry Pi it could provide picture files as well as control and provide DC level, RF power, signal strength plus date and time to name a few, let's see what comes up in the next issue.

Having said all that, there is still room for the old analogue FM system, it's relative cheap to get going and there is lots of information on the web to help you. The Comtech units seem to be the way most are going in this regard although I don't like them. In the past week or so I have been back to revisit the FM receivers used in our repeater. I was setting up the spare units and checking them out in case we ever needed them, we do have a few lightening strikes where the repeater is situated.

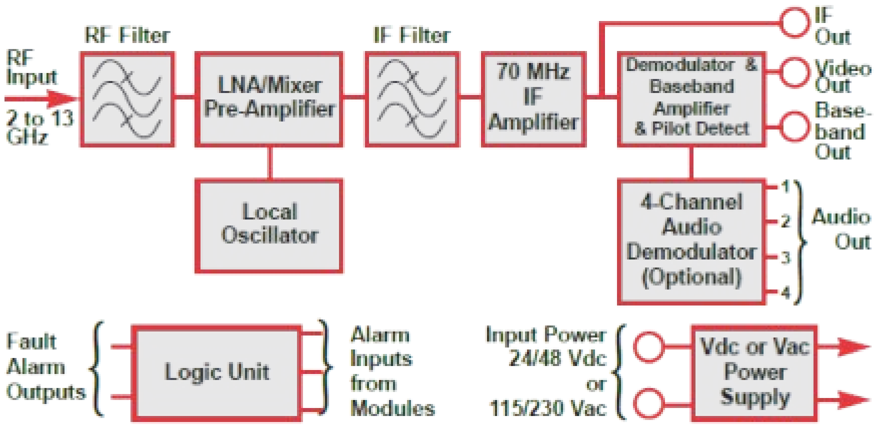


Quite a few years ago now we managed to get hold of some old B-Mac receivers with PAL boards fitted, these made excellent FM receivers for the repeater and worked very well. They are a two rack unit fitted with all the B-Mac digital circuitry and probably an over kill for what we need.

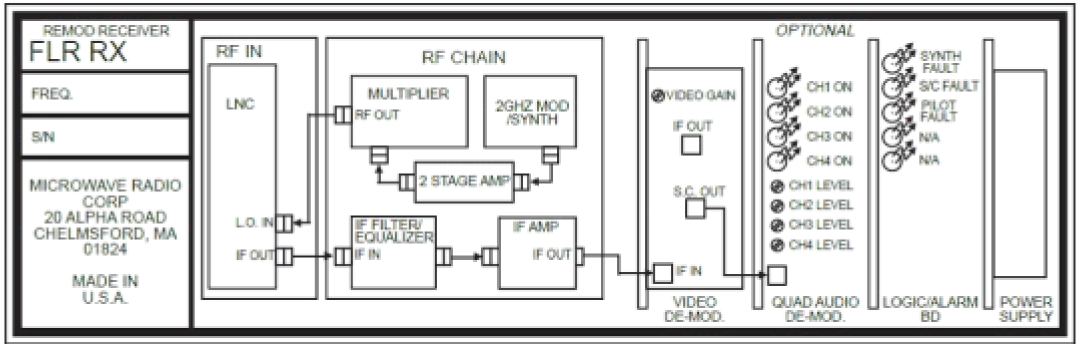
There aren't very many FM receivers around, at least not here in Australia. Grant again has built a receiver that the BATC shop had parts for but I think all have been sold out however the article can be found here http://www.qsl.net/zl1wtt/page4.html.

I first built a card 23cm receiver very much like Grants which worked very nicely, however there was no PIC control as to the setting of the frequency and it used the older chips for the audio decoding. Also at that stage we were using 5.5 and 5.74 MHz sub-carrier frequencies. This meant that the video filter was only 5 MHz giving around 400lines resolution. Since then we have changed over to 6 and 6.5 MHz sub-carriers which gives around 464 lines using a 5.8 MHz video filter.

There has also been a lot of redundant broadcast equipment made available and I was lucky enough to obtain two such receiver units, both operating in the 7 GHz and 12 GHz broadcast bands.



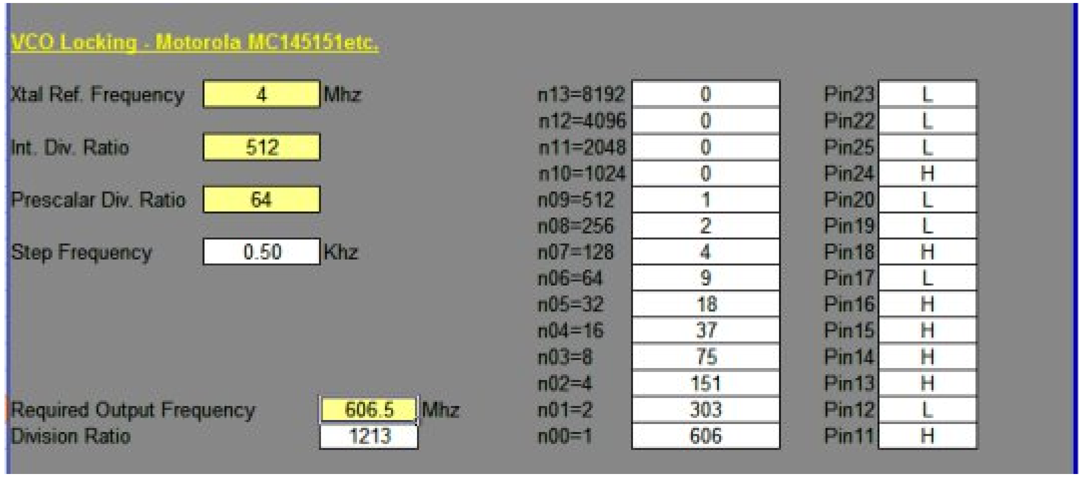
Both these systems as it turns out used a 70 MHz IF, now that wasn't a problem as I have a 70 MHz TX system available for testing. Both units preformed nicely when connected to the 70MHz source. Looking first at the unit from California Microwave called a Central Receiver and its block diagram we see that it can be fitted with 4 sub-carrier demodulators.



This unit had only two at 7.5/8.59 MHz so these had to be changed. Each unit was fitted with a filter hat couldn't be tuned down to where we wanted it. Therefore these were removed and replaced with ceramic filters.

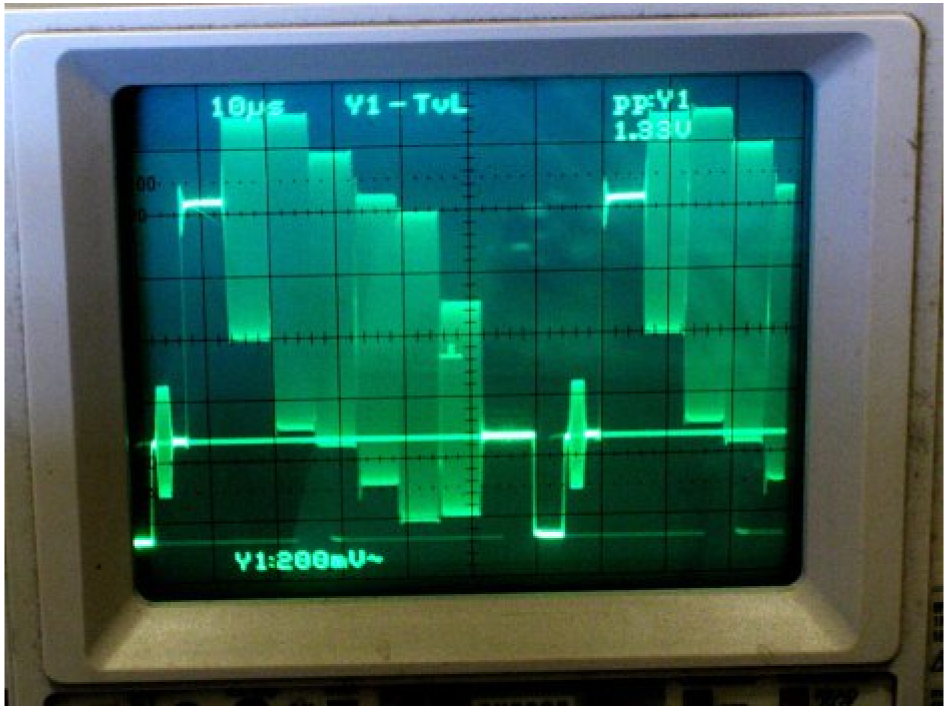
Now moving on to the receivers' front end where looking at the block diagram we see that while not shown two LO were fitted. One was a synthesiser for the higher GHz bands while the second was tuned to 814MHz to provide an output from the mixer at 70MHz.

Therefore the first LO was removed as it wasn't required in this setup and the Mixer was retained as was the 70 MHz IF amplifier. For our requirements we required inputs from 1250 MHz and 1283 MHz therefore the second LO of 814MHz needed to be changed. Unfortunately the VCO only covered from 500 MHz to 1000 MHz and was controlled by a MC145151 and a GAL. It was decided to operate with the second harmonic of the VCO so for 1250 MHz the frequency was 590 MHz (1250/2) and for 1283 MHz (1283/2) the frequency would be 606.5 MHz. The internal divider was also

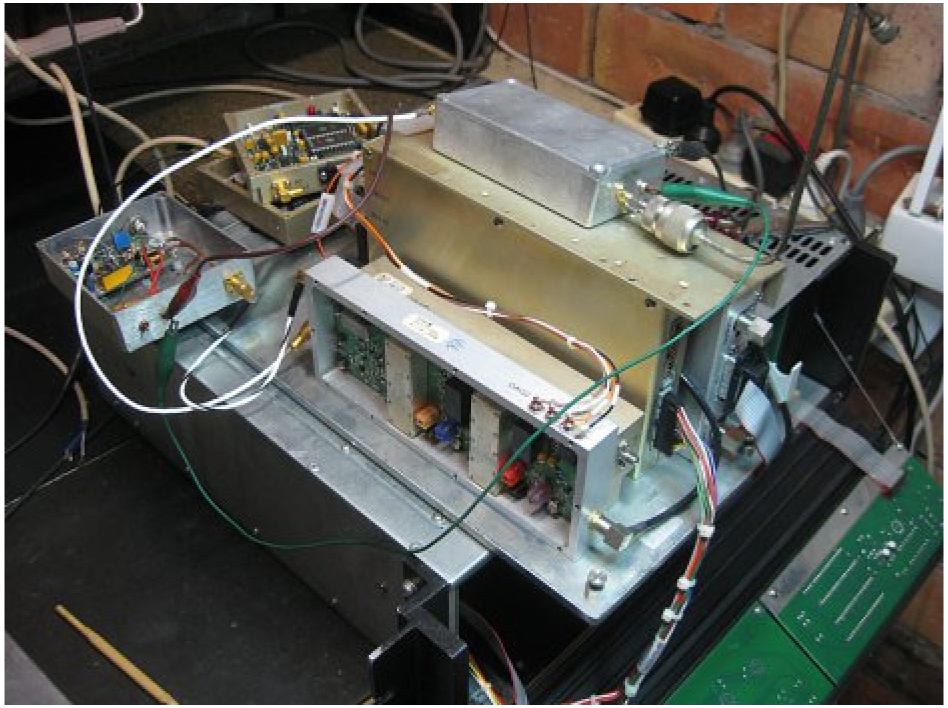


VCO Locking - Motorola MC145151etc.

Xtal Ref. Frequency	4	Mhz	n13=8192	0	Pin23	L
			n12=4096	0	Pin22	L
Int. Div. Ratio	512		n11=2048	0	Pin25	L
			n10=1024	0	Pin24	H
Prescalar Div. Ratio	64		n09=512	1	Pin20	L
			n08=256	2	Pin19	L
Step Frequency	0.50	Khz	n07=128	4	Pin18	H
			n06=64	9	Pin17	L
			n05=32	18	Pin16	H
			n04=16	37	Pin15	H
			n03=8	75	Pin14	H
			n02=4	151	Pin13	H
Required Output Frequency	606.5	Mhz	n01=2	303	Pin12	L
Division Ratio	1213		n00=1	606	Pin11	H



changed from 128 to 512, the GAL was removed and the control pins wired as per the requirements for setting to 1283 MHz which was our FM repeater input frequency. This has all worked very well, however I needed to supply an RF amplifier to the front end of the mixer, this has now been done and the signal received is very good just some slight changes like a filter and amplifier for the LO and maybe a better RF amplifier in front of the mixer.



To be continued...

DATV-Express Project – April update report

Post by KenW6HHC » Thu May 01, 2014 9:42 pm

First, the BAD News - In April, Charles G4GUO managed to get the Raspberry-PI software working as shown in the “Raspberry-Pi Development-phase03” block diagram in the March report. He was able to get it work up to 8 MSymb/sec….BUT it would only run for a few seconds before the software froze. There were two major obstacles. First, the way Raspberry-PI handles USB traffic is to do a “lot of writing to memory” and this consumed CPU-cycles. The CPU consumption on RPI was running maybe 40-80% depending on the Symbol-Rate used. Second, any GUI movement would spike the CPU-cycles to 100% and everything stopped. Charles’ conclusion was the Raspberry-Pi single-core-ARM processor running at 800 MHz does not have enough CPU-horsepower for our project!

Now, the GOOD News – Charles tried using an RKM MK802iv “mini-PC” that is sold on Amazon for turning television sets without internet access into “smart TV’s” that could surf the internet and watch movies via Netflix download or streaming video, etc. See Fig01 below for a size comparison of this “mini-PC’ unit from RikoMagic (RKM).

Rob MØDTS had been successfully using the dualcore-ARM model MK808 unit to run the DigiLite board. The newer model MK802iv unit purchased by Charles has a quadcore-ARM processor that runs at 1.6 GHz!! Just a day or two of tweaking buffers (etc.) allowed Charles to get the DATV-Express software running on PicUntu linux with the DATV-Express board.

For price comparison; a Raspberry-Pi with power-unit, a few cables, and plastic case costs about $59 on Amazon. The

Figure 1 - Size comparison of quadcore-ARM MK802iv with a deck of cards.

MK802iv with power-unit, a few cables, and plastic case costs Ken W6HHC $72 on Amazon in USA (shipping was free, too).

Charles was able to push the MK802iv unit to drive the DATV-Express board at 12 MSymb/s with DVB-S protocol. A block diagram of the MK802iv DVB-S test set-up is shown in Fig02. The block diagram components shown in dashed-lines (Display, keyboard, etc.) are only needed to set-up and configure the software. The dashed-line components are not actually needed to run the transmitter....just a real SPST switch to act as PTT.

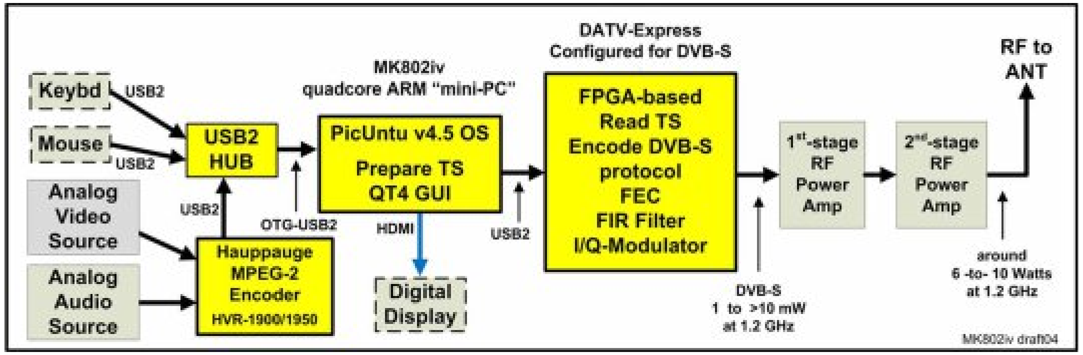


Figure 2 – A Block Diagram of typical MK802iv set-up for transmitting DVB-S

Ken W6HHC spent about a week "polishing" the rough-edges for installing the DATV-Express software on the MK802iv. Ken explains that the MK802iv can be purchased in two flavors. One flavor comes running Android "Jelly Beans" OS. The second flavor comes running Linux OS (called the LE edition). In both cases, the user needs to re-flash-the MK802iv unit to put a different Operating System called PicUntu v4.5 (a light-weight variety of ubuntu linux) onto the unit. All of the software flashing tools and PicUntu v4.5 are free to download on the internet…and takes maybe 15 minutes to perform the re-flashing step.

The plans for the team now are for Charles G4GUO to continue testing and refining the DATV-Express software for the MK802iv, Ken W6HHC will begin drafting a "standalone" User Guide version to support future MK802iv users, and Art WA8RMC will be demonstrating DATV-Express at the Dayton HamConvention in May.

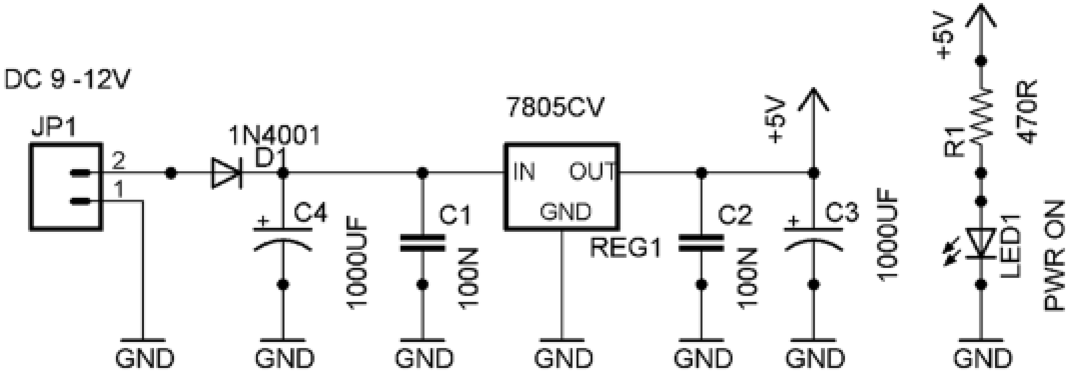
"full speed ahead"…de Ken W6HHC

TV Amateur is a German language magazine. It is published 4 times a year. If you would like to subscribe, go to http://www.agaf.de/

MAX7456 Callsign & Simple Caption OSD Module Preparation

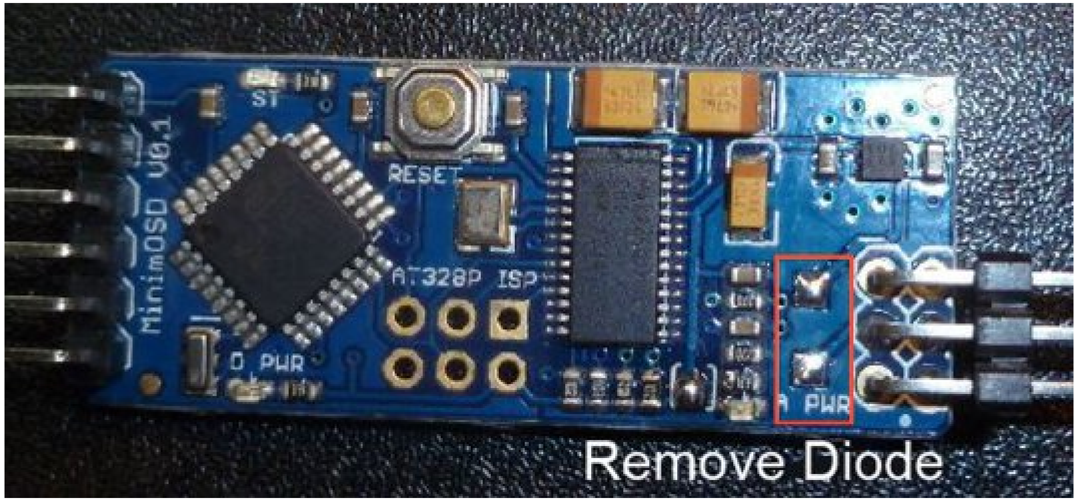
Mike Stevens G7GTN

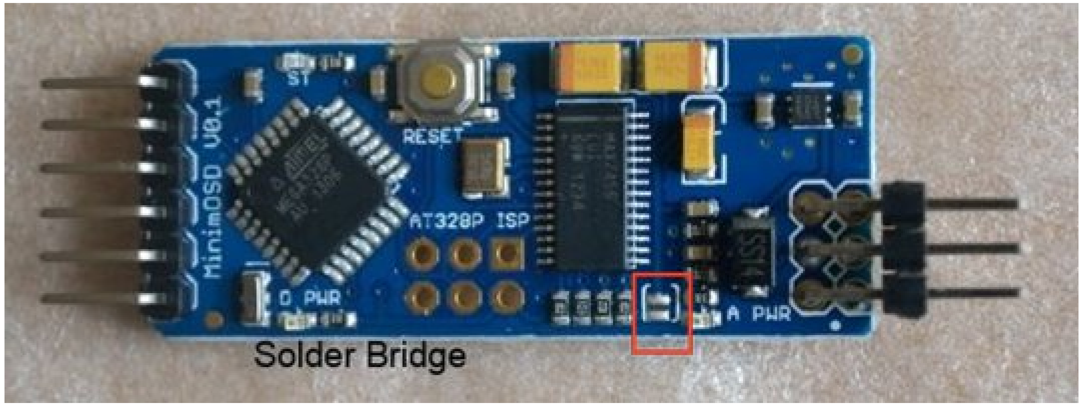
The MAXIM MAX7456 OSD Modules require that the NVRAM Character set be restored to a known standard and not the changed characters and additional graphics that the flying people have programmed the device with. A word of caution do not try and power the module from +12V at the video input/output connector instead spend 5 minutes and make a very basic +5V power supply such as the one illustrated here. The reason being the on board regulator is under specified (on the original first version) to operate the current requirements of the MAX7456 and will actually get very hot and burn out quite easily.

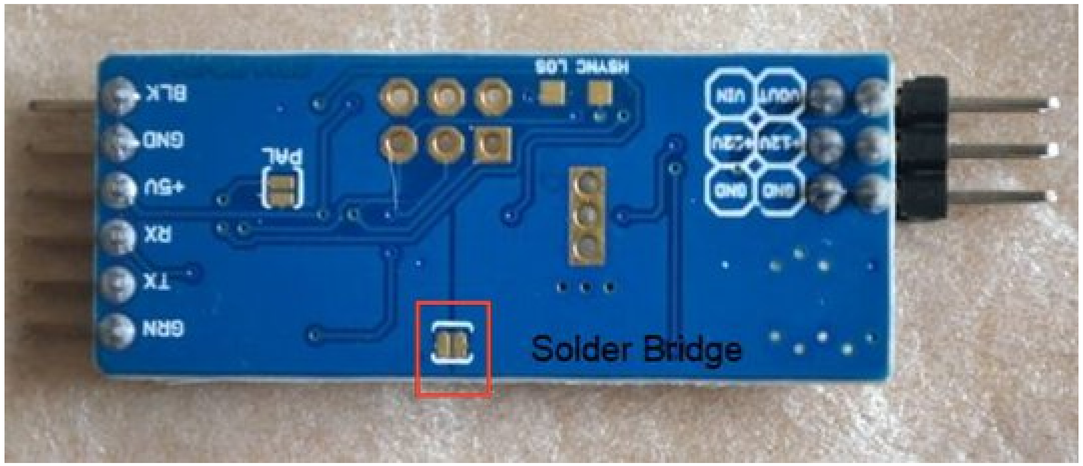


Firstly the SMD Diode should be removed with a hot soldering iron from the area shown in the picture. This will totally isolate all power from the MAX7456 video connection side.

We now need to make two solder bridge connections, the first is on the top side and the second is underneath the PCB. This will enable our +5V power supply to be fed from the single 6 pin connector (Module Left hand side) and will now power the MAX7456 device alongside the Atmel ATMEGA328 Processor.

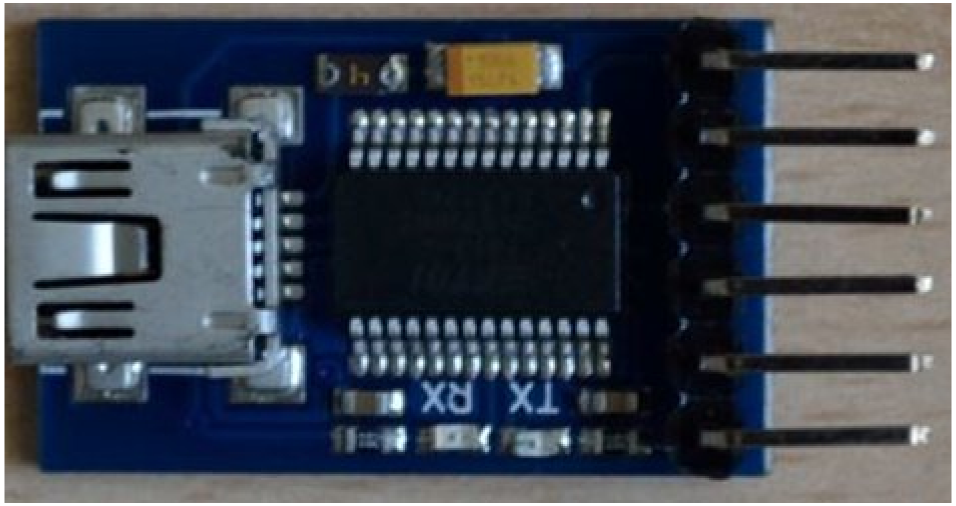






You might find that the newer Version 1.1 boards now much more generally available on eBay already have these two solder connections made for you. The advice for powering them still holds true but you will not have to remove the diode as I did when first experimenting on these units.

You will also notice that the module has a PAL solder bridge connection as well; this is left unconnected as it has no defined function within our own software. Your video input and output connections are made to the board at the points marked on the (3 X 2) dual pin header connector. Since the OSD board as supplied contains an Ardunio Boot loader installed we can connect an FTDI Basic FT232RL USB Breakout board on to the end of the module as detailed.



FTDI BOARD	OSD BOARD
GREEN	GREEN = DTR
TX	RX
RX	TX
+5V	+5V
GND	GND
BLACK = GND	BLACK = GND

* Note TX & RX Crossover

Make sure before proceeding that you have carefully made the two solder bridges to provide a +5V supply to the MAX7456 side of the circuit to enable us to program the NVRAM area, this holds the usable character set or fonts.

Required PC Software downloads

We now require some software, the first is the actual Ardunio IDE software which is freely available from
http://www.ardunio.cc

Secondly we require a basic Terminal application, the following is recommended and has been used by me quite extensively on the Windows platform
http://en.sourceforge.jp/projects/ttssh2/releases/
At this point to save magazine page space and much more importantly to make sure you all have good results I have compiled a comprehensive document in PDF format to accompany the required software for this article. Follow each step exactly as described and you will end up with a very nice & compact OSD Unit.

Generating your own captions

Your board is now ready to be programmed with your Callsign or caption data using some more Ardunio code. I have supplied a basic starting point for your own experiments to display a four line caption on screen in a file named OSDTEST.INO load this code & modify the text between lines 66 & 67 as you require and with your FTDI Board still connected, press the IDE upload button to send this to the OSD Module. Shown is the final output display from these incredibly basic modifications.

Conclusion

I hope you will also have fun configuring & using these handy little OSD generator modules. We will have a small series of projects based on these modules to feature within the next few editions of CQ-DATV. This initial but required setup process being the most complex of them all.

A ZIP file which contains both the code and a comprehensive PDF document can be downloaded from the CQ-DATV web site at:
http://cq-datv.mobi/downloads.php

A simple 10GHz power amplifier for beginners

Reproduced with kind permission of VHF Communications editorial office

Introduction

The purpose of this article is to demonstrate how extremely ease it is for beginners in the microwave field to build a 10GHz power amplifier.

Can you understand a guy who usually makes things "dead-bug" style (ugly construction) who proposes this for a 10GHz project?

There is no problem building this 10GHz power amplifier in a similar way to "dead-bug" style because the component that I will explain always works without problems, I even made a sample of this device that will shock hard core microwave fans but it shows the reliability of this component.

I also think that thanks to this article there will be an incentive to use the 10GHz band because many hams have a transverter with 10mW output that can be raised to 1W with this device. The amplifier can be used with SSB modulation, ATV or any other kind of modulation including pulse modulation.

To be sure of the really good application of this device I made eight prototypes with different mounting styles, different serial numbers and different data codes. They all worked well, so I can surely say that the device has no problems.

Microwave power devices

In the microwave field there are two different ways to build a power amplifier:

- *the most popular components are broadband power GaAs-FETs, they have an average price and they are well known and readily available. Because they are broadband (they can be used at 1GHz as well as at 10GHz) they need matching for all frequencies, this may cause some complications. The advantage is that these components have a wider application area and they are a little less expensive than an MMIC. They have a small package because they have no internal matching network.*

- *another solution is to use internally matched GaAs-FETs (also known as MMIC), they are very simple to use because the internal networks match the impedance near 50 ohms but these matching networks limit the bandwidth.*

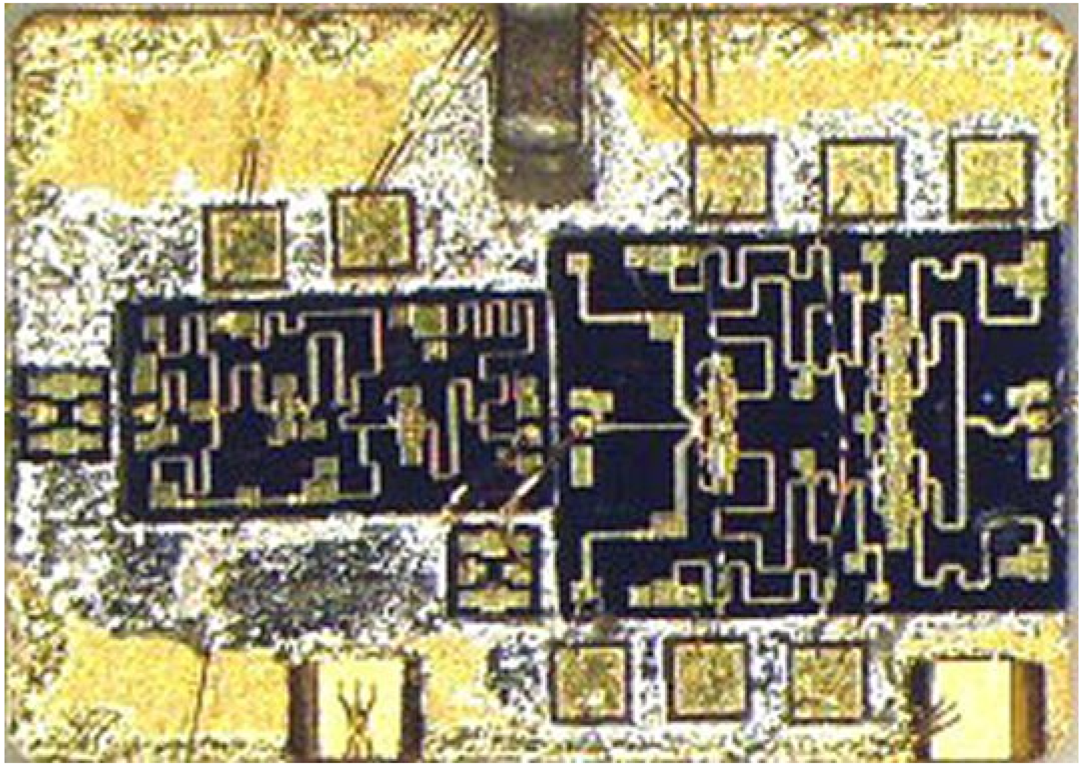


Fig 1: Microscope photograph of the RFMA7185-S1.

If we use a high power device, internally matched, the power combiners and the matching networks in the device reduce the bandwidth. The devices for high power have more complicated internal matching networks that reduce the band- width quite a lot.

If instead we use a medium power device, the power combiners and the matching networks in the device will have a relatively wider bandwidth that will allow it to be used for a wider frequency range than it was designed for. The devices tested are made by Excelics with the part number RFMA7185-S1. It was matched for 7.1 - 8.5GHz but being a device with only 1W output it is suitable for frequencies from 6 to over 10GHz.

I took a photograph using a microscope to see the internal parts of the device and I could see the internal matching network with the power combiners as shown in Fig 1.

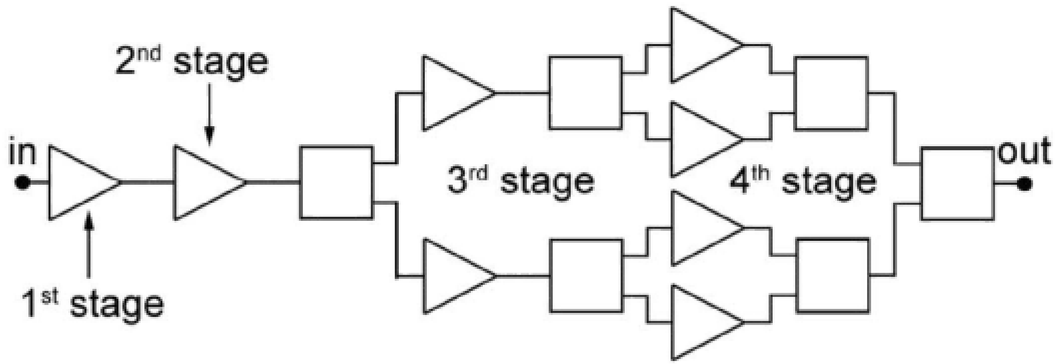


Fig 2: Block diagram of the RFMA7185-S1.

The power combiners have a bandwidth of more or less one octave, with the matching network the overall bandwidth is reduced.

The RFMA7185-S1 has four internal amplifier stages, a block diagram is shown in Fig 2. The first and the second are made from a single GaAs-FET, the third from two GaAs-FETs while the fourth is made of four GaAs-FETs. There are wide band matching circuits and the power combiners for the third and fourth stages.

Fig 3: The RFMA7185-S1.

It has a professional gold plated case that is easy to mount. In fact the case is not SMD or ultra-miniature BGA. It has two little lugs to ease mounting and heat dissipation. (See Fig 3)

RFMA7185-S1 performance

This device is optimised for 7.1 - 8.5GHz the results obtained with my eight prototypes are shown in Table 1 with two examples of the prototypes shown in Figs 4 and 5.

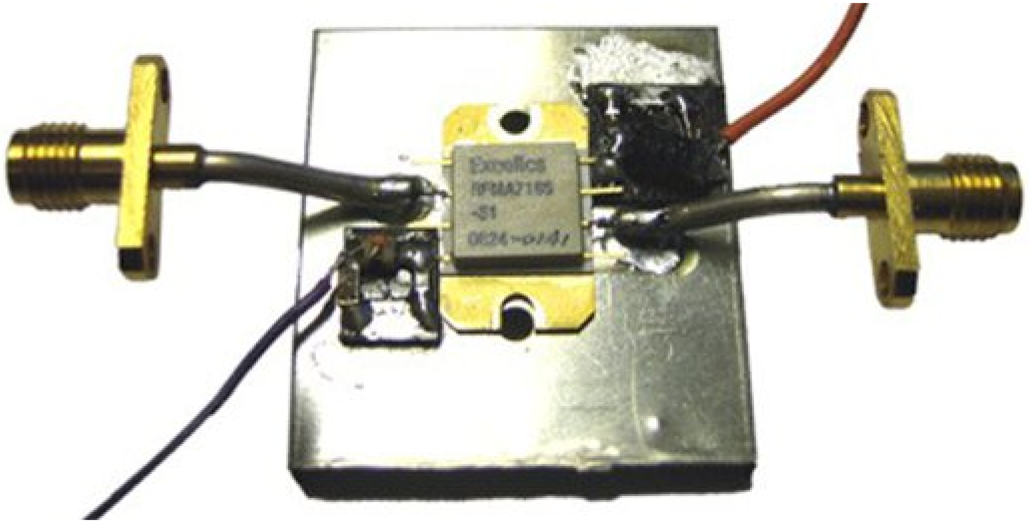


Fig 4: Prototype #2: even though it works we don't suggest mounting like this. This only demonstrates that the device works even in critical conditions.

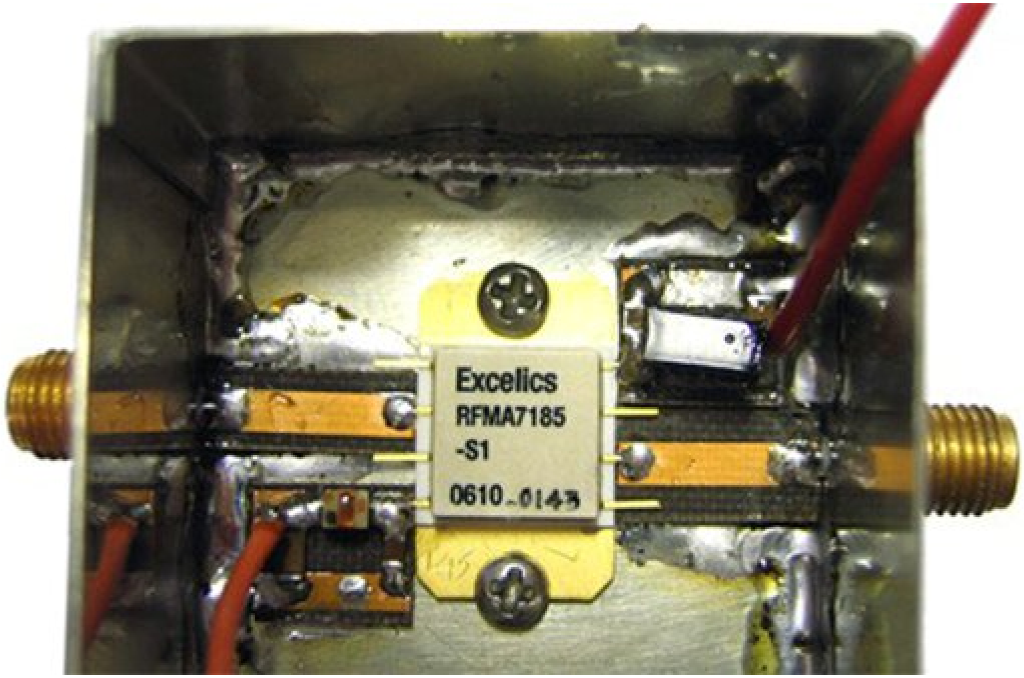


Fig 5: Prototype #6.

It can be seen from the Table 1 that the device is optimised from 7 to 9GHz and in this frequency range the gain is about 30dB with an output power at least +30dBm (1W).

Out of the optimised frequency band the device is still able to provide +30dBm up to 10.4GHz even if the gain is reduced to 20/25dB.

Table 1: RFMA7185-S1 prototype test. Test conditions: VDD +9V power supply, VGG -5V negative bias, Pout = P1dB.

Table 1: RFMA7185-S1 prototype test. Test conditions: VDD +9V power supply, VGG -5V negative bias, Pout = P1dB.

	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8
freq. GHz	Pout Pin dBm	Pout Pin dBm	Pout Pin dBm	Pout Pin dBm	Pout Pin dBm	Pout Pin dBm	Pout Pin dBm	Pout Pin dBm
10.4	+30.5 +8	+29.5 +9	+30.5 +5	+29.7 +10	+29.8 +10	+30 +8	+30.8 +6	30.8 +8
10	+31.7 +4	+29.5 +5	+30.5 0	+30 +8	+30.2 +7	+30.7 +5	+31.4 +3	+31.2 +5
9	+31.8 +2	+29.7 -1	+30.7 -1	+30.7 0	+30.6 -1	+31.3 +2	+31.1 -1	+31 +2
8	+31.5 0	+30.2 -1	+30 -1	+29.8 0	+30.9 -1	+30.7 0	+30.5 -1	+31.1 +1
7	+31.7 -1	+30.1 0	+29.7 -2	+30 0	+30.6 -1	+31.3 0	+31.2 -1	+31.1 +1
6	+31.8 +2	+29.6 +5	+29.5 -1	+29.5 +3	+30.2 -1	+30.1 +2	+30 0	+30.5 +2
5.7	+30.5 +8	+27.5 +10	+29 +9	+28 +9	+29.3 +7	+29 +8	+28 +6	+28.3 +9

20/25dB gain corresponds to a driver of about +7/+10dBm (5/10mW) that is ideal to be driven by a traditional low power MGF1302 GaAs-FET normally used in 10GHz transverters.

During the tests I didn t detect any self- oscillations or any other strange behav- iour. I also maltreated some prototypes with mismatched input and output and nothing happened.

The manufacturer suggests using a +6.5V power supply but the device also behaves well at +9V and it even worked at +11V but I suggest not exceeding +9V.

The -5V negative bias of about 15mA must be provided on the VGG pin by a traditional ICL7660. Under these conditions of power supply and bias the drain current is about 1A that means the device works perfectly in a linear class, in fact the manufacturer designed them for a class A radio link using digital modulation.

Fig 6 shows the circuit diagram and Table 2 shows the parts list. It contains the 9V positive regulator (IC1), I used the LM217T that is the high performance version of the LM317T, the rating must be at least 1.5A.

IC2 is an LM78L06 positive regulator that drives the ICL7660 negative regula- tor (IC3), because the RFMA7185-S1 needs about 15mA of negative bias and the voltage drop of the ICL7660 is about 1V with that current, we will have ex- actly -5V as negative bias.

In order to avoid damage to the GaAs- FET it is necessary to sequence the power supply, first the negative bias and then the power supply. To do this we need the BC847 transistor (T1) and 4V7 Zener diode (D1) that enable IC1, if the negative bias is missing it will block the power supply.

The components around the GaAs-FET are not particularly critical, I only remind you that for 1A or more current it is necessary to use a choke that has this current rating, the 17.5nH Coilcraft type B06T choke (L1) can carry 4A.

Fig 6: Circuit diagram of the amplifier and power supply.

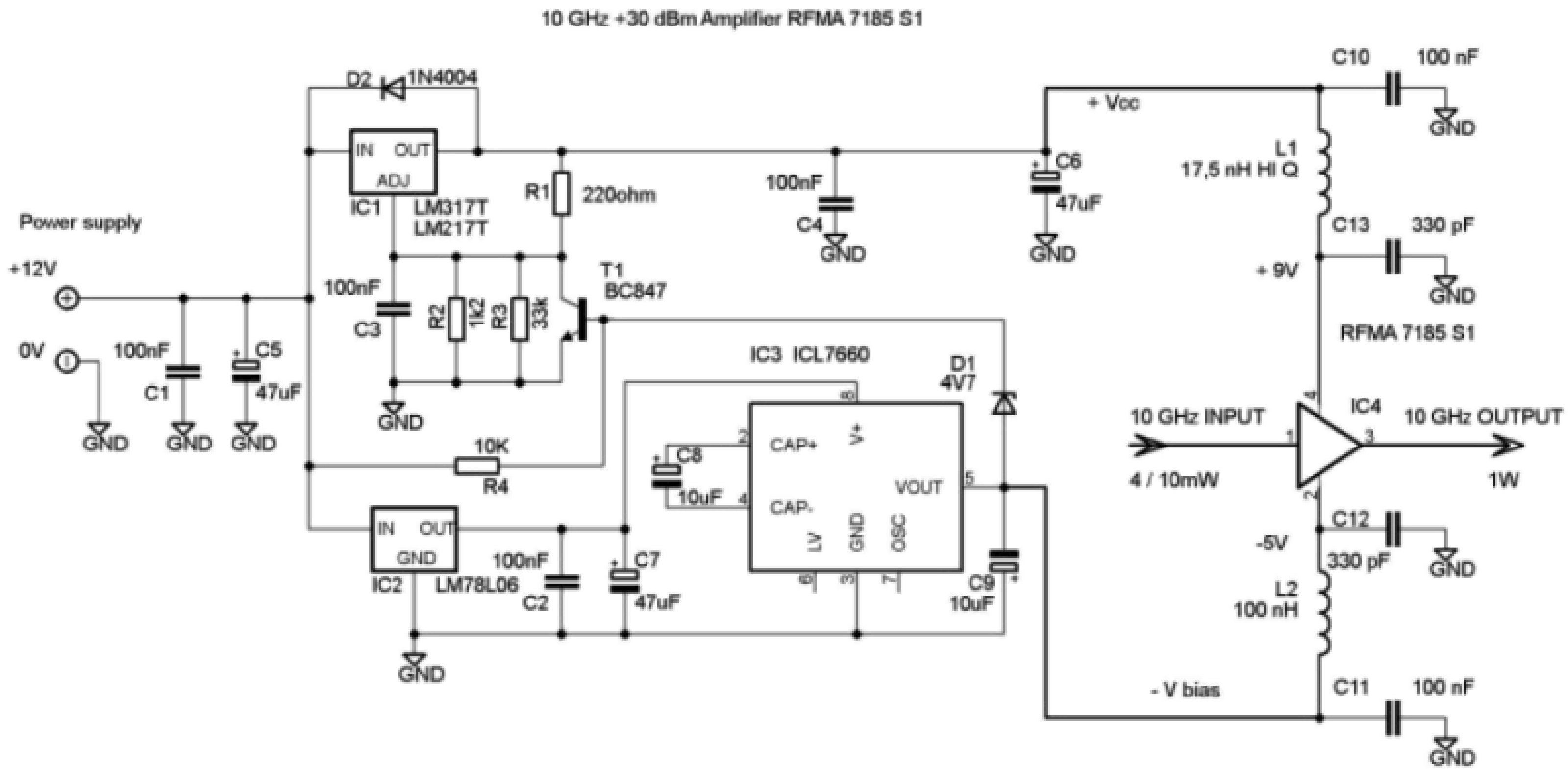


Table 2: Parts list.

C1, C2, C3, C4, C10, C11	100nF
C5, C6, C7	47µF 16V electrolytic
C8, C9	10µF 10V electrolytic
C12, C13	330pF
D1	4V7 0,4W Zener diode
D2	1N4004
IC1	LM217T or LM317T
IC2	LM78L06 or any 6V 100mA regulator
IC3	ICL7660 DIL or SMD
IC4	RFMA7185-S1
L1	17.5nH HQ SMD inductor
L2	100nH HQ SMD inductor
T1	BC847 or any NPN general purpose transistor
R1	220Ω
R2	1.2KΩ
R3	33KΩ
R4	10KΩ
RF PCB	see description below or see SU-02 [1]
Absorber	see notes

Table 2: Parts list.

4.0 Assembly

As described the assembly of the power GaAs-FET is not critical. It means that for a good result it is not necessary to use Teflon printed circuit board, if you keep the tracks short between connectors and pins you can use the normal FR4 epoxy fibre-glass laminate.

In this case I suggest using the 30 or 31 mils thickness (0.8 mm) laminate, not the 1.6mm thickness laminate.

The 50ohm input and output tracks can be even saved from any kind of surplus PC board, for example from my SU-02 [1] (see Fig 7). In this case you can cut a piece of the track form the PC board, obviously the PC board must be double sided copper.

Other components can be SMD, or not and it is possible to mount them "dead- bug". Fig 5 shows an example of very simple mounting of the RF parts.

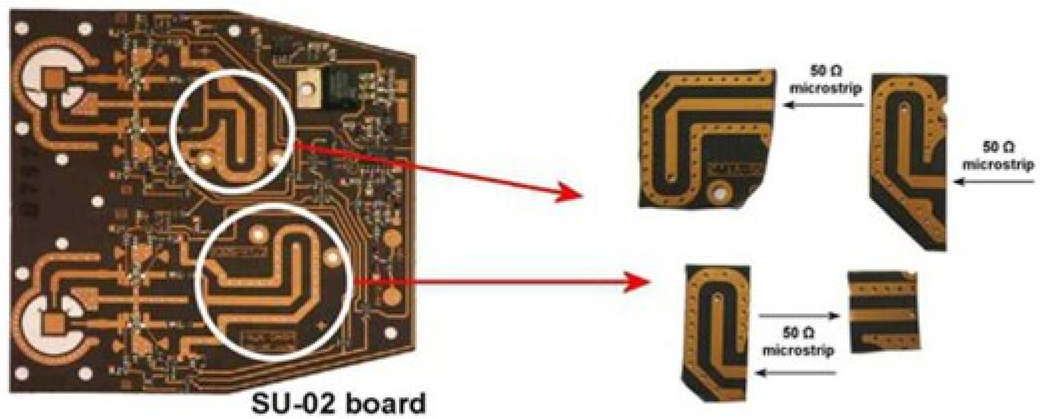


Fig 7: Using the surplus PCB type SU-02 [1].

As for all microwave components it is suggested that a microwave absorber is mounted on the inner side of the top of the box in order to avoid any self- oscillations and unwanted resonances of the box.

See :Franco s Finest Microwave Absorbers" in issue 4/2004 of VHF Communications Magazine, that article explained how microwave absorbers work and the efficiency of these absorbers.

5.0 Conclusions

As explained I assembled eight different prototypes with the purpose to test differ- ent solutions and different mountings, therefore it was not possible to build the PC board because every mounting was different but since many readers will surely want a PC board I designed one just for the power supply and bias cir- cuits. Fig 8 shows the top of t h e PC board (components side). It is double sided with plated through holes for the ground connection while the bottom side is only the ground plane, Fig 9 shows the top side, component side.

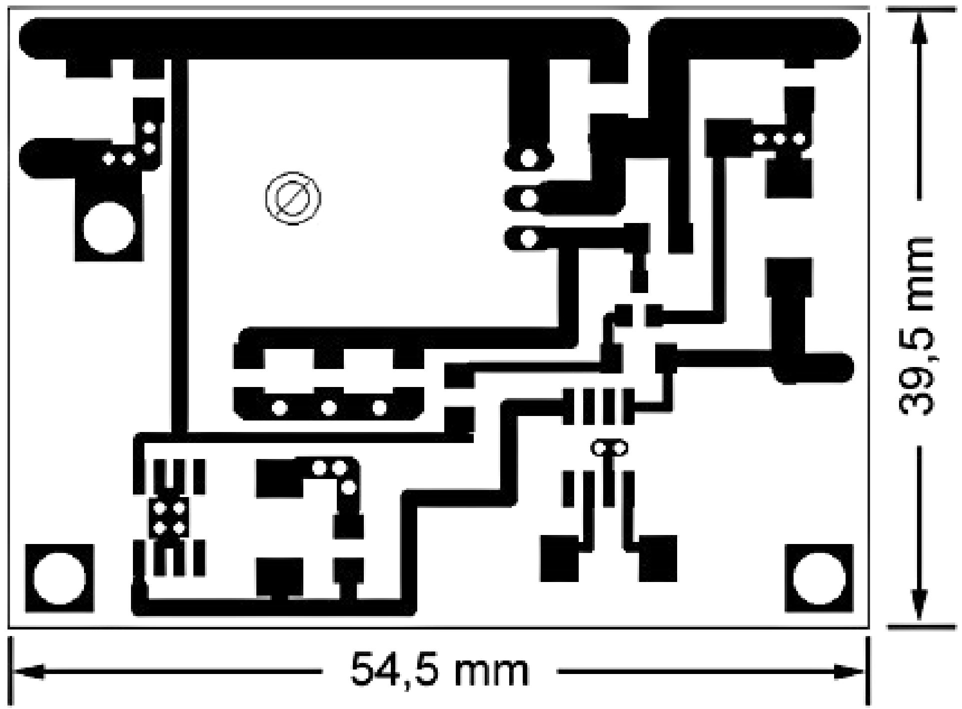
Please read my earlier comments for the RF PC board section.

Special thanks to:
F1CHF Jouan Francois and F6BVA Michel Antonioli for their work, encouragement and technical support.

6.0 References

[1] For RF PC board see also www.rfmicrowave.it/ surplus page code SU-02.

[2] RFMA7185-S1 is available at www.rfmicrowave.it



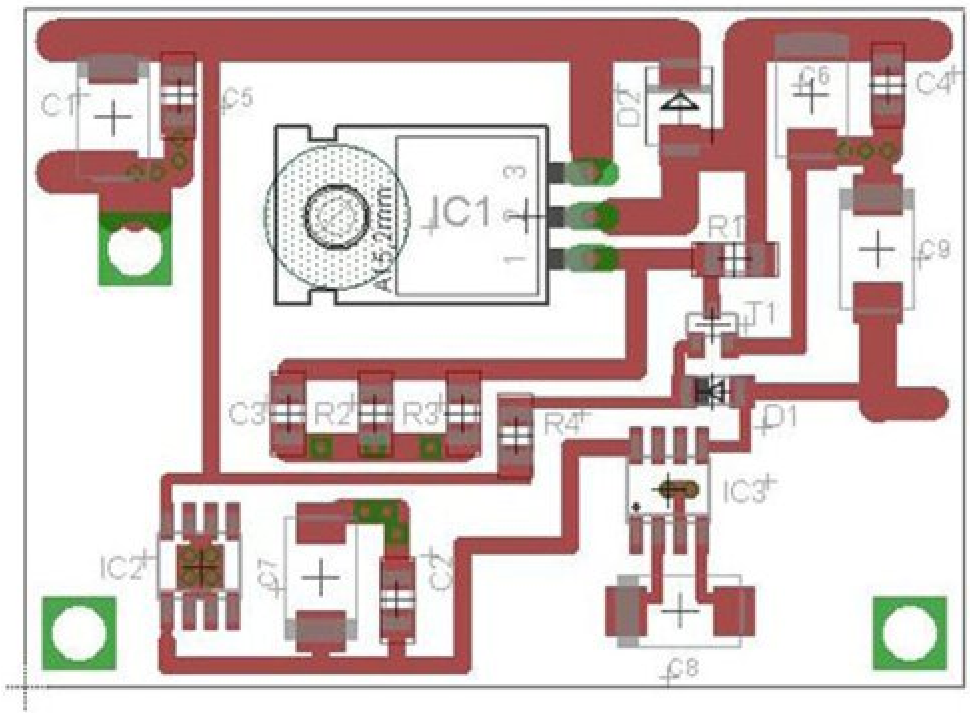


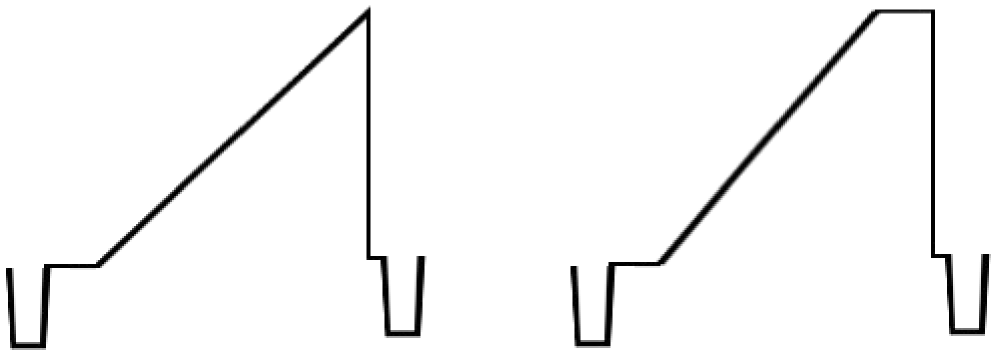
Fig 8 (Top): Double sided FR4 PCB for the power supply.

Fig 9 (Bottom): Component layout for the power supply PCB.

Linearity in an Analogue world

by Trevor Brown G8CJS

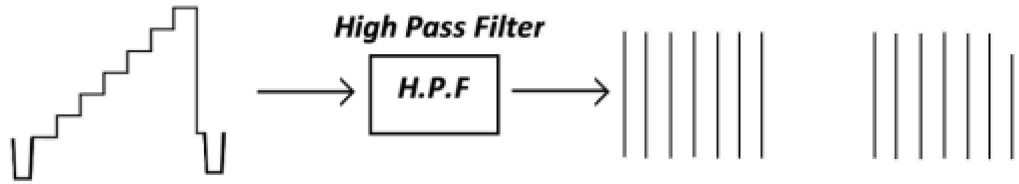
Before we finally become digital from camera lens to viewing screen, I thought it might be interesting to look back on one of the prime requirements of an analogue system, linearity and how it was measured. This involved numerous test waveforms, the first being line rate saw tooth.



Peak White limiting

It was an ideal waveform for identifying peak white limiting and it survived into the colour world where it was modulated with subcarrier, but eventually gave way to the more familiar greyscale.

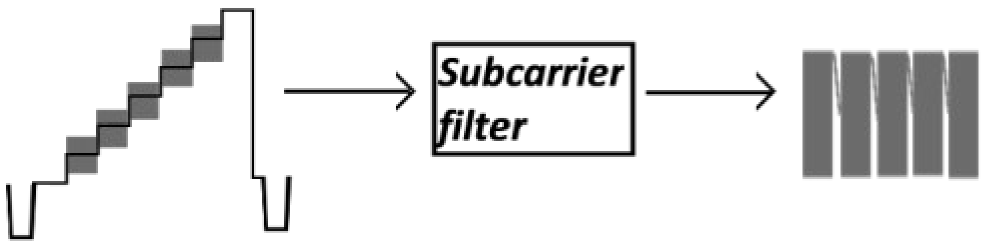
This not only looked better on the screen but when viewed on an oscilloscope or waveform monitor, could be viewed via a high pass filter which would remove the treads of this staircase and produce the risers side by side for easy accurate measurements.



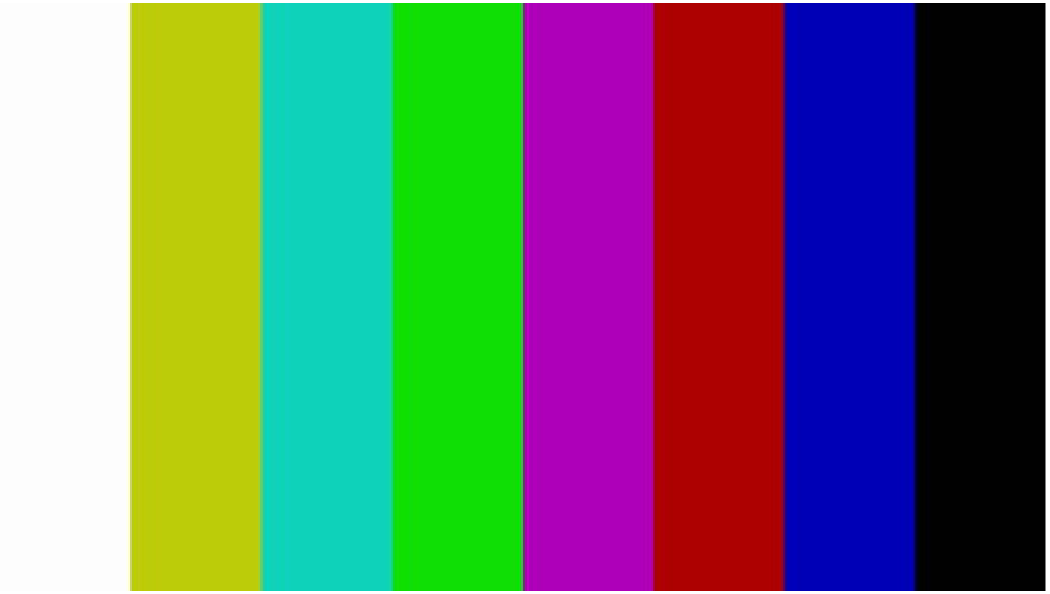
Far right, Peak White limiting

If you were using a waveform monitor it would often have the HPF or spike filter built in and with a simple graticule, the linearity or limiting could easily be read as a percentage.

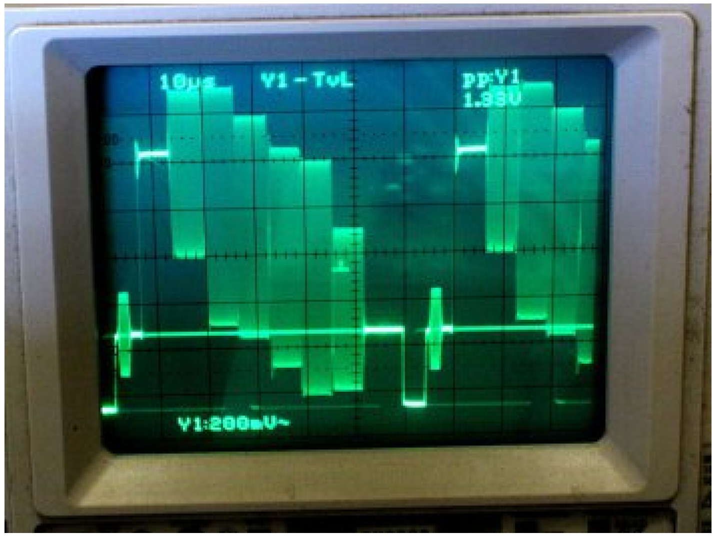
With the advent of colour, where the amplitude of the subcarrier was proportional to the saturation of the colours, engineers started to worry about amplitude changes at different levels of the luminance signal on which the colour signal was modulated and the term for this distortion was called differential gain. The first answer to this was to put subcarrier on every step of the grey scale and then remove the grey scale and check the amplitude of the subcarrier was the same for each step. Initially 125mv of subcarrier was used, but latter this was changed to 225mv, when A to D and D to A converters became part of the video path.
The subcarrier filter was often built into the waveform monitor and gain was also provided to amplify the blocks of subcarrier against a 100% graticule so the differential gain could again be read as the difference between the largest and the smallest block of subcarrier.



The next progression was colour bars, the rising greyscale became a falling greyscale and the subcarrier was modulated to produce colours. The end result was more attractive on a picture monitor, but filters could still be used to remove the individual components for testing. The problem was, there were numerous different standards of colour bars.



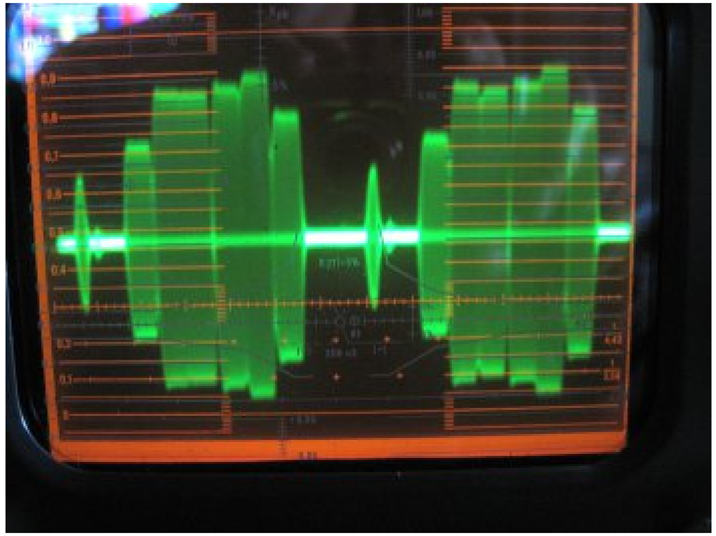
On a picture monitor they all look similar, the biggest difference is the amount of Chroma on each step.

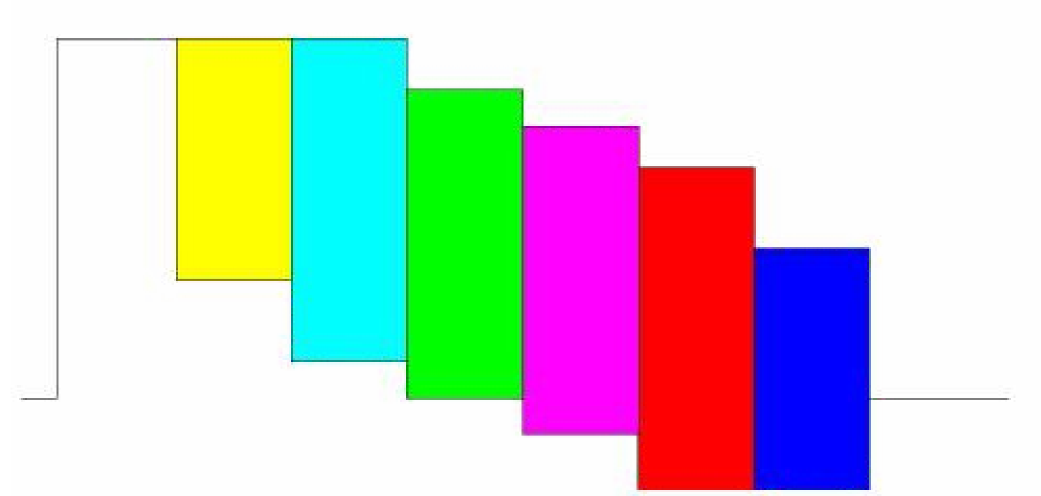


Video engineers preferred 100% colour bars as these could be accommodated by video level technology, but the Chroma went above peak white and was a problem with the transmitter engineers.

The first two colour bars Yellow and Cyan should be level at the top, the last two colour bars should be level at the bottom and the Green bar should extend down to black level. The first and last bar should have the same amplitude although you need to remove the luminance to be able to check this and again the waveform monitor had filters.

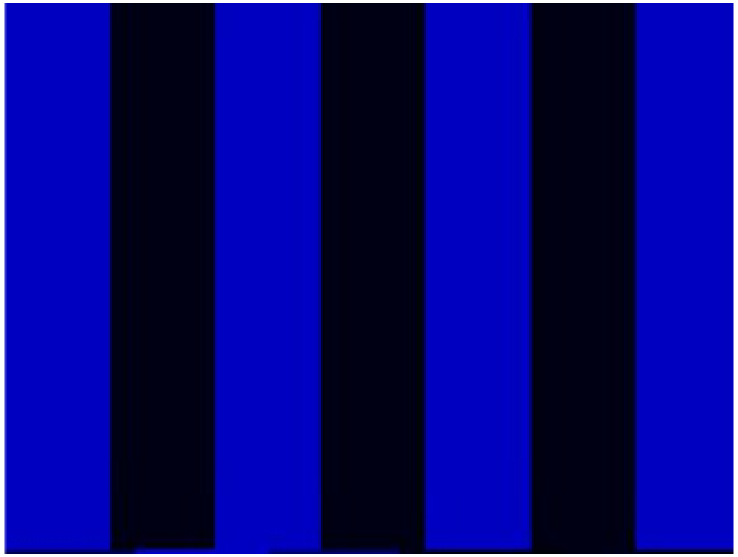
These bars were passed through a Comtec receiver and you can see the difference between the first and last bar indicating differential gain There are so many combinations of colour bars 100% 75% and EBU bars. EBU bars are most often found built into TV cameras.



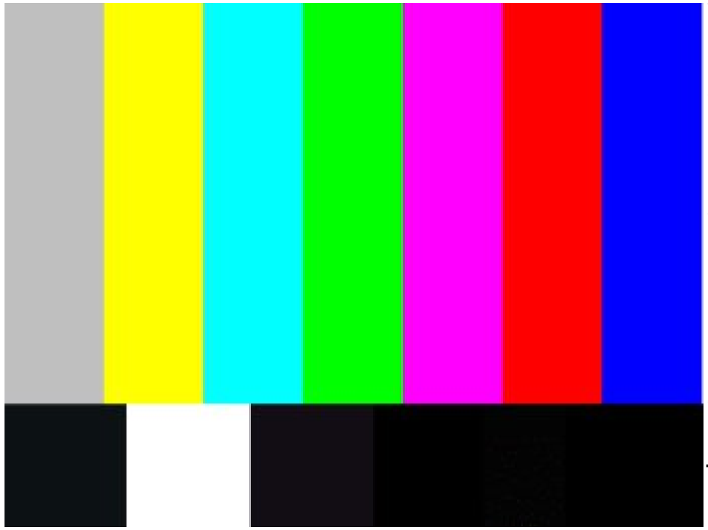


The Yellow bar does not protrude beyond peak white.
The blue bar does not protrude beyond colour burst, the first

and last bar has the same level of chroma, the Green bar sits on black level, so chroma level can be set and they can be used to set chroma gain on a colour monitor if you have one old enough to be able to select blue only. Because the blue content of each alternate colour bar is the same, you could adjust Chroma gain until they all look the same.



To complete setting up a colour monitor you need Pluge to set the black level and contrast, and this was added to later versions. It has a section below black level, so you could reduce the black level or brightness to crush this out



With the appearance of electronic character generators it became trendy to add the identification of your station across the bars, so the source of the colour bars could easily be identified across a TV network.

This replaced Source Ident in ITV where every ITV network company was allocated two audio tones to accompany the colour bars and these could be identified with simple audio filters that would light up a display in master control to indicate where the colour bars were emanating from. It was a nice warm feeling to see the test signal before the programme, such as colour bars from a station who's video source would shortly become your transmission, so you could set levels in an analogue world, but also to know you were connected to the correct TV station, so the following programme was what you were expecting.

The test signals shown were PAL as used in the UK, NTSC used a similar system except NTSC signals are sat on a 7.5% pedestal, which is a requirement to help prevent crushing video blacks, that was not adopted in the UK.

As we move into the digital world many of these test signal and their applications will be lost, so before they become nostalgia I thought it worth a look at the signals and how they were used and how they kept the TV pictures transmitted in the analogue world looking so good.

Information

External links

If you have an eBook reader that does not have WiFi then you will not be able to use the hyper-links in this publication.
If you have an eBook reader that has WiFi then you will be able too providing you are in a WiFi zone.
But if you have a Kindle 3G then yes, but only to Amazon, and there is not a lot of ATV material on their site.
Smart phone reading apps are ok providing that you have a 3G data connection.
Note: These links will fire up your devices browser and if you are using 3G/4G then you will incur data usages charges.

Legal Niceties (the small print)

Copyright

Notice to Contributors

Authors are alone responsible for the content of their articles, including factual and legal accuracy, and opinions expressed by them may not reflect the editorial stance of the publication. Material submitted to dotMOBI should not infringe the copyright of other writers or bodies.
Contributions are accepted for publication on this basis alone.
dotMOBI publications - http://cq-datv.mobi

Author Guidelines

CQ-DATV welcomes contributions from our readers. It does not necessarily have to be on ATV, as long as it is of interest to our readers.

Although a formatted article showing the layout can be sent, we prefer an unformatted text file of the script, along with annotations of where important images should be placed. All images should be identified as Fig 1 etc and sent seperately.

Images should be in PNG format if possible and the best quality available. Do not resize or compress images, we will do all the rework necessary to publish them.

If you are sending a construction project, please include the dimensions of any pcb's and make the pcb image black and white, not greyscale.

CQ-DATV reserves the right to redraw any schematics and pcb layouts to meet our standards.

Coming up in CQ-DATV

Is this the latest issue of CQ-DATV? Click here to go to our web site to check to see if there is a later edition available.

If you would like to read CQ-DATV online rather than having to download it, copies from issue 8 onwards are available on ISSUU. Just point your browser to http://issuu.com/cq-datv