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TV Repeater's REPEATER

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BATC SPECIAL EDITION

The British Amateur Television Club's magazine is called CQ-TV. Their most recent issue, Spring 2021, No. 271 has several articles of interest about narrow-band DVB-T. We have received permission, actually strong encouragement, from the BATC to reprint them here for you.

The ATV hams in the U.K. and Europe had a head start by quite a few years ahead of us USA hams experimenting with digital TV. Early on they adopted DVB-S modulation. The biggest compelling factor in the beginning for them, no doubt was the availability of very low cost (< $50) DVB-S satellite receivers. These were marketed under the title "Free To Air". These set-top boxes are not the complete satellite receiver, but really the IF receiver. The Ku band head-end, block converter is mounted at the dish antenna and the IF is from roughly 1 to 2GHz. Thus the FTA receiver is actually a 23cm band receiver. The 23cm band is more popular in Europe because it is their first band with lots of spectrum available. Their 70cm band is narrower than we enjoy here in the US.

It was fine to have low cost receivers, but a major problem to be overcome was a lack of a low cost DVB-S transmitter. This is where the British Amateur TV Club (BATC)

stepped in and designed and sold kits. Early versions relied upon the ATV ham using his PC computer to handle a lot of the digital number crunching involved with DATV. An outboard pc board than provided basically the RF side of the equation to give a milli-watt level DVB-S signal which could then be amplified by an RF power amplifier. More recently, the BATC is supplying their Portsdown Transmitter. It uses a web-camera, the mini Raspberry Pi computer for the computing horsepower, and a LimeSDR radio. It still needs an RF power amplfier to boost the milliwatt level signals. The first article included in this newsletter is about the BATC's Portsdown, by Dave Crunp, G8GKQ. Dave is BATC Chairman.

The basic DATV system that BATC advocates uses their Portsdown transmitter and now no longer a FTA receiver, but what they call the MiniTiouner receiver. It is a PC computer based system using a USB tuner card which tunes from 143 to 2450 MHz. Both the Portsdown and MiniTiouner handle both standard bandwidths and reduced bandwidths. The BATC has an on-line store for members selling the Portsdown transmitter, and the Mini-Tiouner, Knucker & Ryde receivers, plus misc. components.

The hams in the U.K. and Europe are doing a lot of work on making reduced bandwidth DATV work. This includes on ham bands with less spectrum available such as 71 and 146MHz. Most U.K. and European hams are using the BATC systems.

Here in the US, we ATV hams have come late to the DATV game. Most of us have taken a different approach. For one we have mostly gone with DVB-T rather DVB-S or the US broadcast standard ATSC. The other is most of us are "appliance operators" using stand-alone, boxes from Hi-Des in Taiwan. This is different from the PC computer based approach in Europe for both Tx & Rx. Most European hams are rolling their own gear using the BATC kits.

Well, the hams at the BATC are now migrating somewhat towards DVB-T where they see some advantages. The other three BATC article we are reprinting here are:

"Reduced Bandwidth DVB-T for DATV Use" by Noel Matthews, G8GTZ (BATC General Secretary)

"Reduced Bandwidth DVB-T Receive Systems" by Dave Crump, G8GKQ

"Reduced Bandwith DVB-T Transmit System" by Dave Crump, G8GKQ

The BATC provides a useful service to ATV world-wide. They host a computer server to stream the A/V from ATV repeaters around the world. (https://batc.org.uk/live/). Our Boulder, Colorado club uses it to stream our ATV nets, etc.

To find out more about the BATC, check out their web site: www.batc.org.uk

Jim, KH6HTV, Boulder, Colorado

CQ-TV 271 – Spring 2021

Portsdown 4 – Start here

Dave Crump G8GKQ

This article is aimed at beginners and does not assume any previous knowledge of the Portsdown project or the Raspberry Pi. It discusses each of the four key components in turn but the fifth component required to complete the transmitter, the power amplifier or transverter, is not discussed here.

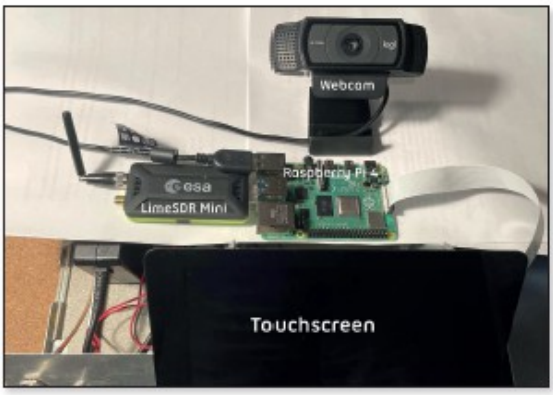
The Portsdown 4 provides a really easy way to get started with digital ATV, either for use on 70 cms and the other terrestrial bands, or for use on QO-100. Unlike many of the more complex solutions (using Windows PCs), it has a standard set of parts and configuration-controlled software, so should "just work" when built and configured according to the instructions.

The key components are the video/audio source, the Raspberry Pi with touchscreen, the software defined radio (SDR) and the optional output switching as shown below. A parts list is provided at the end of the article.

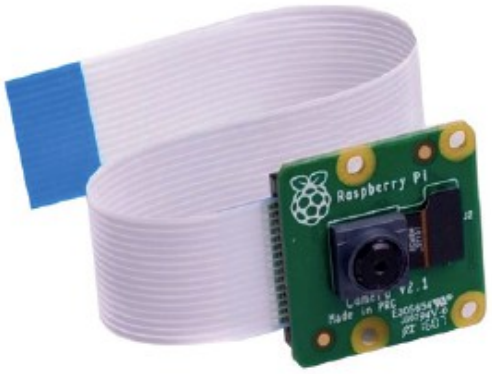
Video and Audio Source

Starting at the beginning, we need a way to get audio and video into the system. You can use a Raspberry Pi camera and a USB audio dongle, a Logitech C920 webcam, or an EasyCap video capture device with a PAL camera. For testing, an internally generated test card is available which does not need any extra hardware.

The Raspberry Pi camera can be an old version one (no longer available), a current version two, or the more expensive HQ camera which takes a (separately-purchased) C-mount lens. All come with short (15 cm) ribbon cables to connect them to the Raspberry Pi. You may want to buy a longer ribbon cable or use adapter sockets to use an HDMI cable extension. As described on the Wiki *https://wiki.batc.org.uk/CSI-2_to_HDMI*, these use HDMI hardware, but not the HDMI electrical standard.



▶ *The simplest "full system". Webcam, RPi4, touchscreen, LimeSDR and PSU (underneath)*



▶ *Raspberry Pi camera version two with ribbon cable*

Video and Audio source	Raspberry Pi and Touchscreen	SDR	Optional output and PTT switching	Power Amplifier(s) and/or Transverters
Pi camera and USB audio dongle	Raspberry Pi 4 with 2GB (or more) of RAM	LimeSDR Mini	Four-way switch	Not discussed here
or	and	or	or	
Logitech C920 Webcam	Programmed SD Card	LimeSDR USB	Eight-way switch	
or	and	or	or	
PAL camera and EasyCap	Official seven-inch touchscreen	Pluto	No switching	
or	and	or		
Internal Testcard	5.2 V 3 Amp PSU	DATV Express PCB (DVB-S only)		

▶ *Adapter to use HDMI cable for camera extension*

▶ *The correct USB audio dongle*

For audio with the Raspberry Pi camera, you should use a cheap (less than £5 from eBay) USB audio dongle of the type shown here. Do not buy any other colour or shape, as they will probably be different internally and not work.

The Logitech C920 webcam is also supported as a video and audio source. There are two versions available – the older version has an internal H264 encoder and is preferable, the newer one works, but not quite as well. **Note that other models of webcams are unlikely to work.**

▶ *The Logitech C920 webcam*

The third option for a video source is to use an old composite video camera and a specific type of EasyCap USB adaptor. Note that there are four types of EasyCap adaptor which are all look identical from the outside. The only one that works is the Fushicai USBTV007. These used to be stocked by the BATC shop (550 were sold) but they are now unobtainable in quantities of under 1000. Work is under way to modify the software to accommodate a suitable replacement.

The final video option, which is useful for testing, is the internal test card. This is selected from the touchscreen and can have your callsign overlaid.

Raspberry Pi and Touchscreen

The Portsdown 4 uses a Raspberry Pi 4. All testing is done on the cheapest 2 GB model, but the more expensive versions with more RAM will work. The Raspberry Pi 4 can run hot, and the best solution is to buy a heatsink case to protect it thermally and mechanically.

You will also need a suitable power supply. The current consumption is up to 3A, and major Raspberry Pi suppliers sell suitable mains power supplies with the USB-C connector. For portable operation a switching power supply (from eBay) can be used to supply 5.2V directly to the GPIO header pins.

The Raspberry Pi needs an SD card with the Portsdown software on it. The recommended type is the SanDisk Ultra 16 GB. These are sold pre-programmed by the BATC shop, or you can program it yourself – full instructions are on GitHub *https://github.com/BritishAmateurTelevisionClub/portsdown4*.

Other brands and types of SD Card do not work well with the Raspberry Pi, and it is not worth the trouble of using them.

The Portsdown is controlled by a touchscreen, which must be the official Raspberry Pi Foundation seven-inch touchscreen.

▶ *The Raspberry Pi touchscreen*

This touchscreen comes with a short ribbon cable to connect to the Raspberry Pi. You may want to buy a longer ribbon cable depending on your mechanical design. The ribbon cable is identical to the one used for the Pi Camera. The touchscreen is powered from the Raspberry Pi.

Software Defined Radio

The choice of SDR comes down to personal preference. The LimeSDR Mini and LimeSDR USB both work well out of the box, but there are not many other systems that use them. The Pluto needs bespoke configuration to be used with the Portsdown and some users have reported difficulty with this process. However, there are other applications (such as the Langstone microwave transceiver and the SatSaGen test equipment software) that also use the Pluto.

Finally, some of you may have a DATV Express PCB (which is no longer in production). This will work with the Portsdown 4 for DVB-S, but not DVB-S2. All produce an output in the region of one to 10 mW.

The LimeSDR Mini is supplied without a USB Cable, so a short USB3 extension cable is required if you are not going to plug it directly into the Raspberry Pi (which can be mechanically awkward).

▶ *The LimeSDR Mini*

For mechanical protection, it is highly recommended the LimeSDR Mini is mounted in a box and provided with adequate cooling as it runs quite hot.

The LimeSDR USB is a more expensive version of the LimeSDR with more options and requires an external power supply.

The Analog Devices Pluto needs three modifications before it can be used with the Portsdown.

Firstly, you need to extend its frequency range by telling it that it has a different IC in it. Details here: *https://wiki.analog.com/university/tools/pluto/users/customizing* and scroll down to "Updating to the AD9364".

Second, you need to enable the second processor. Details here: *https://www.ph4x.com/pluto-sdr-hack-2nd-cpu-core/*.

The final modification is to load a specific version of F5OEO's custom firmware. Note that it must be this version, not more recent versions.

The firmware can be found here together with a link to the upgrade instructions *https://wiki.batc.org.uk/Portsdown_4_Pluto#Suitable_Pluto_Firmware* . If you are not comfortable with these steps, either use a LimeSDR Mini instead or arrange for someone else to make the modifications.

▶ *The Analog Devices Pluto*

The Pluto comes with a suitable USB lead for connection to the Raspberry Pi and is housed in a plastic protective case.

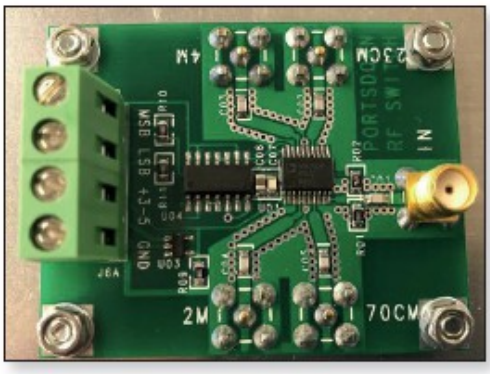
The final SDR option, which is only capable of DVB-S (not DVB-S2) with the Portsdown, is the DATV Express board, which simply connects by USB.

Optional output and PTT switching

If you are manually switching a power amplifier (PA) for a single band, then you can simply connect the output of your chosen SDR to the amplifier and switch the PA on once the SDR has started.

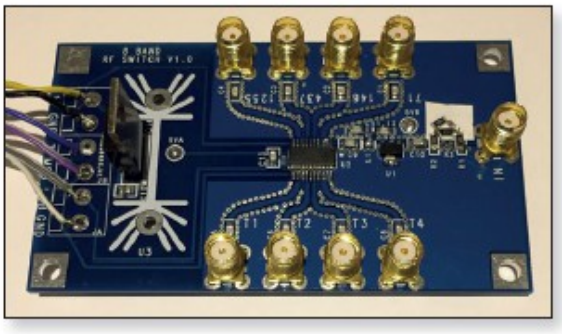
However, some automated switching is strongly recommended as both the LimeSDR and Pluto produce a calibration signal (often much more powerful than the normal transmission) before the transmission starts and this has led to the destruction of several PAs. A delayed PTT signal is available from pin 40 of the Raspberry Pi GPIO connector and this only goes high once the calibration pulse is finished.

If you want to drive up to four PAs for different bands from your Portsdown, then the BATC's four-way RF switch and four-way switch control board are recommended. Full details are on the BATC Wiki here: *https://wiki.batc.org.uk/Portsdown_hardware#4-Band_RF_Output_Switch*



▶ *The four-way RF switch*

You can drive up to eight PAs or transverters with the BATC's eight-way RF switch, control board and PIC. Again, the details are on the BATC Wiki here: *https://wiki.batc.org.uk/8-Band_RF_Output_Switch*



▶ *The eight-way RF switch*

Both the four-way and the eight-way RF switches allow the PTTs for individual PAs to be controlled safely.

Portsdown 4 parts list and suggested suppliers

Here is a list of parts required for the Portsdown 4 and some possible suppliers:

Audio and video Source:

- RPi Camera V2 – RPi Suppliers
- Optional longer ribbon cable – RPi Suppliers
- Optional Arducam CSI to HDMI cable kit – *thepihut.com*
- Optional HDMI cable for extension – Multiple suppliers
- USB audio adapter – eBay ***or:***
- Logitech C920 webcam – multiple suppliers ***or:***
- Fushicai USBTV007 EasyCap video capture device – Ex BATC shop, now out of stock.

Raspberry Pi and touchscreen

- Raspberry Pi 4 2GB model – RPi Suppliers
- Raspberry Pi 4 heatsink Case – RPi Suppliers
- Raspberry Pi 4 3A Power Supply – RPi Suppliers
- Official seven-inch touchscreen – RPi Suppliers

- Optional longer ribbon cable – RPi Suppliers
- Portsdown 4 SD card – BATC Shop

SDR

- LimeSDR Mini – Mouser-UK part number cs-lime-05
- USB 3 extension cable– multiple suppliers ***or:***
- Analog Devices Pluto – Mouser-UK part number 584-ADALM-PLUTO ***or:***
- DATV Express Board – no longer manufactured.

Optional Output and PTT Switching

- Homebuilt PTT Driver controlled from GPIO Pin 40 ***or:***
- BATC four-way switch as described on BATC Wiki ***or:***
- BATC eight-way switch as described on BATC Wiki

Major Raspberry Pi Suppliers:

- Pimoroni *https://shop.pimoroni.com/*
- The Pi Hut *https://thepihut.com/*

Further information

Further reference information can be found on the BATC Wiki *https://wiki.batc.org.uk/*. More information, and answers to specific questions can be found on the BATC Forum *https://forum.batc.org.uk/* .

ATV frequencies and recommended modes

Dave, G8GKQ

I'm often asked what frequencies and modes are used for simplex amateur TV.

There is no mandated list, but here is a guide to the most-used frequencies and modes on each band. There may be extra licence restrictions in some regions and regional variations to prevent interference to and from the band's primary users.

The frequencies stated for the higher bands are those where there is likely to be activity during ATV contests.

ATV repeater input and output channels are not listed.

Voice talkback in the UK is generally on 144.75 MHz FM, but other frequencies may be used in some areas.

Before transmitting, please check your licence and the RSGB band plan.

Frequency	Mode	Parameters	Notes
29.25 MHz	DVB-T	333 kHz QPSK	Max 500 kHz bandwidth
51.7 MHz	DVB-T	333 kHz QPSK	Max 500 kHz bandwidth
71.0 MHz	DVB-T	333 kHz QPSK	NoV required. 70.5 - 71.5 MHz
	DVB-S2	333 kS QPSK	
146.5 MHz	DVB-S2	333 kS QPSK	NoV required. 146.0 – 147.0 MHz
437.0 MHz	DVB-S2	333 kS QPSK 1 MS QPSK	Band plan 436.0 – 438.0 MHz
1255.0 MHz	DVB-S2 FM ATV	Various SRs	FM ATV being replaced by DATV Caution not to interfere with Primary User
2395.0 MHz	DVB-S2	Various SRs	
3405.0 MHz	DVB-S2	333 kS	
5665.0 MHz	FM ATV	Wideband FM	Using FPV drone equipment
5762.5 MHz	DVB-S2	333 kS	Using NB Transverters (from 146.5)
10370.5 MHz	DVB-S2	333 kS	Using NB Transverters (from 146.5)
24047.5 MHz	DVB-S2	333 kS	Using NB Transverters (from 143.5)
47090.5 MHz	DVB-S2	333 kS	Using NB Transverters (from 146.5)
75978.5 MHz	DVB-S2	333 kS	Using NB Transverters (from 146.5)

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Reduced bandwidth DVB-T for DATV use

Noel Matthews G8GTZ

As a result of tests carried out during 2001 at GB3AT in Winchester, the UK and subsequently the European ATV community adopted DVB-S as its standard for amateur digital TV transmissions (see CQ-TV250 page 40).

At the time, the major benefits of DVB-S (single carrier QPSK designed for satellite) were identified as the variable bandwidth capability which allows operation today down to 50 kHz and requiring less linear PAs than wideband DVB-T, which was only then available in six, seven or eight-MHz bandwidths.

However, it was known at the time that the major advantage of the terrestrial DVB-T standard was, due to the use of COFDM (Coded Orthogonal Frequency Division Multiplexing) technology, the resilience to multipath and phase distortions which appear as ghosting on an analogue TV.

This is particularly true for mobile transmission and reception, particularly in built-up areas (see results from the maritime mobile tests conducted on the Solent in CQ-TV 245 page 15) and is the reason why today all wireless broadcast cameras use OFDM-based technologies.

Multipath and phase distortion also become a problem for ATV operators when trying to take advantage of enhanced propagation particularly on the lower VHF and HF bands where modes such as sporadic E are not phase coherent due to ionospheric turbulence.

DVB-T vs DVB-S

Unlike DVB-S which uses one data carrier on a single radio frequency (RF) channel, DVB-T makes use of COFDM. This works by splitting the digital data stream into many slower digital streams, each of which digitally modulates a set of closely-spaced adjacent sub-carrier frequencies.

In DVB-T there are two choices for the number of carriers known as 2K-mode or 8K-mode. Note there are actually 1,705 or 6,817 sub-carriers. These close-spaced signals would normally be expected to interfere with each other, but by making the signals orthogonal (at right angles) to each other, there is no mutual interference.

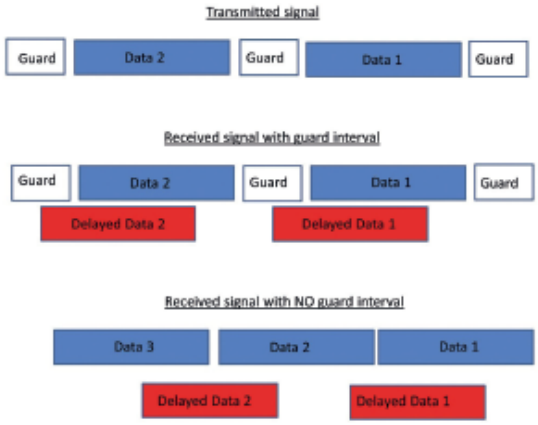
The data to be transmitted is shared across all the carriers and this provides resilience against frequency selective fading from multi-path effects. Nulls caused by multi-path effects or interference on a given frequency only affect a small number of the carriers, those remaining being received correctly.

These individual carriers can be modulated using QPSK, 16 or 64 QAM with the benefit of increasing the amount of data carried but at a cost of increasing the SNR and the amount of signal required to achieve successful decodes. Forward Error Correction (FEC) is also applied to each carrier which also affects the robustness of the signal and amount of data carried.

Some of the carriers don't carry traffic but provide phase and amplitude references to help the receiver decode the signal and others provide information on the format of the signal again to help the receiver do the decoding.

Guard interval

One significant difference between DVB-S and DVB-T Is that OFDM also uses a technique called guard interval to improve multipath performance. When trying to understand guard interval, it is important to think in the time domain rather than frequency domain. The damage done by multipath is when reflected signals (or digital symbols) arrive after the direct signal or symbol and at the same time as the next symbol of information and thereby corrupting it.



A guard interval (or time delay) is added to the beginning of each symbol of data, thereby ensuring any reflections from the previous symbol have been received before the data in the second symbol starts. Any corruption to the first data block by its own delayed reflection can be dealt with by error correction. Note that a longer guard interval

results in a reduction of the payload bits available and therefore reduces picture quality.

Guard interval duration

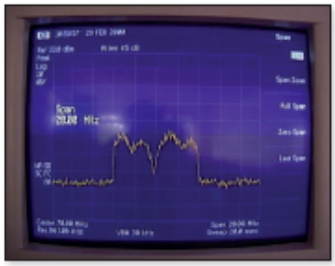
As mentioned previously, DVB-T was designed as a PAL replacement system and the guard interval was set to compensate for typical reflection delays seen on a domestic TV using "rabbit's ear" antennae. With the PAL line scan duration of 64 microseconds, typical ghosting of up to 10 microseconds could be seen before the sync waveforms were too distorted for the set to lock.

With an eight-MHz bandwidth, the maximum guard interval can be set to 1/4 or 56 microseconds and the Freeview SD multiplex currently operates at 1/32 or seven microseconds.

With reduced bandwidth DVB-T, the length of the guard interval directly scales with the reduction in bandwidth and the 1/32 setting gives a guard interval time of 112 microseconds at 500 kHz and 168 microseconds at 333kHz.

The effectiveness of the combination of multicarrier modulation and the guard interval can be seen in this spectrum analyser plot showing an eight-MHz OFDM signal with 20dB notch caused by mobile multipath and frequency selective fading but signal decoding was not affected.

PA linearity



One requirement of the OFDM transmitting and receiving systems is that they must be very linear.

Any non-linearity will cause interference between the carriers because of inter-modulation distortion. This will introduce unwanted signals that would cause interference and impair the orthogonality of the transmission.

In terms of the equipment to be used, the high peak to average ratio of multi-carrier systems such as OFDM requires the RF final amplifier on the output of the transmitter to be able to handle the peaks although the average power is much lower and this leads to inefficiency. Typically power amplifiers should be run at only 10% of their rated power output when DVB-T is used.

Why DVB-T for DATV now?

As mentioned previously, as DVB-T was originally only available in fixed six, seven and eight-MHz bandwidths with a 1.7 MHz variant being developed more recently. These wide bandwidths meant PA linearity was a real issue and for typical amateur applications DVB-S was more efficient although the ATV community in the USA has adopted DVB-T using HiDES equipment.

However, a recent development in silicon technology has meant there is now variable bandwidth DVB-T tuner silicon available that will go to bandwidths below 1 MHz and Charles, G4GUO, has developed core software core to enable its use in amateur applications.

Charles has also developed transmit code to enable DATVExpress and Portsdown systems to transmit narrow band DVB-T down to 250 kHz.

These core developments by Charles have now been used for the basis of the Knucker narrowband DVB-T project which includes a new USB receiver card and DATVExpress and Portsdown transmit capabilities.

Where should we use DVB-T?

DVB-T is NOT a replacement for DVB-S and there is no need to upgrade or replace anything if you do not want to take advantage of the two very specific applications for DVB-T.

Low band VHF and HF DATV

Up until now it has been impossible to use DVB-S based DATV on the lower VHF or HF bands to take advantage of enhanced propagation because certain modes such as sporadic E are not phase coherent. However, it is believed that reduced bandwidth DVB-T will be more resilient and enable ATV operators to take advantage of the recent introduction by IARU Region One of segments for digital experiment in the 29 and 50 MHz bands.

VHF and UHF mobile DATV

It is also envisaged that narrow band DVB-T will enable the use of reliable mobile transmissions on VHF and above and opens up the opportunity for amateurs to develop new repeater and wireless camera applications.

Summary

Reduced bandwidth DVB-T will not replace DVB-S as the preferred technology for most of our applications such as simplex and home station to repeater transmissions or when operating on QO-100.

The development of the reduced bandwidth DVB-T capability does give DATV operators the opportunity to explore new applications and could enable fast scan digital Television QSOs around the world.

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Reduced-Bandwidth DVB-T Receive Systems

Dave Crump G8GKQ

DVB-T has been available for more than 20 years, but only in fixed bandwidths for broadcast use (8, 7, 6 and 1.7 MHz) making it unsuitable for DATV use. However, receiver chips with programmable bandwidths have recently been released and software enabling it to be used for amateur applications has been developed.

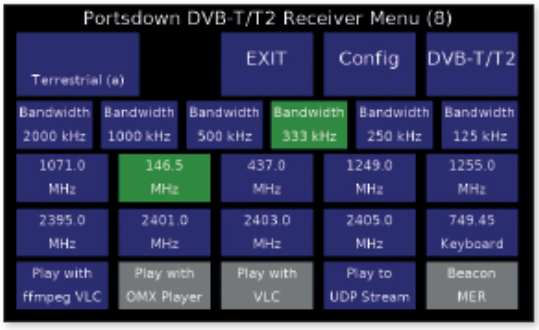
A small team supported by the BATC has developed a new USB receiver PCB known as the Knucker which hosts the Serit FTM-4762 DVB-T NIM (Network Interface Module – the tin can). This tuner enables us, with the right software, to receive DVB-T and DVB-T2 signals with bandwidths of 8 MHz down to 150 kHz. It also covers the wide frequency range of 48 MHz to 1000 MHz.

The BATC wiki has more details of the PCB build and the BATC shop stocks the Serit FTM-4762 NIM, PCB and USB module which, although the same hardware, is programmed differently to the MiniTiouner module.
https://wiki.batc.org.uk/Knucker

There are currently two receive systems that can be used with the Knucker tuner - the Portsdown 4 and the Ryde receiver. There is no Windows software available to use with the Knucker tuner (we're looking for volunteers to write it).

DVB-T Receive With Portsdown 4

Connect the Knucker to the Portsdown 4 (not a Portsdown 2020, as the feature is not available on that version) and disconnect any MiniTiouner. The receiver will not work with both connected. Select "RX". You can then select DVBT/T2 on the top right button (which toggles between that and DVB-S/S2).



The top left button enables you to switch between QO-100 downlink frequencies (which can be used for very brief DVB-T tests) and normal terrestrial frequencies. The next three rows enable you to select the desired receive frequency and bandwidth.

Only two options are available to start the receiver: "Play with ffmpeg VLC" which displays the video on the touchscreen and outputs audio to your selected audio device; and "Play to UDP Stream" which outputs the received transport stream to the UDP address and port set on the receiver configuration menu.

The first time that you select Receive, the tuner takes about 40 seconds to initialise; it is downloading the firmware from the Portsdown to the tuner. Subsequent receive initialisations take about eight seconds. It then starts searching for the signal, and when it achieves lock it displays the signal parameters.

Most amateur signals will be DVB-T, 2K, QPSK. The FEC and Guard Interval are displayed in addition to the:

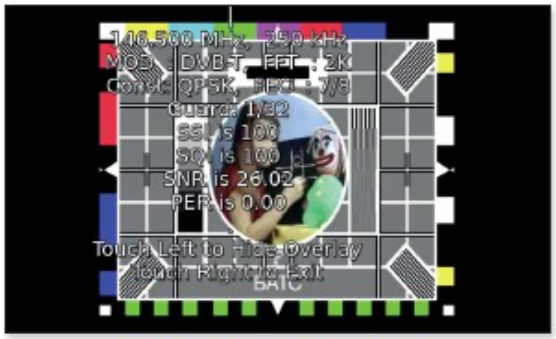
SSI	Signal strength indication	0 – 100 scale
SQI	Signal quality indication	0 – 100 scale
SNR	Signal to noise ratio	dB
PER	Packet error rate	0.00 to 1.00 scale

The signal strength indication is just that. Good results are achieved when this is between 90 and 99. Anymore and you don't know if the receiver is being overloaded. Valid decodes seem to be achieved down to an SSI of 20.

The signal quality indication gives a measure of the accuracy of the received OFDM signal. Transmissions with poor carrier balance, or interfering signals, will cause this number to fall from 100. It has been noticed that transmissions with poor SQI take longer to achieve signal lock at the receiver.

The signal to noise ratio gives an indication of the received signal strength compared with the noise level. Note that a signal with good SNR (> 6dB) might fail to decode if it has a poor SQI. Higher SNRs are required for higher FECs and 16-QAM or 64-QAM.

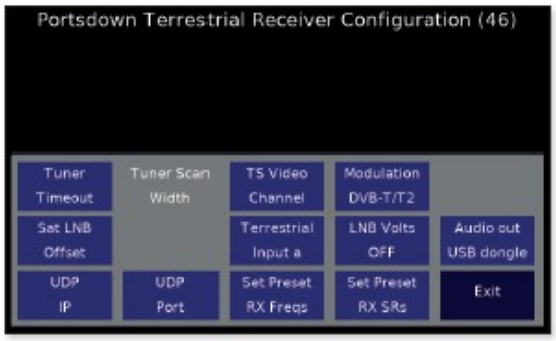
The packet error rate is a measure of the residual errors after digital error correction. Most video players will cease to play video as soon as this error rate begins to rise above zero.



If "Play with ffmpeg VLC" is selected, and a valid transport stream is decoded, then VLC will display the video with the parameter overlay for about five seconds before the overlay disappears.

The overlay can be reselected by touching the top left of the screen. Touching the bottom left of the screen takes a screenshot (saved in the /home/pi/snaps folder), and touching the right side of the screen exits back to the receive menu.

Configuration



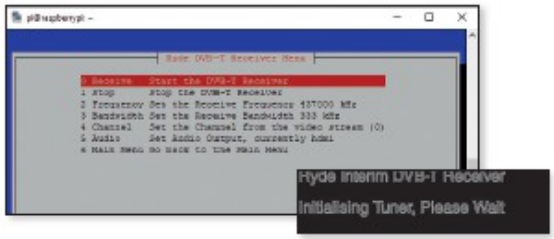
On the receiver configuration menu, the transport Stream video channel (programme) can be selected; this enables broadcast programmes to be selected from broadcast "bouquets". The tuner timeout button has no effect on DVB-T; the tuner resets after about 15 seconds of searching and then resets itself for another search.

The Sat LNB offset can be set from this menu if required, but the input cannot be switched; the lower input socket is always used for DVB-T. Neither is there any facility to switch the LNB voltage. The audio out, UDP and preset selection buttons are all active.

DVB-T Receive With the Ryde Receiver

An interim DVB-T capability has been added to the Ryde receiver. As with the Portsdown receiver, this receiver will work on any bandwidth from 150 kHz to 500 kHz, and on the spot bandwidths of 1, 1.7, 2, 4, 5, 6, 7 and 8 MHz.

The receiver control is accessed through the console menu at present, but it is hoped to add it to the remote control menu in the future. So log in by ssh, type 'menu' and then press enter. Select the DVB-T RX option to get to the DVB-T receiver menu.



This is a more basic receiver than the Portsdown and has no facility to use an LNB offset. You can set the frequency, bandwidth and channel/program within the stream, and audio channel from this menu. Then select receive and the displays are very similar to the Portsdown described above.

Once the video is decoded, it is displayed with a permanent parameter overlay as seen here.

Summary

Apart from the Knucker tuner module, no extra hardware is required for either receiver; just make sure that you have updated to the latest software.

Both DVB-T receivers have the same performance in terms of sensitivity. The Portsdown receiver is optimised for portable operation, while the Ryde DVB-T facility is a temporary shack-based receiver pending full implementation of DVB-T in the Ryde remote control menus. Either will enable you to start experimenting with 50 MHz and 71 MHz DVB-T.

CQ-TV 271 – Spring 2021

Reduced-Bandwidth DVB-T Transmit Systems

Dave Crump G8GKQ

DVB-T Transmit Systems

There are currently three ways to generate reduced bandwidth DVB-T signals for amateur use. If you currently have equipment capable of transmitting DVB-S2, it is very likely that a simple software upgrade can add DVB-T capability.

DATV Express PC Software

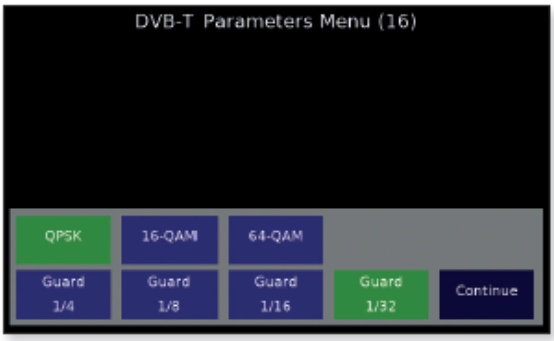
The DATV Express experimental software 1.25p117 running on a Windows PC will drive a DATV Express Board, a LimeSDR Mini, or a Pluto to generate DVB-T. You can download this software from *https://www.dropbox.com/s/ghwlhqugg8yrdxu/setup_datvexpress1.25lp17.zip?dl=0*

Note that the DATV Express software is not optimised for the low bitrates used with reduced bandwidth DVB-T so it needs careful adjustment to transmit a valid reduced bandwidth DVB-T signal.

Portsdown 4 with Pluto

The latest version of the Portsdown 4 will drive a Pluto to generate DVB-T at between 150 kHz and 1 MHz bandwidth. Only the 2K (1705 carriers) mode is supported, but all the standard modulations (QPSK, 16-QAM and 64-QAM) and Guard Intervals (1/4, 1/8, 1/16 and 1/32) are available.

To set up for DVB-T transmit, make sure that you have the Pluto selected as the output device. Then select Modulation, and then DVB-T. The next menu shown will be the DVB-T parameters menu.



For normal operation, make sure that QPSK and 1/32 are selected and then press Continue. If you need to access this menu again, you will need to reselect DVB-T as the modulation, and then it will be displayed.

Select the desired frequency and bandwidth. Note that some of the menus still refer to SR, rather than bandwidth; this is incorrect and will be corrected in due course.

Pi camera, composite video, C920 webcam, test card, and contest numbers are available as video sources, but only with H264 encoding (MPEG-2 is not implemented).

HDMI from an LKV373A cannot be used (unlike for Pluto DVB-S and DVB-S2 transmissions). You can use IPTS In (selected from the Encoder menu). The exact TS bitrate required for IPTS In can be looked up on the Info menu accessed from Menu two.

Note the output power for DVB-T is significantly lower than that for DVB-S and S2. Typical values measured at Pluto Pwr = 0 (the maximum) are listed below:

51.7 MHz	- 10 dBm	0.1 mW
71 MHz	- 8 dBm	0.15 mW
146.5 MHz	-5.5 dBm	0.28 mW
437 MHz	-3 dBm	0.5 mW
1255 MHz	-4 dBm	0.4 mW
2400 MHz	-5.5 dBm	0.28 mW
3400 MHz	-7 dBm	0.2 mW
5760 MHz	-13 dBm	0.05 mW

The output power can be controlled in approximately 1 dB steps. For example, the output power with Pluto Pwr set to -5 is approximately 5 dB lower. The lower frequency limit is 48 MHz and the upper limit 6 GHz.

It is hoped to add LimeSDR Mini DVB-T capability to the Portsdown 4 soon. Evariste F5OEO has very recently added direct DVB-T transmit capabilities to his latest Pluto firmware.

Portsdown 2020 With LimeSDR Mini

Operation of the Portsdown 2020 with the LimeSDR Mini is very similar to the Portsdown 4/Pluto combination. The major difference is that the waveform is fixed using QPSK at a guard interval of 1/32, so the DVB-T Parameters Menu is not shown. The LimeSDR Mini works over a higher bandwidth range than the Pluto: from 150 kHz to 2 MHz.

The LimeSDR does emit a very significant calibration power spike after transmit selection and before the PTT is enabled, so it is important that proper PTT-driven PA switching is used. The output power is generally higher than the Pluto:

51.7 MHz	-1 dBm	0.8 mW	Lime Gain 90
71 MHz	-1 dBm	0.8 mW	Lime Gain 90
146.5 MHz	-1 dBm	0.8 mW	Lime Gain 90
437 MHz	-2 dBm	0.6 mW	Lime Gain 90
1255 MHz	-2 dBm	0.6 mW	Lime Gain 90
2400 MHz	-13 dbm	0.05 mW	Lime Gain 90

The Lime Mini output power can be increased by adjusting the Lime Gain up towards 100, however the spectral purity of the signal is reduced. The practical lower frequency limit for the LimeSDR Mini is 32 MHz. The upper limit is theoretically 3500 MHz, but the output power reduces rapidly above 1500 MHz.

The LimeSDR USB is not yet supported, but this is planned for a future software upgrade. It is not planned to add Pluto support to the Portsdown 2020

Power Amplification

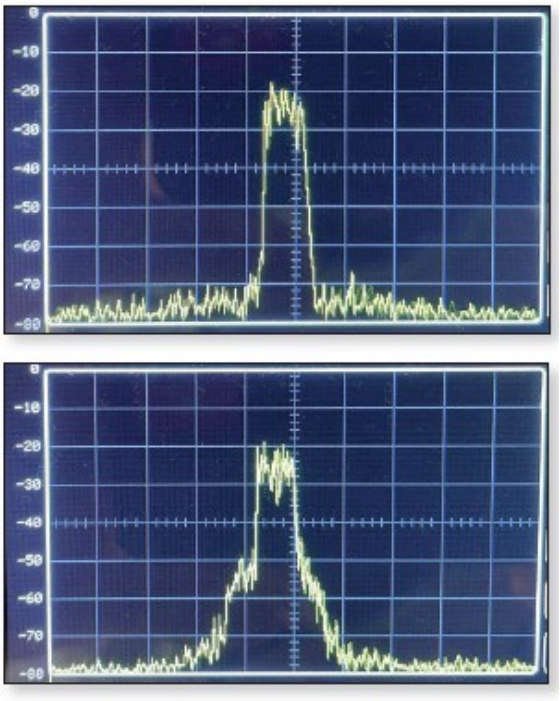
Even though the modulation software used in the Portsdown takes steps to reduce the waveform peak-to-average ratio, great care must be taken when amplifying the low levels from an SDR to reach transmit power levels.

As a rule of thumb, any power amplifier should be operated at between 16 and 10 dB (1/40 to 1/10) below its rated maximum power to prevent re-growth of "shoulders" either side of the signal. The two spectrums on the right show acceptable spectrum and not-so-good spectrum.

If you have access to a spectrum analyser you can adjust the input power to the amplifier (and possibly the amplifier bias) for best results.

Conclusion

The current generation of software defined radios used for DATV are finally showing their full potential, as additional modes can be added with a simple software upgrade. The use of DVB-T is well worth considering for 51.7 MHz and 71 MHz DX, and possibly for mobile experiments on the higher bands.



W0BTV Details:

Inputs: 439.25MHz, analog NTSC, VUSB-TV; 441MHz/6MHz BW, DVB-T & 1243MHz/6MHz BW, DVB-T

Outputs: Channel 57 --- 423MHz/6MHz BW, DVB-T, or optional 421.25MHz, analog VUSB-TV. Also, secondary transmitter, FM-TV output on 5.905 GHz (24/7).

Operational details in AN-51a Technical details in AN-53a. Available at: *https://kh6htv.com/application-notes/*

W0BTV ATV Net: We hold a social ATV net on Thursday afternoon at 3 pm local Mountain time. The net typically runs for 1 to 1 1/2 hours. A DVD ham travelogue is usually played for about one hour before and 1/2 hour after the formal net. ATV nets are streamed live using the British Amateur TV Club's server, via: *https://batc.org.uk/live/kh6htvtvr* or *n0ye*. We use the Boulder ARES (BCARES) 2

meter FM voice repeater for intercom. 146.760 MHz (-600kHz, 100 Hz PL tone required to access).

Newsletter Details: This is a free newsletter distributed electronically via e-mail to ATV hams. The distribution list has now grown to over 450. News and articles from other ATV groups are welcomed. Permission is granted to re-distribute it and also to re-print articles, as long as you acknowledge the source. All past issues are archived at: *https://kh6htv.com/newsletter/*

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