Using cheap 5.8GHz drone equipment for ATV on 6cm

The dramatic increase in popularity of cheap drones has led to the ready availability of cheap 5.8GHz video transmitters and receivers that are used to relay 'first person view' (FPV) pictures back to the operator.

These can easily be used as the basis of a simple but very capable 6cm analogue amateur television (ATV) system. **Photo 1** shows a typical 5.8GHz receiver and transmitter set as purchased via the internet.

PHOTO 1: Typical 5.8GHz receiver and transmitter as purchased.

The transmitter modules

The transmitter modules are typically single PCBs about 20x40mm in size, see **Photo 2**. They accept analogue video, audio and 12V inputs via flying leads connected to a plug-socket pair on the board. They are designed to be as light as possible to maximise the flight time of the drone carrying them.

The video input takes 1V peak-to-peak composite video from a camera or other device. There are many options for the amateur to use as a picture source. Most older camcorders have a suitable video output, as do many video players for SD cards; cheap cameras are also available that are specifically designed for use in drones. A Raspberry Pi computer can also generate composite video from the Pi Camera or from the test card application built into the Portsdown software [1].

There are usually two audio inputs, for left and right stereo channels. The audio signals are modulated onto subcarriers at 6.0 and/or 6.5MHz. The inputs need to be driven at line level – about 0.9V peak-to-peak. In amateur use, both inputs are normally driven in parallel.

The DC power input tends to be very tolerant of voltage variations as it is fed straight into a switch-mode power supply. A typical module will operate from 8 to 15V.

The operating frequency is set using DIP switches. Some modules have 16 channels, some 32, others 48; check before purchasing to make sure that your module covers the preferred ATV operating frequency of 5665MHz – many of the 16 channel versions do not. The modulation is wideband FM. The deviation is preset as double that typically used by amateurs in the 23cm band; it is the same as used by first-generation (analogue) satellite TV. The overall transmitted bandwidth is quite wide, at 27MHz, requiring care to stay within the amateur band limits.

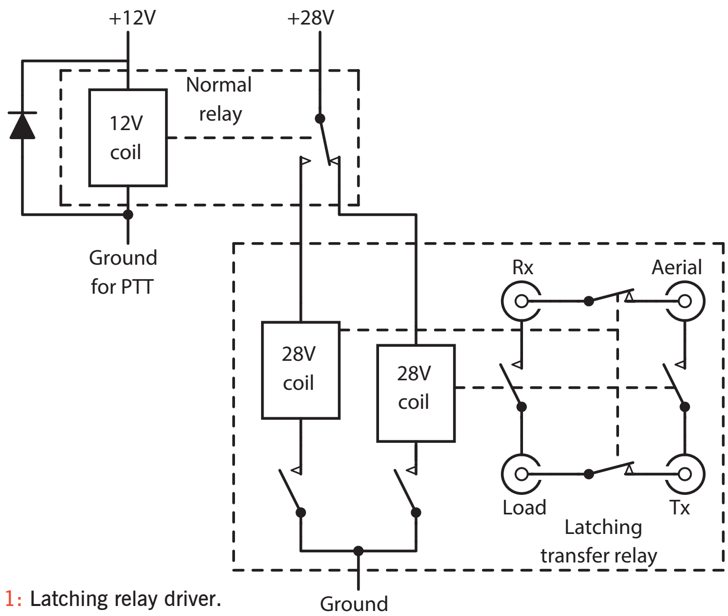

FIGURE 1: Latching relay driver.

The output socket used is normally a reverse-polarity SMA (RP-SMA), of the same type that is normally found on 2.4GHz Wi-Fi equipment. It is not recommended that this socket is changed as the PCBs are delicate and easily damaged. A better solution is one of the cheap RP-SMA to normal SMA adapters, on eBay and elsewhere. Output power is typically up to 600mW, although some recent modules have an output of 2.5W+.

Receiver modules

The receiver modules (**Photo 3**) are generally built to be physically more robust as they do not have to be so light as the transmitters and are subject to more handling during their intended use.

Again, the aerial input is an RP-SMA socket. The receiver sensitivity has been measured as -80dBm (to achieve a picture without 'sparklies' – visible FM noise). This is about as good as could be

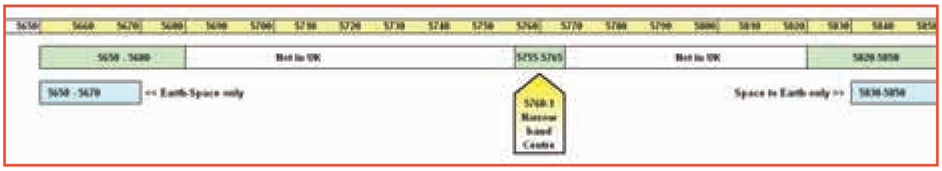

FIGURE 2: The UK 6cm band plan.

FIGURE 3: The transmitted spectrum is about 27MHz wide.

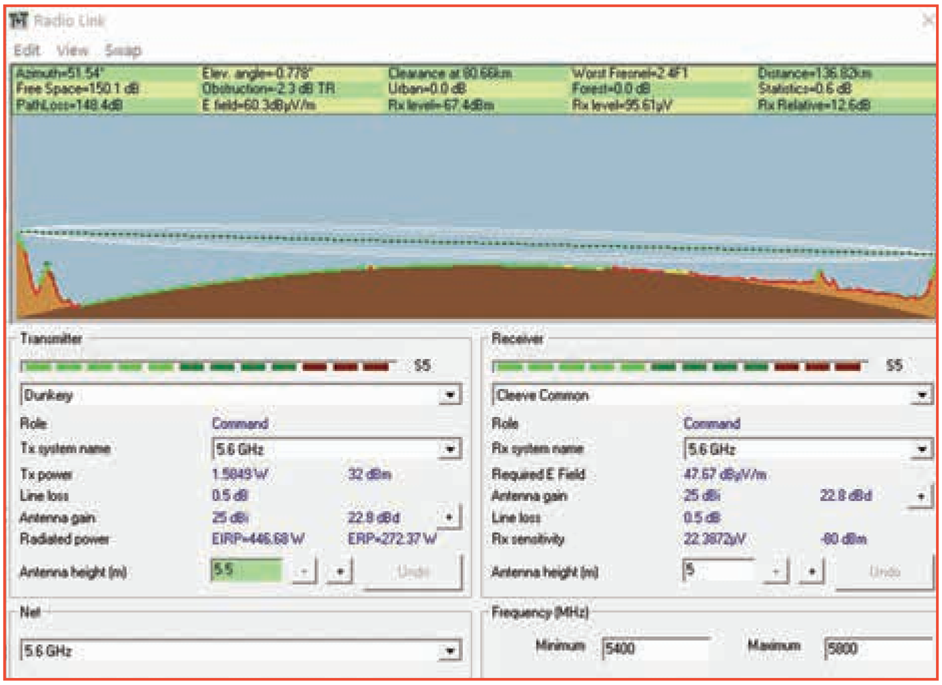

FIGURE 4: A path plot from Radio Mobile.

expected from an integrated receiver. It is certainly sensitive enough that you do not require a preamp before you first get on the air.

Video and audio output connections vary from module to module. A 4-terminal 2.5mm jack is common; the lead supplied for connecting to this should be colour-coded yellow for video, red for right audio and white for left audio. However, some modules seem to be supplied with leads that bring the video out on the red socket and right audio on the yellow socket. The contacts on the 2.5mm jack can be unreliable; the unit in Photo 3 has had the wires soldered to the PCB jack socket terminals and then connected to stripboard and solder pins for reliability.

The video output can be connected directly to a black and white or colour analogue monitor. Old CRT monitors (or TVs with line inputs like SCART or phono) are usually ideal, as they will cope with noisy signals and continue to display a picture. Some more modern CRT TVs go to blue screen, but this can often be disabled via a menu option. Newer LCD monitors display really clear pictures when the signal is good, but tend to only display the blue screen when presented with a noisy picture or no picture at all. This can make it difficult to establish initial contact or to receive pictures on marginal paths. The solution to this problem is a device that adds sync signals back to noisy pictures. An example is the Eachine ProDVR Video Audio Recorder device, available for about £20 on eBay, which is ideal; alternatives include the sync processor described in *CQ-TV 129* [2]. The GTH Electronics Advanced Digital Converter and Video Enhancer (ACE) also does a splendid job, but is more expensive.

The receiver audio outputs are at line level, and are best amplified using a set of computer speakers – these provide a volume control and a suitable amount of gain. Successful (noise-free) reception of audio requires a reasonably strong received signal.

Aerials

For initial cross-shack tests, small aerials (eg a quarter-wavelength 15mm wire) are more than adequate. Do not operate the transmitter without an aerial or dummy load, as the manufacturers warn that the power amplifier stage may be damaged by the reflected power.

For general use, panel or dish aerials are suitable. There are many flat-panel aerials produced for the 5GHz Wi-Fi band that are suitable. Examples include the TP Link TL-ANT5823B. There are also dish aerials produced for Wi-Fi links. A recent 136km video contact used the Hyperlink Technologies HG5827G 27dBi grid dishes at each end (see **Photo 4**).

Sky-type satellite dishes can be used with a simple feed placed at the same point as the mouth of the original (but removed) 10-12GHz satellite LNB. The W1GHZ log periodic aerials (available from G4DDK as a 5.7G Dual Patch [3]) are ideal.

You can also use an existing 10GHz dish for 5.6GHz. For my initial tests, I achieved good results (receiving pictures from 80km away!) by simply taping a 5.6GHz dipole (at the end of a

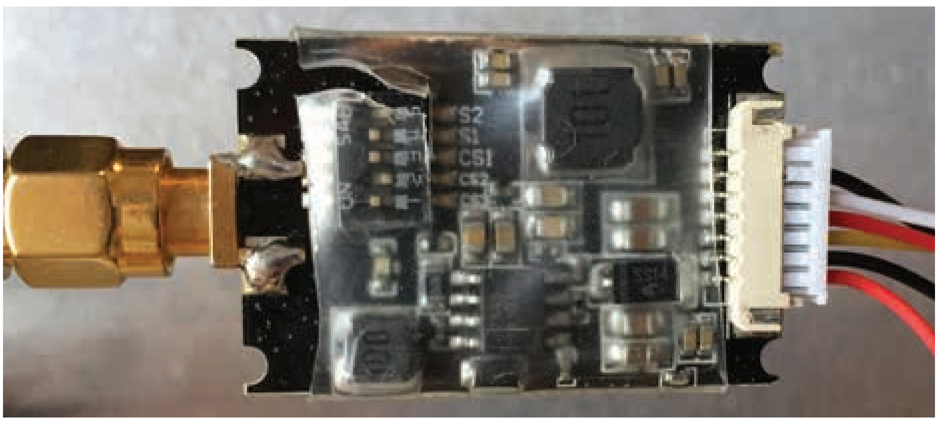

PHOTO 2: Close-up of a typical transmitter module. The DIP switches on the left set the operating channel.

Dave Crump, G8GKQ
dave.g8gkq@gmail.com

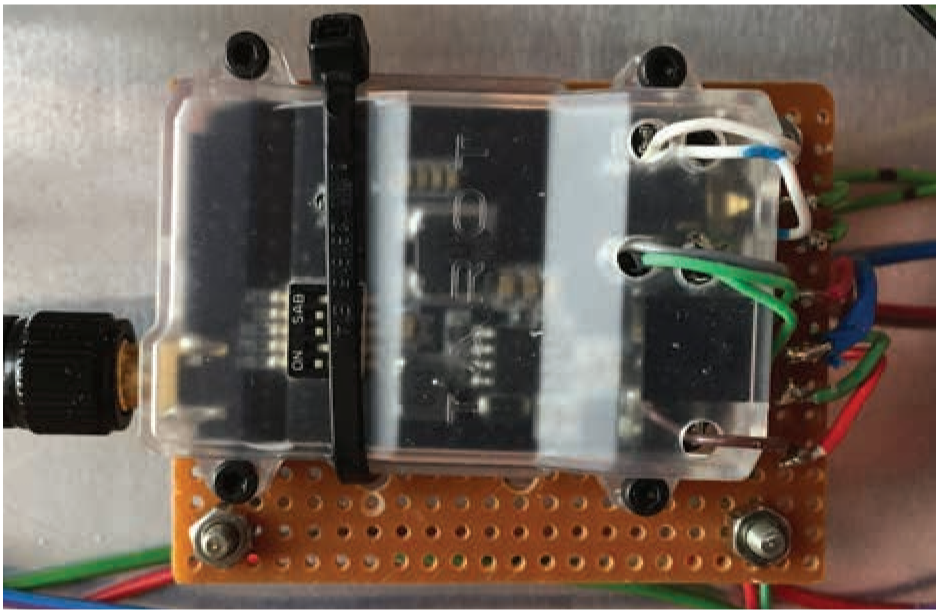

PHOTO 3: Close-up of a typical receiver module. Again, the frequency is set by DIP switches.

PHOTO 4: Hyperlink Technologies HG5 827G 27dBi 5.8GHz grid dish.

PHOTO 5: Sky dish with W1GHz log-periodic feed (the small green triangle).

length of semi-rigid coax) in the mouth of the 10GHz horn feed on a 60cm 10GHz dish, as shown in Photo 6.

Aerial changeover

You will want to be able to change between transmit and receive without having to disconnect and reconnect SMA or RP-SMA connectors, which are fiddly at the best of times and even the best ones are usually only designed for a lifetime of 500 connections and disconnections. There are two possible solutions to this: you can either use two aerials (one for transmit, one for receive) or a coaxial changeover relay.

PHOTO 6: 10GHz dish with 5.6GHz dipole feed.

Despite the extra expense and weight on the aerial mast, a number of operators using this equipment for wideband voice have found the two-aerial solution best for them. Photo 7 shows the portable station of Stewart, G0LGS who uses two TP Link TL-ANT5823B panels.

Changeover relays for 5.6GHz need to be high quality specialised relays with SMA (or possibly N) connectors. They are sometimes available at rallies for between £5 and £25 (but often much more) and are generally in high demand. Some suitable examples are shown in Photo 8. Note that many of these relays are of the latching variety and the more affordable ones are often designed for 28V operation. The voltage step-up modules sold as 'boost regulators' on eBay are ideal to generate the necessary 28V from a 12V supply. Latching relays can be driven by using a conventional relay, as shown in Figure 1. This circuit also comes in handy for any other amateur (usually microwave) operation because latching relays are frequently to be found at rallies etc for much less than their non-latching counterparts.

PHOTO 7: Dual-antenna portable operation by Stewart, G0LGS.

Choice of frequency

In the UK the 6cm amateur band is split into three segments, as seen in Figure 2. The narrow band segment is only 10MHz wide, so totally unsuitable for FM ATV. The two remaining segments are each 30MHz wide, but given that our FM ATV transmission bandwidth is about 27MHz (see Figure 3) there are only two possible transmission centre frequencies – one in the centre of each 30MHz band, at 5665MHz and 5835MHz.

None of the commercially available transmit and receive modules seem to be capable of using 5835MHz, but the 32 and 48 channel ones all

PHOTO 8: Typical suitable changeover relays. Those with four RF connectors are 'transfer' relays, which are also suitable for Tx/Rx changeover use.

PHOTO 9: 2.5W 5.8GHz power amplifier.

seem to cover 5665MHz. This is thus our chosen operating frequency.

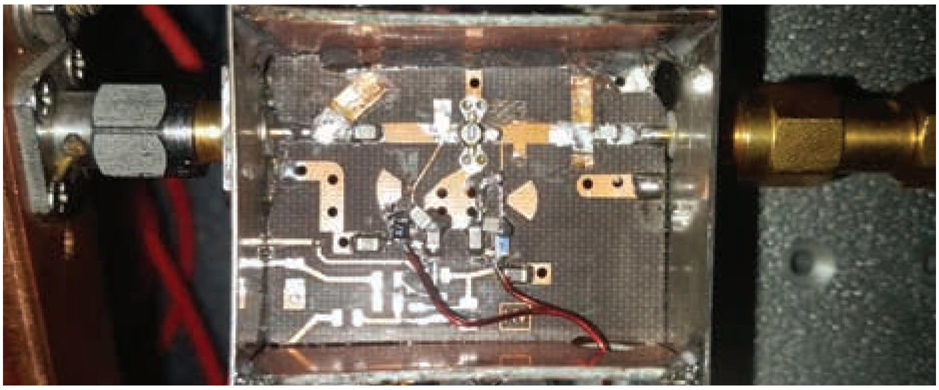

PHOTO 10: Receive preamp for 6cm built by M0DTS, based on the 'Franco' surplus board.

5.6GHz portable operation

It is worth testing your portable station with another station at close range before attempting long distances. Little things like power supply voltage drop in cables and intermittent faults are much easier to diagnose 'across the car park' rather than on a hilltop at tens of km from the other station.

Think about what you are going to use for talkback to set up the contact. Whilst mobile phones are quite acceptable, you may feel more 'in the spirit' if you use 144MHz. At the 50 – 100km that might achieve with your 5.6GHz equipment, it is probably worth taking a small Yagi for 144MHz so that talkback is not a struggle. Traditionally, ATV talkback has been on 144.750MHz FM, but some stations use 144.170MHz SSB for longer distance contacts.

You can use a path-plotting program such as *Radio Mobile* **[4]** to check paths before you travel long distances to try them. **Figure 4** shows a typical plot for a good 5.6GHz path:

Power amplifiers

The output power of many of the commercial modules is only 600mW and there are power amplifiers available on eBay to boost the output to over 2W. These can provide a cheap and effective way of increasing the transmit range of your station. Again, they tend to be provided with RP-SMA connectors and use a switch mode power supply so can be used over a wide supply voltage range. However, they are designed to run right at the limits of their safe operating area and are not tolerant of being used without an aerial, or even with loose RP-SMA connectors. **Photo 9** shows a typical 2.5W "Tx Signal Booster" power amplifier.

Receiver preamplifiers

Whilst the performance of the receivers as supplied seems to be good, the use of a low noise preamp might be advantageous, if only to overcome coax loss and allow the receiver to be located away from the antenna feed point. There are not very many published designs for 5.6GHz preamps, but a number of constructors have reproduced G4DDK's modification of the surplus 'Franco' PCBs as described in in the *RadCom* July 2014 GHz Bands column. M0DTS's preamp built from this design is shown in **Photo 10.**

Other TV modes

This article has described a low-cost method to get on to 6cm with FM ATV. Analog Devices have recently released the ADALM Pluto **[5]**, a cheap software defined radio capable of generating 1mW of digital ATV on 5.6GHz. The unit can be driven by the free *DATV Express* software **[6]** to provide a low-cost entry to digital ATV. It would need to be followed be a linear power amplifier to reach a reasonable power level for transmission. (The cheap 'Tx Signal Booster' amplifiers are rarely very linear, particularly anywhere near their rated power output).

To receive a 5.6GHz digital transmission, a downconverter to a frequency between 144MHz and 2.6GHz would be required. A MiniTiouner **[7]** and PC would then be capable of demodulating and displaying the received signal.

Support

More information about 5.6GHz operation, and ATV operation in general, can be found on the BATC Wiki **[8]**. There is also an active community of 5.6GHz constructors discussing the latest developments on the BATC Forum **[9]**. Newcomers are welcome to post questions there.

Acknowledgements

Thanks to G8GTZ, G0LGS and M0DTS for their support to 5.6GHz operation and particularly for their pictures and contributions to this article.

Websearch

[1] https://github.com/BritishAmateurTelevisionClub/rpidatv
[2] http://batc.org.uk/cq-tv/archive/1985.html
[3] www.g4ddk.com/Prices.html
[4] www.ve2dbe.com/english1.html
[5] https://wiki.analog.com/university/tools/pluto
[6] https://www.datv-express.com/#Item2
[7] https://wiki.batc.tv/MiniTioune
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