The GB3HV digital project – part 1

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Introduction

The Home Counties ATV Group has run GB3HV, the 23cms ATV repeater from a site in High Wycombe (IO91OO) for over 14 years giving good coverage of the Thames Valley, Western London, Berkshire and North Hampshire on 1308MHz

The repeater logic, developed by G4CRJ and G8LES, is very advanced and includes such functions as automatic receive aerial selection based on signal strength and video signal to noise ratio, shack and mast cameras and a 70cms analogue receiver with remotely steerable beam antenna. The logic has the facility to select multiple video sources and it was always intended to link through to other TV repeaters in the area, a feature which has been recently implemented with the installation of aerials and receivers for GB3BH and GB3FT. The pictures from these and other sources are selected by using over air DTMF commands and onscreen menus.

The digital project

In 2002 the club started to undertake a series of digital TV technology projects and have ended up embracing the convergence between traditional television as we know it and the potential offered by the internet.

- Option of QPSK digital receive facility on 23cms input frequency
- Option of QPSK digital receive facility on 70cms
- Selectable digital output on 1308MHz using QPSK modulation
- Permanent internet streaming output at 200Kbit/s using WM9 with unlimited number of users
- Potential internet input using H.263 video conferencing technology.
- Interactive website including streaming and chat room
- Dynamic weather station display on GB3HV and www.GB3HV.com

This article looks at the implementation of the digital TV projects and the lessons learnt whilst a second article will cover the experiences of implementing internet streaming and interactive website.

<u>23cms QPSK receive</u>

In 2003, first generation professional MPEG video encoders and QPSK modulators started to appear on the surplus market and also the German and Dutch DATV project modules became available. This meant that amateurs were now able to generate standard DVB QPSK signals and several members in the group started to experiment with mixed results. As a result of these experiments it was decided to fit an NDS System 3000 professional QPSK satellite receiver at the GB3HV site to receive these signals.

RF installation was relatively simple, splitting off the received signal before the FM receiver and feeding the digital receiver via a line amplifier. A 20dB standard satellite line amplifier was required as it was found that the digital receiver needed more input gain than the existing analogue system.

After some experimentation it was determined that a symbol rate of 4 Msymbols and an FEC rate of ½, giving an RF bandwidth of approximately 4.5 MHz, gave the best compromise between picture quality and RF low signal performance.

Initially it was not possible to implement automatic antenna selection due to the long signal lock time of the first generation digital tuners but the digital receiver signal lock relay was used to switch automatically between the analogue and digital receiver audio and video signals when a digital signal was received.

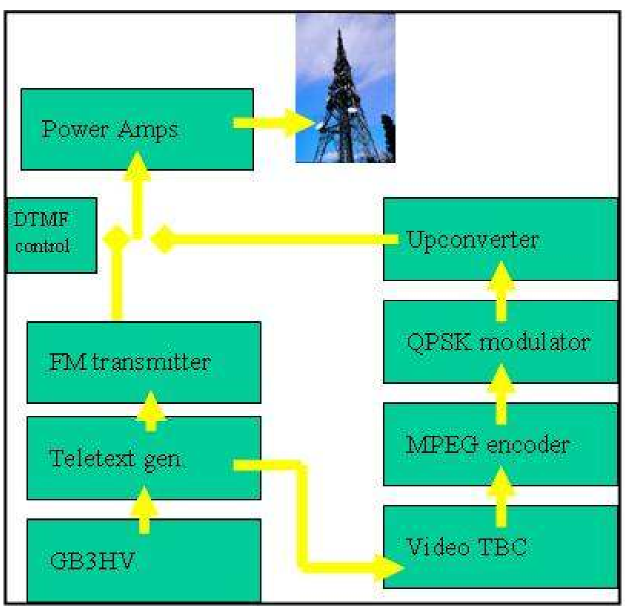
During 2004, a more modern NDS Alteia receiver replaced the System 3000 receiver. This receiver had a greatly reduced tuner lock time allowing automatic aerial selection on digital receive to be implemented and totally reliable MPEG service selection.

Digital transmit on 1308MHz

Having established the viability of digital transmission on 23cms, it was decided at the end of 2003 to add a user selectable digital transmit capability on the main transmit frequency of 1308MHz. By purchasing a digital free to air satellite receiver, available for less than £40, and an RF splitter, users who have normally get P2 analogue pictures can now see P5 pictures from GB3HV.

To implement this facility at HV required additional equipment and modification to the existing transmit chain. A professional ex broadcast MPEG-2 encoder was set up to take the standard repeater video and audio output signals. This simple step proved more difficult than envisaged as the video output from the Vic 20 control computer and Cropody test card generator is not a valid PAL signal, 623 lines rather than 625, and the ex broadcast MPEG-2 encoder would not lock to the signal. Several time-base correctors were tried to deliver a PAL compliant signal and eventually a Fora unit, courtesy of Roy G4WTV of the Worthing group, was found to perform the correction without producing too many digital artefacts on the video when presented with a noisy incoming signal.

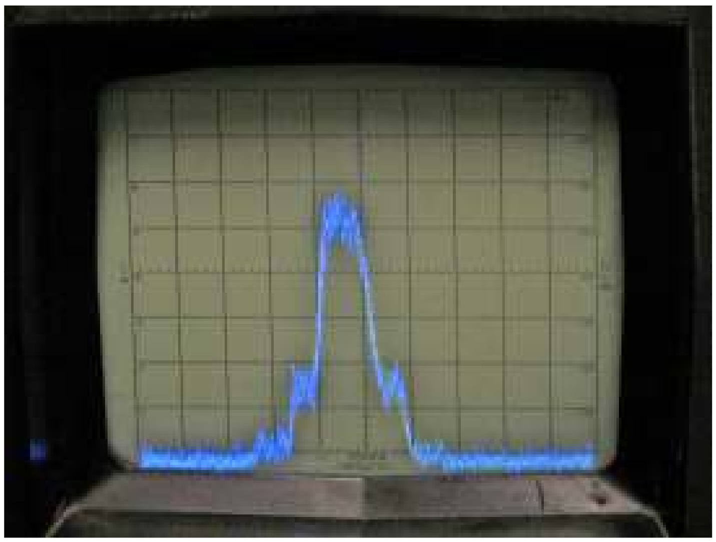
The encoder produces an MPEG-2 compliant data stream in the industry standard 204 byte ASI format that is fed in to the QPSK modulator which produces a tuneable IF output set at 156 MHz at 0dBm level.



A standard amateur linear transmit up converter, designed for SSB operation, is driven by the IF output of the modulator and produces a low level signal (approx +3dBm at

1308MHz). This is then fed in to a second amplifier before being fed in to the final FET brick amplifiers. The original bi-polar power modules proved unsuitable for digital operation due to spectral re-growth issues. They had to be replaced with the latest Mitsubishi FET modules which can be run at 90% power rating and still achieve -40dB regrowth performance. Even so considerable care has to be taken with drive levels, in particular by reducing the output of the transverter, filtering and linearity at all stages to ensure spectral re-growth is below -40dB at the final output.

Switching between analogue and digital driver stage is achieved by DTMF controlled relays that switch DC to the appropriate driver stage and route the RF output in to the final PA stages.



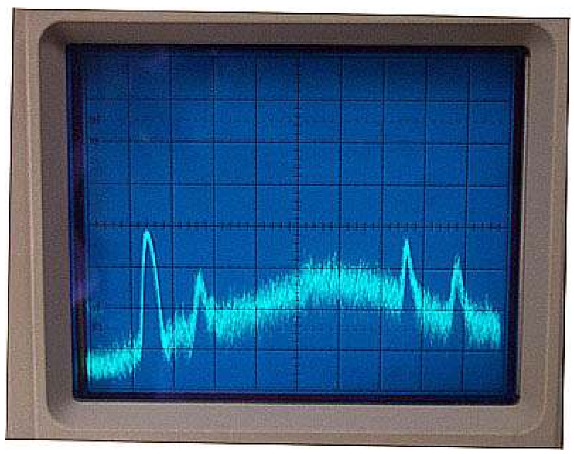
The transmitted QPSK signal is set for 4 Msymbols at ½ FEC and long term tests have shown that the performance of the 4Mhz QPSK signal is superior to the FM performance and a typical user, for a minimal investment of less than £40, can enhance his received signal from a noisy P1.5 to a noise free P5 signal. The QPSK signal is surprisingly robust and does not appear to suffer from multi-path effects, even when viewed over a path with significant aircraft flutter from traffic at Heathrow.

The downsides of the digital transmission appear to be that it is difficult to "tweak" aerials or receivers, due to the digital cliff effect meaning that the picture is either present or not. More modern receivers have both signal level and quality or BER indicators that go some way to resolve this but it is still difficult to adjust system elements when living in a weak signal area.

The second down side is the digital encoding delay that confuses operators when using direct analogue talkback on 2 metres alongside digital encoded signals with a delay of approximately 1 second. Unfortunately this is a fact of digital processing and is unlikely to go away in the near future – it is however, no near as bad as the delays experienced on internet streaming – more on that in the second article!

70cms digital receive

A series of tests conducted between G8GKQ and G8GTZ (see CQTV 200) proved the potential of using a 2MHz wide QPSK signal to transmit P5 colour pictures with 2 channels of audio over a 60 mile obstructed path on 436 MHz.



GB3HV already had a 70cms analogue ATV receive system, with a 5 Element beam and masthead preamp, and in summer 2004 it was decided to add a digital receive to the system. A similar system to that used on 23cms was implemented with automatic selection between analogue and digital receivers.

The system works successfully using 2 Msymbols and ½ FEC to give an RF bandwidth of 2MHz. Unfortunately, an aerial system fault occurred immediately after digital installation and whilst G8GKQ has managed access over the 10 mile with P5 results on a temporary aerial the system has not yet been used to its full potential.

Conclusion

Hopefully this article has given an introduction in to some new aspects of ATV and has shown that ATVers are investigating new spectrum efficient transmission techniques and certainly not content with sticking to "yesteryears tech". It is also hoped that this article will encourage amateurs to investigate ATV in its widest sense and also encourage other ATV repeater groups to look at developing similar projects.