

# BAA Update

## Obituary

### Angus McKenzie, 1933–2005

It is with great sadness that we record the death of Angus McKenzie MBE at the age of 71 after an illness lasting for several months.

Angus was a well respected and long standing member of the Hampstead Scientific Society and the BAA, having joined the HSS at the age of 14 in 1947. He was interested in all aspects of science, in particular, chemistry, radio and above all else, astronomy. As a youthful enthusiast, he was greatly encouraged during the 1950s by the HSS' late astronomy secretary and BAA Curator of Instruments, Henry Wildey.

Angus was born in September 1933 and was educated at St Paul's School, Hammer-smith. He went on to study for City and Guilds in electronic engineering and acoustics, but failing eyesight caused him to abandon the course at the end of the second year. It was typical of Angus, that even the total loss of his eyesight in 1959 did not prevent him from remaining passionately interested in astronomy for the rest of his life. Having

joined the British Astronomical Association in his teens, he remained a member until his death and would frequently attend meetings accompanied by his faithful guide dogs Simon and latterly, Ward.

It is often said that the loss of a sense, such as eyesight, leads to the development of other senses to compensate. In Angus'



*Courtesy Kirsty McKenzie*

case this was clearly demonstrated. He built a career in audio and radio, at first running a recording studio and later becoming an audio and radio consultant. He engineered and produced numerous recordings of classical music and carried out much research into stereo, binaural and quadraphonic sound. He wrote many technical papers and gave

many lectures on topics as diverse as radio and hi-fi, amateur radio, classical music, astronomy and the London underground railway. He broadcast on both radio and television and was the author of many books on the subjects of hi-fi and amateur radio.

His great passion for the London Underground, on which he travelled frequently, led him to produce an auditory guide to the system in 1994 which was available free of charge to blind persons. This innovative guide, a kind of 'sound map', led the user from station to station providing clues as to their location from the pitch of track noises and the different sounds emitted by tube train brakes. I well remember the lecture he gave to the HSS in which he vocalised the different noises made by different makes of tube train and the sounds which they emitted when accelerating, braking and passing over points.

Angus was also a regular speaker and fund raiser for the Guide Dogs for the Blind Association and in recognition for this work he was awarded the MBE in 1997. He was the first blind member of Mensa and was a fellow of the Institute of Electrical Engineers and the Audio Engineers Society.

For many years Angus lived in Finchley in a house crowded with electronic equipment with shelf upon shelf of records and CDs, each labelled meticulously in Braille. I always marvelled that he could find a particular recording instantly. He had a talking computer and the house was equipped with a gigantic rotating radio aerial which could be seen from miles away and was used by him to communicate with fellow radio 'hams' throughout the world.

Angus leaves two daughters, a son and two granddaughters and a multitude of friends, who will mourn the passing of a man who never let a physical disability get the better of him.

**Doug Daniels**

*(Astronomical Secretary, Hampstead Scientific Society)*

## Erratum – February Journal

We regret an error which occurred in the report of the Ordinary Meeting of 2004 May 26 in the February Journal, page 48, where it is incorrectly stated that the speaker said that the currently accepted rotation period of Mercury is 4.4 days. 4.0 (3.995) days is the period of the rotation of the atmosphere of Venus, not Mercury. Our thanks to Dr Roger Griffin for pointing out this error.

## New members

The British Astronomical Association cordially welcomes the following new members:

### **Elected 2004 May 26**

- Blackwell** Alan, Nottingham
- Brownridge** Carl Richard, Exeter, Devon
- Colquhoun** Hugh, Clydebank, West Dunbartonshire
- Eziefula** Obiako, London NW9
- Gawthrope** Gary James, Swinton, South Yorkshire
- Gibbons** Ralph, Chesterfield, Derbyshire
- Gibson** Nicholas Martin, Spilsby, Lincs.
- Haddock** David John, Worcester

**Hendry** John David Robert, Felton, Northumberland

- Jones** William, Sheffield, Yorkshire
- Knowles** James, Chesterfield, Derbyshire
- Leiper** Fiona, Lentrán, Inverness
- Loran** Michael, London N6
- Moffatt** Terrence, Lockerbie, Dumfriesshire
- Parks** Julian, New York, USA
- Sinfield** Aston, London SW12
- Waller** Graham, Loughborough, Leics.

### **Elected 2004 June 26**

- Beesley** David Edward, Belfast
- Belfield** Mark Jonathan, Weybridge, Surrey

## In Memoriam

**A**ngus McKenzie, AES fellow, died of cancer on January 14, in the UK. He was 72 years old.

Born in 1933 in Maida Vale, his family moved to various addresses in Hampstead and St. John's Wood. He was educated at St. Paul's School.

His interests developed along the lines of electronics, music, astronomy, mathematics, and chemistry. His parents soon found their house wired for sound, so that classical music could be fed into every room. From an early age Angus sight was a problem, and he lost the use of his right eye when he was 16. It was wrenching for him to have to give up chemistry, probably his main subject at that time. However, his interest in music and recording developed apace, and he enrolled at Imperial College studying for an electronics degree. Once more, because of vision problems, he was unable to complete the course of study.

In the 1950s, as a member of an Anglo/Hungarian cultural society, he went to help refugees at the time of the Hungarian Revolution. He was stationed at the border at Gussing, and witnessed many traumatic sights. He also helped in deciding which countries refugees should go to.

Returning home, he worked at a recording studio in the North End Road and soon opened Olympic Sound Studios near Baker Street. Early clients included Steve Race and Frankie Vaughan. In the recording of Josh McCrae's "Messing About on the River," the splashy water effects were Angus with a cup in a bucket of water, and a finger pulled sharply out of his cheek provided the "pop" for one of the first Birds Eye pea commercials. Using his studio premises, he founded the Cultural Society of the Disabled, running monthly social meetings or concerts, and obtaining discounts for members on electrical goods.

He married Fiona in 1959. His eye problems worsened, and he shortly

lost the sight in his left eye. He, nevertheless, became the first blind member of Mensa, via a specially designed test and also obtained his amateur radio license.

His children, Kirsty, Robert, and Margaret, were born in the 60s. In that same decade the studio closed on the termination of the lease on the building. Angus then opened Roundabout Records in St. John's Wood, and a second branch in Hendon. He was beginning to write articles in audio magazines and radio reviews for *Hi Fi News*; the latter turned into a regular monthly column. At first his comments were not entirely welcome within the BBC, but later they were viewed as constructive criticism, and he made friends within the BBC. He also made recordings at the house in Finchley and on location.

This recording side developed into testing and reviewing hi fi and amateur radio equipment, with a laboratory in the back of the house, and the employment of engineers. Many Tonmeister students from Surrey University spent their industrial year with Angus. Eventually Angus McKenzie Laboratories became the main hi fi testing laboratory for the publication *Hi-Fi Choice* and for the Consumers' Association. The house would fill up with tape recorders or amplifiers or whatever was being tested. He performed what may have been the only comparative testing of brands of audio cassettes. The company also made many commercially released recordings.

His resolve to use his skills to help equip other blind people to overcome the challenges of life led to the award of an MBE in 1979. He also became a fellow of both the Institute of Electronic Engineers and the Audio Engineering Society. He became skilled in the use of computers, using voice synthesis to read texts. He devised audio metering techniques in which the "display" was audible pitch.

Relaxation was amateur radio, and the rotating aerials over the house,

and the mast in the garden, could be seen from miles away. He transmitted on every band, and "George 3 Oscar Sierra Sierra" was a well-known call sign. He also enjoyed a wide range of scientific, astronomical, and railway magazines. He may have been the only blind member of the British Astronomical Association.

His marriage ended in 1989, and with typical dedication Angus threw himself into the acquisition of new skills. He mastered Braille, learned to cook, and tackled long cane mobility. When he was deemed sufficiently able to go out alone, he qualified for a guide dog, and Simon, a Golden Retriever, came to live with him. Angus became a well-known speaker and fund raiser for Guide Dogs, first with Simon and then with his successor, Ward.

With his knowledge of audio engineering, he became involved in the technical aspects of talking books for the blind. Carrying on his determination that the visually impaired should not be at a disadvantage, in 1994 he produced a cassette guide to the London Underground, using sound clues to help blind people negotiate the baffling maze of tunnels, platforms, and escalators. This was available free of charge to all blind people across the capital.

In recent years Angus greatly valued the fellowship found in Freemasonry, in the 8040 Radio Fraternity Lodge, and in the Old Pauline Lodge. He was also an active member of Rotary, The Hampstead Scientific Society, British Astronomical Society, Radio Society of Great Britain, and the RNIB.

Angus' family, now including granddaughters Sarah and Emma, and friends, have been saddened by the sudden onset last spring of the cancer that overwhelmed him. He will be remembered and missed by very many people who have known him through his various activities.

—Fiona McKenzie with additions by Kenneth Gundry, long-time friend.



Now: In Store and  
**CHECK OUT OUR NEW W**  
**FOR WEEKLY UPDA**



## Angus McKenzie MBE (1933–2005)

Paul Messenger | Jan 17, 2005



Angus McKenzie was a wholly remarkable individual. One of British hi-fi's legends, he was the country's leading equipment reviewer for more than a decade, but that was only one of several careers and passions he pursued with repeated and conspicuous success, despite losing his sight completely at the age of 26.

He studied electronics and acoustics, and at the same time his passions for music and radio, both amateur and FM, developed. It was early days in the professional recording business, and his first business venture was to start up the famous Olympic Studios—Led Zeppelin, The Who, Small Faces, and the Rolling Stones, among others, recorded there—which began life in West Hampstead in the 1960s before moving to its current home in Barnes in suburban South London. With failing sight, he sold Olympic, moved on, and set up a shop specializing in classical records and select hi-fi. At the same time he began writing for the magazines that were emerging, such as *Tape Recorder* (which evolved into the professional audio title *Studio Sound*) and *Hi-Fi News*, where his regular column on FM radio ran for several decades, and served as a very effective "quality monitor" for the BBC. Among the well-known personalities who entered the audio business as Angus' intern are A-list classical engineer Tony Faulkner and Francis Rumsey of the Audio Engineering Society and the University of Surrey.

Although blindness unquestionably is a serious handicap to any engineer, Angus courageously treated his lack of sight as a challenge. Improved hearing acuity enhanced his work as an audio critic, while he used great ingenuity in adapting his instrumentation to operate by "feel" (analog) and voice synthesis (digital). As the hi-fi business entered the 1970s "boom" years, Angus left retail and brought his audio expertise and engineering know-how to bear on evaluating hi-fi equipment of all kinds. He effectively invented the British magazine *Hi-Fi Choice*, authoring most of the early titles on receivers, cassette decks, and loudspeakers. He also did a considerable amount of consultancy work, especially for tape manufacturers and the European Consumers Association. Crucially, he developed the methodologies for large-scale group measurement and listening tests, and established the rigorous standards that made the UK hi-fi press respected throughout the world.

His tireless work on behalf of the blind, memorably including an audio tape guide so the unsighted could safely navigate the complexities of the London Underground (subway) network, received due recognition in the accolade of a prestigious MBE (Member of the British Empire) award in 1979.

Angus wasn't the easiest guy to get on with, as John Atkinson, who was one of his editors at *Hi-Fi News*, can attest. He could be stubborn, and sometimes arrogant, but was a genuine polymath whose formidable creative intellect always commanded respect, as JA will also attest to. He will be missed by all he encountered across a wide variety of audio and radio fields.

# More Ripping Yarns

One of the funniest incidents that happened to me some years ago, came as the result of two or three evenings worth of concentrated activity on 10m when I had been beaming south. The following morning after this activity, I had gone

asked what the problem was. She was told that an automatic garage door opener had been fitted in a house some days earlier, and his customer had complained that two evenings before he had come home in his car and opened the doors

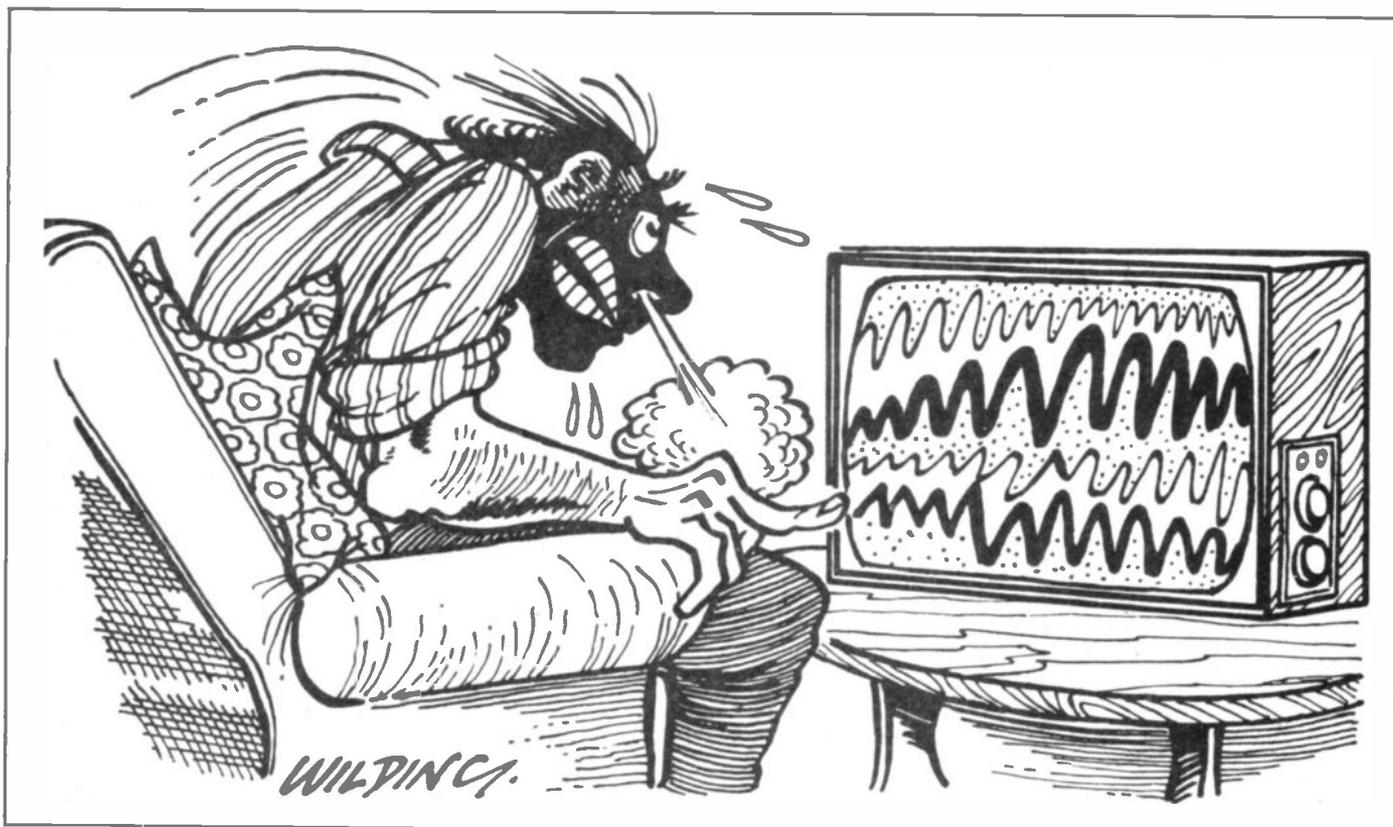
completely illegal, and uncomfortably close to 28MHz! Can you just see the garage door opening and closing every five minutes which corresponded to my overs on 10m!! This really did happen, and I am not inventing it. Indeed, on mentioning the fact to the Home Office, I think they laughed more than I've ever heard them laugh before, finally commenting that they would fix the householder concerned if and when they filled in the Radio interference form which my wife had suggested should be filled in as a parting shot to the enormous bruiser!

*Angus McKenzie, G3OSS, provides a few more anecdotes from the back pages of his logbook...*

abroad on business, but during the day my wife was visited by a very irate and rather large builder who claimed to have been doing some work in the next road. In a bruiser type of voice he asked if there was a radio ham transmitting in the place. My wife quite politely said that there was, to be followed by a command to stop transmitting. My wife maintained her cool and

automatically from it, had parked the car inside and then closed it to find it open the next morning. The following evening, after the same process, the 'builder' gave the following description, as from his client:- "Up, down, up, down, up, down, every ----- five minutes with ---- grinding noises," etc etc. Quite clearly, the equipment was using the 27MHz band which was then

There are some stories that may appear very doubtful, but which are completely true, and perhaps one of the most amazing ones, is the time that I broke into my neighbour's burglar alarm. Just



how can an amateur radio transmission get into a burglar alarm and create a problem? At one o'clock in the morning, I had a QSO on 80m with a friend, and had just finished when my wife came through to say the whole place was surrounded with police. . . On looking through our bedroom window, a black maria and two police cars could be seen, together with hairy police dogs and coppers everywhere. One came to the back door, and explained that the whole area was surrounded and that they were looking for an intruder, as a result of a 999 call. We were both very puzzled, and frankly, rather scared, particularly when the policeman requested a search of our premises, finding nothing of course. After perhaps half an hour, the pandemonium died down and there was just my neighbour remaining looking incredibly puzzled, in his dressing gown by the back door telling my wife that he couldn't understand it. He had been in bed with his wife upstairs, and their very young child had been fast asleep in another room, when they all woke up as they heard some noise. The child later claimed that there had been a large doggy in her bedroom, while my two friendly neighbours had heard burglars' voices downstairs. The husband got out of bed, and looked for the nearest blunt instrument, and crept to the top of the stairs whilst his XYL disappeared under the sheets with the telephone and whispered to Scotland Yard that they had intruders. The police asked her to speak up, so she whispered louder, giving her name and address which resulted in the police arriving. They must have thought they were a house of lunatics, but I knew them to be very level headed folk and so I suggested that it might have been my amateur radio. The following morning, I discovered that indeed it was, for the alarm had a minute audio IC in it feeding a very small loudspeaker which was designed to make a hooting noise when the system had been set, properly, but not completely turned on. The problem was that the audio IC and miniature speaker (only around 2cms) was always live, and only the hooter section was muting, and so my voice was picked up on 80m, rectified in the normal way at the input and a garbling noise came

out of the miniature speaker at full volume, thus sounding like an intruder downstairs to sleepy people upstairs! Of course I was incredibly embarrassed, but both the police and the Home Office thought it a huge joke, although the burglar alarm people did get fairly cross. The large dog in the bedroom will still remain a mystery!

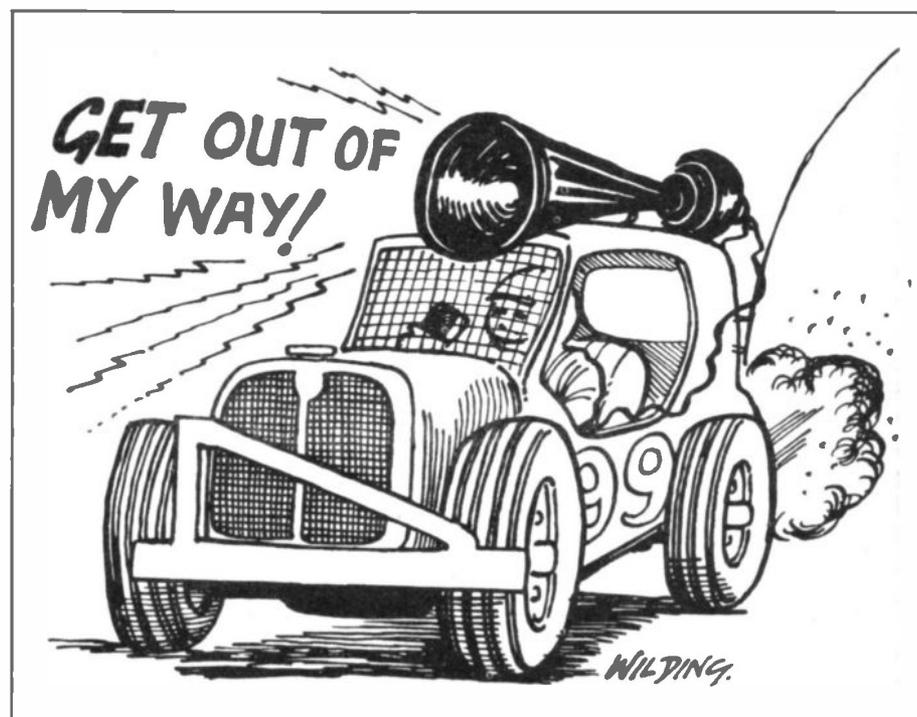
### Going mobile

Mobile operators are always having interesting experiences, and in the days of AM on the HF bands one heard the most amazing tales of amateurs passing a gymkhana and hearing their voices booming out over the tannoy system and making various remarks which greatly disturbed the gymkhana organisers! I suppose the funniest incident that happened to me though, while mobile, was when my wife and I were trying to find a very high point in the old Welsh county of Montgomeryshire in 1961. We had found an old disused farm with gates either end of it, with a track going right through the farm, but we realised that we were completely lost and time was running a little short. After many calls, we eventually raised G4LU, Stan, in Oswestry, Shropshire, who took bearing on us and who was able to give us an approximate position. He contacted two other friends on 2m, and with the help of an ordnance survey map, managed to locate our exact position using normal direc-



"NOT A WORD ON THE RADIO ABOUT LAST NIGHT'S TORRENTIAL RAIN, DEAR!"

tion finding methods. He was able to tell us that we should drive north through the farm and then immediately turn left, and at the top of a track turn right onto an unclassified road which eventually led up to a very high point. We were fairly sure which was North, and so my wife drove as directed, but the ground was getting soggy and more grassy, eventually with no sign of a track at all. We stopped our Standard Companion estate car in the middle of a field of cows, scratched our heads, and drove all the way down again, while remaining in contact with G4LU, who eventually twigged that we had indeed got South and North mixed up. After this rather hair raising adventure, we eventually did find the correct way, and managed to work many stations who had not heard anyone in Montgomeryshire before, on 2M.



My early mobile installation on 2M included a Withers halo on the top end of a metal rod which used to slide down behind the hinges of the back doors of the estate car. It always struck me as amazing how Tom Withers' halos seemed to remain shiny and bright, and looked brand, spanking new for years. It was not for 10 years or so that I eventually found out what in reality had been happening, surprisingly regularly. Every few weeks my wife would forget that the halo was up, and would drive into our garage, and just before coming to a halt would hear once again the expensive crunching noise heralding the destruction of yet another halo. This was invariably followed by my wife making a fast trip to Withers' original factory in North Enfield, where apparently she got a good exchange deal of new for old, being easily Withers' best customer for halos. At the time, rather a strain on the housekeeping!

#### Accidents can happen

There are some occasions when it can be very embarrassing to be transmitting inadvertently. I can well remember twenty years ago one amateur who had very bad asthma as well as an incredibly loud parrot (which used to over-modulated like hell) and who was given a bottle of scotch on New Year's Eve. He drank the entire bottle over a three hour period, as all good Welshmen do, followed by the loudest final I have ever heard, his speech becoming more and more slurred and wheezy followed by a bump and happy snoring. The following morning, he was discovered still snoring by his rig which was still transmitting happily.

My own terrifying moment came when twenty years ago, my lovely fluffy white cat switched on my transmitter with her back left foot, and when I came home I proceeded to have a slight disagreement with my mother-in-law just outside the shack, not realising the rig was on! Before long, my telephone rang and a friendly local amateur warmed me to what was happening, amid much loud laughter from his end.

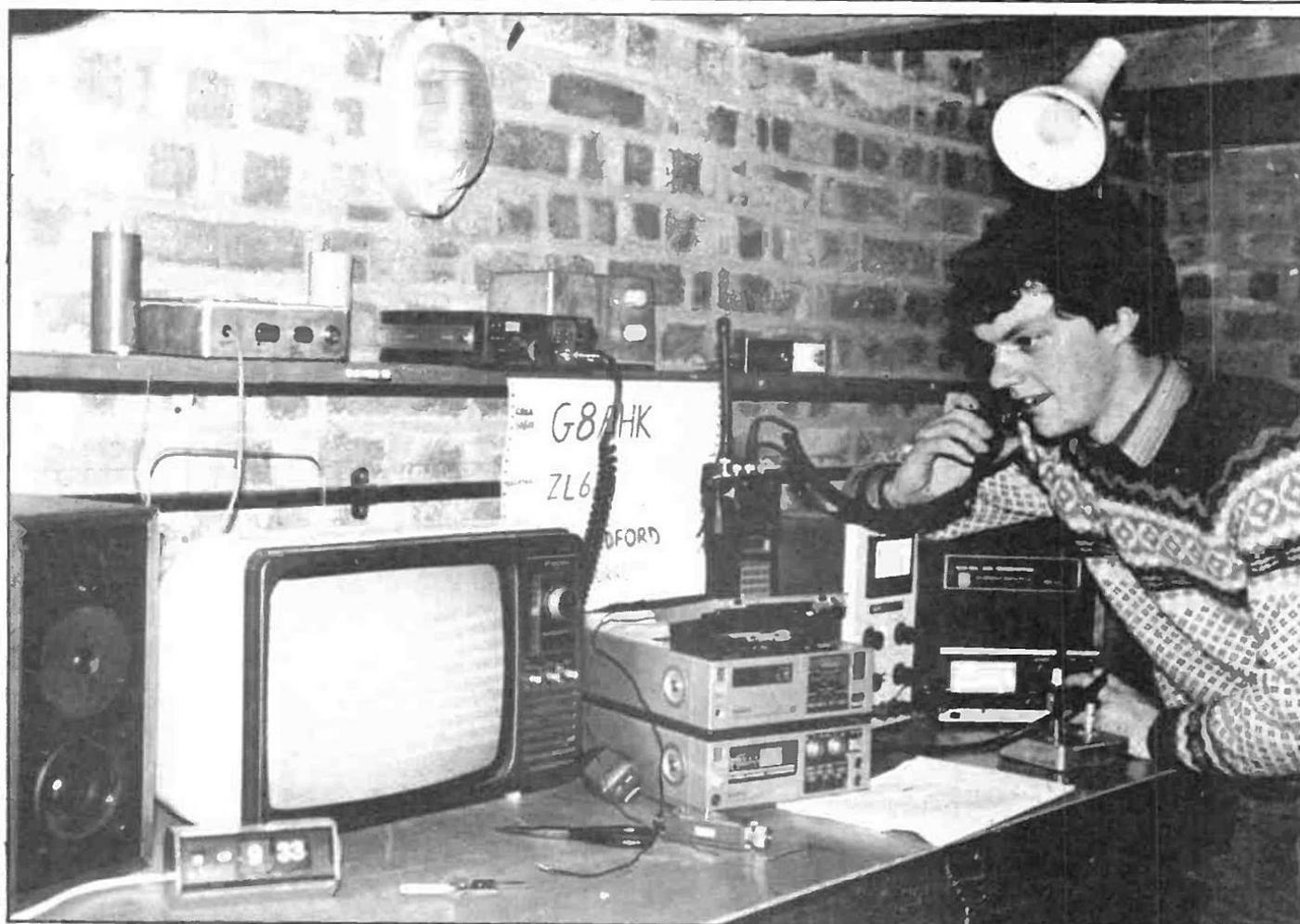
We can all do quite ridiculous things at times, and I can be as stupid as anybody. So now you can all have a laugh at my expense if I



admit to something really crazy. I used to have a Withers crystal controlled valve converter for 2m whose output used to be plugged into my normal receiver. One day I commenced loading up on 14MHz, into what I thought was my aerial, but the anode load and tune controls seemed to be in very strange positions indeed. After a short while, there was a most expensive smell coming from the gear which turned out to be my Withers converter going up in smoke as I was attempting to tune up 100W of RF into its output stage, back to front as it were. The manufacturer said he had never seen one of his converters in such a mess before but perhaps a few readers have even

more crazy stories to tell! Has anyone heard of anybody loading up the overhead power cable of a disused tram line anywhere on top band yet?

On one Scottish holiday, while mobile near Loch Lomond, we stopped to transmit in a village, attracting the attention of a couple of small boys. Soon they were sitting in the back of the car, eating our toffees. It was a good location, and I decided to amaze them with a tour of the furthest points of the globe. No reaction from the lads, so when the toffees were finished, I said brightly, "well, what did you think of that?". A pause for reflection, and the more talkative of the two said, "Can ya no get France?".



# Why not hi-fi audio on amateur radio?

Many years ago I transmitted my first stereo on 2m, using an extraordinary lash-up. Two microphones were fed through a control desk and into a limiter and thence through a Dolby B processor. The output from this modulated a stereo encoder whose composite output was used to drive a signal generator with output frequency on 145.5MHz in the days (14 years ago) when this part of the band was not used normally in London, only coming to life in an opening!

The signal generator output was amplified up to 3w drive for a QV07/50 PA valve which could give out a healthy 90w for 150w DC input. My stereo test signals and speech were heard, and recorded in stereo by G8AMG when he used to live in South east London; he made a special converter from 2m to 100MHz so that he could use his normal stereo FM tuner. The path worked very well, but it was not long before I was goaded by my good BBC friends for transmitting some hum in the background. It was quite right that they should criticise this, for as FM radio critic for *Hi Fi News*, I often criticise them for the same reason!

**I have always been interested in the highest possible quality of audio transmission, recording, and reproduction, and whilst there is no direct connection between this and the transmitting of information on amateur radio in the normal sense, there is no reason at all why amateur radio should not be the breeding ground for researching into higher and higher quality audio transmissions.**  
Angus McKenzie, G30SS

The system worked well, both with narrow and with wide deviation and whilst one station criticised me for spreading, others found the whole exercise of interest. The critic, however, was calling the kettle black, for his AM transmissions used to spread like hell every time his incredibly noisy parrot squawked about three feet from the mic, causing violent flat topping and over 50kHz band occupancy on the peak!

Some years later I repeated the whole exercise again on UHF, again proving that it can be done quite easily. Strangely, the

RSGB took absolutely no interest in what was believed to be the first multiplex stereo transmissions on an amateur radio band, and yet when I wrote it up in detail in *Hi Fi News*, I received dozens of letters from amateurs all over the world who would have liked to have seen it written up in an amateur radio magazine.

I was preparing, two years ago, to carry out some prolonged tests on the 23cm amateur band of multiplex stereo in order to check the occurrence of multi path and other anomalous propagations, when it occurred to me that I should be able to do some interesting research into the transmission of digital signals in order to see if they would be ruled right out of court. Or alternatively could be worthwhile.

## Analogue to digital conversion

It would be as well to describe in detail what PCM actually is and roughly how it works before detailing all the experiments that my friends and I have been making. Although there are many different standards for digital sampling, the most usual one is at just over 44kHz. The incoming

signal is sampled at this frequency to ascertain its level at the moment of sampling.

It would be as well to describe in detail what PCM actually is and roughly how it works before detailing all the experiments that my friends and I have been making. Although there are many different standards for digital sampling, the most usual one is at just over 44kHz. The incoming signal is sampled at this frequency to ascertain its level at the moment of sampling.

Immediately preceding the sampling stage there has to be a low pass filter having an extremely steep cut in response, with its wall at or below half the sampling frequency. This filter stops aliasing, since frequencies above the Nyquist frequency could be digitised, and then brought back to analogue at a frequency below the Nyquist frequency.

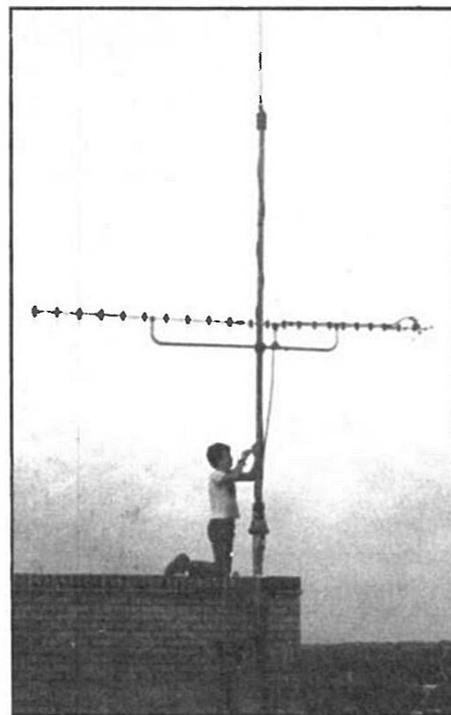
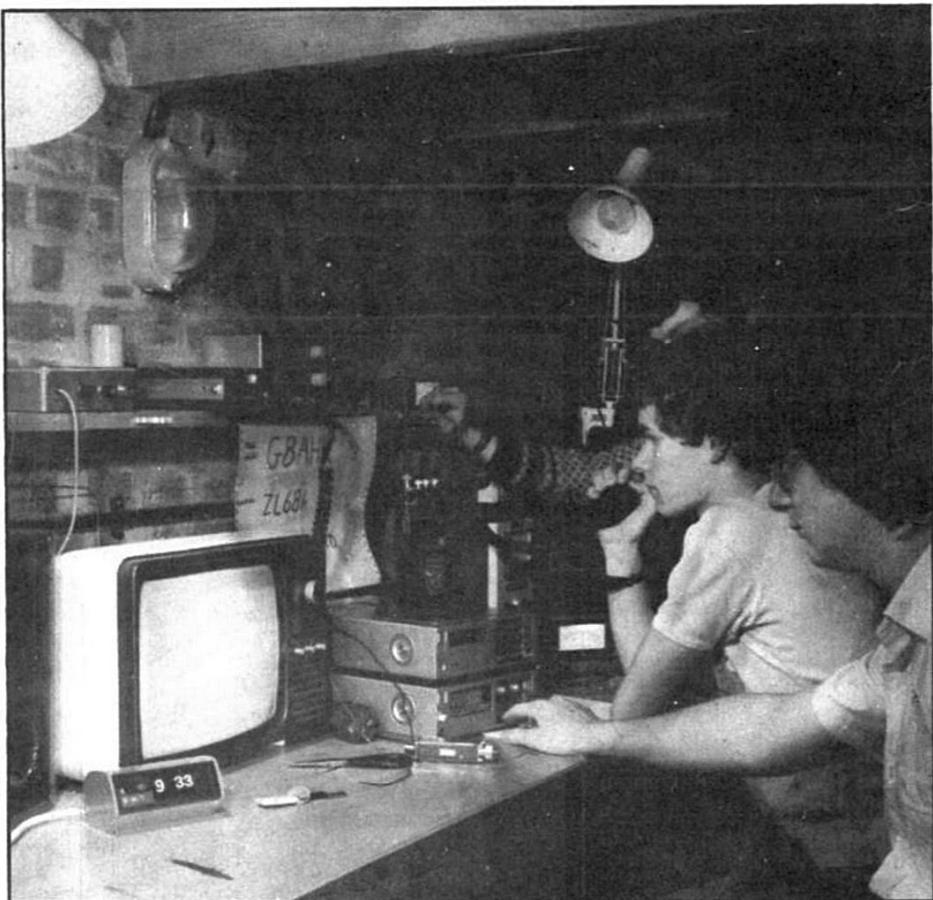
---

**“Eight-bit coding gives a reasonable quality for telecommunication purposes.”**

---

The accuracy with which the level is sampled is governed by the number of bits available for expressing the number. In extremely low quality links, as few as four bit coding has been used, with the resultant diabolical sound which is intelligible. Eight-bit coding gives a reasonable quality for telecommunication purposes, 13-bit coding being used by the BBC (with a sampling frequency of 32kHz) on many of their digital links to transmitters, whereas early digital sound recordings and any compact disc playback systems are replaying 14. Sixteen-bit coding is available, even on domestic digital equipment and all the high quality new compact disc playback decks give 16-bit playback, even if they use 14-bit deprocessors, but this is with a technique called “over sampling” which allows an extra two bits to be given by interpolative processes.

The characteristics of the digital audio system are of particular interest. With reference to the top bit, (full modulation) distortion levels should be not far above the noise level, and a 16-bit system should have distortion of around 0.01 per cent, with noise perhaps at least 10dB lower than this. Distortion is not only harmonic, and its equivalent, intermodulation, for alias tones are produced represented by harmonics of the input frequency beating with the sampling frequency, or any other frequency around in the digital processor. The art of good design is to keep all these down to a minimum.



*Far left Mike Hatch, Simon Whittle and Keith Davies operating the PCM link from the University of Surrey EARS shack*

*Top of this page: Keith Davies, G6VCQ, using a 2m talkback to Angus McKenzie, G3OSS. The PCM-F1 and SL-F1 video recorder are in the centre of the picture, to the right of the television screen.*

*Above: Amateur radio is not all easy going! Here's Simon Whittle risking life and limb fitting the masthead preamp. And mighty impressive it is too.*

At very low levels, distortion might be audible if you listened at an unrealistic reproduction level, since most digitisation is linear. Imagine a system which digitises from one volt downwards with levels at each millivolt. There would be 1001 levels from 0 to 1000 representing 0 volts to 1000 millivolts, say, positive. These 1000 levels could be represented by 10 bits of binary coding; in other words a 10-figure number in which each single number is either a nought or a one in the binary scale. To express any voltage between + and - 1 volt to a 1mV accuracy, one will need 11 bits in a digital word, thus giving 2001 levels, including 0.

---

**“Dither is a form of white noise added to the signal at a very low level. . .”**

---

A very low level signal will be jerking through the mV sample points up and down as if on a staircase, but the steps will be smoothed out by the steep anti alias filters on reproduction, which is another reason for their presence.

Even so, you might imagine that a level below 1mV would not register and this would be true were it not for the addition of “dither”. Dither is a form of white noise added to the signal at a very low level to push the lowest level signals over the bottom bit some of the time, thus allowing extremely low level signals to register.

An explanation of dither is unfortunately extremely complex and many articles have been written about digitisation in magazines,

## Why not hi-fi audio on amateur radio?

such as *The Audio Engineering Society Journal*.

The frequency response of the digital system can be flat from DC up to extremely close to the Nyquist frequency, and typical signal-to-noise ratios in excess of 90dB can be achieved with better than 90dB cross talk for stereo and virtually no audible distortion in practice. Digital sound, frankly, exposes the listener to all the inadequacies of the original sound balance and has often been criticised by very biased critics who seem terrified of any new technique. It is true that many a hard digital recording has been made when microphones giving a hard sound have been used. But this is not the place to moan about the quality of the source signal . . .

Analogue signals are obtained from digital ones by allowing the digital coded number to churn out a voltage for the requisite time with the anti aliasing filter following

the digital to analogue conversion stage. This voltage then bobs up and down as the original audio did before it was digitised. The digits are clocked through the digital system at one word per sample for each channel being digitised, thus we would get two 16-bit words for stereo at just over 44,000 times per second.

---

**“ . . . how to transmit the bits as easily as possible in an amateur radio context.”**

---

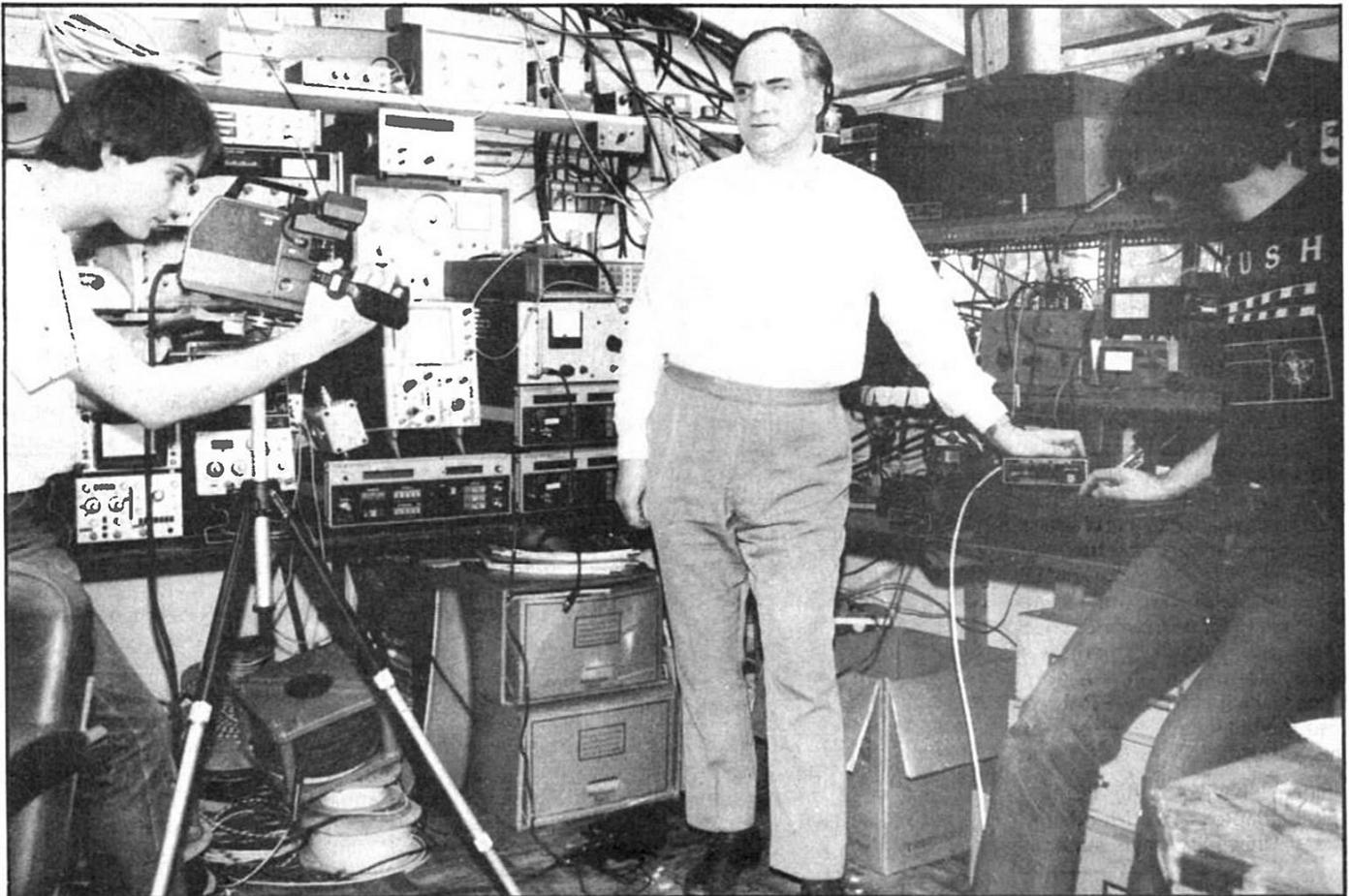
Various other words have to be transmitted in order to operate error correction and concealment within decoding. Various other types of coding concerning, for example, the presence or not of pre emphasis are all put into the melting pot, coming under the generic term of 'digital house-keeping bits', these usually adding up to as much as 30% or so of the total bits transmitted. So now we have the question of how to transmit the bits as easily as

possible in an amateur radio context. And what can be gained from doing it anyway?

I enjoyed the really good quality of 'steam' AM amateur radio as it was over 20 years ago. A guy who put out a good transmission from the States was almost talking to you in your own room if you had a good receiver. There was a major difference between good and bad transmissions. With SSB the "put-your-feet-up, and-relax-back-and chat" contact has been affected, for many, by the listening fatigue of hearing the restricted bandwidth transmitted on SSB.

FM is somewhat better, but the conventional restrictions on bandwidth hold it down to a communication-only mode. You may feel that amateur radio is entirely a communication/intelligibility medium and quality is of no importance. So what of high definition amateur television which has been encouraged for over 30 years?

*Below: General view of the G3OSS laboratory at Finchley. Andrew is at the camera, with Angus McKenzie and Simon Whittle looking on, and looking after the Microwave Modules TV TX and linear.*



My friend Dick, W0QM, who also has the call G3FNL was one of two or three amateurs who were entirely responsible for the start of high definition ATV, and in those days it was all 405 line and black and white, of course. They were never discouraged from using all the bandwidth necessary to transmit the best possible pictures, and even today dozens of amateurs are transmitting the finest possible pictures that they can manage on the 435MHz band with around 5MHz bandwidth side bands. For communication purposes one *could* show sour grapes by suggesting that TV bandwidth requirement is ridiculous and that they should all change over to low definition TV.

Such a requirement would be an outrage, for it is the high definition/wide bandwidth part of the exercise that creates new ideas and results in much serious research work. Many well known and successful TV equipment companies were started by keen young amateur TV enthusiasts. We are now living in a digital age, with amateurs transmitting computer programmes to one another and computers playing an ever-increasing part in our amazing hobby.

---

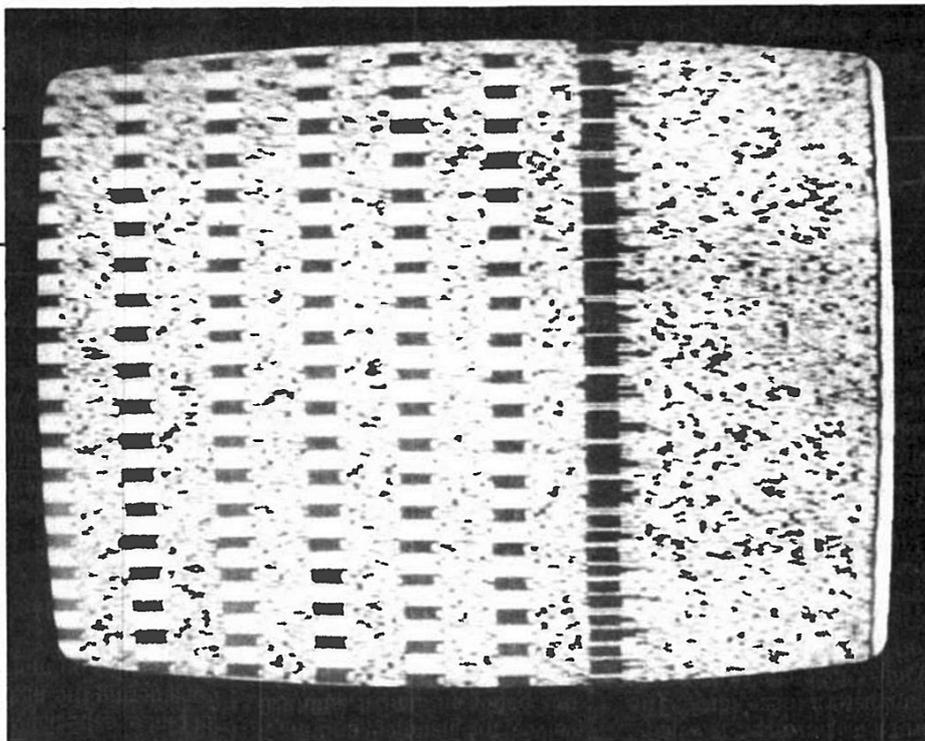
**“We are being allocated increasingly higher frequency bands, and I am astonished . . .”**

---

We are being allocated increasingly higher frequency bands, and I am astonished to see that almost no serious digital data transmissions have been carried out, and virtually the only ones that I know of (in which PCM audio has been used) have been those in which my colleagues and I have been involved.

The easiest way to transmit PCM is within the normal television 625-line carrier. There are several reasons for this, one of the most important ones being that by doing this one is keeping within one's licenced regulations, since in every way the transmission has the characteristics of a black and white TV picture with line and frame sync pulses and rows of digits going across the screen from left to right in groups of 16 for each word. The Sony PCM equipment used to superimpose all the digital information onto a normal video carrier which is 625-line PAL compatible. Even the video levels are standardised at one volt peak.

Since I have a Sony PCMF1 A-D/D-A digital adaptor, and friends of mine at Surrey University have such an adaptor



(and digital audio in this format is becoming very popular amongst hi-fi freaks), it seemed only natural to use this format for the experiment. But first, a small bit of history to put facts right, for my first digital transmissions were nearly one year ago . . .

On August 7th 1982 my two friends Simon G8UQX, and Myles, now G4RCE, helped me to rig up a Sony colour camera with captions and a video link from the Sony PCMF1 to a Microwave Modules ATV transmitter, operating on 70cm. We established a link, using 2m FM talk back, and FM on 70cm with Alan Goddard G3NQR, in North Harrow. Alan first of all obtained Grade 5 colour pictures from us and hooked up his video receiving line to his VHS recorder, monitoring signals on his colour TV. We then switched over to digital and radiated a test tone, having made appropriate announcements on NBFM.

Alan could see as well as us the position of all the bits and end of word bars across the screen, but some beam realignment was necessary to obtain the best definition. When Alan brought round his VHS cassette it unfortunately decoded rather badly with about 90% errors and so we realised that we would have to do better. We each independently took far more trouble in aligning all the equipment, and tried again on Sunday, August 8th.

This time Alan obtained far sharper pictures of the digits, and also obtained much sharper definition when he replayed his video tape, and so he then sent his video recordings of my digital transmissions back to us with Simon, Myles and I running around like mad things in order to see, decode and hear and record Alan's transmissions. We were all thrilled to decode long chunks of between 10 seconds and three minutes of perfect decoding and heard our own test tones and voices coming back with the appropriate an-

*Above: This is the modulated digital pattern on the TV carrier as it appears when viewed on a monitor.*

nouncements, and without the mentioning of call signs, as it was a recording!

It is a great credit to Alan G3NQR, that he managed his own end entirely unaided despite the complexity of the set-up.

We realised that there had been many constraints to the decoding accuracies – multipath reception, bandwidth problems in antennas and equipment, and the fact that we had originally been using an unmodified Microwave Modules 100w linear for TV. The manufacturers subsequently modified the linear for us to make it more suitable for coping with TV, and also kindly modified the TV transmitter to give improved quality; these modifications are now in their latest models.

---

**“Date of the first serious experiments were to be on May 21st, 1983 . . .”**

---

Around Easter 1983, several friends at Surrey University, who were licenced, suggested that they would very much like to attempt receiving some digital PCM from me, over what was to be a 31-mile link, as the fly crows! The date of the first serious experiments was arranged to be May 21st '83, but we carried out site-to-site signal strength tests a few weeks earlier, when we realised that a very good receiving system would be required on the top of one of the highest university buildings in Guildford (Tilingbourne House, Surrey Court) to have a reasonable probability of success. Equipment in Finchley (my home) had

## Why not hi-fi audio on amateur radio?

changed in that year, my two 21-element tonnas having been changed for two 16-element HAAGs, my entire VHF/UHF/microwave aerial stack having collapsed just before Christmas.

By 9am on Saturday May 21st, Simon G8UQX, and Andrew Harding, an SWL, and I, had assembled a studio full of equipment with AKG condenser microphones, a Calrec control desk feeding the PCMF1, whose output fed one of the switchable video inputs of the Microwave Modules TV transmitter which was feeding their linear and up the cable via a bird through-line watt metre and sniffer.

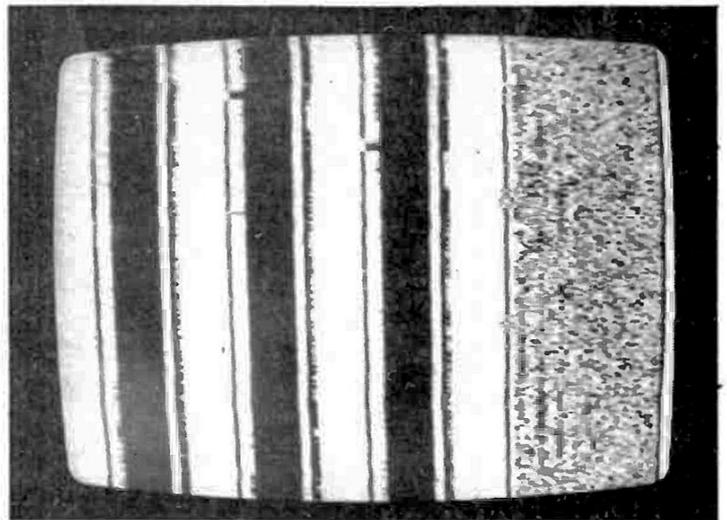
The sniffer was feeding either the video input of a modified TV set (Andrew's Amstrad, which he uses with his BBC computer) or alternatively the waveform was monitored on a D83 telequipment scope. The other video input was from a Sony colour camera. A Trio 9130 transceiver (the one I reviewed recently) was used for

2m talk-back, whilst a Trio 9500 (also recently reviewed) was used for 70cm identification and beam alignment.

At the Guildford end, G6VCQ, Keith Davies, G6EZL, Simon Whittle, G6JCH, David Hall, and Mike Hatch (who owned and loaned his PCMF1) were joined by many observers, particularly from the tonmeister course. They had erected an 88-element Jaybeam at approximately 100 feet above

ground level which fed a Dressler GaAs FET pre-amplifier, which then fed a Microwave Modules converter from 70cm to band 4. The output from this fed a Sony TTF1 tuner whose output fed an SLF1 video recorder (Betamax) as well as a TV video monitor and the PCMF1 decoder. Mike Hatch and other tonmeisters arranged the output from this digital decoder to feed a high quality stereo hi-fi system.

*Right*  
*Unmodulated digital pattern on TV carrier as it appears when viewed on a monitor, ie a blank carrier. No digits*  
*Below: Angus McKenzie, G3OSS, at the Calrec stereo mixing console which feeds the PCM (digital) audio input*



After comparatively few minutes in which we first aligned beams, we sent a TV pattern and soon realised that we had a slight problem with ghosting from the spire of Guildford Cathedral. Careful re-orientation of the antenna soon overcame the problem, and we then switched to colour TV which was received perfectly. Shortly afterwards we went over to digital, and readers can well imagine the excitement at both ends when the Guildford team yelled back to us on 2m that they were hearing my digital audio almost perfectly.

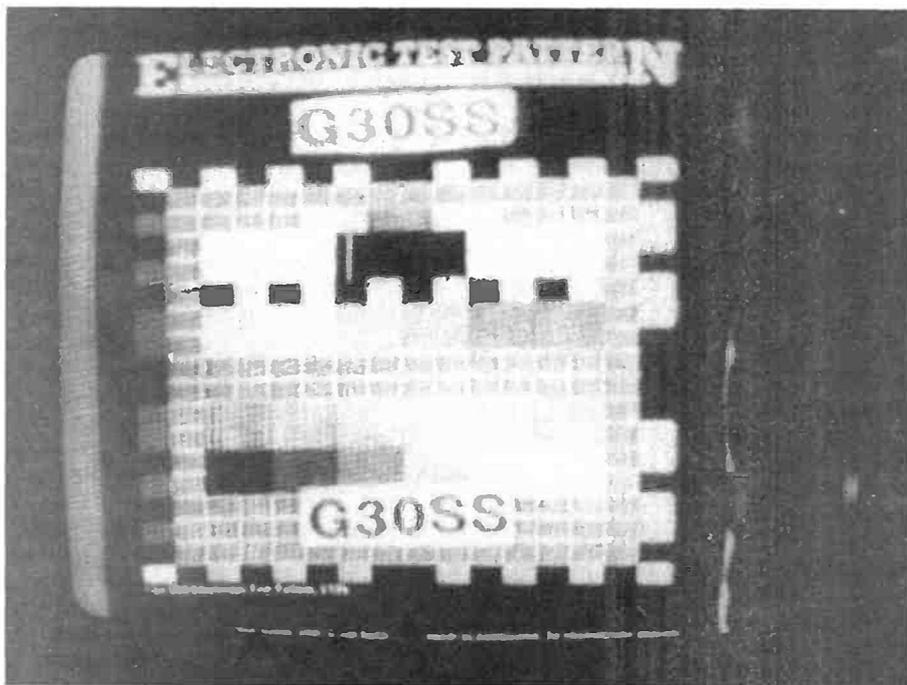
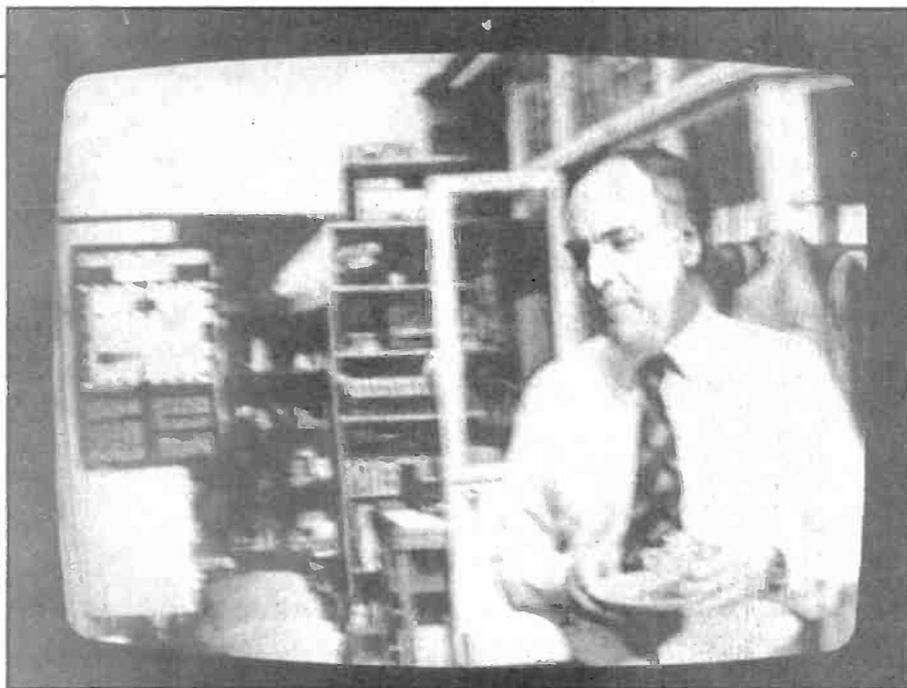
A little trimming of video gain and black level controls on the TV transmitter, and a little bit more fiddling at the Guildford end were all that was required to make the link perfect, apart from an occasional intermittent which turned out to be a 75ohm BNC plug on a 50ohm adaptor! We maintained the digital link for about half an hour, transmitting both Simon's and my voices, as well as making an awful lot of noise, including playing back our own recordings of a steam locomotive and fireworks on Primrose Hill!

**“When SSB was first introduced, it was regarded as rather a crankish type transmission. Now most of us are using it.”**

The jubilation shown by all of us was tremendous, and so on returning to the colour camera it is hardly surprising that my colleagues just had to pan it on to me when I was consuming a very sticky and large Belgian burn. Keith reminded me then that I always seemed to be eating, or talking about food, and this is what happens when you give up smoking!

The Guildford team, after dismantling their gear, took the video recordings down to their tonmeister studio and played everything back quite loud, and they were delighted with the results. I also have heard the tape back on my own system and I cannot hear any difference at all between the sound effects as transmitted and as recorded down in Guildford, the full original dynamic range being heard from the recording.

This goes to show that bits are bits which are either on or off, and if they work their way through satisfactorily there should not be any difference. I hope the fact that my friends and I have had so much fun and jubilation over this project so far will encourage many others to have a go at digital audio in the future. It is fascinating that the



link was so reliable, and probably matters would have been as successful on 23cm, which is the next band to have a go at.

When SSB was first introduced so long ago on amateur radio, it was regarded as rather a crankish scrambling type transmission; now most of us are using it. I suggest that it might not be long before different forms of digital audio are transmitted on UHF and microwave amateur bands.

Come on folks, how about adaptive delta modulation and straight pulse transmissions which could be far more efficient than a TV carrier wave form?

*Top: Caught in the act of having a cheese roll, or something equally sordid, on camera! G30SS foreground, laboratory background.*

*Above: The G30SS test card as received at Guildford, and recorded on a Sony Betamax unit, and photographed from tape.*