Contents

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Committee Contacts

President: Mike Cox, CEng., FIEE

E-mail: president@batc.org.uk

Chairman: Trevor Brown, G8CJS

Club affairs, Videotape library, and Technical queries, especially relating to handbook projects. 14 Stairfoot Close, Adel, Leeds, LS16 8JR. Tel: 01132 670115. E-mail: chairman@batc.org.uk

General Secretary: Paul Marshall, G8MJW

General club correspondence and business. Library queries relating to the borrowing or donation of written material. Fern House, Church Road, Harby, Notts., NG23 7ED. Tel: 01522 703348. Email secretary@batc.org.uk

Hon. Treasurer: Brian Summers, G8GQS

Enquiries regarding club finances, Donations, and constitutional enquiries. 9 Prior Croft Close, Camberley, Surrey, GU15 1DE. Tel: 01276 677879, Mobile: 0797 0417875, Email: treasurer@batc.org.uk

CQ-TV Magazine: Editor Ian Pawson

Anything for publication in CQ-TV, Articles, Review items, Letters to the editor, and other material except as below. 14 Lilac Avenue, Leicester, LE5 1FN, England. Tel: 0116 276 9425, Email: editor@cq-tv.com

Photographs for the CQ-TV covers: - Please send any photographs by post, electronic images by email, to the editor at the above addresses.

TV on the Air: - Graham Hankins G8EMX, 17 Cottesbrook Road, Acocks Green, Birmingham, B27 6LE. Tel: 0121 706 7384

Satellite TV News: - Paul Holland G3TZO, Chatterton, Chapel Lane, Threapwood, Nr. Malpas, Cheshire, SY14 7AX. Tel: 01948 770429, Email: satnews@batc.org.uk

CQ-TV Advertising Manager: - Trevor Brown, 14 Stairfoot Close, Adel, Leeds, LS16 8JR. Tel: 01132 670115. Email: adman@batc.org.uk Members adverts for inclusion in CQ-TV should be sent directly to the editor and the above address, either by post or e-mail.

CQ-TV Awards: - Bob Webb G8VBA, 78 Station Road, Rolleston on Dove, Burton on Trent, Staffs., DE13 9AB. Tel: 01283 814582

Exhibitions

Graham Hankins G8EMX, 17 Cottesbrook Road, Acocks Green, Birmingham, B27 6LE.Tel: 0121 706 7384 Email: exhibitions@batc.org.uk

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Publications: - Handbooks, Back copies CQ-TV, and anything related to the supply of BATC publications. Paul Marshall, Fern House, Church Road, Harby, Notts., NG23 7ED, England. E-mail: publications@batc.org.uk

Membership

Anything to do with membership, including new applications, queries about new and existing membership, non-receipt of CQ-TV, subscriptions, membership records etc. Dave Lawton, G0ANO, 'Grenehurst', Pinewood Road, High Wycombe, Bucks., HP12 4DD. Tel: 01494 528899. E-mail: memsec@batc.org.uk

Club Liaison: - And anything of a political nature, co-ordination of ATV repeater licences. Graham Shirville, G3VZV, The Hill Farm, Potsgrove, Milton Keynes, Bucks., MK17 9HF. Tel: 01525 290343. E-mail g3vzv@amsat.org

Contests: - Richard Parkes, G7MFO, 7 Main Street, Preston, Hull, HU12 8UB. Tel: 01482 898559. Email: contest@batc.org.uk

CQ-TV and BATC web masters

Anything to do with the CQ-TV web site Email: webmaster@cq-tv.com or for the BATCs web site. E-mail: webmaster@batc.org.uk

Chairman's Column

Digital ATV

The Group at Bergische University now have a working Digital ATV encoder and DATV transmitter. The units are being tested on 23 cms in Cologne at the ATV repeater site DB0KO. The transmitter can be programmed to various digital data rates. The system under test is QPSK and adheres to the BVB-S standard, which enables reception via a standard satellite set top box. The repeater has a standard FM TV input demodulated to base band PAL which is then encoded to MPEG ll (5 Mbit/s) and re transmitted. The repeater output can be switched between DATV and FM ATV by DTMF tones to enable comparisons to be made.

Reports from a 50km monitoring station compare a rather noisy FM result with a perfect noise free digital output. The FM signal has a bandwidth of 18 MHz and is running with a 20W transmitter. The DATV is running with a 6 MHz bandwidth and a 10W transmitter. The antenna is the same 10dB omni directional aerial.

I think this is very encouraging news for ATV and as soon as the digital encoder becomes available BATC will purchase one, so we can carry out our own independent tests. I suspect that to establish a common DATV standard in Europe we will have to go with the QPSK system, but I do have concerns about the terrestrial use of this system and multipath. The system was originally

The Transmitter board

designed for satellite use where this is not a problem.

Terrestrial transmission used the COFDM system and is supposed to be more resistant to multipath. This is the system used in the ITV set top box and at the time of writing has an uncertain future. It could be that the receivers will follow the BSB boxes and squarials into the hands of amateurs at bargain prices, but this is not a European standard and has its own engineering problems, as any ITV digital viewer will tell you. Also, it is not possible to engineer a European DATV standard around surplus UK

boxes. I think we need a long term view chosen for the correct engineering reasons, and this will not come out of bargain basement equipment.

Tests are also being carried out at Bergische on a 70 cms DATV system using a 2Mbit/s system, using the same encoder. The encoder can be driven with PAL/NTSC or YC. This may give us the problems of PAL and Digital at the same time, but until we plan and implement a DATV system this is going to have to be a halfway house that we can start from and move forward.

The two pictures show the DATV encoder and DATV transmitter

Trevor Brown, BATC Chairman
email: Chairman@batc.org.uk
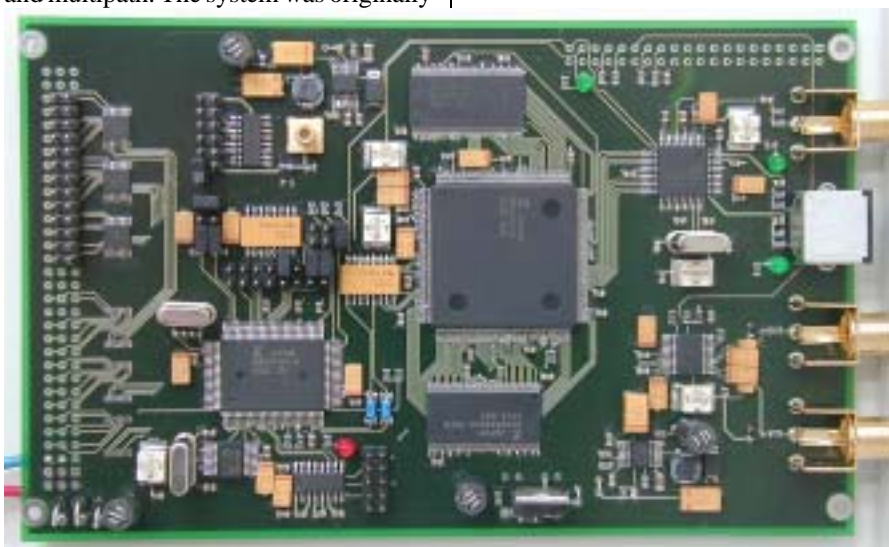
The Encoder board

Severnside Television Group
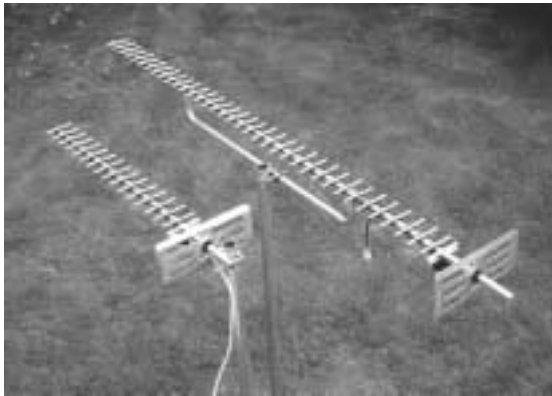
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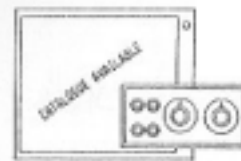
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By the Membership Secretary

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Please note that the '**Surface'** rate covers postage within the EEC, airmail rate is **not** required.

We have also continued to improve our web site at www.batc.org.uk and this has proved to be very popular and is now attracting many new members. Also, we have a web site devoted to the CQ-TV magazine at www.cq-tv.com

If your subscription is due shortly, you will find a renewal letter enclosed with this magazine.

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- *May* .... 20th March
- *August* .... 20th June
- *November* .... 20th September.

Please send your contributions in as soon as you can ***prior*** to this date.

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By Mike Cox

In the last but one issue [CQ-TV 197]. I went on a bit about Digital Terrestrial Television and its slow take up. No one in their wildest dreams foresaw the present [May 2002] state of ITV Digital, and where Monkey's next banana is coming from. With the poor state of Digital Terrestrial Television (DTT) in Spain, Sweden and USA, I suspect analogue transmission will be with us for many years yet.

However, in this piece, I want to tell you about progress on the SDI mixer project, and to propose construction of some useful basic digital building blocks that will give some valuable experience in digital techniques.

Progress Report on SDI Mixer

The initial object mentioned was to produce a lashed-up single channel [Y rather than Y Cb Cr] unit with elements of A/B mixing, keying, split screen and fade to black. Obviously, with a single channel system, inputs can more easily

be PAL for experiment, via a suitable A to D converter. An appropriate ADC was already on the digital work board, and its output could easily be patched in to the other elements.

A second ADC card was cobbled together using a 20 MSPS 8-bit chip [MP7684] that happened to be in the drawer. This takes the output from the lab caption scanner.

Also available is an EPROM derived ramp and pulse/bar generator, already in 8 bit digital format.

Brief Introduction to SDI

Transmitting digital signals involves sampling the three component signals at 13.5 MHz [Y] or 6.75 MHz [Cr or Cb] to derive 8 or 10 bit digital streams. The three streams are then multiplexed together to form an 8 or 10-bit parallel stream with a 27 MHz clock speed. This is referred to as "601", although proper CCIR 601 streams are balanced ECL connections, using 25 way D connectors and special twisted ribbon cables for

inter-connect.

By serialising the parallel stream, a 270 Mb/s serial stream results, designed to be sent over 75 ohm coaxial cables. This is a far more practical system within a studio, although there are limits on cable length [approx. 300 metres] before equalisation is essential, if falling over the "digital cliff" is to be avoided now, or in the future, when jack fields get a little tired. Note that it is a full bandwidth system, with no bit rate reduction as yet. Most current studio equipment now has SDI interface built in.

For further details, please refer to the bibliography at the end.

Overall Architecture (see Fig. 1)

From the diagram, you will see some major building blocks. At left is the SDI receiver block. This carries 8 Gennum GS7005 SDI receiver chips. These take in SDI [270 Msps serial data stream], apply a limited amount of equalisation for up to 75 metres of cable, and then de-serialise the stream to parallel "601" type

Fig.1
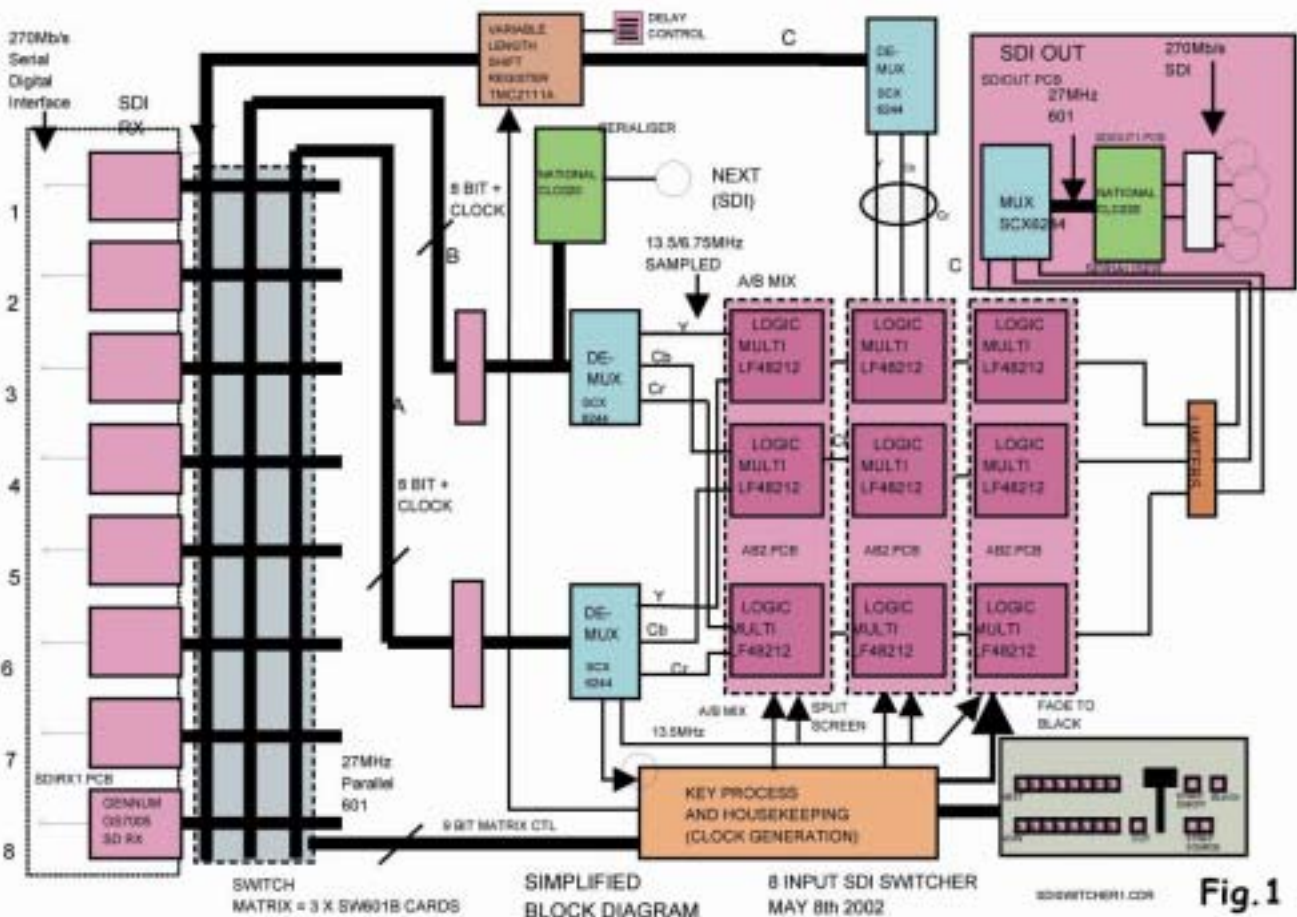
data and associated 27 MHz clock.

It was decided to mount the 8 GS7005 on a strip PCB [Fig. 2] that bolts to the rear panel of the unit with PC mounting BNCs going through the panel. The Gennum chip is a 52-pin QFP device, and a library shape had to be created in BoardMaker [PC layout software]. The pad pitch on this package is 1 mm. There was some apprehension when the PCB arrived from the maker. I am delighted to say that the sample IC married up to the PCB, and has now been installed and one section at least checked. I was able to put solder cream on the pads, put the IC very carefully in place and with a very fine iron bit, reflow the solder on each pad in turn. Even more joy ensued when having put the other components in place [all surface mount], an SDI signal was connected, power applied, and a valid "601" signal appeared at the output connector.

Fig. 2a
SDI RX CARD

Fig. 2b
CIRCUIT OF GS7005

After connecting to a de-multiplexer and DAC, a set of bars appeared on the monitor. Subsequently, the other GS7005 chips and components have been fitted and tested.

The next block is the switching matrix. This is made up from three identical cards each carrying 8 "crosspoints" using 74VHC574 8 bit latches. The output enable pin [/OE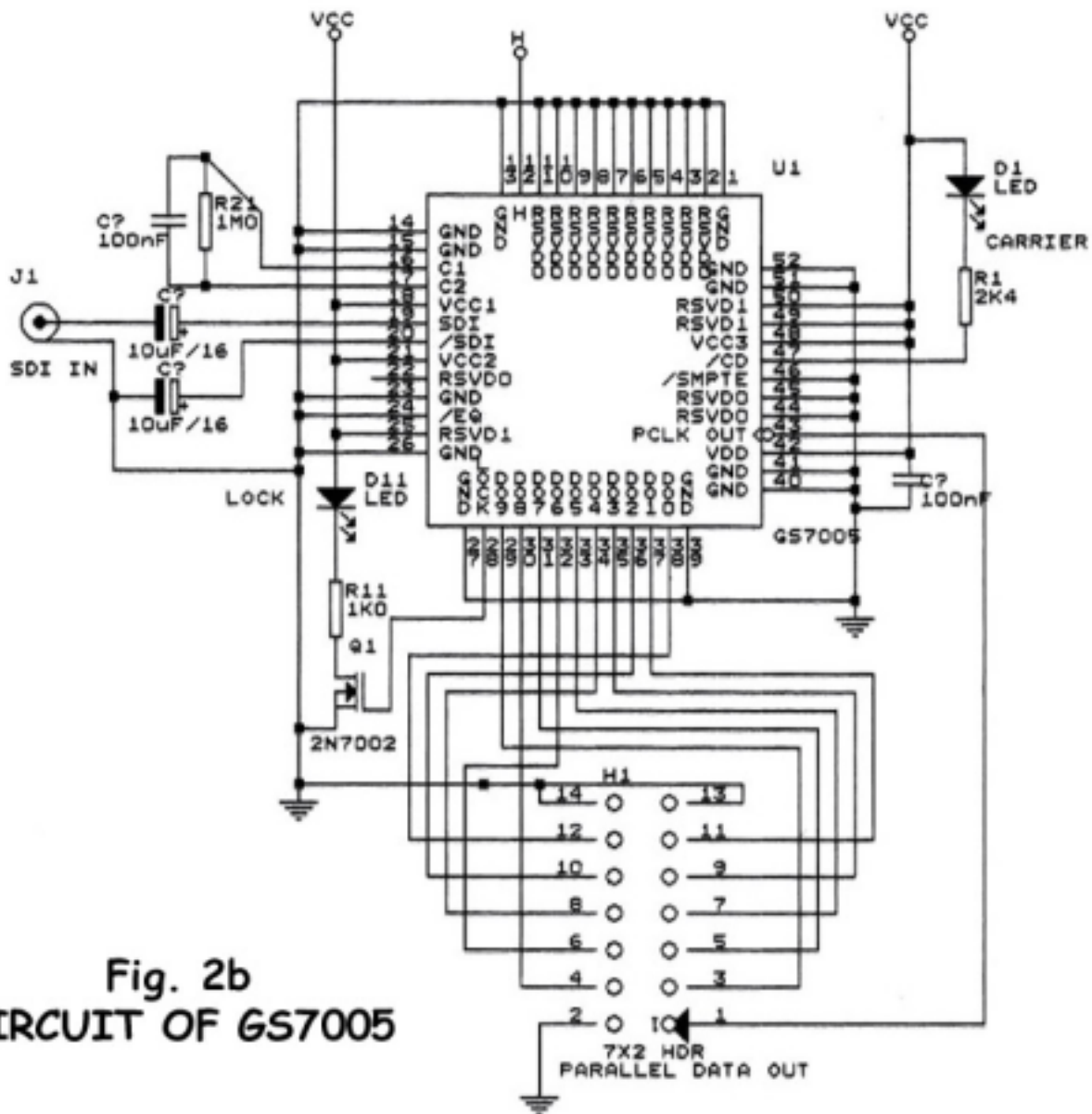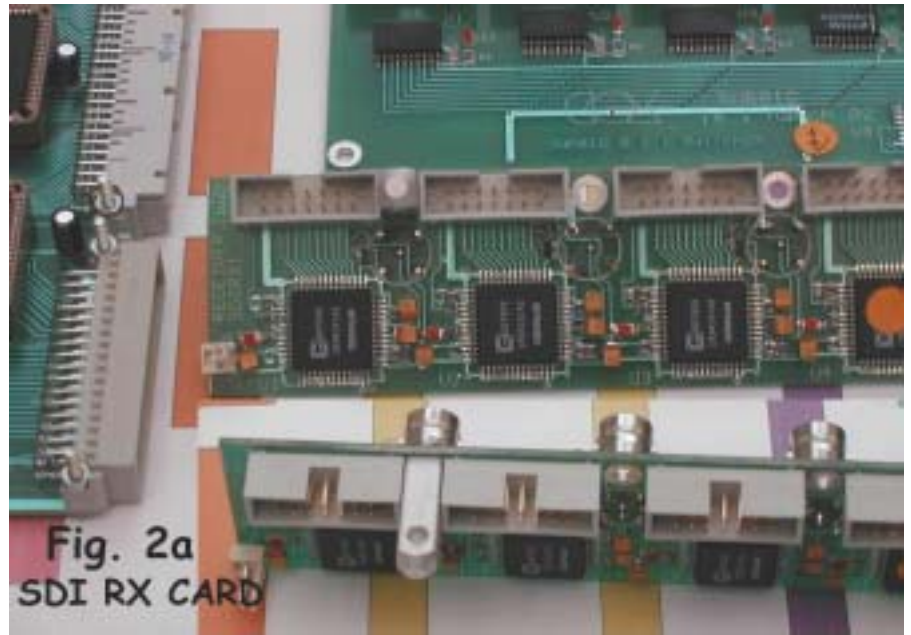] is used to control the crosspoint; the outputs of each chip feeding the output bus. A separate chip [74HC251] is used to switch the clock signals from each SDI input. [Fig. 3] These have now been proved to work. Three working cards are now ready to fit to the motherboard.

The next element that has yet to be laid out is the de-multiplexing of the "601" signals from the switch banks to YCbCr signals for feeding the M/E systems, although a prototype has been lashed up on a bit of card.

"601" Switcher card
3 required
Fig. 3

Fig. 4

The SDI output card [Fig. 4] carries a multiplexer chip which takes in YCbCr data streams, and outputs a "601" stream to the serialiser chip [National CLC020]. A Gennum GS9007 output driver gives 4 outputs of SDI [TX out]. This card is now loaded and tested.

Recently, some LOGIC LF48212 devices have been acquired from DT Electronics [024 7643 7437]. These are an A/B mix element in a 68-pin PLCC package. There are two video inputs, a key or

control input, and an output. All inputs accept up to 12 bits, although 8 or 10 bit rounding can be selected. They are similar to the Aston L5A1466, except that they are currently available chips. The Aston device has two video inputs and two control inputs, which can allow "linear" keying if required. A PC board has been laid out and made, to carry 3 68 pin PLCC sockets for the LF48212 devices. [Figs. 5a and 5b] Each card is then 1 M/E of the system. After the final M/E, the YCbCr signals are fed to the output card where they are multiplexed to "601" and then serialised to form the SDI transmission output signal.

Interconnections

I standardised on 10 pin IDC connectors for Y, Cb and Cr signals, as they are cheap, and quicker to install on the ribbon cable than the average BNC on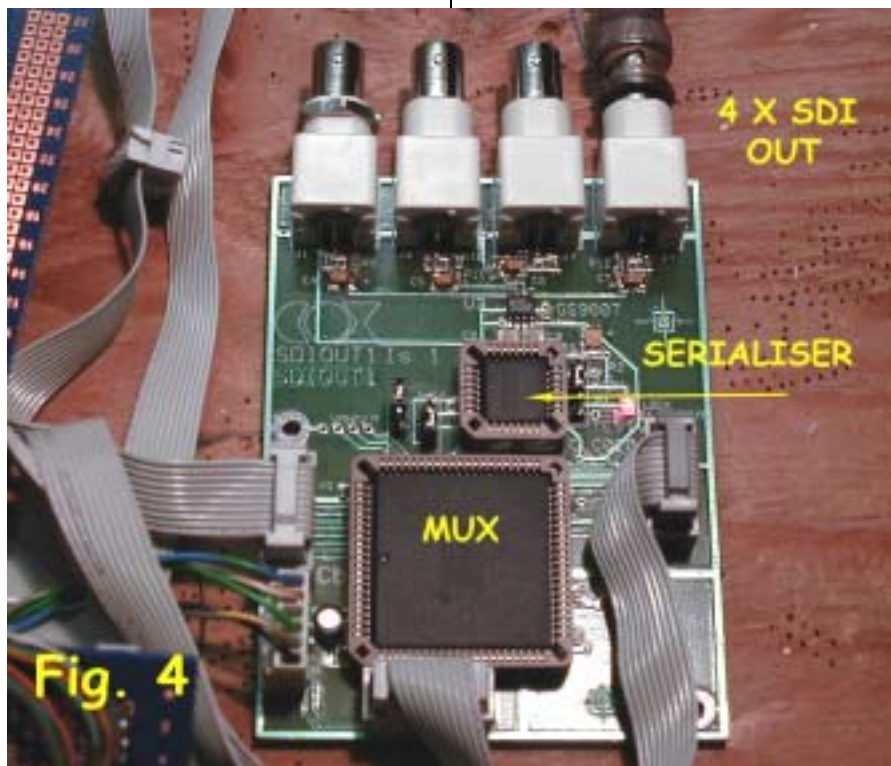 coax. For "601" signals, which need a conductor for clock, I use 14 pin IDC connectors. It is easy enough to make multi-drop cables for occasions when a signal is needed in two or more places; just like looping video. It takes me less time to make up a ribbon cable than it does to put BNCs on a coaxial cable.

Split Screen

To get the horizontal split screen facility needed, a simple card has been built using an EPROM as the ramp generator. A 74HC4040 is used for the address counter, with H sync as clock input and V sync as reset. In the analogue world, the output of the ramp generator would be fed into one input of a comparator, and the fader voltage into the other input. The gain of the comparator is changed to modify the edge softness.

In the digital world, an 8 bit full adder is used to add the fader word [see Control below] to the output of the ramp EPROM. Another EPROM is then used as a look up table to clip the adder output and give a suitable digital signal to drive the multiplier chips [Fig. 6]. This EPROM has a number of pages with variable slopes, and hence selecting one of these provides a softness control. In programming such an EPROM, F8h is chosen as the midpoint of the transition. Thus a change of output from 00h to FFh over 4 input levels centred around F8h [input 00h to F0h, output = 00h; input F4h, output 40h; input F8h, output 80h; input FCh, output C0h; input FFh, output FFh] gives an edge with medium softness.

Note that if you want vertical patterns, you may need to ensure that the EPROM's you use are fast enough – 120/150nS. Farnell offer a 27C256 70nS EPROM for just over £4.

While talking of EPROM's, the values 00h and FFh are no go areas in digital video as they are reserved for timing reference signals. Black level in 601 video is set at 10h, and peak white at EBh [16 and 235 in numbers]. After any processing it is recommended that a clipper be included. One of the fast EPROM's mentioned above does a good job. Other approaches are to use bipolar PROMs, which are faster, but finding kit to programme them is more difficult. Also they are one-trip devices; if you get it wrong first time, it means trying a new device, whereas after 25 minutes or so in the eraser, you are ready for another go with an EPROM.

Control

Mention of Split Screen brings up the topic of control.

Classic mixers will use a fader [what some call a T-bar]. This produces an analogue voltage proportional to fader position. In the digital domain, an ADC must be used to generate a digital word from the fader.

However, there are alternatives to the fader to generate such a digital word.

For a very simple application not requiring operational setting, think of a DIL switch and pull down resistors, or a pair of Hexadecimal rotary or thumb-wheel switches and pull downs.

A very useful tool that is incorporated in my work-board is a number or word generator operated by a shaft encoder. Up/down counter circuitry is driven by rotation of the knob, and once the knob is stationary, the word will remain until power is turned off. The one on my work-board has an 8-segment LED bar-graph to indicate value. [Fig. 7, Fig. 8]

With a suitable clock source, the shaft encoder can be replaced by Up and Down push button switches. Changing the clock speed changes the rate of change.

Any of these word generators will work; the choice is determined by the operational need. These can be made into video level generators by taking the word to an 8 bit buffer or latch [74HC541 or 74HC574] and feeding mixed blanking into the Output Enable pin [/OE]. Pull downs on the outputs except for O5 will pull them all down to 0, except for O5

Fig. 5a

OUTPUT OF A/B MIX TEST RIG -BARS & OFF AIR

LF48212 A/B MIX Fig. 5c

Fig. 6
SIMPLE SPLIT SCREEN GENERATOR

which has a pull up to +5. This sets the blanking level at 10h [level 16].

Do not forget that if you use an 74HC574, it will need clock input. Even a field pulse will do here.

Measurement

I can hear the comments about measurement of digital signals. Yes it is not as straight-forward as probing a circuit with an oscilloscope. But there are ways of doing things simply.

A good digital to analogue converter [DAC] is useful for dynamically looking at signals, but for static checking an LED readout of the digital word value is very useful.

Some years ago, dual 14 segment starburst LEDs were available, and I made up a box containing two of these, two 10 pin IDC sockets and appropriate circuitry. The only useful display part I found is in the Farnell catalogue, a single Hex display [325-016, £8.88 ea.]. Expensive, but does not need much surrounding circuitry, unlike the one I made, which had about 6 CMOS chips and two PROMS. [Fig. 9]

Clock Generation

In a digital system, a prime requirement is for a stable clock generator at a multiple of the horizontal scan rate. This frequency is used as the sampling frequency for the ADC at the beginning of the process, such as in the camera, and is used for re-clocking throughout the signal chain. Nyquist theory states that the sample rate has to be at least twice the highest frequency in the signal. For 625 or 525 signals with a nominal bandwidth of 6 MHz, a common

frequency of 13.5 MHz was agreed. For multiplexed distribution of 3 component signals Y, Cb, Cr, 27 MHz is used, based on the Cb and Cr signals being sampled at half rate i.e. 6.75 MHz. For serial transmission using SDI, the frequency goes up to 270 MHz. This frequency is usually generated in the SDI serialiser chip, so we are not overly concerned with this.

Perhaps surprisingly, Colour Black is still the commonest form of master

Fig. 7

Fig. 8

reference signal in installations.

Accordingly, work has been done on a clock recovery circuit using a Philips SAA1101 sync generator chip, the traditional LM1881 sync separator, and a phase comparator comparing 0.5 MHz from the SPG clock [/10] and 0.5 MHz from the 27 MHz [/54]. The phase comparator error signal steers the crystal frequency so that the 1736 ratio is maintained between horizontal scan rate and master clock. Layout is fairly critical here as I found some unexpected jitters on the sync output. It turned out that 27 MHz was talking to the SPG oscillator. Good grounding and supply decoupling is essential here, particularly around the SPG and sync separator chips. A 74HC4024 is fitted to divide the clock to 13.5 MHz and 6.75 MHz. [Fig. 10]

ADC and DAC

Although the signals offered to the mixer will be digital, to do any tests or experiments with signals available in the lab, an ADC or two will be essential. Luckily, prices have fallen dramatically, and devices running at 20 – 30 Msps are available for a few pounds.

I mentioned Nyquist earlier, and the need for a sample rate higher than twice the highest frequency. In our case we sample at 13.5 MHz, and in the input circuitry to the ADC chip, we need to arrange that frequencies above about 6 MHz are attenuated. Usually "brick-wall" filters are used with fast roll off above the band limit. Good filters of this type are not cheap, but gradual filtering using Gaussian filters can give acceptable results and are far cheaper. The object is to reduce effects of "aliasing" where frequency components higher that half the sample frequency beat with it and re-appear as lower frequency interference. Proprietary filters are available from suppliers like Faraday Electronics, and they offer "professional" filters at a

Fig. 9

better price than the "broadcast" or "601" filters.

The ADCs on the work board use AD9048 and MP7684 devices. Both are 8 bit "flash" chips with 20 Msps performance, so they work very happily at 13.5 MHz clock rate.

Texas Instruments make a range of inexpensive ADCs.

Care has to be taken to establish black level accurately. One of the beauties of digital [there are some!] video processing is that large chunks of the signal no longer have to be reserved for sync and blanking, as these can be represented by simple numbers. The corollary of this is greater accuracy in establishing level 10h [16 in old numbers!]. Feedback clamps are often used for this purpose.

DACs are also necessary, and even in the mixer, will probably be fitted to the Preview output so that an analogue component monitor can be used. A useful DAC is the Philips TDA8702. I am not sure whether Philips still makes it, but I have acquired several recently from Cricklewood Electronics [020 8452 0161] who are a useful source of hard to find ICs. There are also numbers of triple DACs available, handy for YPbPr or RGB outputs. Some of these drive 75-ohm outputs directly. There is always the common DAC08 or DAC0800, but it is not particularly fast.

Experiments

For any one who wants to start some digital experiments, I would suggest starting with a simple ADC and DAC. That way you can convert a PAL signal to digits and get it back again.

There are some considerations which seem to contradict what I may have said earlier. For the clock, to start with, you could have it unrelated to horizontal scan rate – just free running.

Rapid Electronics are offering some excellent 27 MHz crystals at £0.50 each – these appear to be fundamental ones rather than third overtone. A 74HC04 will make an excellent oscillator and buffer. Follow it with a 74HC4024, and you will have 13.5 MHz and 6.75 MHz available to drive the ADC.

To allow some sync and burst through, raise the black level to 3Ch [60 in real numbers]. To allow for subcarrier above peak white, set the gain of the amplifier driving the ADC so that peak white sits at C8h [200].

I dealt with the anti-alias filter earlier. It is worth looking at Toko. They offer a whole range of relatively cheap low-pass and band-pass filters. Cirkit [01992 444111] are one of their UK agents. They are also a useful source of inductors of all sorts, fixed and variable.

You will find it useful to make up some sort of Hex display so that you can run static tests on ADCs and DACs together with a word generator such as I described earlier. Another useful item is a scientific calculator that can do numerical to hexadecimal conversions, particularly if you want to blow EPROMs.

A good oscilloscope is essential for video work, but then you knew that anyway. A 100 MHz dual trace 'scope will serve well, but watch probes. Some of them have poor bandwidth even though the 'scope is adequate.

In the next issue, if the Editor wills, we will talk about de-multiplexing and multiplexing from "601" to YCbCr and back, and talk more about the whole project, as it should be further on by then, or it will not be finished by IBC.
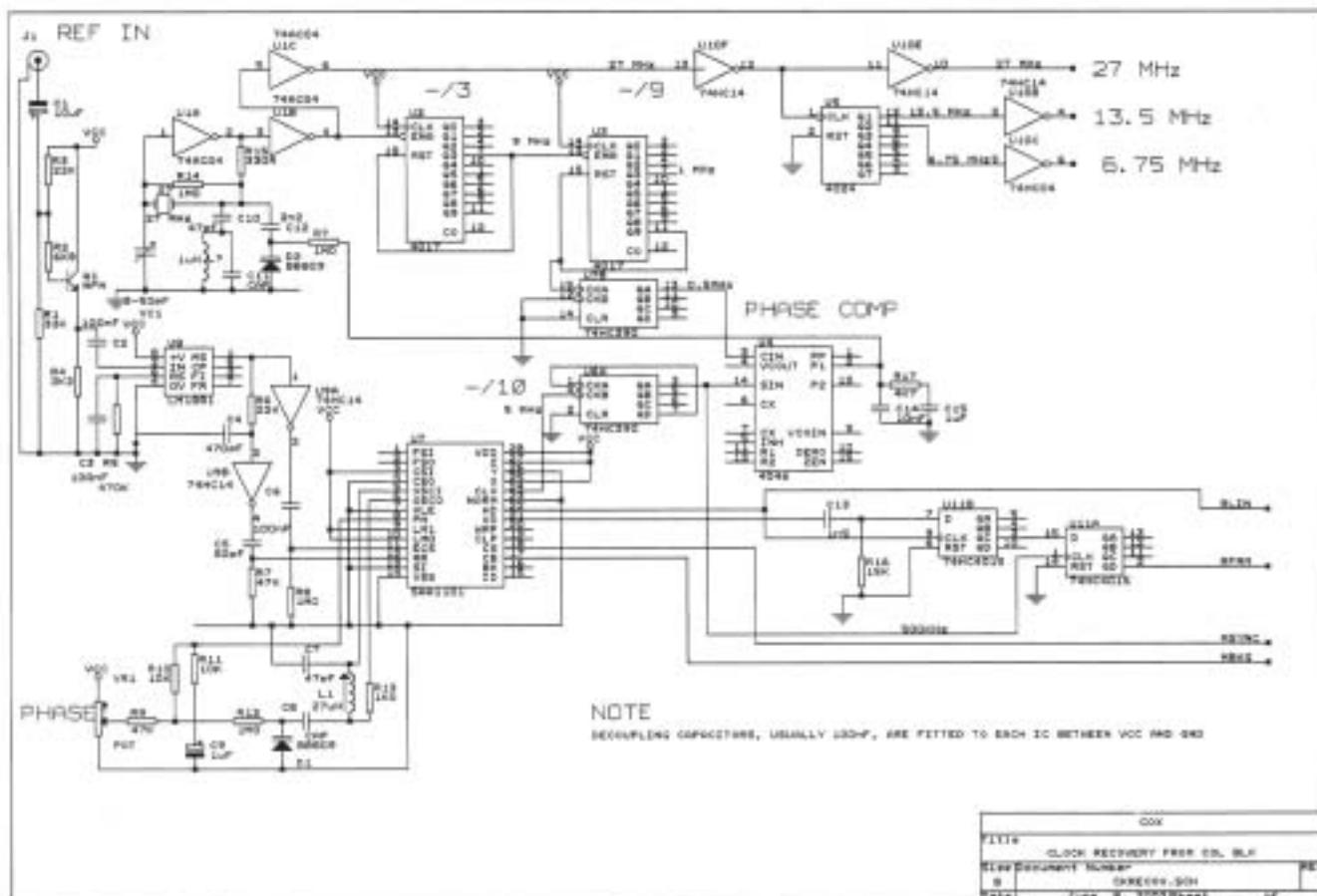
Some useful references

The Digital Interface Handbook, by Francis Rumsey and John Watkinson,

Focal Press, ISBN 0 240 51396 7. [My edition is 2nd, published 1995]

This gives some very useful information about digital video and audio standards and interfaces such as SDI, MIDI etc.

Video Standards, by Victor Steinberg

Snell and Wilcox, ISBN 1900739 07 0

Terminology

In this piece, I refer to YCbCr as the digital component signal, and YPbPr as the analogue component signal.

Satellite TV news

By Paul Holland

Apologies but this time around, the clock has beaten me as far as Sat News is concerned. I am away now from tomorrow until 1st July. I was hoping to find time over the last few days but it did not happen, which is a shame because there has been a fair bit of post and material to use. If this looks like happening again I will try to give you more notice or if it looks like an ongoing problem, perhaps you may consider letting someone more reliable have a go.

73's, Paul G3TZO

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38	PCF8574P Input expander IC	£4.70	£0.30	....	....
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68	4.433618MHz crystal	£3.25	£0.30	....	....
69	5.0MHz crystal	£3.25	£0.30	....	....
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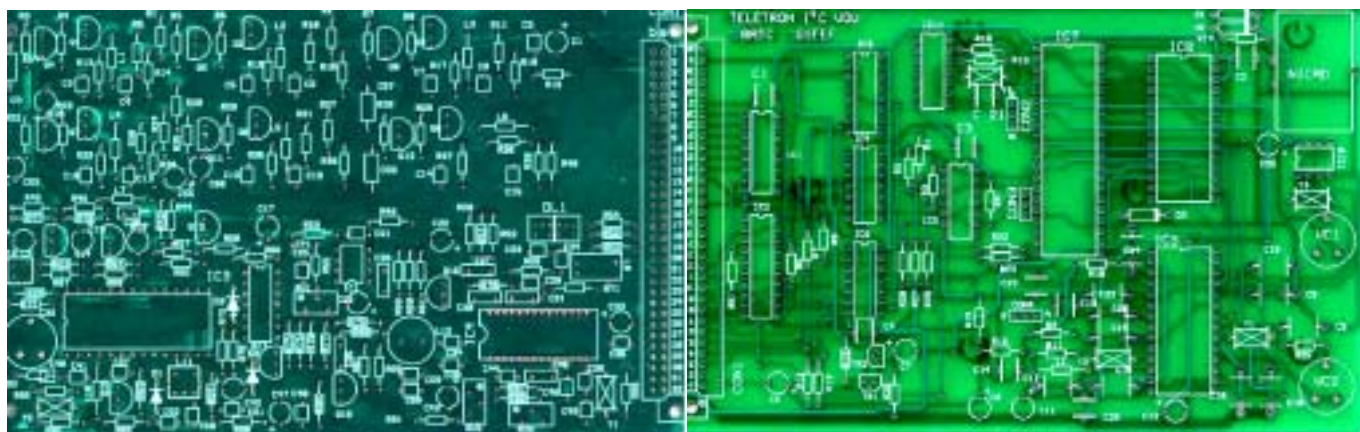
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Circuit Details can be found as follows:

An Introduction to ATV: PCB's 10, 40, 41, 47, 86**. CQ-TV 174:** PCB 7

CAMERA TUBES A tube guide appears in CQ-TV 149 and 150. Tubes are now difficult to obtain and members requesting information on availability, prices or other types of tubes or equivalents are asked to send a stamped addressed envelope for their reply.

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Teletext encoder

By Werner Damman, PE1OBW

Nowadays it is hard to find a television station which doesn't transmit teletext information.

Teletext has existed for a considerable amount of time and found its way to almost every television set. Why shouldn't we supply our HAM television signals with teletext information?

This article describes a design which adds teletext data lines to any PAL video signal.

So, what is the usefulness of this design for amateur television? Especially for repeaters, teletext can be a good way to provide some background information, for example information about the station; besides that it is just fun to broadcast a TV signal that is as complete as possible.

We need some equipment to add the teletext data to the video signal. A couple of years ago I developed a PC card to do this. This functioned well, but was not very practical for amateur use because it needed a dedicated PC which always had to be turned on. Another disadvantage is that a PC card needs a low-level driver which differs for each operating system. The original driver was written for Windows 3.1 and does not function with later versions. Writing a Windows device driver is not easy and requires an expensive driver development kit and a lot of knowledge.

Enough reasons to look for another way. The encoder described in this article

Figure 3
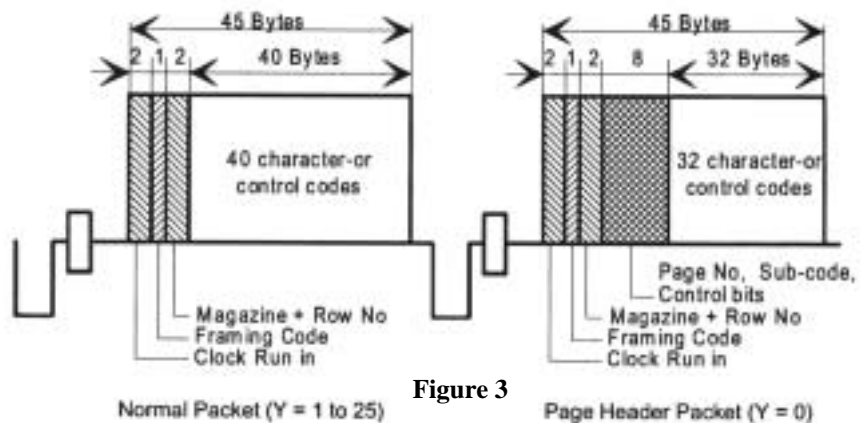
works "stand alone" and has sufficient memory for several hundred pages. These pages remain in memory after power down. The use of an FPGA and a microcontroller with Flash-ROM memory resulted in a compact design, and the complete encoder, including a power supply, fits on two single-sided printed circuit boards.

The pages are produced with the PC using the so-called 'page editor' program. Another program, the 'sequence manager', allows you to select pages and send them to the encoder. This is done using a serial RS232 link.

More about teletext

A PAL video source produces 25 complete pictures per second. Each picture (or 'frame') consists of 625 lines. The pictures are split up in two fields of 312.5 lines each. 287.5 of these lines are visible. So, between the visible lines of each field there are 25 invisible lines. Eight of them are needed for vertical synchronisation; the remaining lines (line 6 to 22 and 318 to 335) can be used to

transmit teletext data or other information. See also figure 2. You will often see that a couple of lines are used for special test signals. These are the so called VIP lines, used to examine the quality of the transmission path.

Each teletext video line carries 45 bytes of data (360 bits).

The first two bytes of each line are the so-called clock run-in bytes to synchronize the teletext decoder in the receiver. These bytes are followed by a 'framing byte' to mark the start of the data, two bytes containing the page row number and finally forty data bytes.

A normal teletext page consists of 24 text rows containing 40 characters each. Each video line contains data for a single text row, so transmitting a complete page requires 24 video lines. The top row of each page contains only 32 displayed characters, the remaining 8 bytes are used to code the page number, the sub page number and some more page-specific information. See also figure 3.
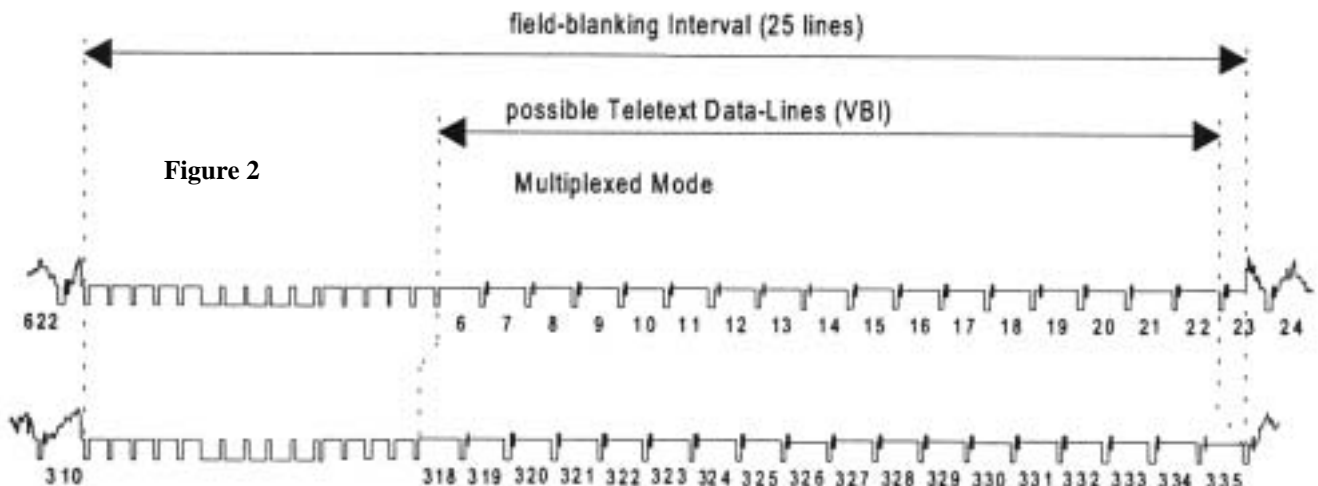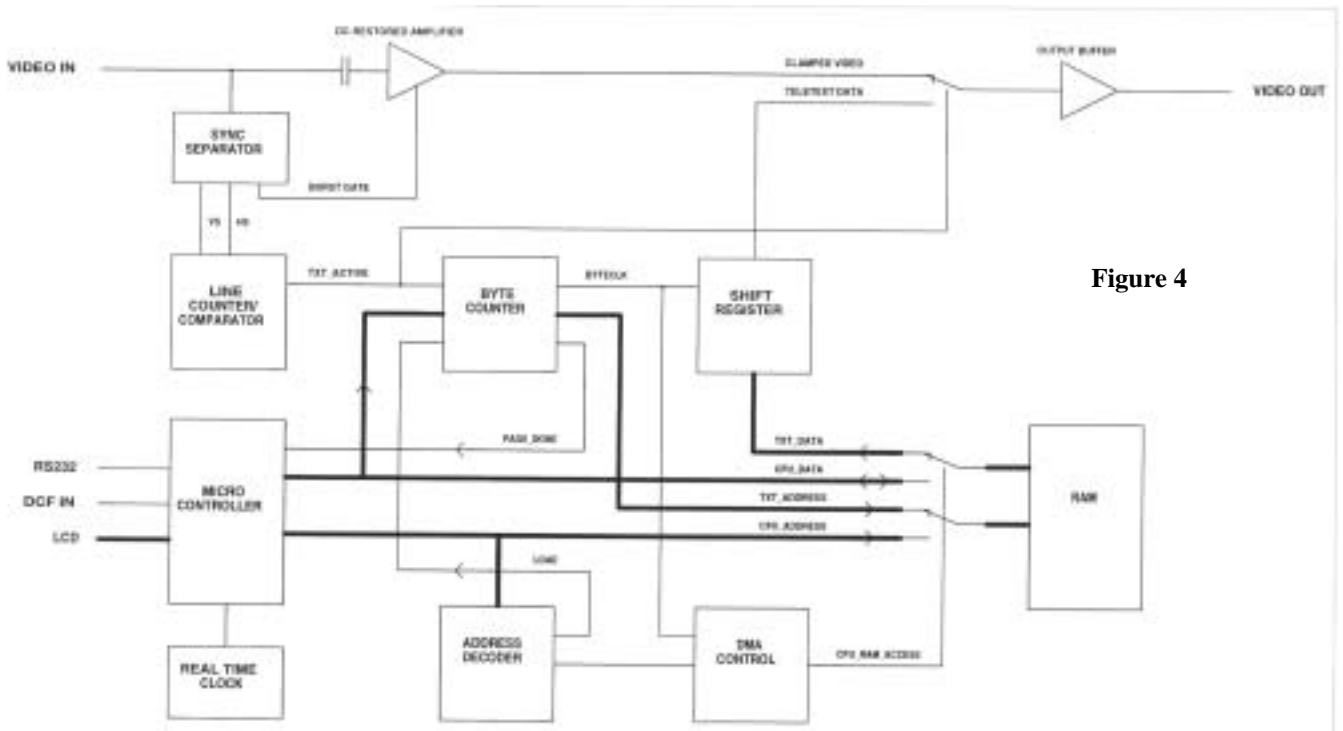

Figure 2

Figure 4

The block diagram

Figure 4 shows a global view of the teletext encoder.

The incoming video signal is fed to the sync separator and to a DC-restored video amplifier. The DC-restored amplifier brings the black level of the video signal on its output to zero volts DC. The amplifier forces the DC-level of the video signal to 0 volt during the colour burst. The sync separator provides

a burst gate pulse for this purpose.

The horizontal and vertical sync pulses go to the 'line counter/comparator' block. This circuit counts the video lines and enables the 'txt active' signal during the teletext lines. This signal drives the video switch. The video switch selects the original video signal, or, if 'txt active' is enabled, the teletext data. The original content of these video lines will be replaced by the teletext data. This implies that formerly present teletext

data is replaced by our own teletext.

The 'txt active' signal also drives the 'byte counter'. The 'byte counter' keeps track of the RAM address of the byte being transmitted. The pages are placed behind each other in RAM memory and the counter initially points to the first byte of a page. When the 'txt active' signal becomes active, the 'byte counter' counts 45 bytes (the amount of teletext data for one video line). After each transmitted byte the counter is
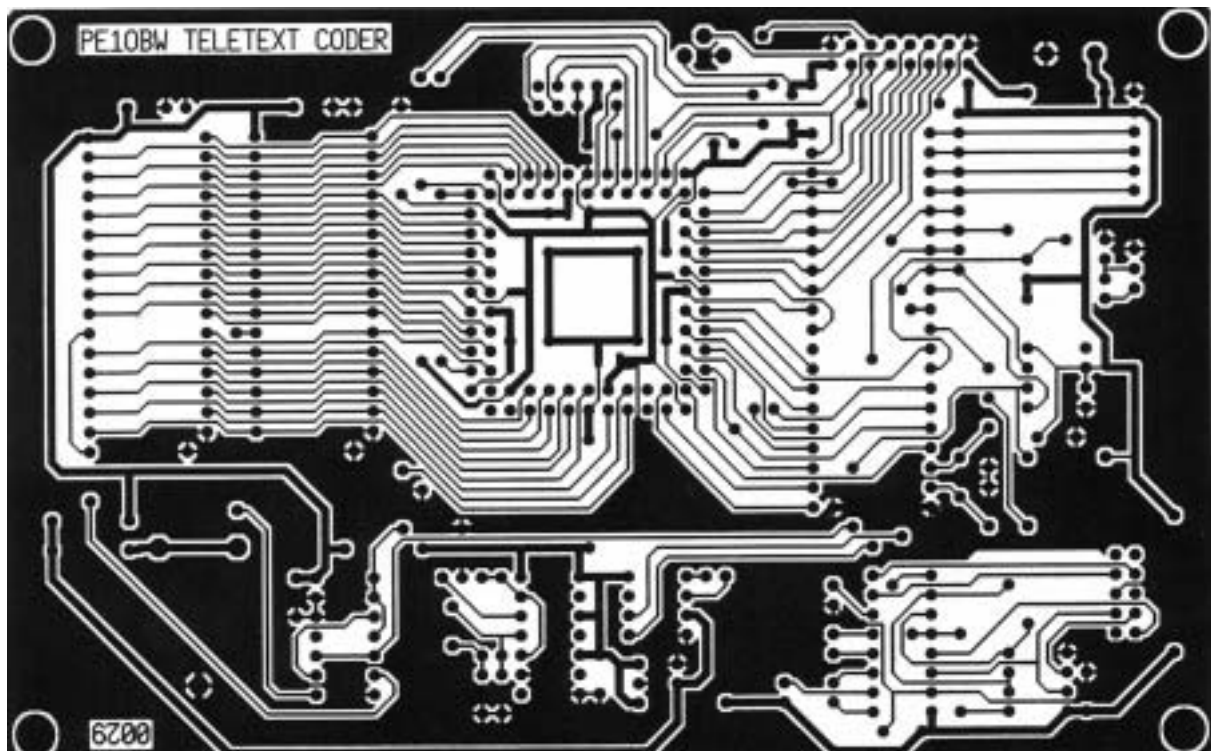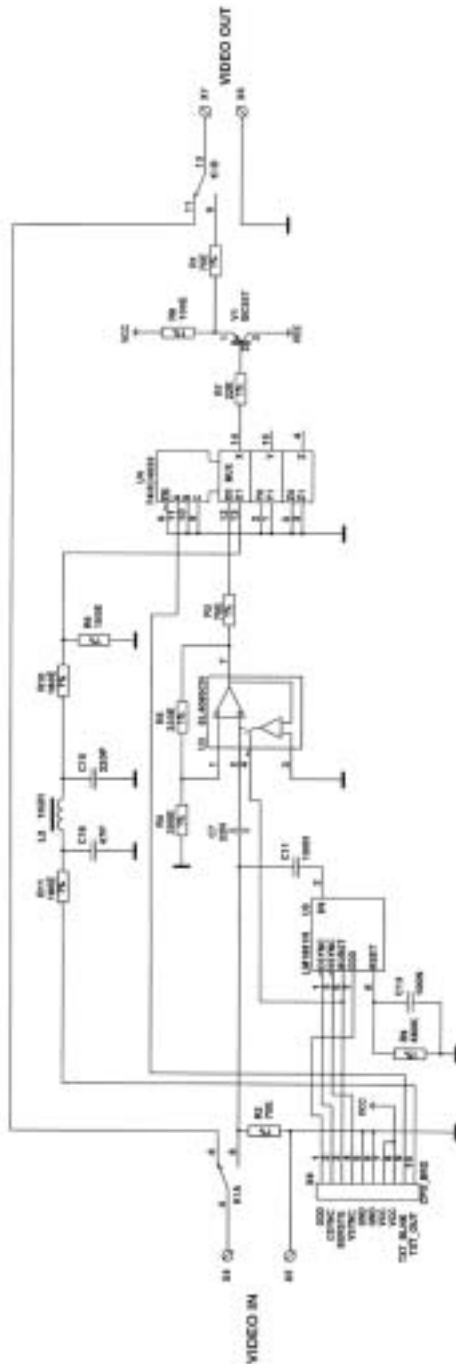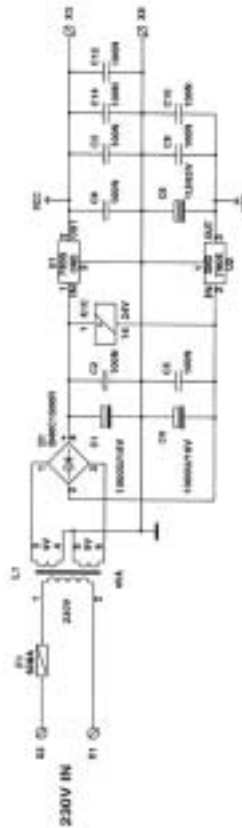

Figure 7

Figure 5

incremented by one.

If the last row of a page has been sent, the 'page done' signal goes active, which interrupts the microcontroller. The microcontroller will then program the 'byte counter' to the start of the next page to transmit.

The 'shift register' is controlled by the 'byte counter'. The data to be sent is read from RAM and clocked out with the correct speed. The shift register also produces the clock run in bytes and the frame byte at the start of each teletext video line.

The microcontroller reloads the 'byte counter' after a complete page is

transmitted. For the rest of the time it keeps up with the clock time and data and it communicates with the PC.

Because both the shift register and the microcontroller need access to the RAM, the block 'DMA control' is required. This circuit controls memory access and switches between the shift register and the microcontroller.

The complete circuit

After examining the block diagram it is time to take a look at the complete schematics. The circuit consists of three parts: the power supply, the video interface and the digital logic. The power supply and the video interface are shown

in figure 5. A simple power supply is sufficient here, because the encoder doesn't need much power. The digital logic and the sync separator need a single +5 Volt supply, the video opamp and the electronic switch require a bipolar +/- 5 Volt supply. A relay is placed across the unregulated supply voltage to feed through the video signal if the encoder is powered down.

The video interface contains the well-known LM1881 sync separator. The sync pulses are fed to the digital logic, the burst gate output is also used to drive the EL4089, the DC-restored video amplifier. This chip amplifies the video by a factor two and also provides for a black level of 0 Volt DC on its output. The datasheet of the EL4089 suggests that it shouldn't be suitable for composite video; however, in practice it works fine.

The 74HC4053, an electronic switch, toggles between teletext data and the amplified and DC-restored video signal. Because the FPGA drives 5 Volt TTL pulses at its output the teletext data needs to be filtered and attenuated. The filter is not very steep but the video filter in the transmitter will do the rest. The video signal with teletext data is buffered by an emitter follower.

The digital part of the schematic is shown in figure 6. The core is based on an Atmel AT89C55 microcontroller, a Xilinx XCS10 FPGA and one or two 512kbyte SRAM chips. Each RAM chip can contain data for about 400 teletext pages. After the encoder is turned off, the SRAM is powered by a 3 V lithium cell to preserve its contents. The battery also supplies the 74HC00 and the DS1307, a real time clock chip. The 74HC00 brings the RAM in the power-down mode (by pulling the CS pin high) after switching off.

The encoder communicates with the PC using a serial RS232 interface. The TTL output voltages are converted to RS232 levels by the MAX232. A watchdog/reset circuit provides for a reliable start-up.

The teletext data stream bit rate is 6.9375 Mbit per second. This speed is derived from a 13.875 MHz crystal oscillator, built using two 74HC04 inverters. The greater part of the digital logic is located in the FPGA. This 'field programmable logic array' is configured by the

microcontroller after power up and is then responsible for a large part of the functions described in the block diagram. If desired you can connect an LC-display with one row of 16 characters to the encoder. On the display you can see the actual time and the number of pages currently loaded.

DCF receiver
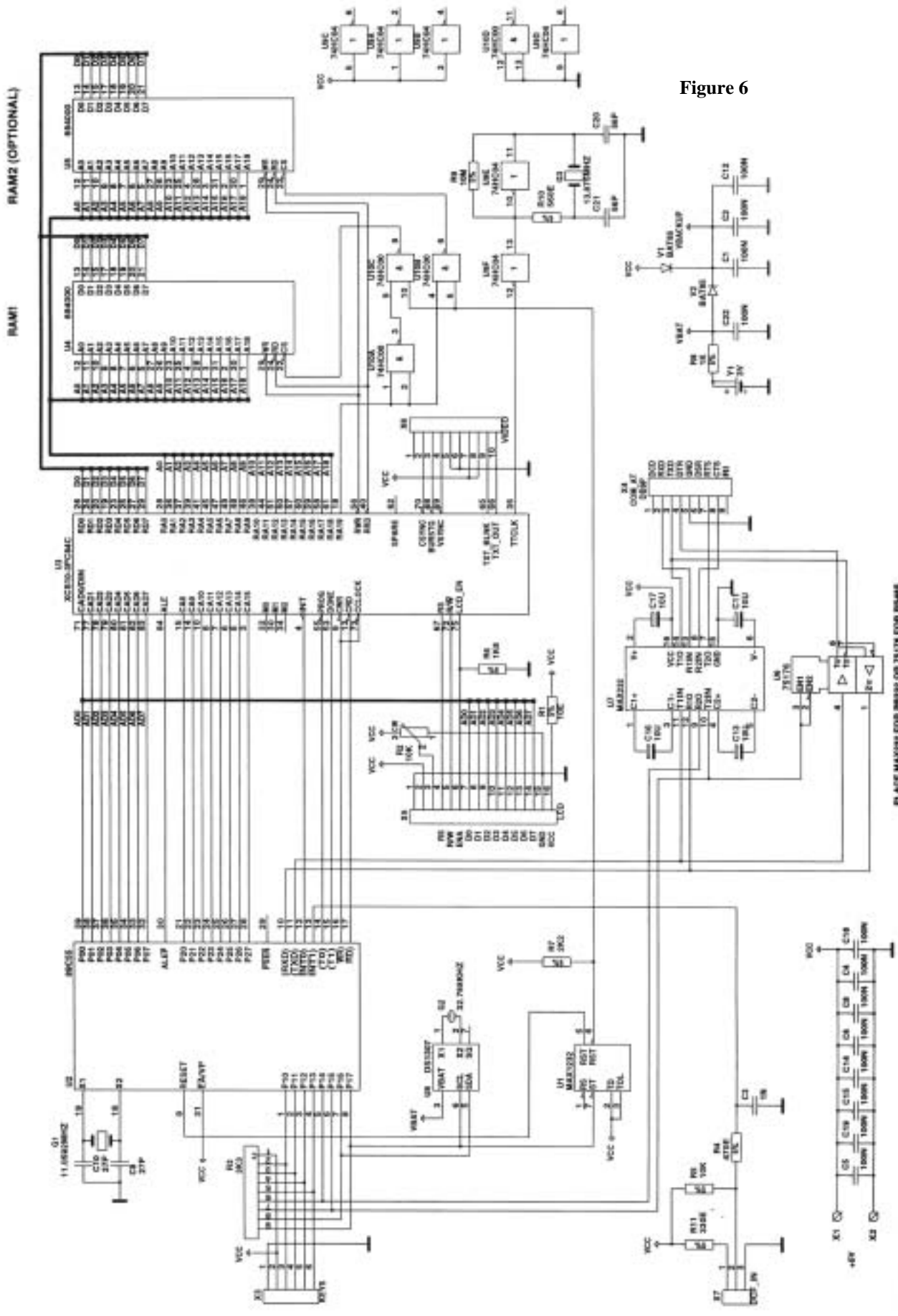
Figure 6
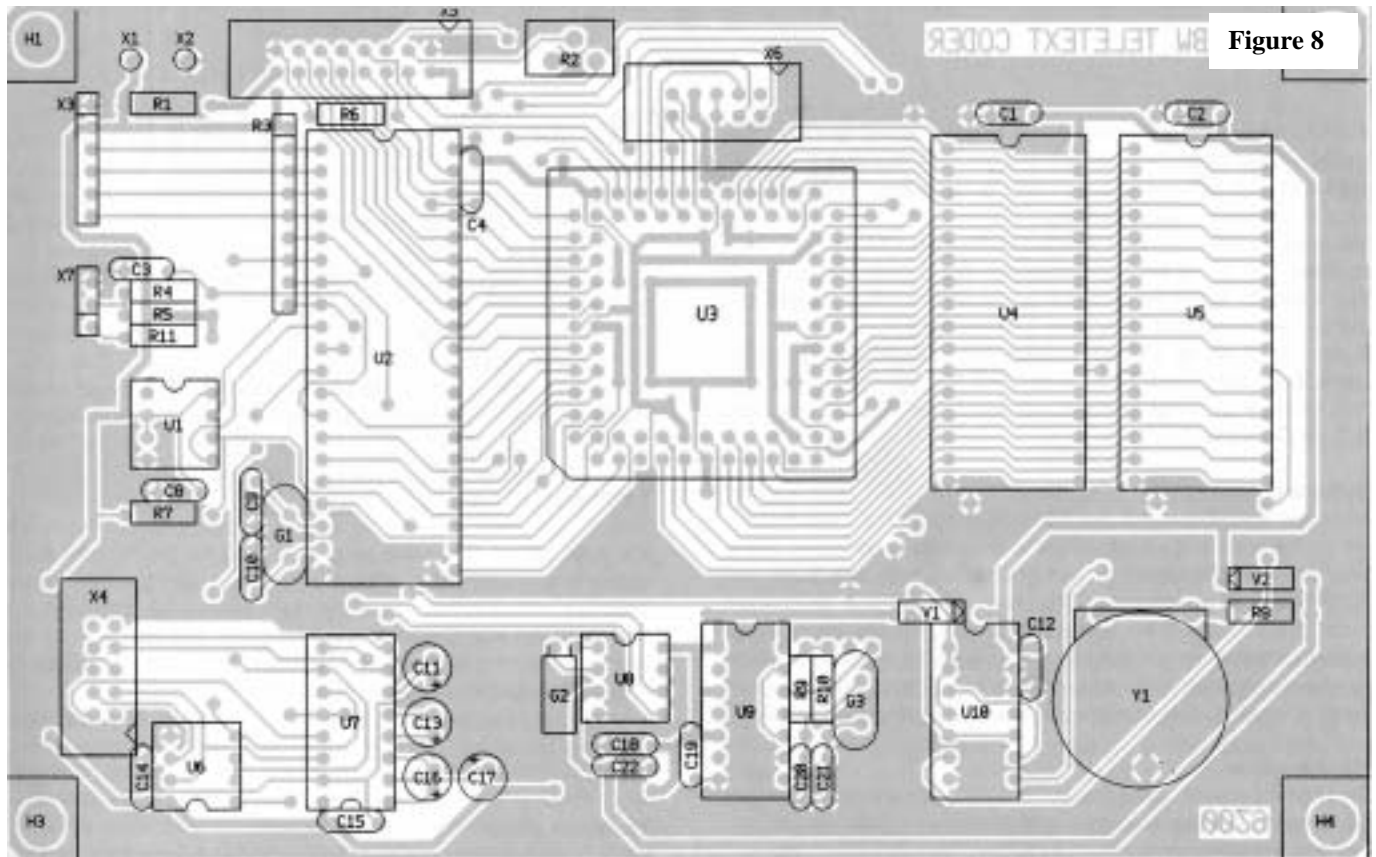
Figure 8
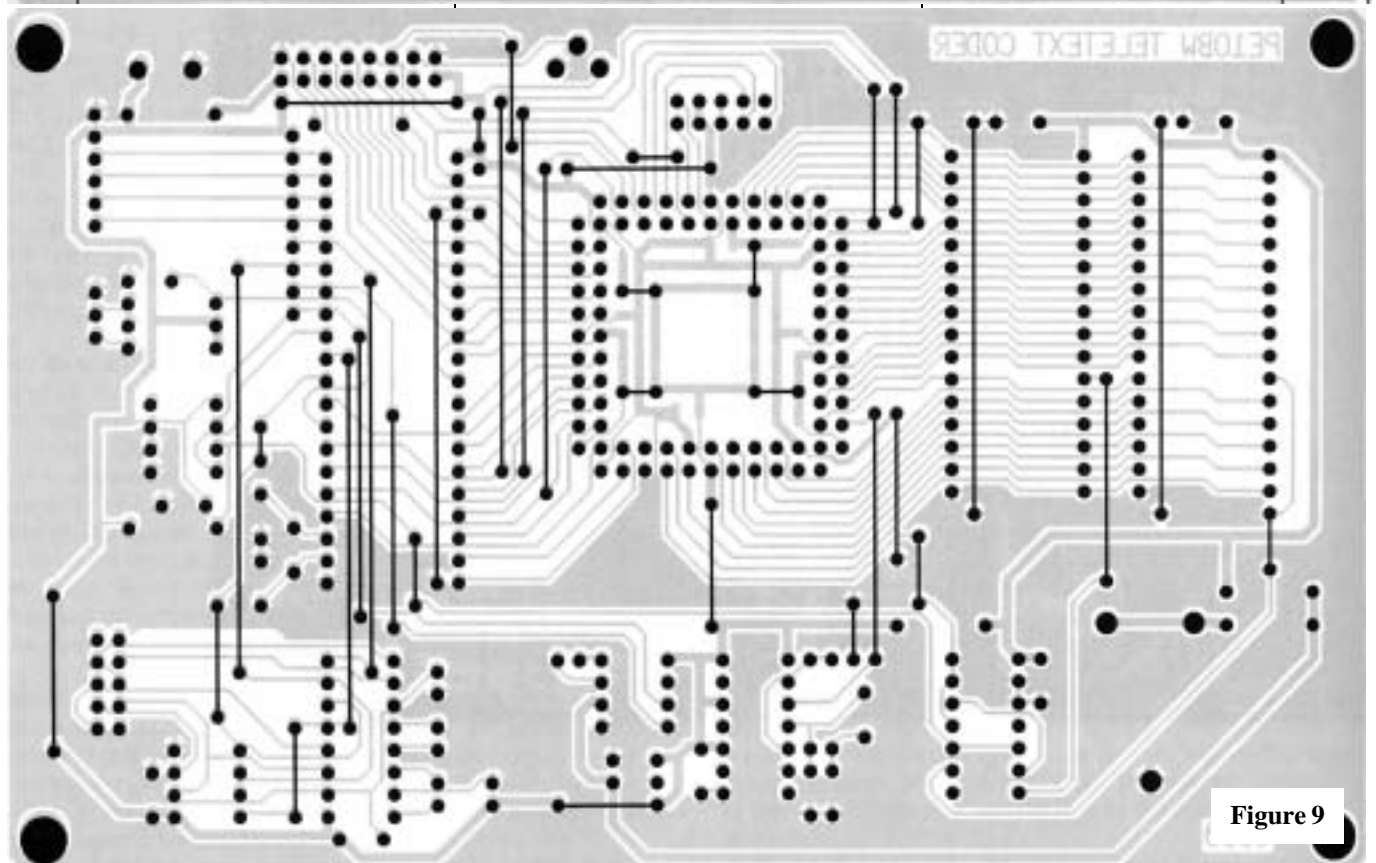
Figure 9

Real fanatics can also connect a separate DCF77 receiver to transmit teletext time with the accuracy of an atomic clock. The receiver should have a demodulated pulse output. Reception of the DCF77 signal is possible in a radius of 2000 km around Frankfurt, Germany. The receiver is connected to the three pole 'DCF in' connector. On this connector you will find the supply voltage (+5 V), ground, and an input for the DCF pulses. The polarity of the pulses can be changed by the PC software. A LED connected between pin 1 and pin 3 of X3 flashes at the received DCF pulse rate. The software automatically detects the clock if connected and will give the correct time after at least two minutes of error free reception.

A usable receiver could be purchased from Conrad Electronics (fig.16). When using the Conrad receiver, a small modification of the DCF input circuit is

Figure 10

Figure 11

necessary. The receiver requires 3 V supply voltage, you can use a 3 V zener diode between pin 1 and pin 3 of the receiver. You also have to remove the pull-up resistor (R5) at the input.

The PCBs

An easy construction of the encoder was one of the design targets. This is achieved by spreading the design over two PCBs. The power supply and the video interface are placed on the first PCB; the digital logic is placed on the second one.
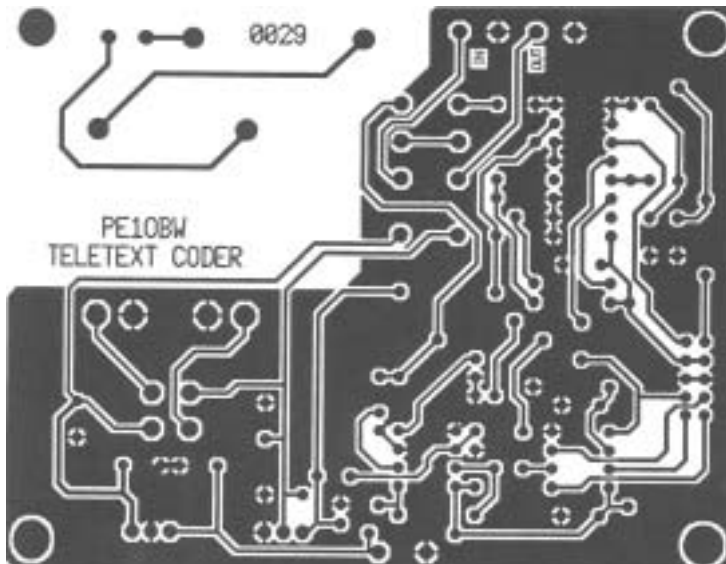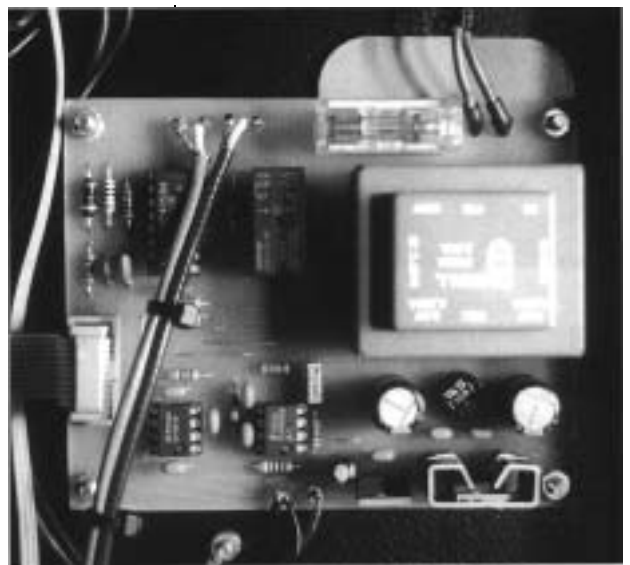
The PCB layout and the component placement of the power supply/video interface are shown in figure 10 and 12. The PCB measures 8 x 10 cm (half a Eurocard) and holds besides the components of the schematic diagram also a few wire links. The 7805 voltage regulator needs some cooling; a small heatsink is sufficient.

The digital PCB is single sided just like the power supply/video interface board. This is possible because the FPGA allows a large freedom in pin assignments. See figure 7 for the PCB. This PCB contains a large number of wire links (fig.9). These are particularly needed for IC decoupling and to guarantee a good overall ground connection, which is needed for reliable operation of the circuit.

Construction

Construction starts with the placement of the wire links! Some links are placed underneath the ICs and cannot be accessed after the ICs are placed. The FPGA and the microcontroller must be placed on sockets; the other ICs could be soldered to the PCB directly. The lithium cell should be the last part to be placed and must be soldered quickly. Don't ever short-circuit it because the lithium cell could explode!

The 89C55 microcontroller needs to be programmed. The software can be downloaded from our website (http://home.wanadoo.nl/pi6dig/). The file format is Intel HEX which can be read by most programmers. The FPGA is configured after power up by the microcontroller and needs no preceding programming.

Case assembly and connection

The PCBs are mounted next to each other and are connected with a short 10-pole flat cable. Mount a mains entry, two BNC sockets and a male RS232 socket (D9 type) at the back of the case. The mains entry may contain a mains filter and/or a mains switch. If you want to use a DCF receiver you should also provide for a suitable 3-pole DC female connector. You can place a mains switch and possibly an LC-display at the front panel.
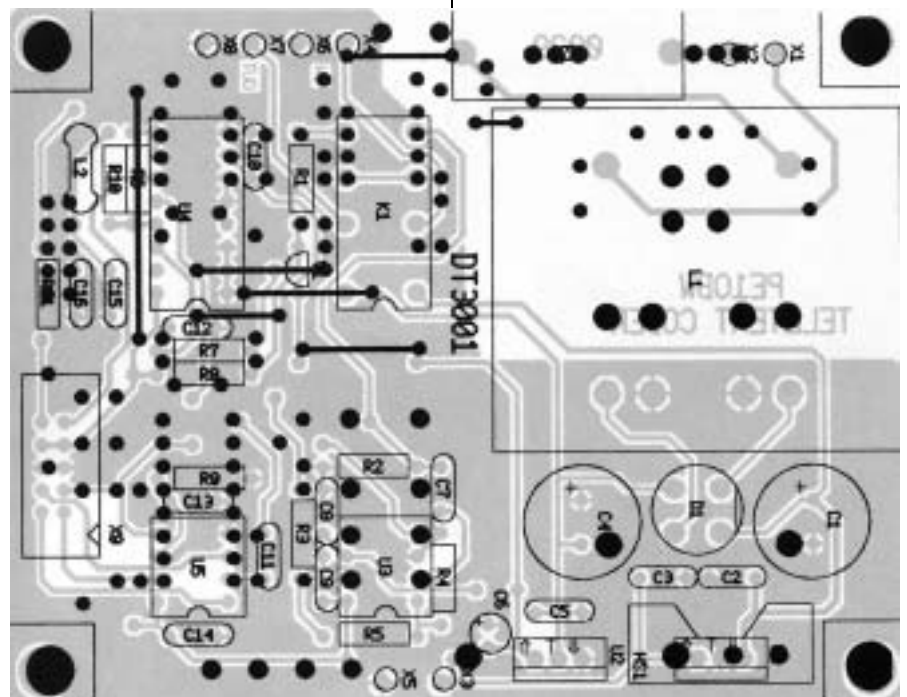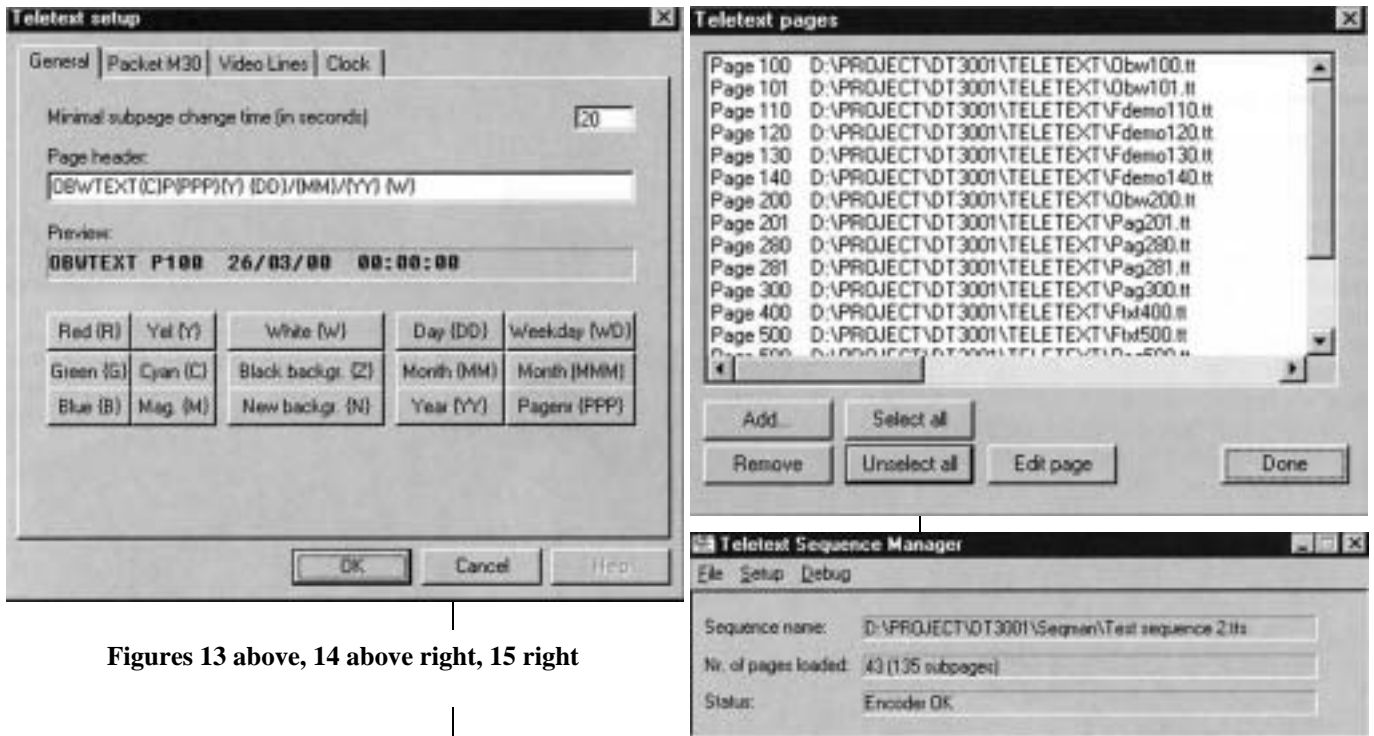

Figure 12

Figures 13 above, 14 above right, 15 right

Connect the video in/outputs with the BNC sockets. Care should be taken when connecting the RS232 socket. Pin 1 of the flat cable connector is soldered to pin 1 of the D-socket, pin 2 is soldered to pin 2, and so on.

To connect the encoder to the PC you will need a so-called null modem cable. This cable has two 9-pole female plugs and should be wired as following: pin 5 to 5, 2 to 3, 3 to 2, 7 to 8 and 8 to 7.

Software

Two PC programs are written for the teletext project. The first is the page editor. This is the program I used for the PC card encoder, enlarged with some additional functions like FLOF (see further on). This program was originally written for Windows 3.1 and thus will not support long filenames and the like.

As I write this, the user interface is in Dutch, but maybe I'll find some time to translate it...

The second program is the 'sequence manager'. Both programs need no installing; you can start them from any location you want.

The page editor

Pages are made with the page editor. To be able to work with the editor you will need some basic knowledge about the construction of a teletext page.

To start with: The original teletext specification is from the 70s of the last century, but has constantly evolved since then. Nowadays we distinguish between four 'presentation levels', namely level 1, level 1.5, level 2.5 and level 3.5. The higher levels have more features but are downward compatible with the lower levels. You should think of features like extended character sets, extended colour palettes, high resolution graphics, proportional fonts, etc.

The software written for this project is restricted to the level 1 specification. This is done because only the latest TV sets have support for the higher levels. For those who are interested: on page 819 of the Dutch teletext service (Nederland 1) you will find an example of a level 2.5 page. Maybe a future update of the software will support some higher level functions.

A teletext page starts with a top line (the header), followed by 23 or 24 rows with 40 characters each. These characters can be alphanumerical digits, graphics or control characters. The control characters are used to select other colours, double height text, etc. A control character occupies the space of a character and looks like a space on the TV set.

For example: to produce a line with red text, the text must be preceded by a control character 'red text'. The effect of a control character remains valid until the end of the line. If more text rows should be red you should start each row with a control character 'red text'.

After start-up the program shows an empty page. At the right you see a group of buttons to produce the control characters.

The buttons with the coloured letters will produce the control characters for coloured text. If you press a button a small 'c' appears on the teletext page at the cursor position. This 'c' is not visible on the final page but indicates the presence of a control character on that place.

The effect of the control characters will become clear to you soon. If you move the mouse pointer over a control character its function appears at the left bottom of the editor window (in Dutch, unfortunately...). Special attention must

DT3001 teletext encoder Main PCB Component list
Revision B, 2000-11-17

Qty	Reference	Value	Description	Pitch/shape
10	C1,2,4,6,12,14,15,18,19,22	100n	Multilayer capacitor	5 mm
1	C3	1nF	Ceramic capacitor	5 mm
2	C5,6	100nF	SMD capacitor	C1206
2	C9,10	27pf	Ceramic capacitor	5 mm
4	C11,13,16,17	10uF	Electrolytic capacitor	2.5 mm
2	C20,21	56pF	Ceramic capacitor	5 mm
1	G1	11.0592MHz	Crystal	HC49
1	G2	32.768kHz	Watch crystal	
1	G3	13.875MHz	Crystal	HC49
1	R1	10 ohm	Resistor 5%	10 mm
2	R2,5	10k	Resistor 5%	10 mm
1	R3	3k3 x 9	Resistor array 8x3k3 SIL9	SIL9
1	R4	470 ohm	Resistor 5%	10 mm
1	R6	1k8	Resistor 5%	10 mm
1	R7	2k2	Resistor 5%	10 mm
1	R8	1k	Resistor 5%	10 mm
1	R9	10M	Resistor 5%	10 mm
1	R10	560 ohm	Resistor 5%	10 mm
1	R11	22 ohm	Resistor 5%	10 mm
1	U1	MAX1232	Maxim watchdog/reset circuit	DIP8
1	U2	AT89C55-24PC	Atmel CPU 20k FLASH	DIP40
1	U3	XC5210-3PC84C	Xilinx FPGA	PLCC84
1(2)	U4,U5	KM684000A	Samsung 4 Mbit (512kx8) 70ns SRAM	DIP32
1	U6	-	do not place!	
1	U7	MAX232N	RS232 network transceiver	DIP16
1	U8	DS1307N	Dallas real time clock	DIP8
1	U9	74HC04	Hex inverter	DIP14
1	U10	74HC00	Quad nand	DIP14
2	V1,2	BAT85	Schottky diode	
2	X1,2	Pin 1 mm	Solder pin	
1	X3	SIL6	6 pole pin header	2.5 mm
1	X4	10 pole boxed header	16 pole flatcable header	2.5 mm
1	X5	16 pole boxed header	16 pole flatcable header	2.5 mm
1	X6	10 pole boxed header	10 pole flatcable header	2.5 mm
1	X7	SIL3	3 pole pin header	2.5 mm
1	Y1	CR2032PCB	3V Lithium cell with solder lips	

Notes
• U2 and U3 should be placed in sockets!
• U2 should be programmed with DT3001.HEX
• For U4,5 you can use 512KByte chips of several manufacturers, but check pinout, shape (DIP32) and supply voltage (5V)!
• U5 is optional.
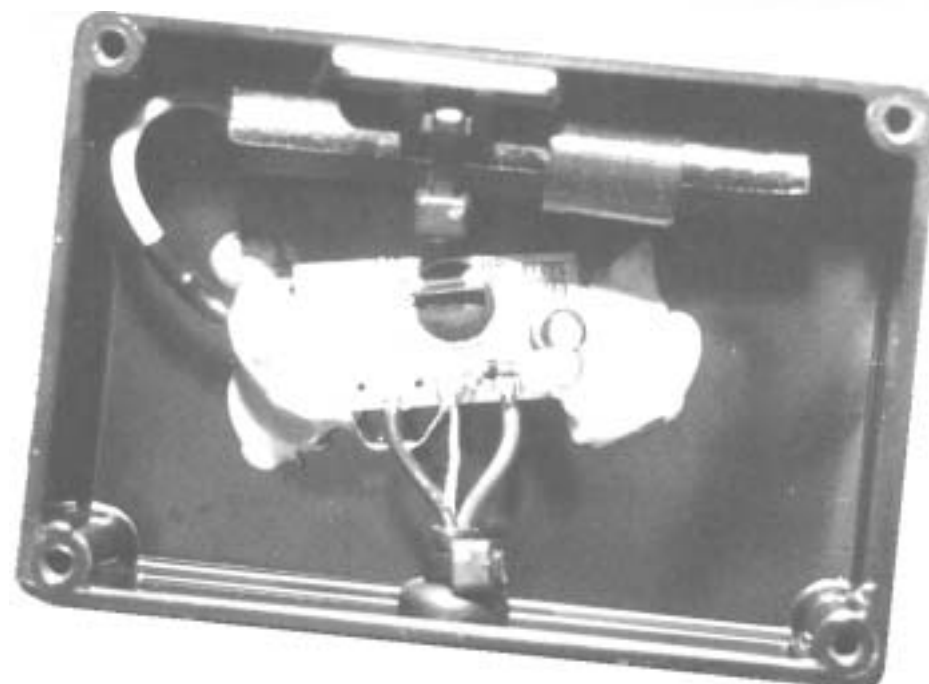
Figure 16

be paid to the 'start box' and 'end box' control characters. These are placed under the buttons with the '[' and ']' symbols. These symbols are, among other things, used for subtitles. To produce a page with subtitles, you must first turn on the 'C6-ondertitel' option in the page-setup screen. Then type the subtitle text, precede it by TWO start box characters and end it with TWO end box characters. This is because on teletext pages, a transmission error resulting in a false start box character should cause a large black stripe on the screen.

Graphics

The graphic capabilities of teletext level 1 are limited. Simple drawings can be made with 64 graphical characters. The editor allows you to draw with the mouse. To be able to draw you should first select a graphic colour. Press a button with a coloured

rectangle to get a graphic colour control character. It is now possible to paint with the mouse on the row behind the control character. Maybe you will first have to click on the pencil button to activate drawing mode. By starting more rows with a graphic colour control character you can make larger drawings.

You can choose between 'contiguous graphics' and 'separate graphics'. Generate the corresponding control characters by clicking the button with the black box or the button with the six small black boxes. These symbols should be placed just before or after a graphic colour control character.

Importing text and graphics

It is possible to import text and simple bitmaps in a teletext page by cutting and pasting from other software. Text is pasted from the current cursor position. If you try to paste a bitmap, a cursor with four small arrows appears. With this cursor you can draw a rectangle in which the bitmap will appear (in 'teletext resolution', of course). Since the editor itself has only limited drawing tools it is better to prepare the picture with a program like Paint.

Page numbers and sub pages

Teletext pages are numbered from 100 to 899. The page number can be set by selecting 'opties' and then 'paginanummer'.

A teletext page can have one or more sub pages. Sub pages are changed with a specific adjustable time interval, for example each 20 seconds. You can add or remove sub pages with the functions in the Options menu. It is also possible to add existing pages as sub pages in a page. Choose under 'Bestand' the option 'Opvragen'.

FLOF

The teletext encoder supports the FLOF system (Full Level One Facilities). This is a navigation system using the four coloured buttons on the remote control of most TV sets. At the bottom of a teletext page an additional row is visible with (up to) four coloured 'links'. The colours of the 'links' correspond to a coloured keys on the remote control. By pressing a coloured key the TV will jump to the selected page. This system is used by most TV-stations in Holland and Belgium.

The page editor allows you to enable the FLOF function per page. Select in the menu 'opties' and then open the 'pagina gegevens' page. Here you can check the 'gebruik FLOF' checkbox if you want links under this page. You can also enter the page numbers where you want the TV to jump to if the user presses a coloured button. Also provided is an 'Index' field. Some TV's have an 'Index' button on the remote control to select this page.

After you entered the page numbers you should enter a short description of each link on the bottom row of the page. The correct colour control characters are already placed on this row.

Figures 17 to 20

Sequence Manager

With the Sequence Manager you can select the pages to be transmitted. Page lists can be stored and retrieved. You can also make some general settings for the encoder. The program keeps track of the contents of the encoder memory. If pages are added to or removed from the sequence the sequence manager will only transmit the changed pages. After start-up the program will immediately try to contact the encoder. If this fails, for example because the com port is not setup yet or the encoder is not connected, the status field shows 'Encoder not found'. Select 'Sequence manager setup' in the 'Setup' menu to setup the com port. After changing the com port you should restart the program for the changes to take effect. You can select pages by choosing 'Setup' and then 'Select pages'. The page select window appears. From here you can also start the page editor. The editor must be installed in the same directory as the sequence manager. After pressing OK in the page select window, the new sequence will be sent to the encoder immediately.

Settings

You can enter the encoder setup screen by clicking 'Setup' in the menu and then 'Teletext setup'. On the 'General' screen you can change some general settings. The 'minimal sub page change time' is the minimal time a single sub page is shown before it is changed to the next one. The 'Page header' is the top line shown on top of each page. The page header can contain special codes to display the current date and the page number.

The time is always automatically inserted in the last eight positions of the header. On the 'Packet M30' screen a number of additional functions can be setup. Not every TV supports these functions. The 'initial page' is the first page displayed if the user selects teletext on his/her TV. The 'Station ID' row is superimposed over the normal TV picture for a few seconds if the user selects your channel. The field 'Network identifier' is, as far as I can see, completely useless. In the 'Video lines' window you can determine which video lines you want to use for teletext and which not. By the way, not all selected lines will be used for teletext data due to limitations of the teletext protocol. The tab sheet 'Clock' allows you to select the polarity of the DCF pulses, if applicable. You can also synchronize the PC time with the encoder time or vice versa.

In conclusion

Enough for now. If you decide to build this encoder you will find all software and the PCB layouts (as HP-LaserJet printable files) on our website. This is also the place where you will find updates and additional information. Have fun with it! A tip: examine the teletext pages of the public TV stations to learn their tricks; in spite of its shortcomings, you can do nice things with teletext graphics. The encoder has successfully been built by some amateurs. The pictures in this article are from the encoder built by Bas Weijers (PE10WS). Meanwhile, we found that a relatively strong received signal is needed for useful teletext reception, so you are warned... You can always mail me for questions and comments; my email address is pe1obw@dds.nl

Sources and links:

• Enhanced Teletext Specifications, ETS 300 706, EBU/ETSI • Teletekst decoder deel 1, Elektuur oktober 1981

- Spartan and SpartanXL datasheet, http://www.xilinx.com/partinfo/databook. htm#spartan
- AT89C55 datasheet http://www.atmel.com/atmel/products/prod71.htm
- DCF-77 info, http://www.dcf77.com/deutsch/index.htm
- Software and PCB layouts for this project, http://home.wanadoo. nl/pi6dig/
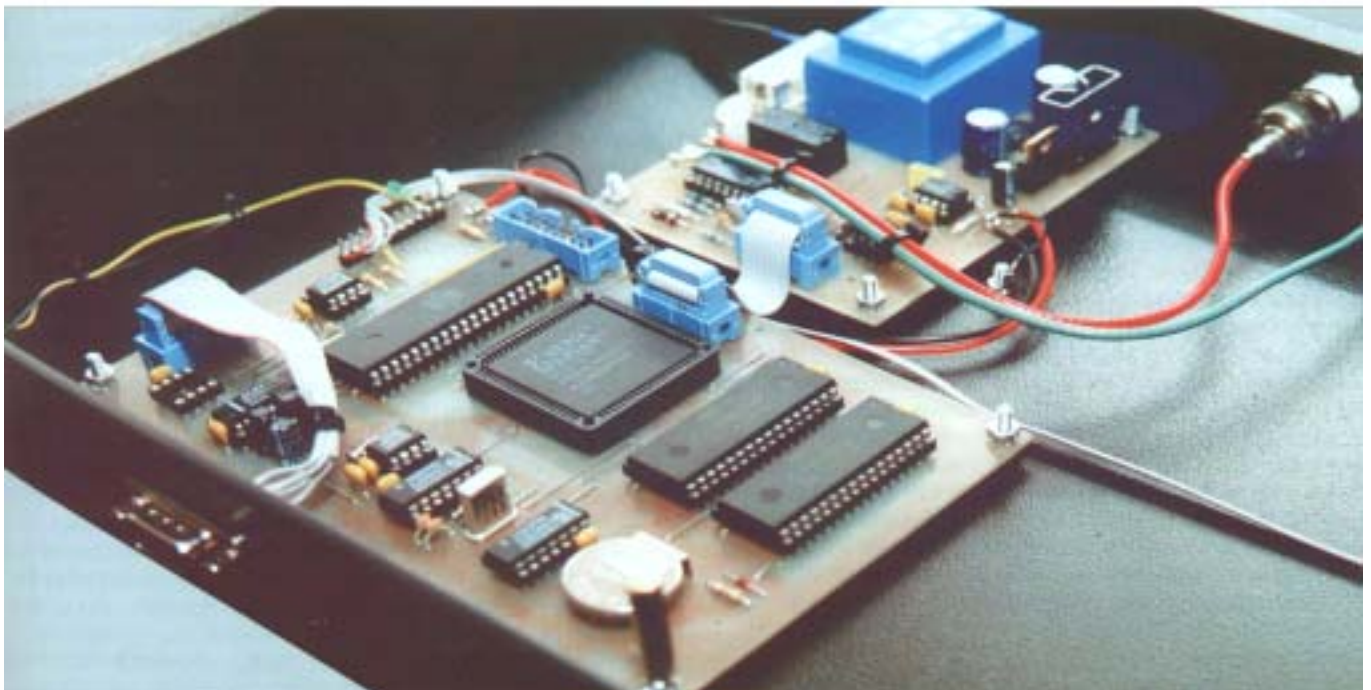
Figure 21

Emulating the ZX Spectrum on a PC

By Paul Godfrey G8JBD

Introduction

I became interested in ATV in about 1980. Domestic sources of video signals were becoming plentiful, VCRs, cameras and then microcomputers. The government of the day decreed that all classrooms in the country would have a computer and parents were looking at the various offerings so they could help educate their child. I was whipped along in this frenzy and purchased a Sinclair ZX Spectrum for the education of my children. Many articles and programmes were written for and about it, many of which were in CQ-TV and other BATC publications. It soon became clear, in my case, which this new equipment was not so much educational but a video games platform and Hungry Horace and Jet Set Willy seemed to be permanently displayed on the screen. I purchased the ATV program and later the New ATV program from The Worthing Video Repeater Group. This excellent piece of software could generate testcards, calculate distances using QRA locator and much more. But the Spectrum never made it to the radio shack because of the high level of demand from my children. Eventually the Spectrum was ousted by a Commodore Amiga and was put in a cupboard along with the software.
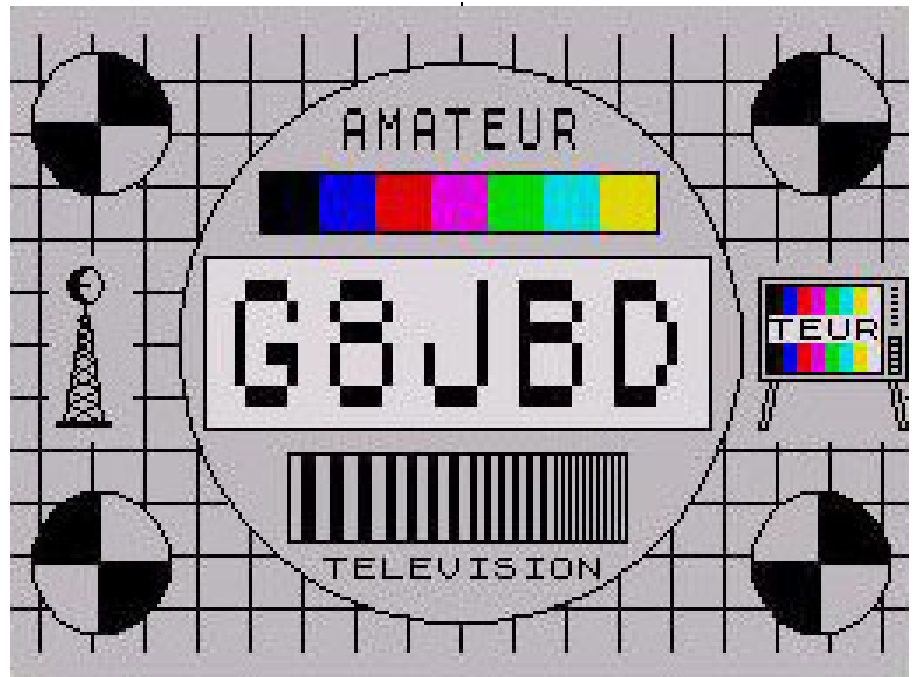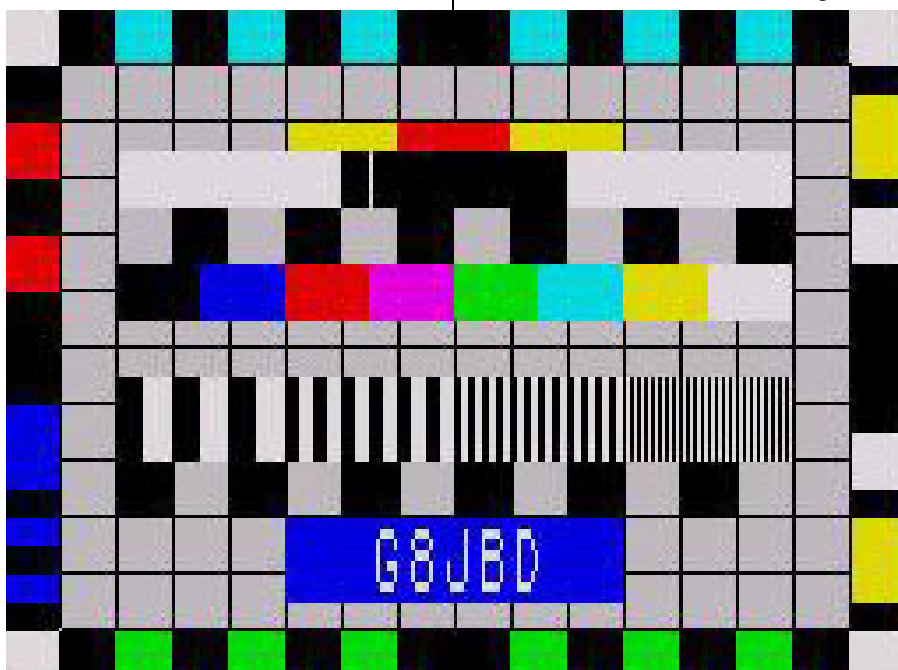

Testcard from the ATV Program

20 years later

Now nearly 20 years later there is a PC in my shack. I began looking on the internet and put the words ZX Spectrum into a search engine and was greeted with loads of links to sites offering a variety of things from emulators to software as well as nostalgic looks back at the fairly recent past. One site www.cdworld.co.uk was offering a CD,

Testcard from Worthing Program

The World of Spectrum, with programmes and emulators for a cost of £5. I sent off for it and was impressed by the large quantity of software on this CD. All of the emulators are DOS except one and are not zipped, so they can be run straight from the CD, which means that you do not have lose hard disc space to use the disc. I was able to run all the emulators with an old 486 100 MHz, so the latest and greatest PC is not necessary. The disc contains thousands of old Spectrum games and demos as well as several rewrites of games that run on a PC without the use of an emulator. It is a good attempt at cataloguing the history of Spectrum software and a second disc is available for a further £5 that contains the endings of games and scanned images of cassette case inserts and Spectrum magazines of the era. All the old games and demos that my children had seemed to be on it, but not the Worthing ATV Program. I began to think that it would be nice to use this programme again and my old copies were dug out. The original software is on cassette tape and none of the emulators on the disc seemed to support cassette tape loading. The programme files on the disc are in various converted formats such as .sna .tap and .zip. I needed a Spectrum emulator that my tape file would load into and convert to one of these formats. Another look on an Internet search engine found

www.methedrine.demon.co.uk this site offered SpecX a ZX Spectrum emulator for the PC. Minimum requirements Pentium 133 with Direct X. This emulator works in Windows 95/98/NT as a Windows programme rather than a DOS programme running in Windows. I downloaded a shareware copy. The shareware version only runs for 10 minutes before it times out and it then has to be reloaded. Sending SpecX's author Robin Edwards a registration fee of £10 will result in you receiving a code that gives a full working version.

Loading Tapes into SpecX

First of all the tape must be turned into a .wav file. The Windows sound recorder will do this, although I used Crystal Audio Station by Voyetra. Simply connect a mono cassette recorder to the mic input of your sound card, play the tape and record the sound. Some adjustment of the audio level of the cassette recorder output and the input to the PC is necessary. Once this is done record the Spectrum tape and save it as a .wav file. Then load up SpecX. Type J then Ctrl PP, this will bring up the old familiar LOAD" ". Click on File and Open Snapshot, then locate your saved .wav file and open that. Click on File, then tape control and set the sampling frequency to the same value as your saved .wav file: I used 22050 Hz. You can stop, rewind and play your virtual tape. If all is well you will see the software loading in the border just like a real Spectrum. Most programs run when loaded just like the old Worthing program. You can now save your software as a snapshot on the File menu save option. The saved file will then work with any of the emulators on The World of Spectrum CD.

In Conclusion

The ZX Spectrum was not ideal as testcard generator as the working area of the display did not go any way near to the very edges of the screen. The emulators also do not give a full screen display, but it is fun to use the old Worthing program again. The next step for me will be fitting a VGA graphics card with a PAL video output so the PC can be used on the air. Not a very technical article, just something that some may find fun to do.

References

www.methedrine.demon.co.uk SpecX

www.cdworld.co.uk for World of Spectrum CD. Warning this site and the CD contains some adult material.

The Worthing ATV program and the Spec X program are available for download from the www.cq-tv.com/software web site - ED

The Berlin-Brandenburg Link-Experiment

By Jörg Hedtmann, DF3EI (Sysop of DB0ZS)

Why

At the beginning of this year (2002) north-German ATV-repeater sysops met to discuss plans for the creation of links between the various sites. This started off an intensive discussion of link-issues all over Germany, especially topics like:

Exchange of Control Information between Repeaters and dedicated Interlink-Stations

User Control of Local Access Point and Remote Repeater (the usability of DTMF is highly disputed)

Not much emphasis was put on RF-issues, as everybody felt that this can be handled by available technology, so long as the RF-path was suitable (i.e. the topography between participating stations).

Our local Berlin-Brandenburg ATV-Group thought that practical experience was the best solution to contribute to the discussion and so it was decided to set up a multi link experiment on 1st June 2002 during a festivity in the small town of Zossen, the site of the DB0ZS repeater, abt. 40 km south of Berlin. Our aim was to assess the quality of the video after being fed through multiple transmitters and receivers, as we thought that this could be a major obstacle to linking repeaters (due to the non-availability of suitable sync-restoration equipment).

How

We planned to place a number of cameras around the site and have one set up in a rucsac for an operator to walk around over the whole site without the restriction of cables. The fixed installation cameras were equipped with cheap 13 cm video transmitters (available at the local discounter at abt. 50.- EURO per RX/TX set). Of the four channels available three were used for cameras, the walk-about system had a 3.5 W transmitter operating about 100 MHz below the video-transmitters. DL7TF had set up a make shift OB-van in his camper, were the 13 cm feeds were switched onto a dedicated 9 cm link transmitter to the local DB0ZS repeater. At the repeater site we mounted a temporary 9 cm receiver, as the 13 cm uplink would have disturbed the onsite video distribution.

From the DB0ZS repeater the signal was transmitted over the 6 cm link to DB0KK, one of the Berlin ATV repeaters, over a distance of abut 40 km. This link is a permanent feature and allows regular duplex contacts between Berlin and Zossen stations. In Berlin the received 6 cm-signal was combined with the local 13 cm user access with a p.i.p. arrangement and re-transmitted over the regular 23 cm and 3 cm outputs. By this time Berlin ATV-viewers could follow all activities in Zossen and still have local contacts as well. The 3 cm DB0KK output is used for monitoring at the DB0ZS site (also a permanent facility) and was re-transmitted in Zossen on 23 cm (the regular output frequency of DB0ZS). On the festive site the received signal was again re-transmitted over the remaining free 13 cm video tx to a large colour TV set in the exhibition tent, were it was viewed by many guests, radio hams and the general public alike. The diagram above illustrates the complex link arrangement.

As can be seen from the schematic an additional link was set up to the
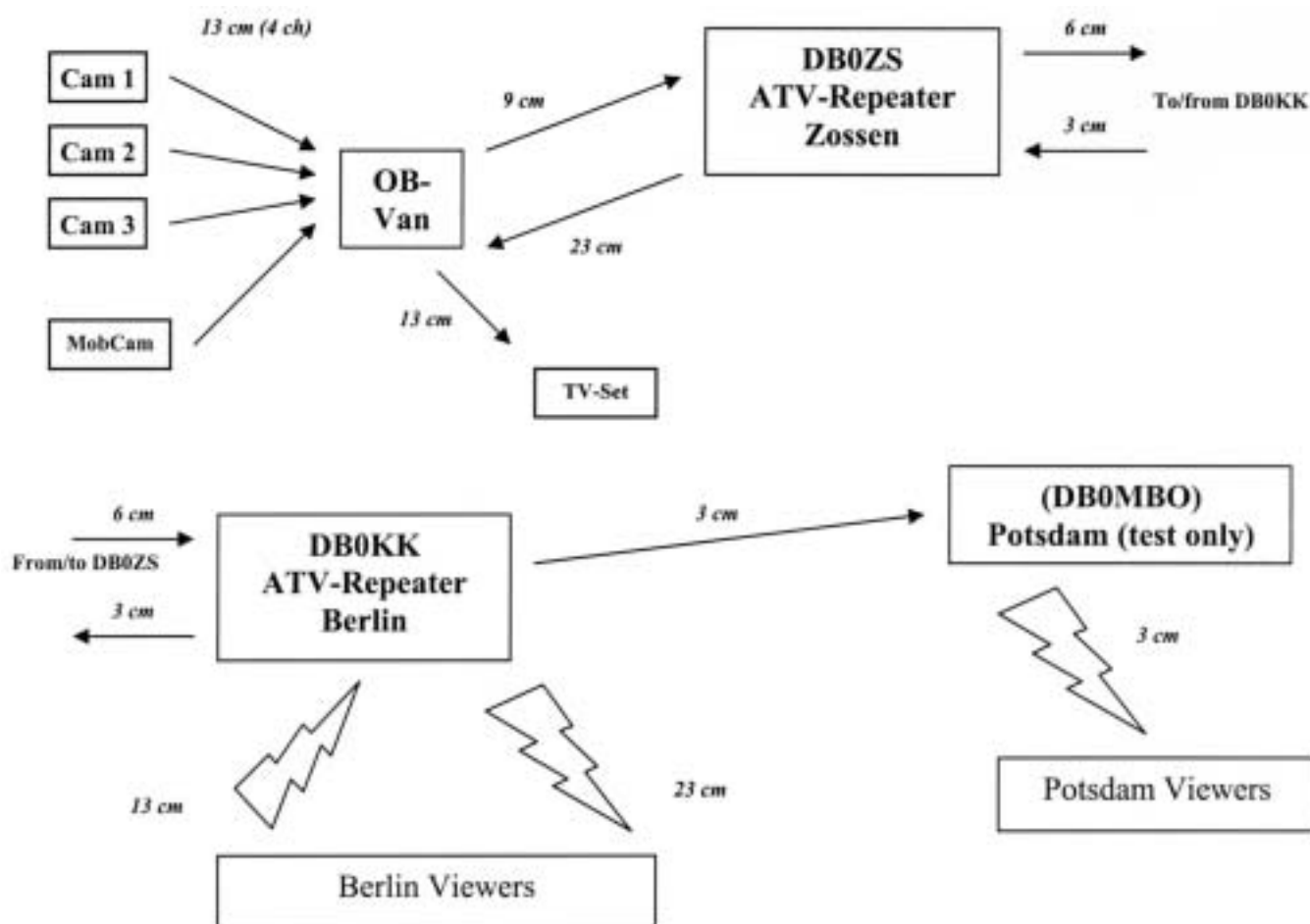
experimental ATV-repeater in Potsdam, about 40 km to the south west of DB0KK, and from DB0BC, the second Berlin ATV-repeater (not shown in schematic).

Results

Signals from the site in Zossen were transmitted and forwarded over up to 6 links in the 23, 13, 9, 6 and 3 cm bands. Additional feeds from Berlin and Zossen were added in the 13 and 70 cm bands. The total distance covered was well in excess of 120 km and, most of all, the picture quality of the received signal back on the site was such that most viewers there believed it to be the local repeater output or indeed CCTV from the site. When viewed on the scope, however, there was a distinct degradation of sync and colour information and various monitors did have difficulties locking onto the incoming video. We are therefore convinced that we have to find a solution to restoring the video waveform at each link in the chain, especially, as incoming local signals might (and usually already have) noise and distortion added to their video. Maybe there is somebody amongst the

readers of this article who can point out a solution affordable enough for amateur use.

The second important result for us is the use of DTMF for repeater and link control is feasible only for a limited number of linked-up sites. There has to be a regional co-ordination of codes to avoid unwanted side effects from a DTMF-command at one repeater initiating something else at another. We are currently introducing strict 3-digit coding with an individual 4th digit to indicate completed commands and to distinguish different repeaters. Also, for similar reasons as for video forwarding, sound is also degrading and thus DTMF-signals are not properly recognised at the target site. We believe that there has to be a digital solution to exchanging control information between repeaters and we are currently trying to establish a contact to a public broadcaster over the use of their Videodat system, where digital information is coded into one or more lines of the video itself. This has been used for many years to transmit computer programs to viewers of the Computer Club television programme.

An alternative we are discussing is the use of slow AFSK on the sound channel, where two tones in the frequency range of 20 kHz could be used. At present we are using a 20 kHz pilot tone on the sound channels of the DB0ZS and DB0BC links to DB0KK, to indicate a valid user access on the input frequencies. This is evaluated by logic at DB0KK to shut down the repeater after all activities have ceased at the connected stations.

Conclusions

Multiple linking is possible and national regulations allow this to take place on dedicated frequencies, however, many control and operational aspects will have to be discussed and co-ordinated on at least a national, if not European level (due to cross-border links already in place). Maybe this article will carry the discussion into the UK and other parts of the world and we hope for fruitful and plentiful feedback on these issues. More information and pictures on this experiment are due to appear on the repeaters' web sites www.db0zs.de and www.db0kk.de. Regards from Germany.

Shuttleworth 2002

June 16th was the BATC annual get-together, this year held at Shuttleworth. The event started with a dinner on Saturday evening, which was well attended, with many familiar faces and quite a few new ones. Mike Cox, the club president, attended, and proposed a toast to the continued success of the Club. Sunday saw the setting up of the Southern OB scanner, now privately owned by the club secretary Paul Marshall. Paul Read set up his collection of broadcast TV cameras. The club stand was soon up and running as were the trade stands.

The Lecture room was converted into a TV studio for the day with Richard Harris providing the direction for all the lights brought by various members; this soon proved too much for the electrical supply and we were plunged into darkness. This would never have happened in Alan Watson's days - his supply stiffeners and unique electrical know how is still legendary in the club. Eventually the supply was restored and various lights were diverted to other supplies and the rig continued.

Mark Bloor provided a video toaster for the production switching and two Hitachi broadcast cameras. A few more teething problems and we were up and running in TV production. Tony Kempton also brought his enlarged rack that some of you will remember from Bletchley; the rack seems to have grown with the addition of several picture monitors.

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By the time Ian Waters arrived to update us all on his 70 cm work, at least four cameras were running, two being recorded on Digi Beta by Tony Kempton, and two being recorded on the Toaster's hard disc. My thanks also to Bob Robson and Paul Pitts who helped rig and were both then pressed into service as camera operators.

The second lecture was also recorded and was provided by Mike Ferriday, who unravelled some of the mysteries behind digital signal processing. After Lunch, Mike Cox took centre stage and took us through the intricacies of vision mixing using SDI. Mike Cox vision mixers have a long history and a well-earned reputation in broadcast TV. I have worked on his PAL and component mixers and still sometimes find myself sat in front of one. SDI is now replacing component in broadcast, and I am pleased to see Mike is designing mixers for this latest system, even if it involves some of the world's largest breadboards.

The day ended with the BGM and various reports on the clubs progress through the years. I joked that we had out performed ITV digital in that we were still on the air and in the black. We have also had the A4 CQ-TV in production for three years and, although it was hard to break with A5 production, I do not think any of us would want to go back to A5 now. We have Ian Pawson to thank for making this new format work. The BATC website, also under Ian's control,

is going from strength to strength; we may have dropped the forum but we are getting almost 3000 hits a day for the CQ-TV site and in excess of 6000 for the BATC site.

Brian Summers explained the clubs financial situation, which is very healthy, but we are suffering from a decline in the general membership of the club, something the newly elected committee can take on board.

The meeting ended with the presentation of the Grant Dixon award. This is presented at every BGM for the best contribution to CQ-TV, as decided by the editor. It takes into consideration the article, its content, and how it was presented to the editor. This year the award was presented to Mike Cox for his numerous articles that have appeared in CQ-TV over the years. A special presentation was also made to Bob Robson who retired from the committee at the BGM. Bob is best known for his printed circuit designs, which started with a colour SPG designed by yours truly and continued through Teletron, I2C, the 24 cms RX and - more recently - the NBTV standards converter. My thanks to everyone that attended and helped at Shuttleworth; there were many more of you than I can name in this limited space.

Paul Marshal working one of his OB cameras

Raising the flag over Paul's truck

Mr Hankins drooling over some aerials

Chairmen, present and past

Treasurer tries to remember membership secretary's name

The BATC stand

Part of the presidents lecture display equipment

Adjustments to the model helicopter

The flying camera

Mr Hankins favourite subject?

A lecture in full flow

Paul Marshall's' OB vehicle

The President makes final adjustments for his lecture

The chairman in edit mode

Photographs by Bob Robson, Peter Delaney, Graham Hankins, John Lawrence and Ian Pawson

High Performance Synthesized 2.5 GHz/ 3cm FM TV Exciter

By Ian F Bennett G6TVJ

Here is a design for a 2.5 GHz FM TV exciter; when used in conjunction with an X4 multiplier it may be operated as a 10 GHz/3cm transmitter. This design has been successfully installed in the 3cm ATV repeater GB3XG at Bristol, where this new exciter has replaced a gunn oscillator unit. The transmitter works by generating a 2.51625 GHz signal in an indoor unit which is then cabled to a multiplier/PA combination, which is co-sited with the transmit antenna. The multiplier produces an output frequency of 10.065 GHz. The 2.5 GHz source is fully synthesized providing the stable frequency required for repeater operation, also the sound subcarrier modulator is of a synthesized design. The exciter provides the sound and video modulation reducing the number of cables to be sent to the antenna to just a coax and DC power.

This article describes the 2.5 GHz exciter. The multiplier used is the Microwave Committee produced G3WDG001. The exciter provides an output level of +17 dBm which, allowing for cable loss, is sufficient to drive the multiplier.

Operation

The exciter consists of two basic units, a video modulator/synthesizer and an audio modulator/synthesizer.

Video Synthesizer

A video signal entering the exciter is first pre-emphasized by a standard CCIR 405 network and then buffered by an AD810 (eqv. EL2020) video op-amp. The pre-emphasis is primarily used to reduce the effects of group delay distortion in the

Colour bars at P2
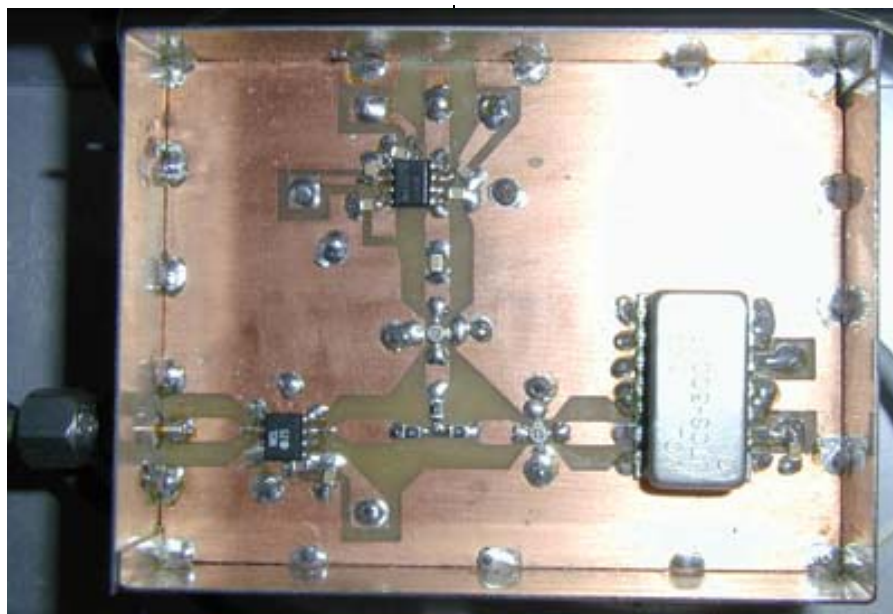
The SHF microwave module only

subsequent RF channel; it also improves the received signal to noise ratio by a few dBs. An audio subcarrier is added to the video signal at the input to the op-amp. The subcarrier is buffered by a second dc-coupled op-amp before being applied to the video; this prevents the frequency response from being affected by the coupling components.

The video signal is resistively combined with a DC voltage provided by an op-amp loop filter followed by an emitter follower, this combined signal is then applied to a VCO. The heart of the exciter is formed by a 2.5 GHz voltage controlled oscillator (VCO) type JTOS3000 made by Mini Circuits. The JTOS3000 operates over a wide frequency range and also exhibits a high input impedance, which ensures a flat video frequency response. The VCO is frequency modulated by the video signal feeding it and the centre frequency of operation of 2.51625 GHz is set by the DC voltage. The output of the VCO feeds an output amplifier and a pre-scaler via isolating 3dB SMD attenuators (MCL PAT3) and a SMD resistive splitter. The pre-scaler, a Motorola type MC12079 provides, a 1/256 signal for the synthesizer. The output amplifier consists of a MCL VNA25 producing around 60mW.

The pre-scaler provides a low frequency signal of approximately 9.8 MHz which is applied to a Motorola MC145151

parallel synthesizer. The radiated transmitter frequency may be monitored at this point as it represents the exciter output frequency at 1/256th. The synthesizer operates with a 10 MHz reference crystal divided down by a factor of 8192 to a 1220Hz discriminator frequency. The 9.8 MHz VCO frequency is also further divided by a factor 8052 in the synthesizer. The discriminator feeds an LF351 op-amp loop filter which in turn generates the DC voltage to set the frequency. The loop filter time constant is set to provide a slow lock up time to ensure good video LF performance and prevent demodulation.

The MC145151 is a very useful chip and works well in TV modulators. Other types such as the SP5055 which are common-place in ATV simply cannot produce as good results due to sub optimum loop filter components. The beauty of the MC145151 is that it is flexible to use and does not require the use of micro processors to communicate with it.

The synthesizer tunes in 312.5 KHz steps (1.25 MHz at 10 GHz) so alternative frequencies are possible. This design will operate in the 13cm ATV band and so can be used as an effective transmitter with a high quality output. The reference crystal may be "Pulled" a little if a non standard frequency is required or a specially cut reference crystal may be used.

GB3XG 2.5 GHz Exciter
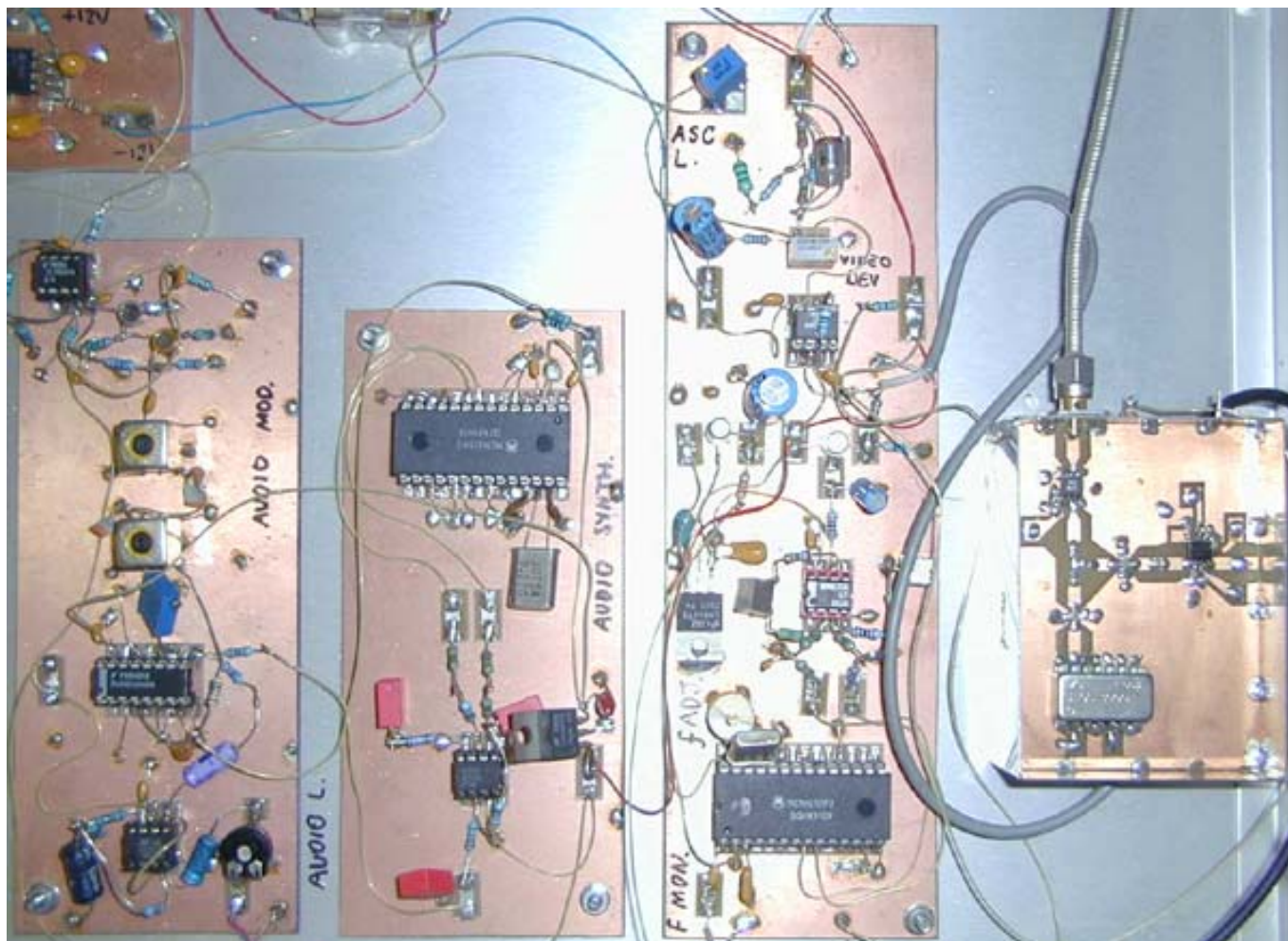
The complete exciter

Audio Modulator

The audio modulator works in a similar way to the video modulator (Both FM). A 74HCT4046 VCO is applied with a combined DC voltage to set the frequency and an audio signal to provide modulation. A 4046 was used instead of an LC oscillator due to the difficulty in obtaining suitable variable capacitance diodes. The output of the VCO is essentially a square wave so a simple low pass filter is used to remove the harmonics and provide a sine wave

Received pulse and bar test signal on a scope (line rate)

signal for combination with the video.

A second cmos parallel synthesizer type MC145151 is used to set the subcarrier frequency to 6 MHz. A crystal reference of 5.12 MHz is used and the discriminator works at 5 KHz. An op-amp loop filter is used with a slow time constant to preserve the audio LF. The subcarrier synthesizer tunes in 5 KHz steps and may be operated on other frequencies by changing the synthesizer programming. It is also possible to combine the outputs of several subcarrier modulators to provide additional audio channels. In ATV systems, operation with multiple audio subcarriers may produce patterning effects due to intermodulation and so should be attempted with care.

Multiplier

The output of the exciter is intended to be fed to a multiplier unit. The G3WDG001 unit is used and aligned to 10.065 GHz. The drive level for this unit ranges from around 0-10 dBm so a substantial length of coax cable may

separate it from the exciter. For testing a 10 dB attenuator should be inserted between the exciter and the multiplier. The GB3XG installation uses about 11m of Westflex 103 cable which introduces about 10dB of loss at 2.5 GHz. In the repeater installation the multiplier output is boosted by a DL2AM 3cm amplifier module before feeding the antenna.

The exciter/multiplier combination produces very good pictures. The exciter operates at a deviation of 1.8 MHz/V producing a corresponding output

Received 50Hz square wave on scope (Field rate)

50Hz video square wave at P2

deviation at 7.2 MHz/V as per the repeater specification. Much higher deviation is possible and if used alone, the exciter deviation may be turned up to 8 MHz/V. Excessive deviation into the multiplier may result in some AM due to slope demodulation by the high Q cavity filter within the multiplier. The deviation is very linear and is a substantial improvement over a gunn oscillator.

Construction and alignment

The low frequency circuitry was all constructed on copper clad ground planes by using "Wainwright Mini Mount" prototyping stick-on pads (Upturned pieces of stripboard stuck down to the copper clad with double sided tape will work). The SHF components were built into a special tin plate module with an etched micro strip board (Shown). All the tracks are 50R (No matching required) made on double sided 1.6mm fibreglass board.

The exact layout is not critical provided good microwave practice is adhered to. LF decoupling and a regulator was mounted on the board under side. The SHF output was provided on a SMA connector. The basic mechanical construction of the module is similar to that of the multiplier module. Before attempting to build this design the various data sheets for the ICs and VCO should be studied for pin outs etc. Minicircuits can supply components directly subject to a minimum order charge. The Motorola stuff is trickier, try JAB electronics for the MC145151 on 01216817045 and Richardson electronics or Avnet for the MC12079.

It was found that the exciter could be monitored (at reduced deviation) with an S band LNB (13cm) or a 10 GHz converted LNB would detect a small amount of 2nd harmonic energy from the exciter.

The synthesizer should lock up in a few seconds after switch on, the VCO drive level should be around 6V. The lock light flickers as the synth approaches lock and then illuminates with a steady glow. The prescaled frequency (9.829101 MHz) should be measured and the exact frequency tweaked by adjusting the reference crystal trimmer with the modulation off. The deviation should ideally be set with a spectrum analyzer.

The audio modulator should be adjusted

Micro strip board
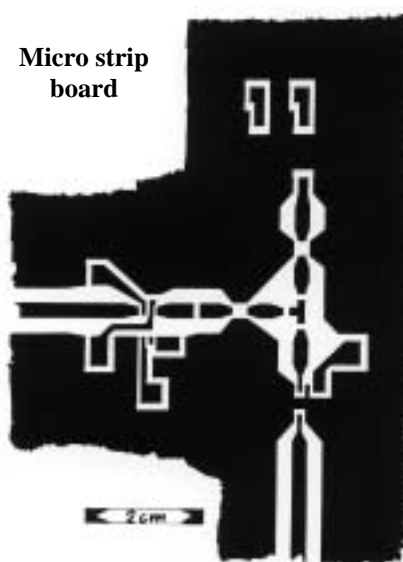
Audio Synthesizer programming (6MHz)													
Pin No	23	22	25	24	20	19	18	17	16	15	14	13	12	11
N (1200)	0	0	0	1	0	0	1	0	1	1	0	0	0	0

SHF Synthesizer programming (2.51625 GHz)													
Pin No	23	22	25	24	20	19	18	17	16	15	14	13	12	11
N (8052)	0	1	1	1	1	1	0	1	1	1	0	1	0	0

SHF Synthesizer programming (2.330 GHz ATV Simplex)													
Pin No	23	22	25	24	20	19	18	17	16	15	14	13	12	11
N (7456)	0	1	1	1	0	1	0	0	1	0	0	0	0	0

for around 5V or for least audio distortion and the BPF tweaked for max subcarrier level. The ASC injection should be set for around 20% of video level.

Results

This exciter was intended for repeater use and so was made as good as possible. The video performance is excellent. The pictures show a square wave signal deliberately reduced to about a P1 or P2 quality, this severe test produced no rolling or tearing of the picture. The output of an unclamped receiver is also perfectly flat ensuring no field sync distortion. Colour bars also reduced to P1 or P2 quality remained locked and in colour. Despite no deliberate equalization of the video signal frequency response, the transmitter is very flat with no loss at HF. In difficult propagation conditions the repeater should be watchable at low signal strength. Pre equalizing and clamping of signals is not necessary and will introduce other problems.

Extra circuitry could be added to monitor the synthesizers for repeater operation and the 10MHz reference could be oven stabilized for better frequency stability. Out of lock detection could prevent unwanted emissions from a repeater by muting the transmit PA.

The multiplier incorporates a high Q cavity filter tuned to 10.065 GHz; if the synthesizer goes off lock the cavity attenuates the signal, so some off-frequency protection is inherent in this configuration.

The frequencies of the synthesizers may be altered by re-programming the least significant "divide by N" bits using dip switches. A more elaborate system could use an eprom driven by a BCD switch etc. (See G6TVJ 13cm TX MK2 in CQTV)

Note the MC145151 has internal pull ups 1=5V 0=GND

More Information

www.minicircuits.com
www.g3wdg.free-online.co.uk
www.motorola.com

Please mention that you saw it in CQ-TV, when replying to adverts

NAB2002: Something Old, Something New

Peter J. Stonard visited this year's broadcast and media show in Las Vegas, Nevada, USA.

Pick up the phone in March each year and try to find a customer contact in broadcasting, or a person at a broadcast equipment vendor, and you will hear the same cry "Sorry, too busy with NAB to chat."

In April each year broadcasters hold a major venue organised by the American National Association of Broadcasters (NAB). This is the biggest Broadcast show anywhere perhaps twice the size of IBC. Recently NAB reached the 100k visitors mark, drawing from all over the globe.

Visitors at the main entrance

NAB Influence
NAB shows (along with Olympic Sports and Political Elections) shape the coming year for broadcasters and to many vendors the show spells business success or failure. Post NAB meetings quickly determine the future of new product designs and in some cases the health and survival of the vendors themselves.

A Jewel in the Desert: Las Vegas
Las Vegas' reputation as a hard drinkin' ambling' holiday bash just for the guys, (where you only need three things: wine, women and card games) is a stark contrast to a modern visit on business or pleasure. The famous 'strip' has grown in size and shifted to a politically correct family venue in the last couple of decades. Hotels still feature casino games, but focus on family and the kids.

For all its faults, Las Vegas is the ideal convention town to accommodate 100k+ people in comfort.

So, how big is it?
Unlike previous NAB shows there is now a new South Hall, so exhibits were spread thin in spots (the OB vans and satellite trucks were moved indoors). Next year, it is rumoured, they will change to a single location. For the past ten years or so, the show was on two sites a few miles apart, with a bus service between them.

Well Organised (and free) bus routes visit local hotels

What's to see?
The convention is divided into sessions (technical papers, committee meetings) and the exhibits. Oh, the exhibits! Some vendors build house size booths, and have dozens of uniformed booth staff. For the TV camera demos, vendors build well lit and very colourful stages, complete with live models (guys and dolls), or stage a live TV show to demonstrate studio automation or chroma key techniques.

Chroma Key Demo

There is far too much to see in one day, better to stay for two or three.

NAB2002 Exhibit Floor

The Convergence Marketplace
The exhibits are separated into topics: *Radio/Audio, Television/Video/Film, Satellite & Telecommunications,* and *Internet/Streaming*. Wait a minute? Internet/Streaming? At a show held for Broadcasters? Yes, the NAB show started a section for computer digital graphics and Internet centric broadcasting in the late 1990's and adopted the label *"The Convergence Marketplace"*. A better definition of the changes away from traditional broadcasting that we have seen in the past decade.

OB Vans and Sattelite Trucks

The presence of 'computer companies' at the NAB show had a dramatic effect on the show's character, with vendors from non-broadcast markets coming to the show for the first time. Household computer company names like Microsoft, Intel, Apple Computer, are now mixed in with Snell & Wilcox, Pinnacle, Vinten, and Ikegami.

Many large companies with both Professional and Consumer products bring everything to the NAB show, creating a surge of people all trying to demo the latest toys from Panasonic, Sony, or JVC.

Who is where now?
Some of the longest serving company names in the industry have been recycled

or merged. Visitors have not found an RCA booth since the mid 1980's, but Ampex was here. Grass Valley Group had a premium spot according to the floor maps, but instead visitors found only a large rest and seating area. The former Grass Valley Group has recently been purchased by Thomson, and was blended (well, more like hidden) inside the new owner's booth. However, wait; it is not that Thomson, is it? Well, no. The former broadcast equipment maker ThomsonCSF became Thales Group in 2000. In addition, they are not to be confused with Thomson Consumer Products, owners of the old RCA name and logo.

Hands On camera demo

Ikegami HDK-790E HDTV 1080i 16:9 Note that the on-camera viewfinder is a colour TFT LCD

What is going on Here?
Clearly, this is not a re-enactment of NAB shows from years ago. No question the world has changed and in particular, technology has changed the greatest. As we still struggle through a deep depression in technology, after a couple of really good years, it's fair to say the 'business model' has broken. Using historical data to predict future performance is near impossible and little better than gambling (how fitting that we are in 'Vegas).

Show attendance for example is down 8% over last year (95,000 compared to 113,300), which in turn was down from NAB2000 (115,800). Breaking an attendance growth streak in the prior fourteen years.

In the good old days, NAB business deals were done on the show floor. Large ticket items from cameras to transmitters to OB vans had "Sold to customer X at NAB" signs proudly displayed. The release of new products (if you are shopping) or competitor ingenuity (if you are a vendor) was the main reason to be there

Today much of the buzz is in intangibles such as software and vendor stability. Do you want to be on-air with an orphaned transmitter? What happens to that live feed if the vision mixer looses software preset (and rehearsed) fades and wipes?

Perhaps the hardest challenge to this observer is the presentation of software at the shows. I can use a personal computer, but my experience is built on many hours over the years as popular software matured. To sit in on a canned demo of a proprietary software demo while in a noisily show venue is too much to comprehend.

The idea of selling these products to a passive audience on the hour, every hour is wearing thin (with or without the Showgirls or Magician act). Therefore, for a few years the shift has been to one-on-one selling at a quiet workstation within the booth. Those of us too shy to play the customer role can watch from a little distance, often on overhead screens. How does one convey intangibles such as 'reliability' 'ease of use' '24-7 support' at a trade show?

And now for something completely different…
Chuck Pharis has been in the broadcast field for over thirty years, as a camera operator and more recently as the video engineer on the Panasonic HDTV OB truck used for American football.

Chuck has a massive collection of old gear, in particular TV cameras, and for this year's NAB he brought a dozen examples of 'old iron' from the 1950s and '60s for display.

This was no small feat, the truck rolled in with over 3,000kg (about 6500 pounds) of camera, pan heads, and pedestals.

See more of Chuck's collection here: http://www.pharis-video.com/

Some of Chuck's Cameras

Chuck Pharis with an RCA TK60

Chuck's RCA Monoscope

Photos by the author, who lives in California, and is best reached by email: **pstonard@ix.netcom.com**

Plumbicon Camera Tubes: A Lost Technology

Peter J. Stonard takes a look at an almost lost technology.

Background

Over the past decade the once familiar camera pick up tube has given way to solid-state image devices such as the CCD array, in all but a few special applications.

In the broadcast field lead oxide tubes created a revolution in TV camera technology in 1962 with the advent by Philips of the Plumbicon® It wasn't until 1974 that a new multi-layer camera tube target, called the SATicon®, co-developed by the Japanese NHK and Hitachi, challenged the Plumbicon's performance.

Narragansett Imaging

Recently, I had the chance to visit one of the last remaining camera tube manufacturers and take a detailed tour of their manufacturing facility in Slatersville, Rhode Island, USA. While the name *"Narragansett Imaging"* (http://www.nimaging.com) may not sound familiar, the company's forbearer Philips Components will. Since 2001 Narragansett Imaging has operated the
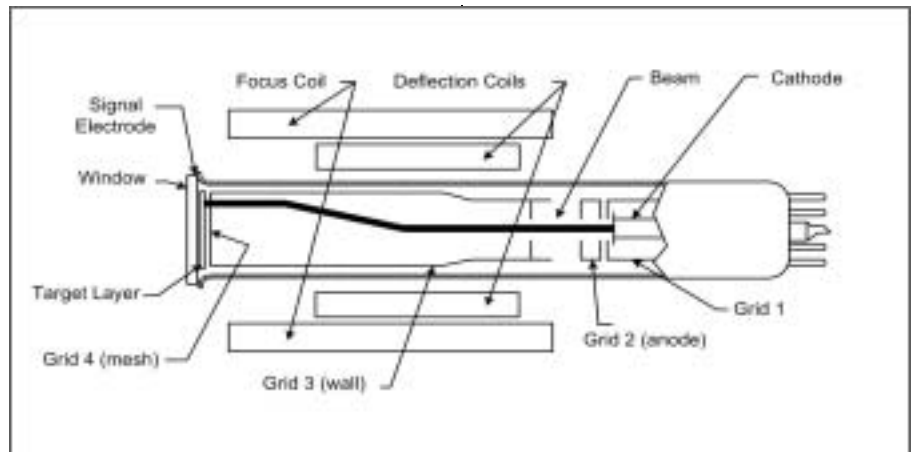
Figure 1 Typical Camera Tube MM

former Amperex/Philips facility under its own name.

So why continue to make camera tubes? Simply because there are non-broadcast needs such as medical X-Ray cameras that demand very high performance. Also, because tubes have a finite operating life there is a need for replacements.

TV Camera Basics

Before we explore the manufacture of Plumbicon tubes, a brief refresher on

cameras and tube technology.

The function of all electronic cameras is to convert an optical image to an electrical signal. Until recently this meant, at a minimum, a TV camera tube and lens, electronics, and power supply, which together made an analogue video output. Nowadays many simple (and very good performance) solid-state CCD cameras come with just a USB or similar digital connection for use with personal computers, where they are powered by low voltage DC.
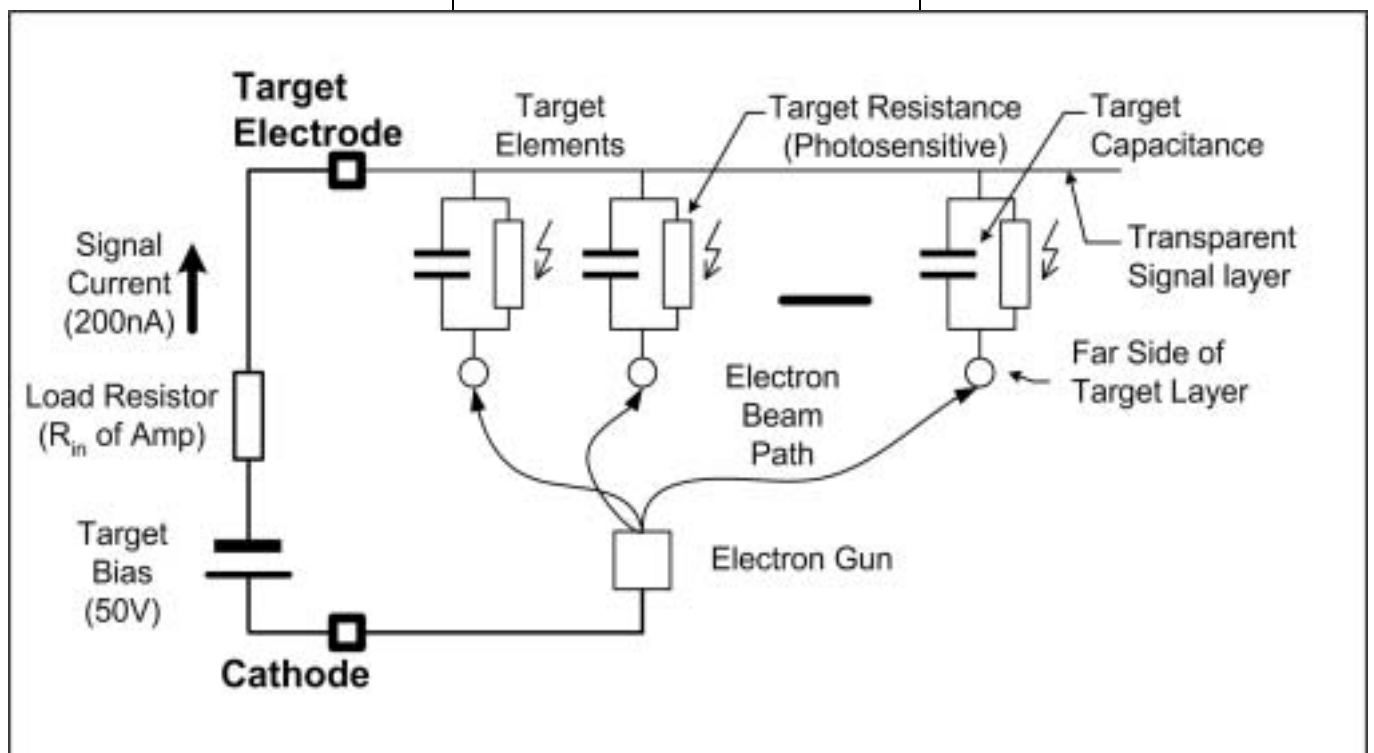
Figure 2 Tube Equivalent Circuit

Camera Tubes

TV camera tubes follow one of two operating principles: *Photo Emission* or *Photo Conduction*. The former uses incoming light photons to emit electrons from a photocathode, which are in turn captured and amplified by a photomultiplier within the tube, while the latter uses changes in the conductivity of a photo target to modulate a scanning beam. **Figure 1**

Iconoscopes and Image Orthicons are photo-emissive types, while the Vidicon, Plumbicon, and Saticon are photoconductive. Both types use image storage to collect photons between scans, a great improvement in sensitivity over the first practical camera tubes, called Image Dissectors.

Photo Target

Light from a lens is focused on a thin layer called the *target*, inside the vacuum tube. Without light stimulation the target is high impedance, something like a capacitor, but the resistance drops in proportion to light. **Figure 2.** In a
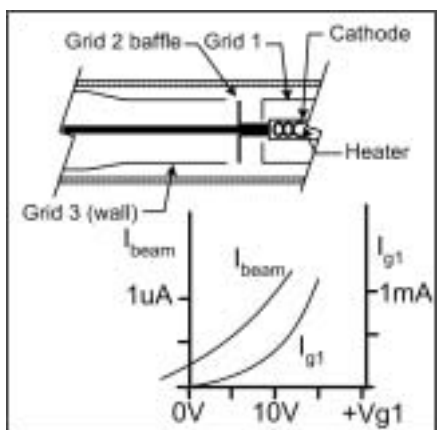

Figure 5 Diode Gun *(From the author's collection)*

Figure 3 Triode Gun

Figure 4 Diode Gun

Plumbicon target this is a linear transfer function (*unity gamma*).

Between the target and the window (glass faceplate) is a uniform transparent layer contact, which connects through the glass.

An electrical path is completed from the far side of the target to the electron gun cathode, by an electron beam, which systematically covers the target by scanning. At any instant the beam cross-section lands on a small area of the target, and if necessary, energy charges the target capacitance. The same area will be scanned again at frame rate. During this interval the capacitor may remain charged (if the target was dark) or it may loose charge (If the target area was illuminated).

The replenishing of the charge on the target capacitance modulates the beam current and produces an analogue video signal *current* at the target. The magnitude of the signal current is typically less than one micro-amp, and suitable low noise wideband amplifiers are required to bring it up to a standard level.

Electron Gun

The scanning beam is produced by an electron gun that is designed to place a focused stream of electrons at a given point on the target. The beam landing is dictated by a deflection system, which can be magnetic or electrostatic or a combination of both.

Borrowing from CRT technology the electron gun originally had a triode structure. **Figure 3**. Electrons are drawn from a Cathode, which is heated by a filament, and accelerate towards an Anode, a control electrode (Grid 1) pinches-off the beam, and a hole in the anode creates the stream of electrons that travel down the tube axis.

Triode beam current is one micro-amp or less, often set to twice the anticipated signal current.

Diode Gun Tubes

Electron optics development in the late 1970s produced a *Diode Gun* structure. By operating the grid with positive bias, it draws current. **Figure 4**. The advantages are that a diode gun produces a smaller diameter beam, for greater image resolution, and also a greater beam current reserve. **Figure 5**

The beam's ability to rapidly charge the target in areas of high illumination translates to a camera with better scene highlight performance.

	MM Triode	MM Diode	MS Diode
HTR	6.3V at 95mA		
K	0 / +25 Blanking		
Grid 1	-80/-30	0/+15	0/+10
	~0uA	1.5 / 5mA	3mA
Grid 2	+300	+300	+200
	500uA	100uA	100uA
Grid 3	+430		+220
H_{def}	Magnetic		155p-p
V_{def}			116p-p
Grid 4	+750		+340
Target	Bias Voltage: +45		
	Dark Current: 1 – 3nA		
	Signal Current 100 – 300nA		

Table 1 Electrode Voltages

This eliminates the 'comet tails' seen while panning across bright objects. Highlight overload handling is especially important in ENG and EFP cameras when used outside of a studio with controlled lighting. Portable cameras typically use 18mm (2/3inch) tubes.

Camera electronics that take advantage of diode gun tubes apply positive feedback to the grid, boosting beam current only in picture highlights, often known as ABO (Automatic Beam Optimisation) or DBC (Dynamic Beam Control).

Mesh Electrode

Before the beam lands on the target it must decelerate to prevent secondary electron emissions degrading the image quality. A fine metal mesh (G4) is placed between the target and the electron gun. It performs two functions: A voltage gradient that slows the electron beam, and also as a collector. Electrons repelled by the target layer land back on the mesh.

Magnetic Deflection & Focus (MM)

Moving the beam over the target requires control in two axes, both horizontally and vertically at TV picture scan rates. The popular method utilises magnetic deflection from a scanning yoke, and includes a simple DC solenoid that provides a focusing field along the length of the tube. This is called MM deflection. There have been other combinations, such as Electrostatic Focus, which saves focus coil power (and size) but requires a more complex electron gun and higher electrode voltages (~ 1000V).

Electrostatic Deflection (MS)

A need to scan at higher speeds, to improve resolution for high definition systems (HDTV and some medical applications) revealed limitations of magnetic deflection. The solution is to adopt electrostatic deflection while retaining the magnetic focus. This is called MS deflection. Tubes designed for electrostatic deflection have four deflection electrodes in place of the G3 wall anode found in MM tubes. These electrodes operate in pairs, to deflect the beam, using opposite phase ramp voltages.

Tube Manufacture

The tubes for medical applications are quite small, typically 25 to 50mm diameter and 200mm long, so the entire production line is housed in one large room. The most important requirement for a production area is cleanliness, followed by material handling. Technology borrowed from semiconductor manufacture is used here,

Figure 7 Zigzag Deflection plates *(From the author's collection)*

so the first step was to don 'bunny suits' that include booties over our street shoes, hair covering (including this author's beard) and static-proofed coveralls over our street clothes.

Clean Rooms

An airlock separates the clean room, and positive air pressure inside blows all the dirt and fibres off as we entered. Sticky mats collect debris from our booties. Workstations are installed over a perforated floor, with some equipment and supply lines running on the lower

Figure 6 A Clean Room Workstation *(Narragansett Imaging Photo)*

floor level.

A down draught from air filters overhead keeps the work areas clean and carries off any vapours or escaping gases. The room is rated 'class 100' (meaning filtering to 100 micron size).

Laser Etched Deflection Plates

Our first stop on the tour was in an area that forms the deflection plates on the inside of the tube glass used for MS

Figure 8 Plumbicons (L to R) 18mm (2/3in), 25mm (1in), 30mm, and 45mm Plumbicon tubes. *(From the author's collection)*

(electrostatic deflection) types. A layer of chromium metal has been deposited on the inside of the tube and in this operation a computer-controlled laser vaporizes narrow lines in the metal on the inner wall. Rotation of the tube while the laser is energised leaves a zigzag pattern that separates the metal into four deflection plates.

Continuing the tour, we stop at the tube glass fabrication area. The outer glass envelope is made in a glass lathe that, like its metalworking cousin, rotates the glass tube stock in a chuck. Instead of metal cutting tools, the operator has 'fires' (oxygen enriched gas burners) and hand tools to form the softened glass.

For tubes with magnetic deflection the glass tube assembly is completed when a 'window' glass is fused to the end. A metallic contact passes through the tube wall to be used later as the target electrical contact. MS types have an additional annular electrode, which is installed between the window and the tube body, to support and connect to the mesh electrode, which is installed later. **Figure 9.**

Figure 9 Target and Mesh Contacts *(From the author's collection*

Bake Out Furnaces

Apart from assembly area cleanliness, all materials introduced into the finished tube are treated in a hydrogen atmosphere at high temperature for many hours (using tube furnaces similar to those found in semiconductor fabrication). This drives off surface contamination and prevents later outgassing that would shorten the tube's life.

Mounts (Electron Gun Assy.)

While the outer glass is being prepared the inner electron gun is assembled in a separate area. The metal electrodes are held in the final tube by glass spacers called *multiforms*. Glass colours allow parts to be identified by model number,

Figure 10 Tubes on Aging Racks *(Narragansett Imaging Photo*

and spacing of the electrodes is very critical (cathode cup to grid thimble greatly affects beam cut-off voltage).

External electrical connections are made through the base pins (plus the target contact ring, and G4 ring in MS tubes), and these pins are connected to the electrodes by metal wire using spot welds. Obviously soldering wouldn't work as later the tube must be heated as part of the sealing process. The electron gun assembly is built up from the glass wafer base with the electrical pins, but a glass 'tip-off' tube tail also exists in the middle of the pin array for later connection to the pumping manifold. This entire assembly is often called a *mount*.

Target Formation

While the mount was being prepared the target electrode and target layer are formed by vacuum deposition on the window already sealed to the bulb glass.

A transparent layer of ITO (Indium Tin Oxide) is evaporated on to the inside of the window, followed by the Lead Oxide (PbO) target layer. PbO material is carefully weighed to control the target thickness and quality. Other gases are injected during this operation to modify the layer's behaviour, much like the deliberate doping of semiconductor materials.

Mesh Electrode

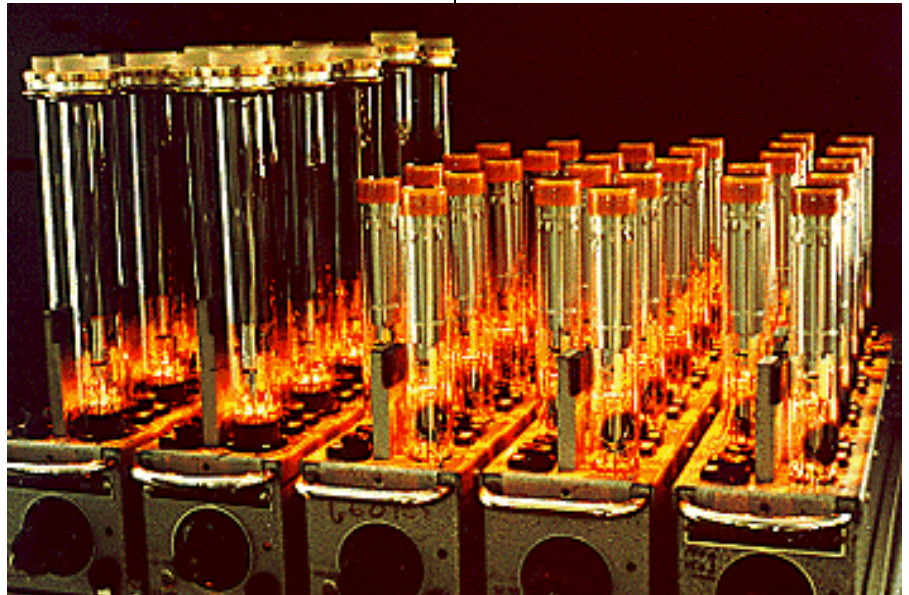In MS tubes the Mesh (G4) is attached to the ring already prepared as part of the glass envelope.

Some MM tube types attach the mesh to the wall electrode (G3) as part of the mount assembly. Either way, placement of the mesh is very critical, and the mesh material must be free from distortion (kinks) or co-planarity (lack of flatness). The mount and tube bulb are sealed together on a vertical glass lathe called a sealing machine.

Pump and Seal

The tube is almost ready, but we have to put the vacuum inside…err. Better said that we have to pump all the air out! There is a three stage process involving a roughing pump (mechanical) followed by a mercury diffusion pump (to improve

vacuum beyond that of a mechanical pump) and at the same time the electrodes are heated by RF induction to drive off trapped gas impurities in the materials.

The Getter Flash

Before the tube is sealed, a third vacuum device is activated – the *Getter*.

This technique stays with the finished tube for it's working life and helps maintain the initial vacuum should out-gassing of internal surfaces occur. A pellet of barium (often with a mixture of other ingredients) is flashed by RF induction heating. The metal vapour condenses on the inside of the glass bulb, giving that characteristic shinny patch to most radio valves (tubes). Getter material is metallic, so care must be taken not to let any land on the target or short out the electrodes!

Tip Off

An electric heater in the tube socket of the pumping station activates and softens the glass 'tip-off' tube, which collapses, sealing the tube and separating it from the pump manifold. Waste glass is snapped off, we now have a finished tube!

Aging Racks

Like a fine wine, the tube is aged. Usually for many hours under higher than normal heater power. This process stabilizes the cathode.

Anti Halation Button

The Plumbicon target is a characteristic orange, and this causes problems with reflections leading to a reduced performance, especially in the red colours.

To stop the 'halo' effect, the front of the tube has a glass button attached. Prior to attachment the tube is polished to remove any defects in the glass window. Depending upon the final application, button glass may be coloured to modify the light response. In broadcast applications tubes were often produced for specific colour channels of the camera.

Figure 11 Camera Tubes. (L to R) 45mm Philips XQ5002 MS (Medical),45mm Philips XQ4502 MM (Medical), 30mm RCA Vistacon BC4592/L MM, 25mm (1in) EEV P8022HG MM, 18mm (2/3in), Philips XQ3457B MM, 18mm (2/3in) Sony CT2332 MS. *(From the author's collection*

Final Test

Using laboratory grade equipment and a special 'bench camera' each tube is examined and tested to specification limits.

Grading

Earlier in the development of tubes it was common for manufacturers to increase the yield from a given production run by offering lower grade tubes at reduced prices. Those days have gone. Modern process control has greatly increased the yields. Also, tubes that fall out of spec at final test can be aged again (to fix electrical spec issues) or at worse 'cut' and remanufactured (to fix gross errors such as target layer failure or internal shorts).

Finishing Up the Tour

We left the clean room and undressed from the 'bunny suits' the tour continued through the underworld. Below the clean room area is a second floor with a wide array of plumbing and gas supply lines and 'RF Bombers' that power RF heating coils used in tube assembly.

On our way out the door there stood a glass cabinet with some TV camera tubes that predate the vidicon. Once commonplace in the television industry, these tubes have all but vanished. Remember the Iconoscope? Image orthicon? Image Isocon? Perhaps we will visit these again in future writings.

Visit our web site at www.cq-tv.com

Circuit Notebook 78

By John Lawrence GW3JGA

Using Coax Relays with High Voltage Coils

Useful coax relays appear from time to time at radio rallies, but if the coil is marked 24 V or higher, rather than the more useful 12 V, then the tendency is to think again or haggle harder over the price.

With mains operated equipment in the home shack, the higher voltage coil is not a problem; all that is required is a suitable separate supply. With portable gear, operating from 12 V supplies, the problem is not so easily solved. If the coil is easily removable then reducing the number of turns or rewinding for the lower voltage is possible. Some experimentation may be needed to arrive at the optimum wire gauge and the right number of turns.

When a relay coil is connected to its correct voltage, the relay contacts will operate smartly and stay fully closed until the supply is removed. Relays can be operated from a reduced voltage, but the operation may be slower and the contacts may not be fully closed – causing poor electrical contact.

I have measured the mechanical performance of three typical coax relays, shown in Figure 1, with the results given in the table below: -

Figure 1

	Relay type	Coil Volts	Coil Resistance	V operate	V release
(a)	Amphenol 'BNC' 316-10082-3 Coil 28115-51	26 V D.C.	265 ohms (98 mA) (2.5 W)	14 V	5 V
(b)	Transco 'SMA' 317-10242	28 V D.C.	290 ohms (96 mA) (2.7 W)	14 V	7 V
I	Amphenol 'N' 317-10242-4	48 V D.C.	1215 ohms (40 mA) (1.9 W)	32 V	12 V

At the 'V operate' condition relays (a) and (b) closed with a 'click' whereas relay (c) closed electrically but did not seem to be fully 'home'.

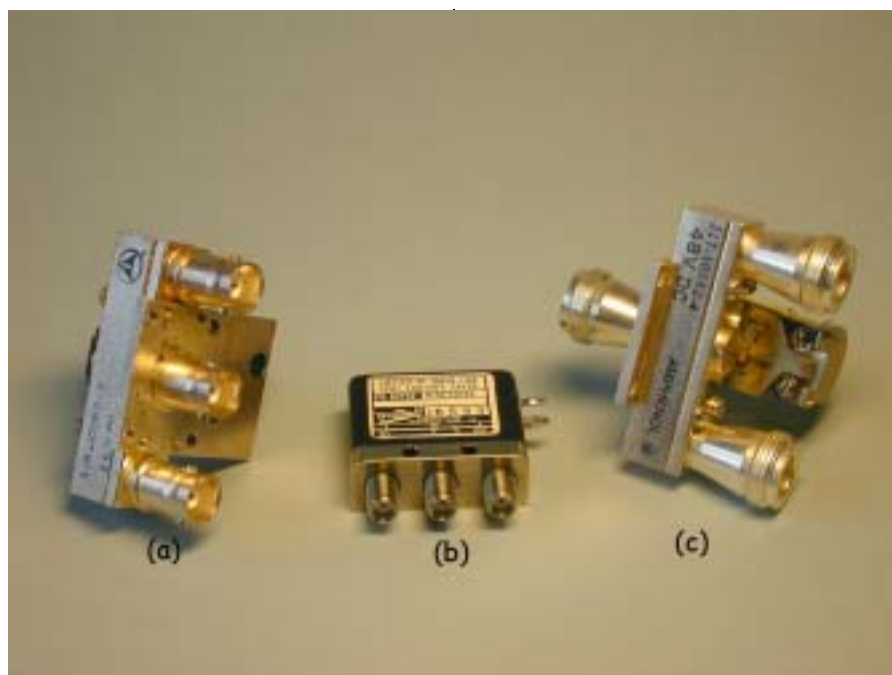A circuit by K1KP, shown in Figure 2, appeared recently in G3SEK's 'In Practice' column in 'RadCom' [1]. Its purpose is to speed up relay operation by momentarily doubling the supply voltage. The circuit would prove useful for relays (a) and (b) as it would provide about 24 volts to close the relay after which the 12 V supply would hold it closed.

The following description of how the circuit works is taken from G3SEK's article. Initially the 'control' line is ungrounded and C1 charges up to almost the full supply voltage of 12 V via the relay RL1, D1 and D2. TR1 has no forward base voltage at this time and does not conduct.

Activating (grounding) the 'control' line grounds the positive terminal of C1, so that the negative terminal of C1 takes the emitter of TR1 down below ground potential almost to – 12 V. This causes base current to flow into TR1, which turns fully on so that its collector is also very close to – 12 V. At this moment the relay sees + 12 V on one terminal and - 12 V on the other, a total of twice the supply rail voltage, so it pulls in very sharply.

The golden moment doesn't last of course, because the relay current will discharge C1 within a few milliseconds. D1 and D2 were both reverse biased while C1 was pulsing the relay, but when C1 discharges D1 starts to conduct again and holds the relay in at its reduced voltage for as long as the 'transmit' line is grounded. Note that R1 is essential to allow the base of TR1 to follow the emitter down towards – 12 V.

When the 'control' line is released, C1 recharges through RL1, D1 and D2, so the circuit is ready for repeat operation. A bonus is that when you release the 'control' line, the back EMF, generated by the energy stored in the relay's magnetic field goes into recharging C1, no other diode is required. Further information is given in G3SEK's article. Typical component values are shown in Figure 2.

Relays with even higher voltage coils

Where the above method is impractical, as in the case of relay I then an additional supply is required. This can be easily
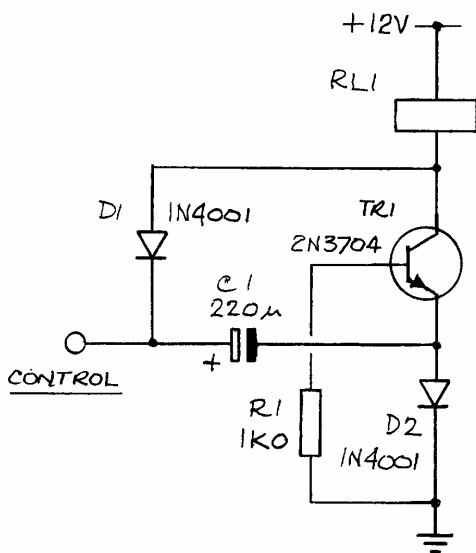
Fig. 2.

Fig. 3.

generated by using a small DC-DC converter and either using the output directly or by added it to the existing 12 V supply.

A suitable circuit is shown in Figure 3. The DC-DC converter (NMH 1215S, Farnell 200-153) provides +15 V/ 0 / -15 V (total 30 V) from a 12 V input and this added to the 12 V supply to provide about 55 V under no-load conditions and about 42 V under load. Although this is below the 48 V rating, the relay pulls in with a click and is held fully 'home'. A conventional catching diode D1 is required across the relay.
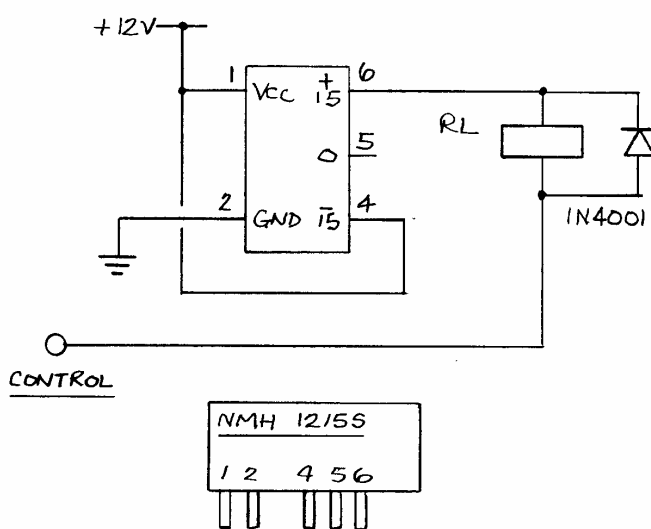
References

[1]Relay Speed-up Circuit – K1KP'In practice'Ian White G3SEK, 'RadCom' Magazine, April 2002, p. 55.

Circuit Notebook 77, CQ-TV 198, up-date

The PAL waveform, shown in Figure 1, was taken from Reference [5]. The timings shown differ slightly from the 'PAL System I', which is used in the UK. I wish to thank Peter Vince G8ZZR for providing the correct information, as follows:

The front porch should be: -1.65µs, +400/-100ns

Overall line blanking should be: -12.05µs +550/-250ns

Sync to end of blanking is nominally 10.4µs

Burst start should be: -5.6µs +/-100ns.

More detailed information is given in the 1984 DTI document "Specification of Television Standards for 625-Line System I Transmissions in the United Kingdom"

Members only!

As mentioned previously (CQ-TV 188, page 42), we have set up a 'members' only' section on our web site. Access to these pages requires a username and password. This quarter's codes are –

Username: amember

Password: whynot

TV embraces time dynamic spectrum

If only a few people in the country watch a particular TV channel, why do you have to transmit it to everyone and use up valuable spectrum? After all, according to the latest research, 90% of viewers watch the 10 most popular channels.

This is one of the issues being tackled by a pan-European project called Embrace –

Efficient Millimetre Broadband Radio Access for Convergence and Evolution – run by Telenor in Norway and including Telewest, the Rutherford Appleton Labs in Oxford and the University of Cardiff.

Embrace has developed a two-way broadband fixed wireless access system running at 42GHz that could be used for just such a purpose, as well as being used

for sending high-speed data to small and medium-sized businesses for applications such as training and videoconferencing.

The heart of Embrace is a true quality of service-based dynamic spectrum allocation technology for Internet Protocol services. It uses a multicast push approach, where requests are sent as unicast messages to the base station

and then a multicast query is sent to all the other base stations. Responses with the requested content are then multicast to all the users in the cell.

The system uses 25Mbit/s downstream to each client terminal in a 28MHz band with a 2Mbit/s return path based on the digital video broadcasting satellite return path standard in a 6MHz band, although it supports up to 50Mbit/s down and 4Mbt/s back.

Because it is based on time rather than frequency division, the bandwidth can be dynamically allocated allowing unused downlink bandwidth to be allocated temporarily to uplink requirements, or for less popular TV channels to be broadcast, or rather multicast, when requested, rather than taking up spectrum without being viewed.

The 42GHz hardware is based on a previous European project, Crabs, which

resulted in terminals for about 1200 each, but never resulted in volume production, says Otto Koudelka, Crabs project member from Joanneum Research in Austria.

From Electronics Times 24/9/01, www.eetimes.com

The thoughts of Chairman Trevor

No, not a picture of a young Dicky Howett with a homemade cardboard camera. This is a genuine shot from 1938 of a Philips demonstration Iconoscope rig. The cameraman's wife is probably still wondering what happened to the wheels of her child's pram!

Dicky Howett writes: Here is something you do not see anymore. Image Orthicon TV cameras for sale at BATC rallies. As my pictures of a few years ago prove, these cameras were just a load of neglected tv junk, on offer for a few pounds (if that). These days such television sights are as rare as ducks dentures.
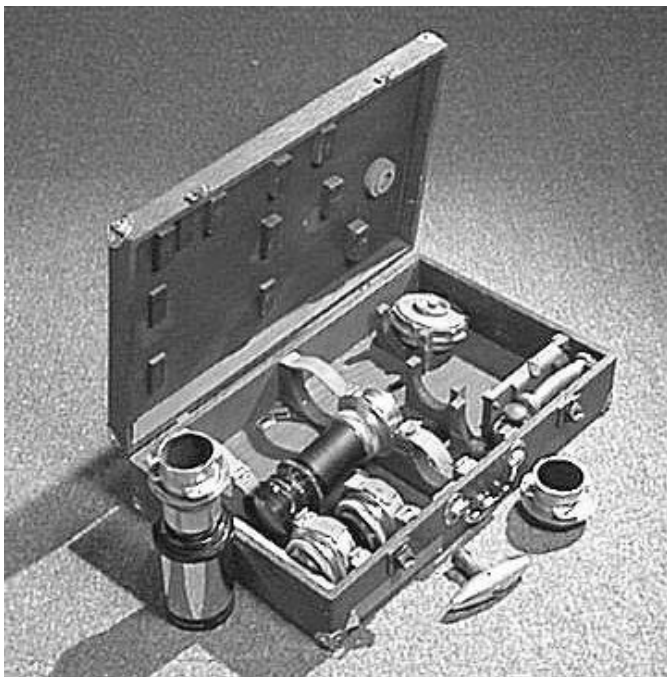
A plea from Dicky Howett: "The box of strange TV camera Dallmeyer lenses pictured has me baffled. The lenses- dating from 1952- fit no known TV camera. They are in a dedicated box and apparently came originally from the EMI development labs at Hayes. The lenses and mounts are very robust indicating perhaps a military prototype? If any Members have a clue please contact me at dicky.howett@btinternet.com or 01371 820155."

Digital ATV, is this the future?

Building the G8SUY 24cm ATV transmitter.

By Graham Hankins G8EMX

Andy Parnell's ATV kits started out as projects within the Kent Television Group, which runs 24cm ATV repeater GB3KT. A 1.3GHz transmitter, receiver, video switcher module and video distribution amplifier were available, and Andy began to spread these to a wider audience with his 'G8SUY Bits and Pieces' handouts at rallies.

The transmitter seemed interesting. Providing a useful 2W output from a 'black brick' module on either 1249MHz for repeater input, or 1265MHz for simplex working, the circuit was designed around surface mounted devices. As I had never 'dabbled' with these before, and fancied building a new transmitter anyway (as you do), and wanted something to write about, I put my pennies in the post and awaited delivery. A brown padded bag arrived almost by return. The PCB. is professionally etched and clearly sign written, all sensitive components are in anti-static bags, but wow – they are SMALL! Drop one and there is VIRTUALLY NO CHANCE of rescue!

Equipped with a magnifying glass, metal and plastic tweezers, 36swg solder and a new, fine tip iron, I started with the resistors. Similar values are packed together, but be very careful how you take them out of the packaging – this is the most likely time to lose one. Drop them onto something white otherwise, even if they are not lost, they might not be seen! Then establish where the pads are on the PCB – Andy includes circuit and layout diagrams in the paperwork, and a photo of the assembled transmitter, but this lacks enough definition to positively identify some of the detail.

Using minimal solder, apply to just ONE of the pads. With surgical care, pick up the R in the metal tweezers, then under the magnifier slide the R into place, remove heat. Then solder the other connection. The p.c.b. was laid on an upturned mouse pad to prevent it sliding.

I found the large inductors would not fit between their pads, although these components in Andy's photo seem ok. I mounted mine either diagonally, or scraped away to clear a bit more track. Contrarily, L5 was too short and required a sliver of solder to bridge its pads.

The large phase lock loop chip needs its leads bending and trimming before mounting, and it's very tricky to determine Pin 1 of the pre-scaler. Look very closely, under the glass again, to see the beveled edge of the package. Be warned, this is quite difficult to see. Look at the IC from above, with the beveled edge on the left, Pin 1 is top left!

Construction is complete, quite easy with care, the correct size iron and solder, a magnifying aid if needed and usual anti-static precautions.

I might have it tested for the next 'CQ-TV'….

For Sale

TEST EQUIPMENT FOR DISPOSAL.

TEK

- 655HR monitor PAL/NTSC
- 521 PAL Vectorscope.
- SYSTEM VIDEO
- 1258 Waveform analyzer.

HP

- 191A TV wave form monitor
- 8614A 0.8/2.4gHz signal generator.
- 8616A 1.8/4.5gHz signal generator.

MARCONI

- TF1246 40kHz/50mHz oscillator
- TF1247 20/50mHz oscillator
- TF2000 20Hz/20kHz AF oscillator
- TF2330A Wave analyzer 20Hz/76kHz
- TF2331 Distortion factor meter
- TF2331M"""
- TF2331AM"""
- TF2333 30Hz/550kHz MF oscillator

- TF2600A Video voltmeter
- TF2904 Colour gain & delay test set.

LEVEL

- TM3A Transistor AC micro-voltmeter.

BELAR

- AM modulation monitor

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