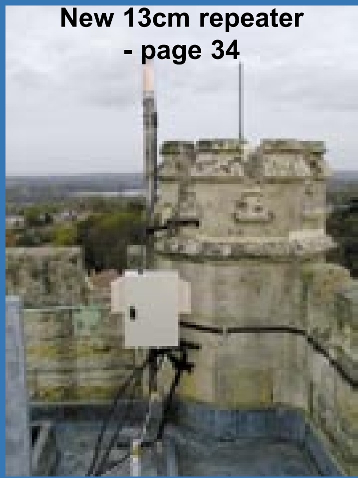
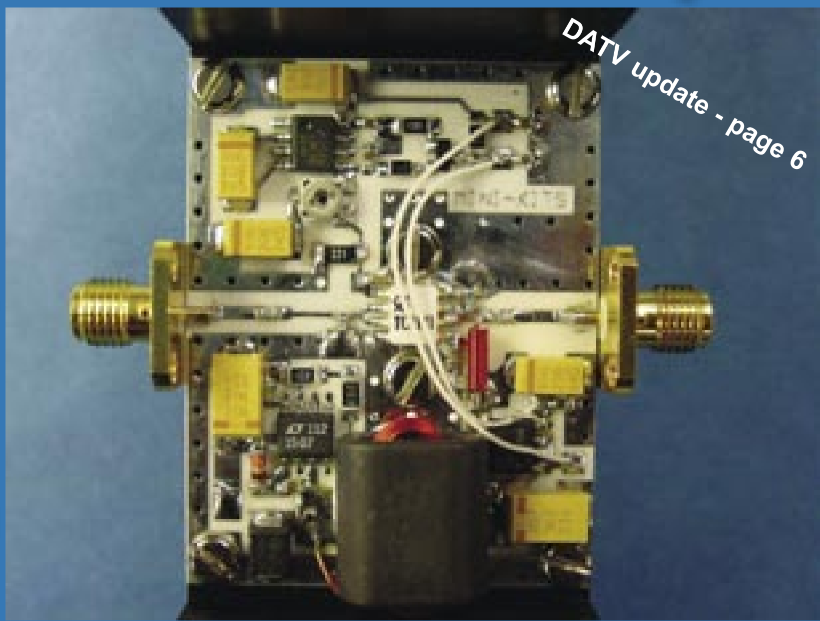
# CQ-TV 209

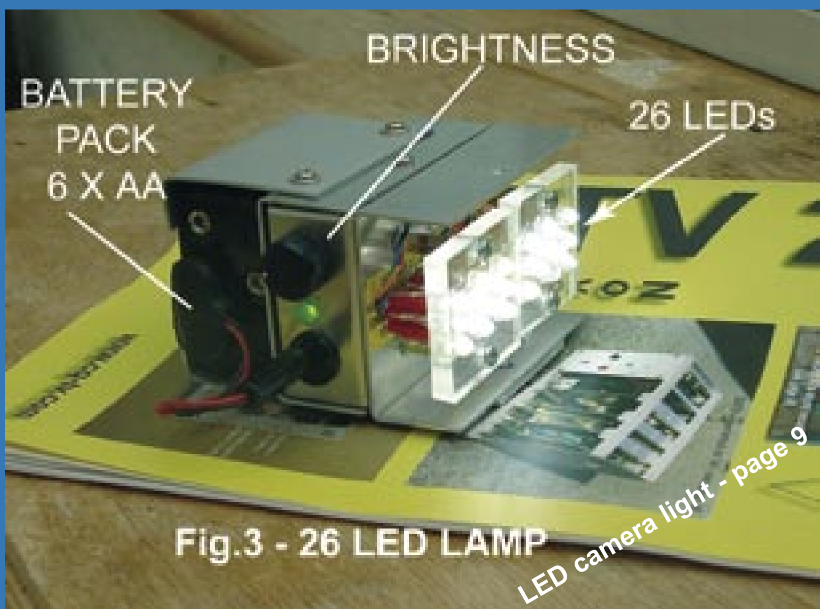
February 2005

ISSN 1466-6790

BATC

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The STVKBD unit allows control of the STV5730A's functionality from a PC keyboard. For full details of the unit's operation please see the documentation.

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- ►Compatible with colour and mono composite video signals. 1Vp-p. PAL or NTSC*
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*By default the unit will be supplied compatible with the video standard of the country from which you make your order.

If you require further information please contact us: *sales@STV5730A.co.uk*

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CQ-TV 209

## 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, Mobile077 4029 1191, Email: treasurer@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. **Pat Hellen**, The Villa, Plas Panteidal, Aberdyfi, Gwynedd, LL35 0RF, UK. Telephone 01654 767702. 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: contests@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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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

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# Chairman's Column

**By Trevor Brown**

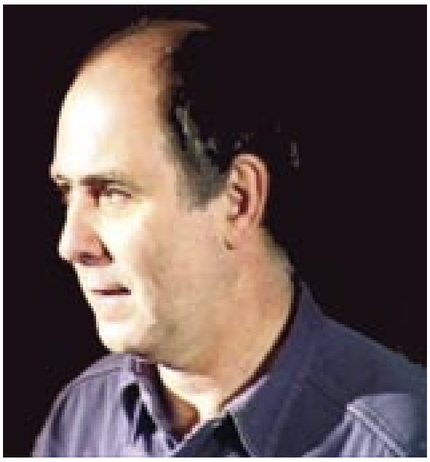
Well I do seem to have stirred up a hornet's nest by presenting my own personal view of the BATC's future. In particular my suggestion of CQ-TV being circulated electronically instead of the traditional print it and 'snail mail' it. It just seemed to solve most of the problems in that it was cost effective, in colour, and all the electronic links were just a simple click and visit rather than copy type several long addresses into the PC to see what the author is referring to. Perhaps, by the time you have read "In the edit suite 3" and visited all the sites, you might agree with me. It does not matter, because it was my own personal view and not any BATC policy decision. I have not as yet read all the letters that flooded in.

The debate on Acrobat 6 for electronic distribution of the magazine still seems to be generating emails. The problem seems to be that although the software is free, it needs IE 6 to be resident on the PC. You don't have to use IE6, just have it on the PC - as one reader pointed out. The advantage of this format is file size. The number of emails flooding in can be counted on one hand. So let's keep every thing in proportion. Remember that these decisions are taken by unpaid volunteers who have nothing but the best interests of the club on their agenda.

(*In order to keep the file size as small as possible, I used the maximum compression settings. This considerably reduced the quality of the diagrams and images. After discussion with cyber members and some experimentation, we have come up with a format that is a compromise between file size and quality. It also uses Acrobat version 5 so it should be readable on Linux and Mac platforms. I hope that it will prove to acceptable for this and future editions. - Ed.)*

What else has happened? Well, Giles, G1MFG, managed to transport a chair to the edge of space and televise the event. It was all in the name of art - I covered this in the Radcom ATV column for January and it has produced some interesting feedback.

Ian Pawson is out of surgery and back at his PC editing CQ-TV. I am pleased Ian has recovered and is back at his desk. Ian has also re-written the CQ-TV.COM web site code, in order to make it more transportable. Why? Well, we have moved to a new ISP provider. The problem with the old ISP was the cost. It was cost effective for a small web site, but not for a large one and as we now have so many electronic



CQ-TV's stored on the web pages, we needed a bigger site.

We did mange to make it into the Sunday Times in December - I don't know if anyone noticed. "Think Geek you know it makes sense" was a story of Britain; a land awash with committed, capable and energetic amateurs of every persuasion — astronomers, writers, painters, magistrates, soldiers, landscape gardeners, sportsmen, anglers, actors, pet breeders, political activists and computer programmers. These people are having more fun than the rest of us. I'm not sure that holds true for ATV enthusiasts, but the reporter rang to check and wanted to interview, on the telephone, an amateur with no professional involvement. I was a reject; Graham Shirville jumped into the breach and gave an interview, giving his day job as "door knob salesman" , (like Rupert Murdoch is a newspaper worker !). The story was all about the power of the non professional enthusiast. When Graham explained his ATV on the international space station idea, and how he was in contact with NASA over the project ………….. well I think he made their point.

# Letters and emails

From: “tnltv” <tnltvr@slt.lk>

To: <chairman@batc.org.uk>

Subject: CQ TV 207/208

Dear Trevor,

Since 1966 I have been a member of BATC. That was when I entered Northern Polytechnic in North London. Even when I returned to Sri Lanka in 1970 I was ardent fan of CQ-TV. Even if I lost few copies in the mail or problem due to exchange control regulations in the 70’s in my country and until to date I still enjoy the CQ-TV. Last evening I was going thorough my copy of CQ-TV 208 received few days ago.

I am in Television Broadcasting full time. I began the first TV station in Sri Lanka in 1979 and since then I run my own TV and FM radio stations. I travel a lot in this small country,where I set up relay stations from 100watts to 10kw on VHF and UHF,Microwave links from 2.5 to 13 Ghz. I try to complete at least three sites of very high elevation (over 2000mtrs),installing Antenna towers/ equipment and. buildings within six months period with adverse weather conditions.Once a month at least a 12hour Live program from Archeological sites in Sri Lanka which dates over 2500 years. Co-ordinate at least four live studio programs per week.Then sit down after dinner (9pm) and answer the mails including emails. Down load emails with unwanted mail. In the mad rush I still read the CQ-TV before falling a sleep ,while travelling and I all ways take a copy with me to the remote sites.

Dear Chairman what happens when the magazine becomes virtual? Can I wait hours for it to down load then read the content and thereafter take a hard copy.Otherwise carry a lap top/ ISDN connection to down load at remote areas? The enjoyment is all gone? I think we have to be practical. Yes we are moving into the future but are we going to sacrifice that little bit of CQ-TV to be virtual ? Even in the 1960’s I enjoyed the little B/W copy of CQ-TV.

I think we should be more practical and think in positive terms:-

a) Make the paper smaller than A4

b) Why should it be on expensive glossy paper?

c) Why not try printing in a country other than UK?

The CQ-TV comes out 4 times per year, therefore there is ample time to print and correct proof by email in another place where printing cost will be 50% less than in UK. Even postage would be cheaper outside UK. If you are really interested I could find out the costs in Sri Lanka if you could email the requirements.

**Best Rgds, Shan Wickremesinghe**

*Shan*

*Many thanks for your email*

*I will give your suggestions some thought, I have sent a copy to Ian who is in charge of Editing, Printing, and distribution of CQ-TV.*

*We live in a world of change, as long as our club is proactive in looking at the technology and trying to benefit from any change, survival is possible.*

*What I worry about the most is the dinosaurs who don’t keep on top of the technology and therefore can not see any benefits. There are many decisions ahead and as long as the club helm is manned by proactive management looking at the changing technology and getting the best out of it for the club I believe we will survive.*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*The decline in membership is probably the most worrying trend as most of the costs for this club are fixed and divided by the number of members, the more members we have the cheaper it is to run and the greater the benefits of being a member. We all would like to live within our comfort zone, but this may not help the club, and doing anything just because that's the way we did it in the past is not any justification for doing it that way in the future.*

*The move to an A4 magazine was a necessary step, as the circuits become more complex the need more space, and the software and printing industry is geared up to A4. The A5 magazine was developed on A4 templates using the centre only of the page and then printed on A4 stock and cut down. It made more sense to use the whole page and stop the waste.*

*I like the current format it is easier to sell ad space and is limited in its appeal only by the lack of colour and small circulation. otherwise I would be able to sell more ad space and stave off any increase in subscriptions.*

*Please be assured we all want the same thing a club with a future and reputation for televison inovation through technology*

***Trevor Brown, BATC Chairman***


From: David J Taylor [david-taylor@blueyonder.co.uk]

To: editor@cq-tv.com

Subject: Scrapping the Journal

Folks,

I do admire your efforts to make CQ-TV available as widely as possible, and I can quite understand that postage abroad may make membership more expensive than is desirable. Ensuring a good intake of young people into technical hobbies such as ours is very important in today's society.

Nevertheless, I am not convinced that giving someone a PFD file or CD-ROM rather than a magazine they can take away in their hand is the best way to do this. My experience with give-away CDs and PDF files is that they mostly sit just taking shelf or computer space, and are not read as widely as a journal. Producing PDF files that cannot be read by the majority of computers out there is to deny access to the information to the very people you are trying to target. They should be readable in Adobe Reader from V4 upwards at least.

You produce an excellent journal, and I for one would be very sorry to it go or become a black-and-white photocopied news-sheet. As I am no longer directly active in ATV (although very involved with DVB and satellites), it would take away my link to the club of which I have been a member for about 40 years. There would be no point in taking out a subscription, to be honest. If the cost of membership needs to be increased, the make it so! And perhaps, even though my income is now considerably less than it once was, I would join those who take the view that subsidising third-world members (and those still at school?) is a "good thing", rather than insisting that they pay 100% of the going rate.

If there is a need for more rapid communication to the members, why not set up a mailing list or Yahoo group for those who are interested to join?

It costs nothing.

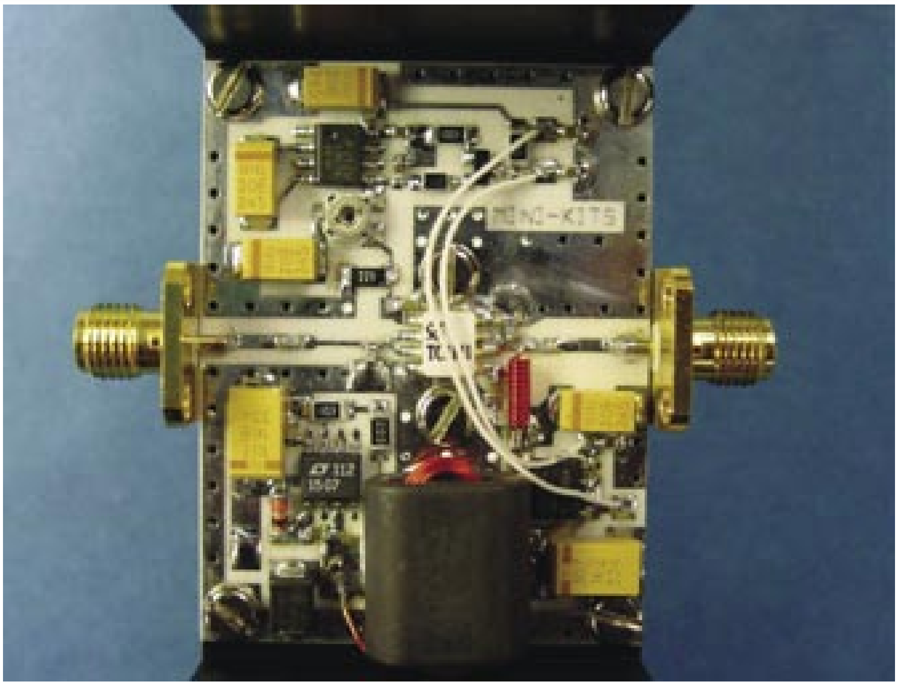
I hope we can take some of these ideas forward in a more beneficial way than seems to be happening at present.

73,

David Taylor, GM8ARV

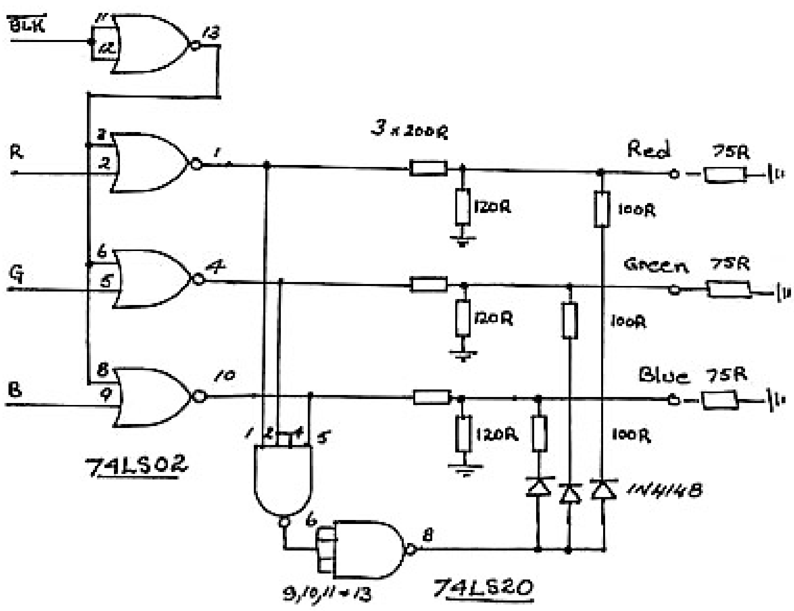
# EBU and DATV Re-visited

**By Richard L. Carden VK4XRL**




## EBU Bars

In CQ-TV 202 I described the generation of EBU colour bars using gates and resistive dividers. To improve the performance of the original, diodes should be added to the 390r series resistors, anode towards the 100r AOT resistor. The resistor values will need altering to obtain the required levels.Over the past few weeks I have had the opportunity to rebuild my ATV test signal rack which has a spare colour coder (blue book) so I thought I would utilize this by supplying EBU colour bars. Now the old composite test card generator (blue book) has the necessary waveforms, although one has to be careful. The RGB bar waveforms are inverted and therefore require inverting before using them. This is not a problem normally, but these waveforms go right up to the LE of sync and therefore need blanking. When I first looked at the problem I used a 74LS86 an exe. Nor gate. This produced a small pulse just before the LE sync, the trailing edge being consistent with LE sync which caused some problems later on in the chain which caused line jitter. The problem was overcome using a 74LS02, by inverting the BLK signal in the spare gate. The rest of the circuit is nearly the same as already published in CQ-TV202. The circuit of the new EBU colour bar generator including the resistor and value changes are shown below. The green bar output is taken from H8, red from H7 and blue from H6.




## DATV update

Since writing the two articles DATV Down Under found in CQ-TV 202 and 204, the reference to the Mini-kits 2W power unit has been superseded and now has been replaced with Kit Part Number E128 KITB. This kit now uses a PHEMT MMIC IC which has a gain of 29db and a saturated output power of +33dbm at –1db compression point. I have now purchased one of these for evaluation, and it would appear possible to run this at 6db lower then the +32dbm output (i.e. +26dbm) for shoulders around –30dbc. Two of these units could then be used for near +30dbm output.The RA18H1213G power amplifier is now available from Mini-Kits. The suggested ratings for this unit are 18W output for 200mW I/P on FM ATV or 14W PEP linear output on SSB. I have now purchased one of these for evaluation on DATV. The norm has been to run these at –6db lower then the stated output for DATV. This would mean an output of +35dbm or 3W approx. Tests have indicated this to be correct with shoulders around -35dbm. If more power is required then again two of these units could be coupled together via 3db couplers producing a power output of around +38dbm (i.e. 6 W).The Dutch System mentioned in those articles has now had a pre-production run and it shouldn't be long before these are available. The web site www.d-atv.com has also been updated with many photos and articles relating to DATV and especially to their own system. This is in English and is worth reading. Also take a look at Mini-Kits Web site at www.minikits.com.au for further information on the above power amplifiers including price and availability.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# An LED Camera Light

**By Mike Cox**

## Introduction

In CQ-TV 208, in the Review of IBC2004, mention was made of the large number of LED camera lamps that were on show. Being of an inquisitive turn of mind, I decided to have a go at building one for use on my JVC camcorder. Oddly enough, I just happened to have some white LEDs in my drawer. I had ordered some blue LEDs a while back [CQTV 206], but when I checked them recently, about half of them turned out to be white. So I had around 30 plus white LEDs available to build a lamp.

The requirements for a camera light are adequate brightness, correct colour temperature; light construction coupled with ease of mounting, and simple power requirements. I hope in the followings words and pictures to show how most of these are met.

## The Science Bit

Some basic details of white LEDs need to be set out so that the design can proceed.

Most LEDs radiate over a narrow part of the visible spectrum; indeed some are so narrow band that they behave like a laser, hence our portable CD and DVD players.

For a white LED however, a spectral emission is needed that is substantially flat over the visible region, or appears so to the eye. Given that bright Red, Green and Blue LEDs are available, a cluster of three could be used, but would be somewhat impractical for normal illumination purposes.

However, phosphors blended to produce an approximation to white light already exist and are used in fluorescent tubes. They are activated by ultra violet [UV] coming from the mercury vapour discharge. Similarly an LED element giving UV radiation will activate such a phosphor. [Fig. 1]

The basic physics of a light emitting diode involves a p – n semiconductor junction operating in the forward conduction mode. Electron – hole re-combination occurs at the junction, and with certain materials some of the energy appears as light. The colour of the light is determined by the material, Gallium Phosphide [GaP] gives green light, while Aluminium Gallium Arsenide [AlGaAs] gives red or infra red. Zinc Selenide [ZnSe] emits light at the blue or ultra violet end of the spectrum. Most of these materials are pretty opaque and so the junction has to be very thin, around 1 um, to allow light to emerge.

To give adequate light output, a large area die has to be used, and because of the current flowing, heat is generated and has to be got away.

The forward characteristic of an LED is similar to a diode, but with a somewhat higher forward voltage; red LEDs start to conduct at around 1.6 volts, while blue LEDs start at around 3.5 volts. They tend not to like much reverse voltage, unlike normal diodes. [Fig. 2] To protect the LED if there is risk of reverse voltage greater than about 5 volts, put a normal diode in reverse parallel.

To digress a little, LEDs make useful low voltage “zener” diodes, where you need to hold off around 1.6 to 3 volts. You also get to see if any current is flowing.

## LEDs in Use

From the discussion of the forward voltage above and from the characteristic curve [Fig. 2], we can see that once voltage reaches the threshold of conduction, the current through the device rises very quickly. Consequently in most applications, current limiting is essential. Many techniques exist for this, the simplest and commonest being a resistor to a fixed voltage. Depending on voltage available, and the brightness required, multiple LEDs

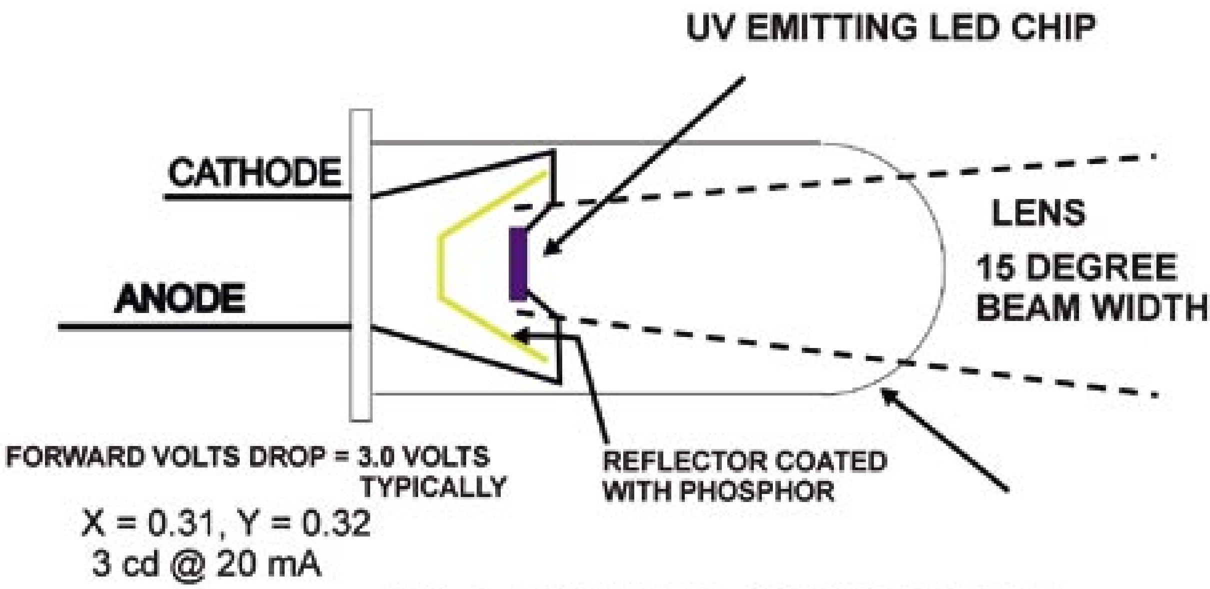


FIG. 1 WHITE LED X-OPTO WT5111A

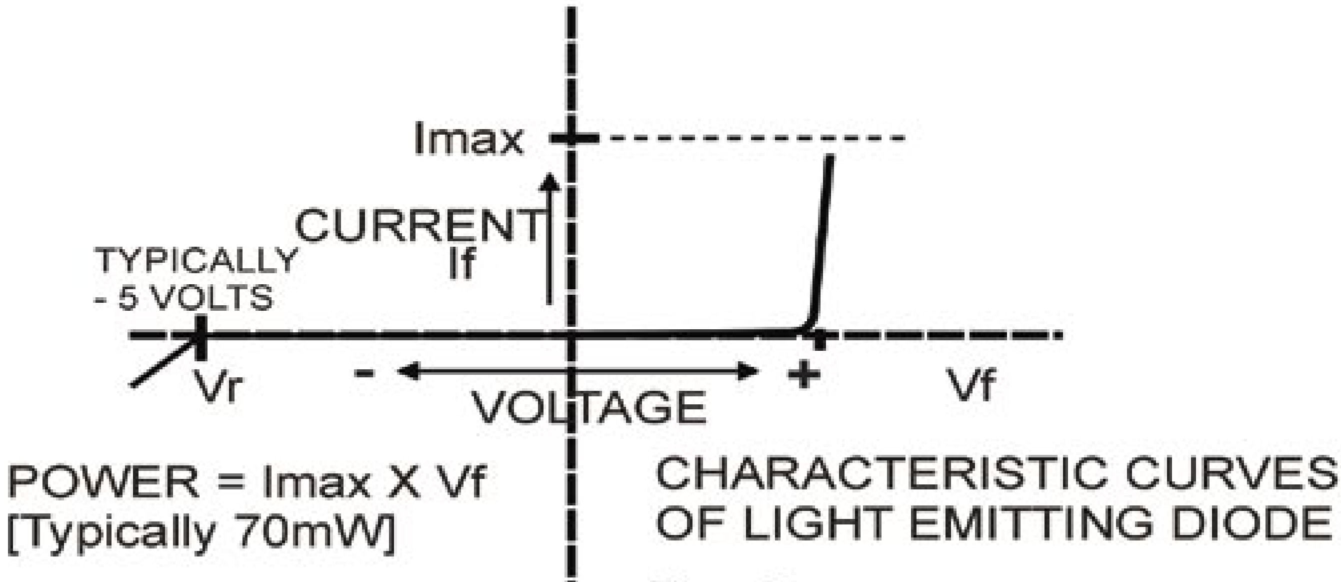


Fig. 2

can be connected in series or parallel, or a combination of both.

In the lamp being described, 26 white LEDs are connected in parallel, but each has a 33R series resistor to limit current and to ensure that all LEDs share current equally, mopping up any slight differences in forward voltage between devices.

In the first experiments, it was decided to use Pulse Width Modulation [PWM] to alter the brightness of the lamp. This works very effectively. It can be applied to filament lamps equally, but an advantage of the white LED is that there is no discernible colour temperature change with dimming. On a camera, the lamp has to carry its own supply, as few camcorders allow you to tap off the camera power supply. Thought was given to type of supply to use. In the end it was decided to use multiple NimH AA cells. These are widely available, and I already have a selection that I use in my still camera. Six of these cells give 7.2 volts nominal, which give adequate headroom to run LEDs at just over 3 volts forward voltage; and should, using 1800 –2000 mA/hr cells, have a life in excess of an hour. To maintain a constant voltage for the PWM system, a buck regulator was used. This behaves like a step down transformer in that the current from the output side is greater than the input current, so that the lamp can operate from nominal 7.2 volts up to 12 volts with no change in lamp output. At 12 volts the current draw is around 300 mA at full brightness, compared with 500 mA with 7.2 volts input.

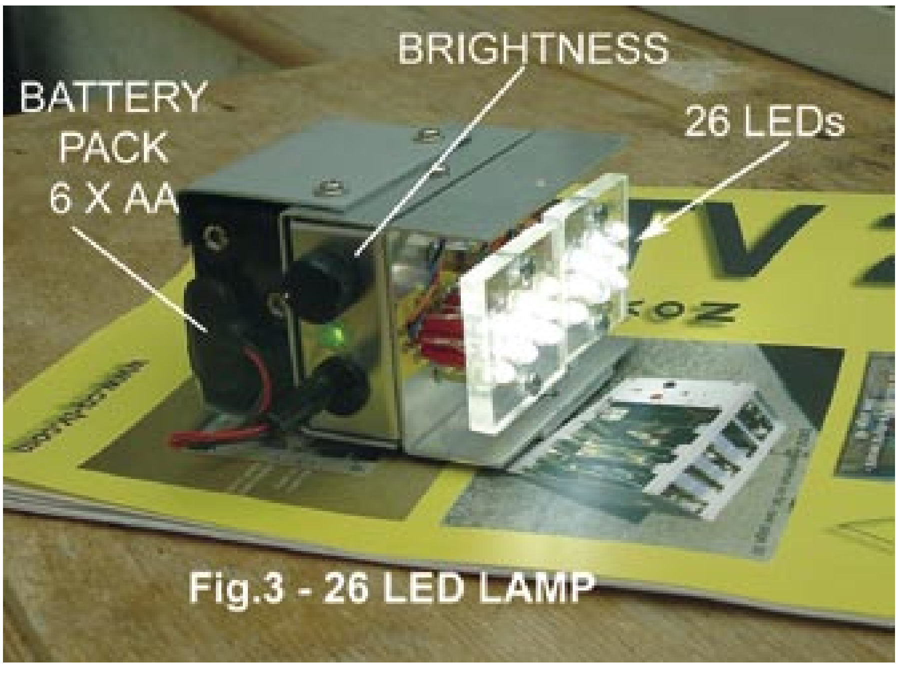


Fig.3 - 26 LED LAMP

For the first design, I used 26 5 mm LEDs arranged closely together and mounted in a piece of clear acrylic sheet. The first attempt used just 13 LEDs in a 3 high by 4 wide cluster, with a second cluster added alongside later. As the camcorder operates on 16:9, this seems reasonable. [Fig. 3 & 4]

Look at the circuit diagram [Fig. 5]. The battery pack feeds the input of the buck regulator U1 via a simple filter circuit to minimise radiation back into the camcorder audio circuits.

The buck regulator contains a switch that in conjunction with inductor [L2] and diode [D1] produces 5 volts dc across the reservoir capacitor [C4]

The original work on Pulse width Modulation [PWM] was carried out using a section of an ‘HC14 as an oscillator. This type of oscillator generates a square wave. Coupling this into another ‘HC14 section via a short and variable time constant gave a type of PWM that could be used to drive a MOSFET switch in series with the LEDs.

However when the buck regulator was introduced, it seemed right to use the 52 KHz oscillator already in the regulator. The falling edge of the signal across the inductor is differentiated , and the resulting narrow pulse is used to discharge a capacitor and thus generate a ramp waveform. This is ac coupled to

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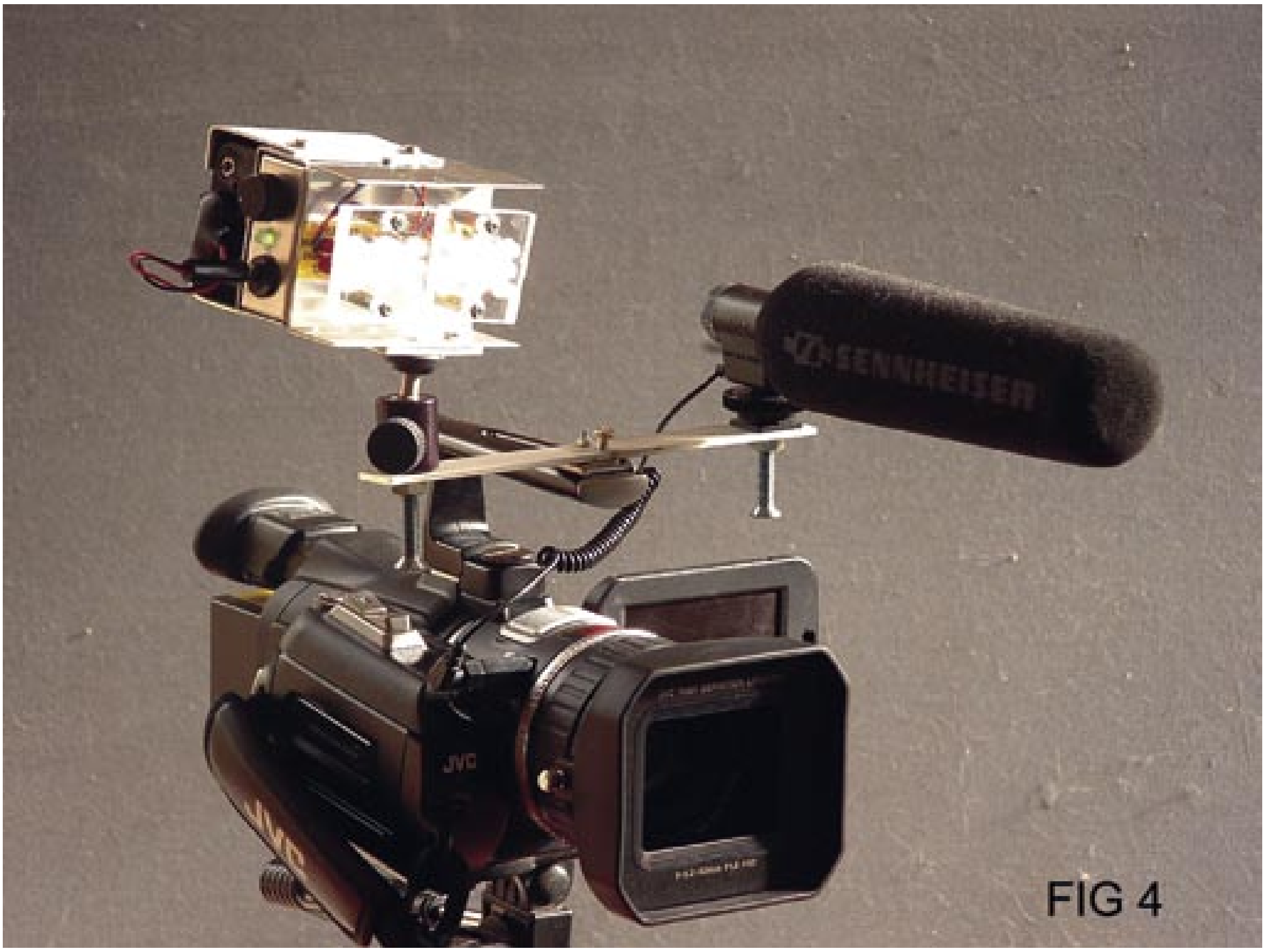


a section of 'HC14 with variable dc sit controlled by the BRIGHTNESS pot. The output of this is a variable mark-space signal to apply to the switching MOSFET.

When the first unit was made, no single MOSFET was available [in my drawer!] with low Rdson, so 3 2N7000 devices [Rdson 5 ohms each] were used in parallel. Any significant resistance in the MOSFET will reduce the drive for the LEDs, as the peak current will be around 400 mA with 26 LEDs.

LED 1 [bicolour] is normally green, and indicates power is available even though the Brightness control may be turned down. When the battery voltages falls off, the LED flashes alternately green and red to indicate need to replace battery pack. On test, VR2 should be set so that LED 1 flashes when battery voltage falls to around 6 volts.

The original lamp was built in a couple of Maplin's aluminium boxes, size 76 x 57 x 26 mm; type AB12.

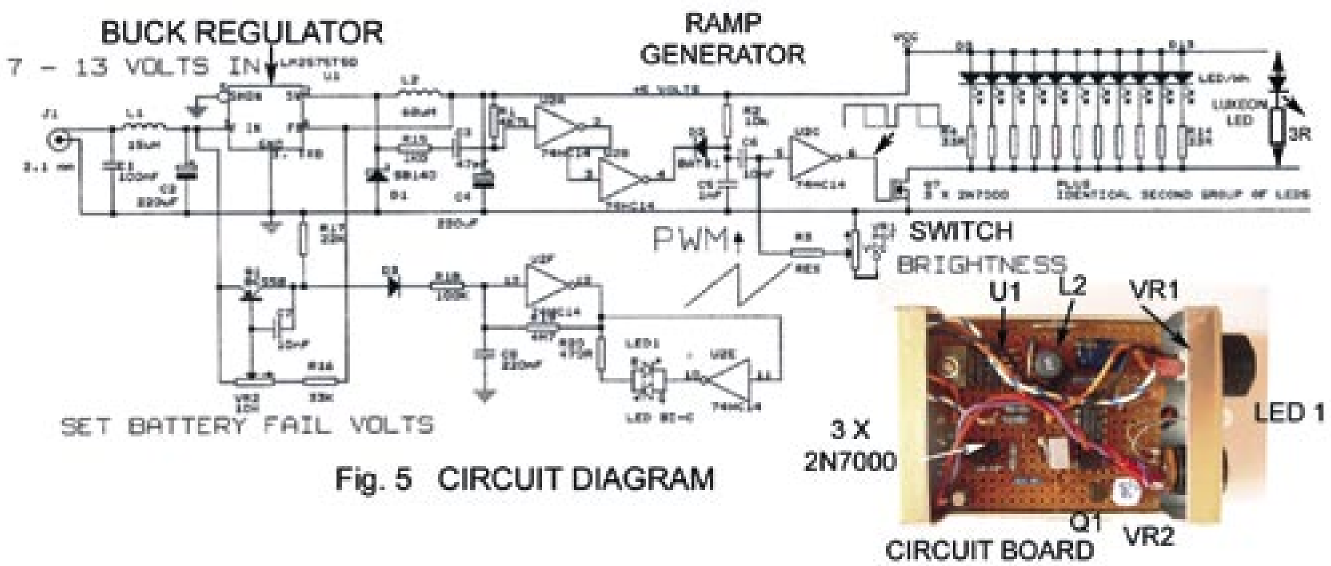


Fig. 5 CIRCUIT DIAGRAM

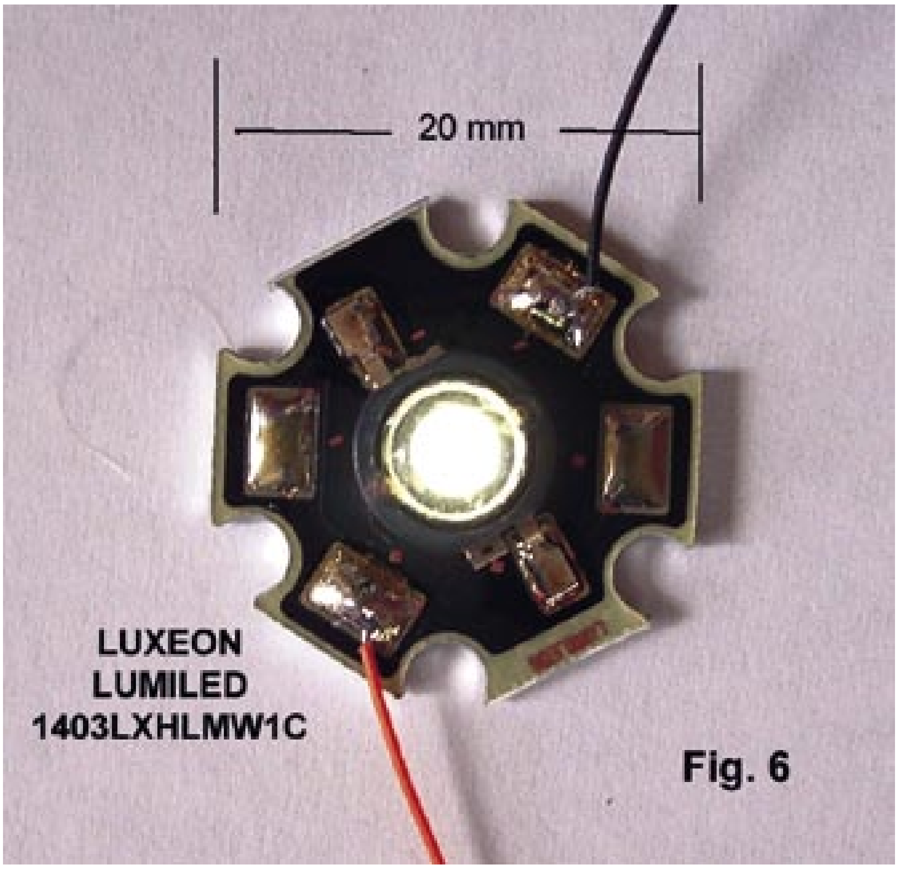

Fig. 6

The White LEDs [X_OPTO WT5111A], the LM2575T50 buck regulator and the 6 x AA cell holder came from Rapid Electronics, as did the 68uH inductor.

Since the lamp was made, Maplin have started stocking Luxeon power LEDs. The white one has type no. LHXL-BW01. It is mounted on an Aluminium heat sink and can run at 350 mA. With a forward voltage around 3.5, it is dissipating around 1 watt! Unlike the X-Opto and Kingbright LEDs, it has a broad beam, and gives out a lot of light. [Fig. 6]

Luxeon make a range of similar devices in all possible colours, up to 4 element devices requiring a forward voltage of 6.8 volts and a current of 700 mA. Light output of 120 lumens is claimed.

Type no. is LXHL- PW03. They are of course more costly than the one shown in the picture, which has a claimed output of 25 lumens.

Such a device as the LXHL-BW01 can be fitted straight into the circuit [Fig. 5] with a 3 ohm series resistor as current limit.

## Other Details

The device has to be mounted on the camera; in my case with a Sennheiser microphone as well. The microphone has a camera shoe mount and a1/4" bush as well. So the case for the lamp has a thick piece of aluminium araldited underneath, then drilled and tapped ¼" BSW. A bar was then made up with a fitting to engage with the camera shoe in the centre, and two ¼" holes at the ends. The lamp and microphone are then bolted to the bars with ¼" set screws.

Because of the fairly narrow beam width, the lamp is mounted on a small ball and socket joint to allow the lamp beam to be aligned with the camera lens.

The lamp appears pretty bright to the subject, and some form of scrim to soften the light a little would be useful. A single ply of tissue is effective but attenuates the light somewhat. Experiments will continue to find an appropriate material. Because of the low surface temperature of LEDs, fireproofing is not necessary. Nor are the LEDs likely to shatter, as halogen bulbs do occasionally, so no safety glass is needed either.

No measurements have been made of colour temperature, but the appearance suggests Illuminant D, or around 6500 K.

As white LEDS get more common, prices will drop and it will be economic to make more powerful lamps. They are already in use for garden and cycle lights, and it will not be long before they are used for car headlights.

I hope I have explained the rudiments of using LEDs for serious lighting applications. Why not have a go – they are getting cheaper all the time. You will find the web addresses of Maplin and Rapid Electronics below. It should be an illuminating experience!

Rapid Electronics :- www.rapidelectronics.co.uk

Maplin:- www.maplin.co.uk


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# In the Edit Suite - part 3

## By Trevor Brown

I the last issue, I talked about building a non-linear edit suite around a PC or, in the case of Final Cut Pro, around an Apple Mac. I gave you some web addresses where you could download free demonstration software and evaluate some of the systems for yourself. In this issue, I would like to start by looking at some HDTV and how post production can be implemented for these new standards.

| **Minimum Configuration (to play 720p video)** | **Optimum Configuration (to play 1080p video with 5.1 surround sound)** |
| --- | --- |
| Windows XP | Windows XP |
| Windows Media Player 9 Series | Windows Media Player 10 |
| 2.4 GHz processor or equivalent | DirectX 9.0 |
| 384 MB of RAM | 3.0 GHz processor or equivalent |
| 64 MB video card | 512 MB of RAM |
| 1024 x 768 screen resolution | 128 MB video card |
| 16-bit sound card | 1920 x 1440 screen resolution |
| Speakers | 24-bit 96 kHz multichannel sound card |
| | 5.1 surround sound speaker system |

Standard resolution TV in the UK has 625 lines, so the vertical resolution is at best 625 pixels. The are various things like kell (see Digital versus Analog - The Kell Factor) factors and field blanking that reduce it, but let's keep it simple, at say 600. The picture is wider and, therefore, to keep a similar resolution would require more pixels - for 4 by 3 let's say 600 by 800 pixels, to put it in computer terms.

HDTV improves the vertical resolution by introducing two new line standards, 1080 and 720. To make things a little more complex, both these standards have interlaced and progressive formats, so we have 720p and 720i, 1080p and 1080i. These formats can easily be converted for computer or domestic HD displays, and are also easily down sampled to both the existing 525 and 625 standards. The horizontal resolution for 1080p and 1080i is 1920 pixels and for 720p and 720i is 1280 pixels http://support.gateway.com/s/CsmrEltrncs/DigitalTV/Shared/2517984faq42.shtml

. I hope the interlaced formats will disappear and that we will join the world of film with sequential pictures by adopting the progressive formats i.e. 720p and 1080p

The USA is standardising on a 720 line format and Europe is set to adopt 1080. We maybe divided by a common language, but we are not united by a common television standard. The results from both these systems are stunning. It is not just the resolution, but the clever gamma that has been implemented on both standards, that gives the pictures that wonderful film look. I have worked with 1080p with the Sony HDW750 camera and, even if you standards convert the pictures to 625, they still look terrific and carry the film look with them. If you have Windows Media player 9 or 10 you can play 720p and 1080p. You do need a reasonably fast PC. My 2.8 GHz Pentium copes with 720p and just frame stutters on 1080p. The advice from Microsoft is:-

Sample clips are available in both formats from http://www.asia.microsoft.com/windows/windowsmedia/content_provider/film/ContentShowcase.aspx

The resolutions vary so right click to see what you are viewing.

The clips have data rates between 6,384 kbps and 10,440 kbps. The higher the data rate, the higher the resource requirement. The clips are large files and even with broadband will take around an hour each to down load. Most of the clips are film transfers, and as such you cannot judge the benefits of electronic images and the film-look gamma. The clips are best viewed on a VDU which, although it has a different colour balance to a domestic TV, does have a better phosphor pitch - typically 0.26, whereas a domestic TV will at best have a phosphor pitch of 0.5. The kit for filming either of these standards may be a little beyond the reach of most of us at the moment. But with the ever reducing prices of TV hardware, it may be worth planning HDTV into a post production suite to give some future proofing, if that is possible in our ever changing world.

In the last issue I replaced my linear suite with a Newtek Toaster, or VT3 as they would now like it to be known. Newtek must have heard that I had invested my hard earned cash and immediately introduced VT4; in truth I knew it was coming and was part of the reason I could afford VT3. The new hardware requires a PCIX mother card and comes with some even more exciting software. Some of the things that I and others have complained about have been fixed and, sadly, some have remained. The new hardware is centred on live production and faster stream handling in what is a real time world. Most of what I do is post production, where rendering time is possible, but not desirable. The best news is that VT4 software will run on VT3 hardware, so I have not been too badly treated, if only I can find the $500 for the software update.

But how does this fit into HDTV? Well, Newtek have announced that VT4 will remain a standard definition platform for the foreseeable future, so HDTV editing might not be an option for me without further investment. This is not true for other manufacturers - Adobe Premier Pro Ver 1.5, Editions 6 and Sony Vegas have added HDTV. Apple has Final Cut Pro HD for the Mac. Black Magic are producing the hardware at a reasonable price - currently $595. http://www.blackmagic-design.com/site/decklinkhd.htm

It's the shooting part that is going to hurt the most, but there is HDV on the horizon which will be big brother to DVcam. JVC already have a 720 line version available. http://www.camcorderinfo.com/content/jvc_grhd1_fi_camcorder_review.htm

The humble DV tape format is hard pressed to deliver the required data rate for standard resolution, so how do we fit HD on the tape and still be able to acquire down the fire wire into the editing suite. Well, first of all HDV is not 1920 pixels - it is 1280 (some of the Windows Media clips are at this resolution). This is still not large enough reduction in the data rate to make it work. The second fix is to MPEG compress it in the camera, so you record compressed pictures.

Dvcam and Mini DV worked the other way around. It was compressed before committing it to tape, but only by about 5 to 1, so at worst you were editing mild compression without the complex frame sequence of MPEG2.. If you are producing a DVD, you then apply the much heavier compression to fit the programme onto the plastic disc after it has been edited. So why not apply this compression in the camcorder and edit the MPEG2 file?

Not quite a simple thing to implement. Remember how the compression works for MPEG2, we transmit the first frame and then frame 16, with all the frames in between being transmitted as the difference between the two pictures. Not the simplest concept to edit, but technology marches on and, yes, it is possible - even my VT3 will edit MPEG2, providing you have a direct show filter (don't ask).

So is MPEG encoding at the camera going to be the domestic camcorder way of working and will the professionals still do it differently? Well, DVcam and its 5 to 1 compression is generally accepted for news and has almost pushed out the analogue Beta SP (See the flourish of activity selling Beta SP on EBay). Things are about to change. Sony have produced the XDcam aimed at the news market - domestic it certainly is not - and the pictures end up MPEG2 encoded on a plastic disc in the camera. http://bssc.sel.sony.com/Professional/markets/optical/cameras.html

Not to be outdone, Panasonic have produced a P2 camera which records on SD memory cards - 5 in all. It only records on one card at a time, so you can hot swap full cards for a continuous recording. Again, sorry, this is a long web address:- http://panasonic-broadcast.com/index.cfm?uuid=A130E452C09F11269B89B84D8643F16D&CatID=4283&ClassID=1&PID=11420

Cox Television of Atlanta has announced that it is to convert the newsgathering operations of its 15 television stations to the DVCPRO P2 solid-state memory recording system. The sale encompasses more than 130 pieces of DVCPRO P2 equipment, including AJ-SPX800 camcorders, AJ-PCD10 drives and AJ-SPD850 studio editing recorders, as well as over 360 P2 cards.

All this, I hope, highlights the changes that are appearing in TV recording formats, and if you are planning an edit suite to cope with the various formats, then you have a lot of research on you hands. So far with my VT 3, I am limited to standard definition, I can import MPEG1 and Newtek have workarounds for MPEG2 and Divx. The workarounds involve changing the file extension to AVI and then importing the clips onto the time line. It's not as smooth to edit this material, and I suspect access to every frame is not possible, but I don't think in the case of MPEG2 it is as crude as limiting you to the 16 frame blocks of data.

Most of the camera manufactures are working with partners to develop editing systems - it is just with such diversity it may be difficult to set up a single suite which will cope with every format, and future proof any investment. I am sorry not to be able to locate any demo software for you to down load and edit the clips on the Windows Media site. It seems that the demo software is limited to standard definition.

In the next issue we will be looking at DVD authoring.

Since writing In the edit suite 2, Avid have introduced and extensive on-line tutorial for there editing software.

It has sound accompaniment and is ideal, if this is the software you have decided is the one you prefer.

To download or view this tutorial go to http://www.avid.com/freedv/tutorials/index.asp?dm=AvidInFocus041105


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# Digital versus Analog - The Kell Factor

### From the Internet

The smallest detail that can be reproduced in the image is known as a picture element (pixel). Ideally, each [of the smallest] detail [s] of the [original] scene should be represented by one picture element [in the image], that is, each scanning line would be available for one picture element along any vertical line in the image. In practice, however, some of the details in the scene fall between scanning lines, so two [scanning] lines are required for such ... [details that are one scan line high]. Thus some vertical resolution is lost. Measurements of this effect show that only about 70% of the vertical detail [s one scan line high] is prersented by the scanning lines.

This ratio is known as the Kell factor; it applies irrespective of the manner of scanning, whether the lines follow each other sequentially (progressive scan) or alternately (interlaced scan).” From K. Blair Benson and Donald G. Fink, “HDTV: Advanced Television for the 1990’s”, 1991, McGraw Hill, NY, bracketed words added by me.

We are continuing to research this topic, some sources say that the Kell factor only pertains to the degradation caused by interlacing. One source states that the Kell factor is the ratio of the scan line thickness to the scan line spacing, which coincidentally approximates the ratio of lines of resolution to scan lines when it is close to but less than unity. We will use the term “Extended Kell Factor” to relate the resolution as perceived to the number of scan lines taking into account all reasons for the degradation.

There is also recognized the “Interlace Factor” which is the ratio of lines of resolution as perceived in a video picture produced using interlaced scan, divided by the lines of resolution as perceived in the same video picture except produced using progressive scan.

The number of lines of resolution must be less than the number of scan lines or pixels (spanning the same distance) because the scan lines or pixels can straddle picture details so as to yield a total blur.

Since the early days of television, the effective resolution has been expressed as a Kell factor. There are probably some more modern formulas for use with digital video today but none have been widely published.


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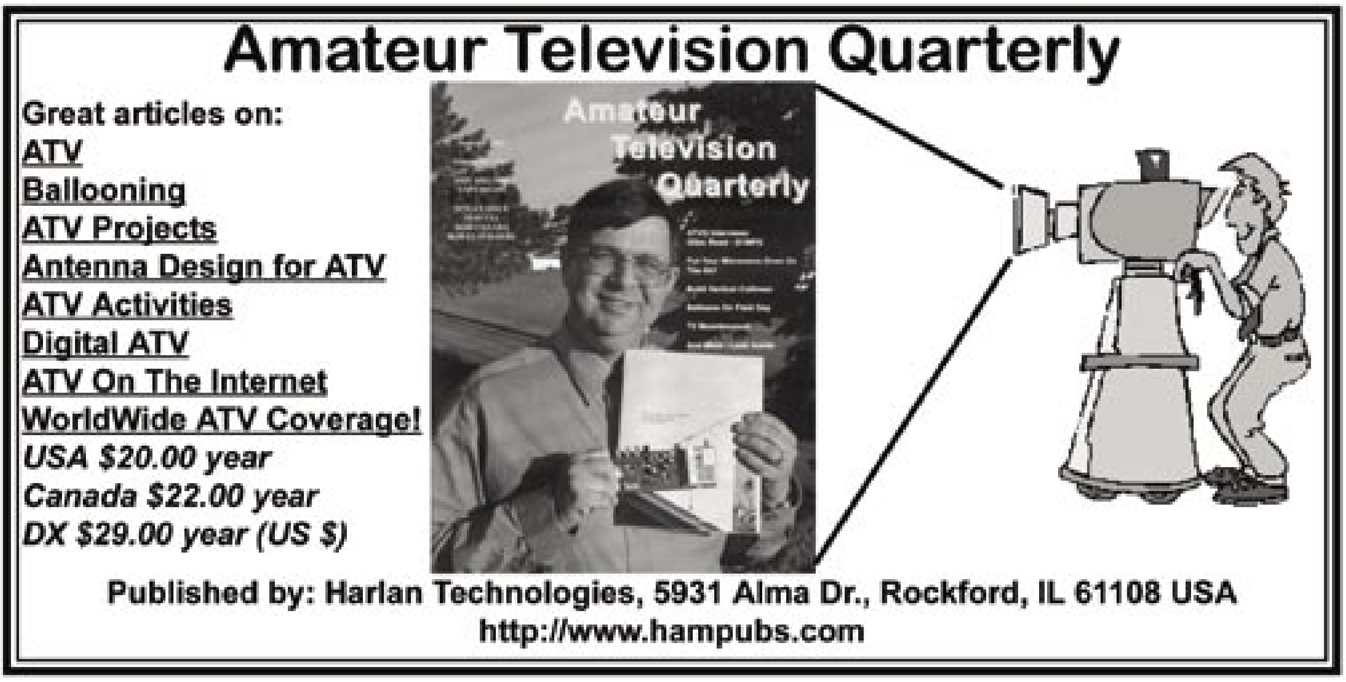

# DATV in simple terms – Part 2

**By Brian Kelly**

We looked last time at how an analogue voltage, which could well be a video or sound signal, could be represented by a stream of numbers. In this part, I hope to explain why converting to digital makes the job of handling the signal so much easier.

It isn't only the fact that digital signals do not normally degrade along their transmission path like analogue ones do that makes them attractive, they are easier to handle in a production environment. Trying to do clever tricks on analogue signals is very difficult, even something as straightforward as cross-fading one picture to another involves sync stripping, locking picture source timings together and then mixing through variable gain amplifiers. I'll explain the simple way it's done digitally a little later.

Before getting deeply engrossed in the studio, let's first take a step back and see why digital signals are so much more robust than analogue ones. It all boils down to the ways signals may be degraded as they pass through circuits, cables and over the air.

We can break analogue degradation into two categories, loss of signal integrity and addition of unwanted interference. The signal integrity is impaired whenever it passes through a non-linear circuit, meaning that for a given change of signal entering the circuit, the output changes by a disproportionate amount. Visibly this shows as an error in contrast or brightness and its severity may change with frequency, giving strange shading or smearing effects. If the problem exists near the colour sub-carrier frequency (4.433MHz in PAL, 3.579MHz in NTSC) it can additionally cause loss or excessive colour or even completely wrong colours. The second category, that of unwanted additional signals becoming mixed with the one we want, can be equally troublesome. The most obvious impairment comes from 'snow' in the picture, such as seen when the signal level is weak. This is actually caused by the addition of random voltages to the picture, either from natural sources or from random electron flows in amplifier devices. In most circumstances, the amplification level is turned down when a strong signal is received and this also results in less amplification of the noise source. Undesired effects can also come from reflections or time-shifted versions of the signal being mixed with the original. When the reflection is delayed enough it shows as a 'ghost' image, shadowing its source and displaced to the side. When the delay is smaller, it is no longer visible as a separate image but it can still cause problems due to the ghost adding or subtracting from individual cycles. You have probably noticed that some 'ghost' images look like photographic negatives and if caused by aircraft passing nearby, may alternate from positive to negative. When the delays are very small, the adding of positive reflections and subtraction of negative ones can cause all manner of nasty waveform distortion or even cancellation. Just as over the air signals suffer from this 'multi-path' effect, so can cabled signals if the source and terminating impedances do not match the cable impedance. The effect can be very serious ghosting. The effect is used deliberately sometimes to measure the length of a cable (Time Domain Reflectometry or TDR) as the time delay between a signal and its reflection is proportional to the distance they have travelled and hence the length.

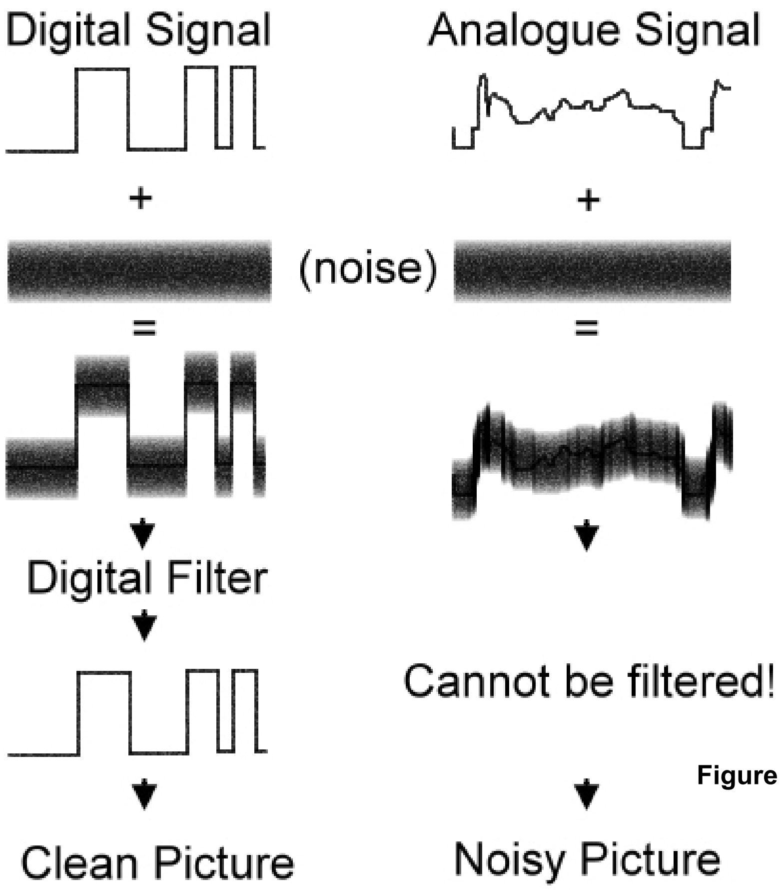

**Figure 3**

Digital signals have a huge advantage over analogue ones in that they only have two voltage levels instead of the infinite number that analogue has. This virtually removes the need to carry it through linear circuits. The binary bits from the ADC only have two states, a zero or a one. A zero is usually considered to be an absence of voltage while a one is usually a positive voltage, typically 5V. Somewhere between the two there is a threshold, anything below it being considered zero and anything above it considered a one. If 5V is assumed to be the 'one' level and half of that, 2.5V, is assumed to be the threshold, even a signal with 2.4V of noise would still appear to have 100% integrity as it would not cross the threshold from one state to the other. In practice, that would be considered extremely noisy, digital noise levels are usually much lower than that. Even though digital systems are highly immune to noise (fig.3), steps are still taken to minimise the possibility of it interfering. The most common of these is to make the threshold higher than half voltage before assuming a one and lower than half voltage before assuming a zero. In

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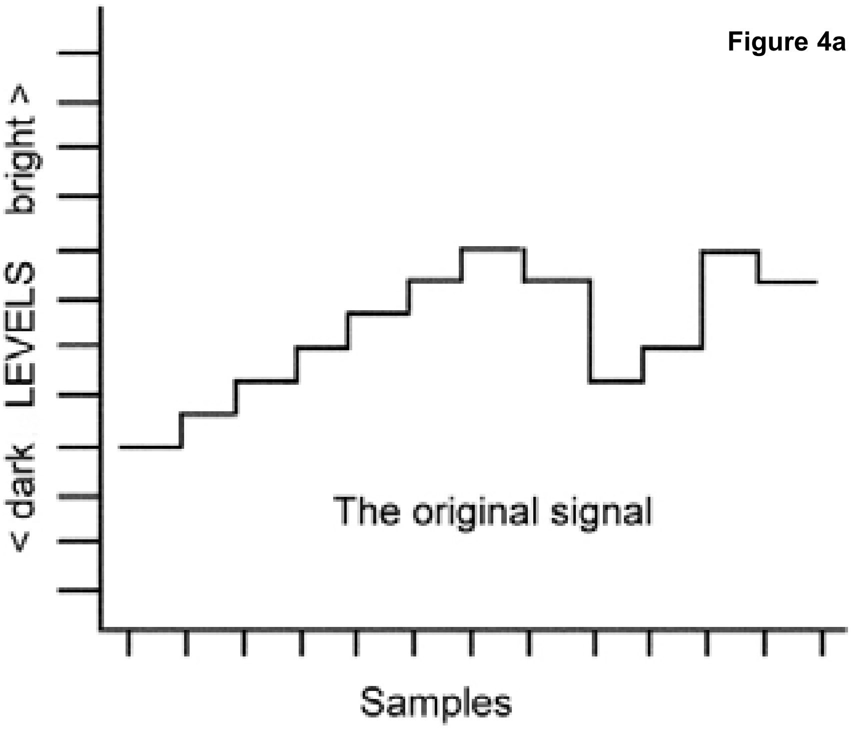


Figure 4a

other words, the threshold is no longer fixed, the voltage has to go beyond the half way point to change state either way. This has the effect of cleaning the edges of the signal where the likelihood of noise causing problems is greater during the time rising and falling edges pass through the threshold zone. Not only is a digital signal far less immune to random noise, any reflections in the signal that have lower levels than the threshold are also ignored.

So digital is less prone to distortion and noise, in itself a good reason for using it. Lets now turn to manipulating digital video in various ways and see how much easier it is than in the analogue world. I've broken the myriads of video effects into just a few categories, most of the more complex tricks are just combinations of these.

## Brightness control.

As the picture is made of samples (pixels) and each has a numeric value, simply adding or subtracting from the value will shift the brightness (fig.4abc). The normal value ranged used is 0 – 255 (assuming 8-bit data, it's 0-1024 if 10-bit data is used) with higher numbers meaning nearer to peak white. Moving all the pixels up in value makes the whole picture move toward the peak white level. Conversely, if the pixel values are reduced the picture goes darker. Obviously, there is a need to constrain the values so they do not go outside the valid range but that's easy to do.

## Contrast control.

By contrast we mean the amount of difference between the darkest and lightest parts of the picture. A high contrast means the difference is greater (fig.5). To expand the pixel values so the contrast is higher, all we have to do is multiply each value by a fixed amount. Similarly, dividing causes a contrast reduction.

## Hue and saturation.

How these work is somewhat dependant on the way the signals were originally digitised. If the samples represent separate red, green and blue pixel values, the hue can be changed by multiplying (like changing the contrast) each by a different amount. The effect is to unbalance their relative levels and visually cause a colour shift. Saturation is controlled in a similar way but the calculation is a little different as the differences between each colour have to be enhanced by a combination of partially subtracting one from another then multiplying the result to bring the levels back up again. If the samples were digitised from a composite signal, the maths is very complicated and involves a process not too far removed from decoding, enhancing and re-encoding the signal again. I promised no math in part one so I'll leave this aspect for your study elsewhere.

## Keying and overlaying.

These are the processes of substituting part of one picture for another. In its simplest form, overlaying, one image, usually a caption or text, is given priority over its background. You will have seen this effect used to put channel logos in the corner of commercial TV broadcasts and to add the names or locations of news reporters into news programmes. Keying is a variation of this where one or more pictures are inserted into another. The effect is frequently used to put weather forecast presenters 'in front' of weather maps. The difference between the two is that one is replacing the background with a new one while the other is switching picture sources at a time decided by either the contents of one of the pictures

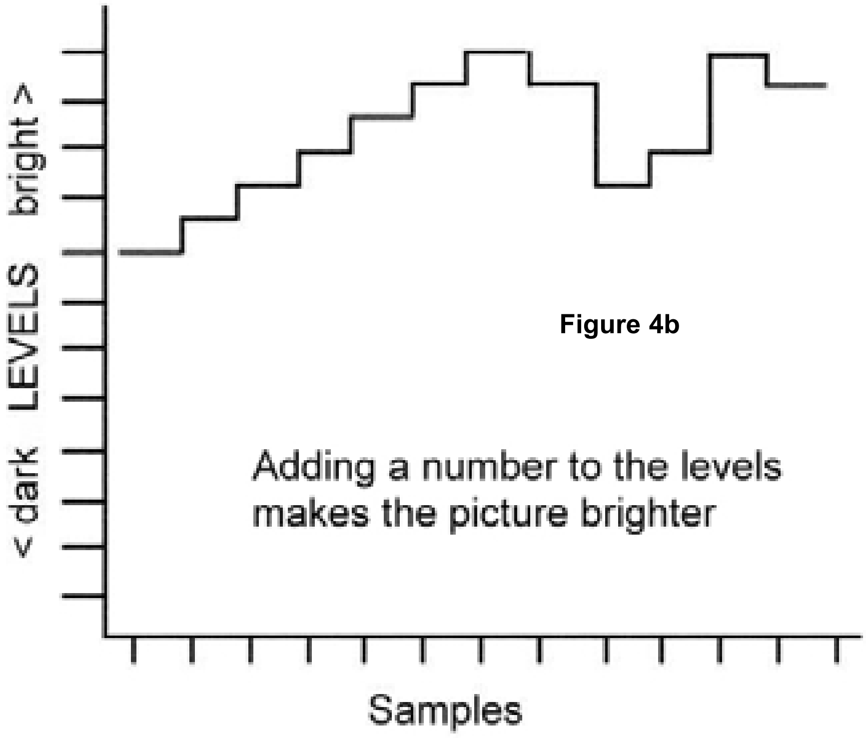


Figure 4b

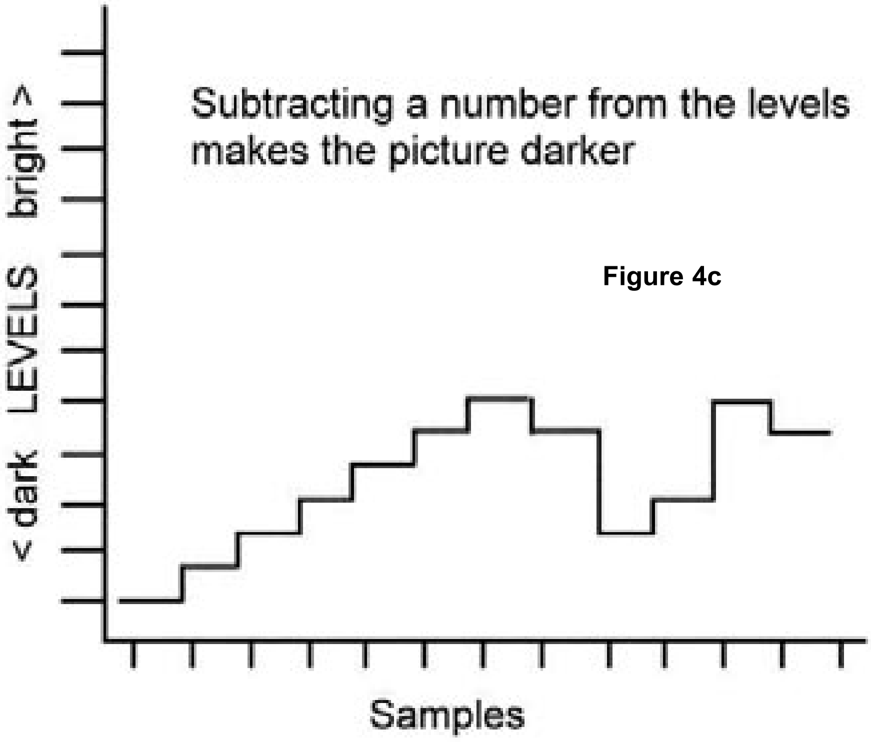


Figure 4c

or a third image called a matte. The matte is usually a black on white fixed image (for example a rectangle the size of the weather map) which decides which image is selected. Black means picture A while white means picture B, obviously the matte image needs to be carefully placed or the picture in picture effect will cut at the wrong places. A variation on the keying theme is colour keying (chroma keying) or luminance keying where the content of one picture, whether colour or brightness is used to switch images. In the analogue world it is quite difficult to distinguish exact levels or colours to operate the signal switch but digitally it is quite easy. Rather than trying to define exact luminance, hues and saturation levels using analogue comparators, we can simply define a range of numbers, the mathematics is very simple.

## Cross fading.

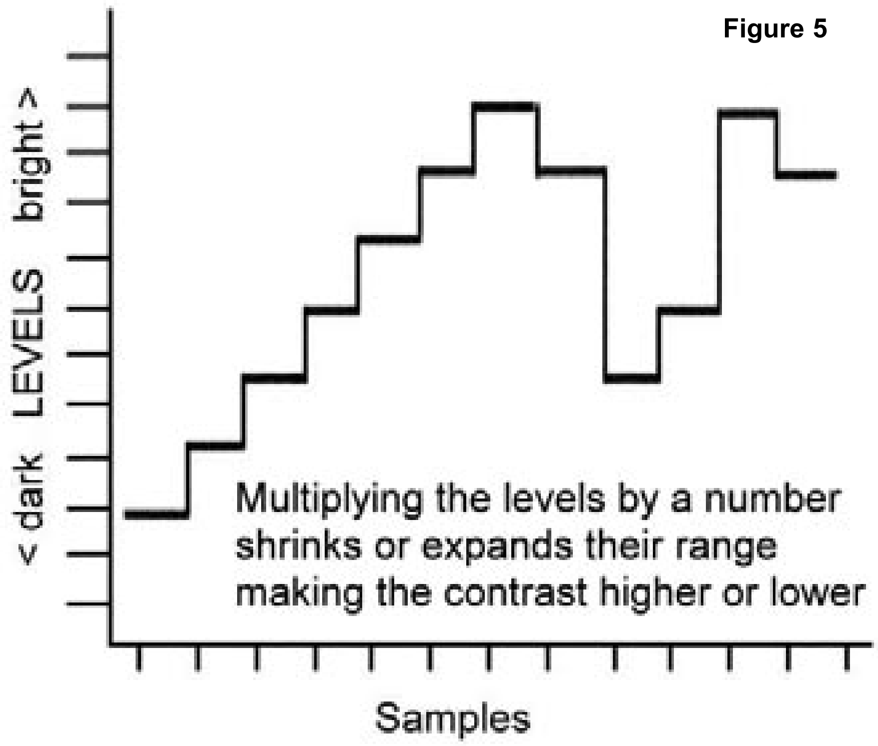
Changing from one video source to another can either be an abrupt switch or a gradual fade out of one source as the other fades in. This isn't too difficult to do in analogue circuitry if the signals are synchronised together. However, it involves more than just lowering the level of one source and raising the other. This is because the sync pulses must remain at a contant level throughout. Normally, both sources are stripped of syncs, the video cross faded and then one of the original syncs is re-inserted. Digitally, the same idea is used but the fading in and out is done by numerically reducing one of the samples while applying the same factor to increase the other. For example if sources A and B are multiplied by 0.5, they will both be half level, adding them together will result in full level of a 50/50 mix. Changing so source A is multiplied by 0.25 and source B by 0.75 (that's 1 – 0.25) will give a 25/75 mix in favour of source B.

## Synchronising video sources.

The only way to do this using analogue techniques is to 'genlock' the video sources together. A video signal has a visible 'raster' area and synchronising pulses which are not visible but essential to make sure each scan line is in the correct position on the screen. When two or more video sources are mixed, it is essential the sync pulses line up with each other or the one of the pictures will be displaced relative to the other. Normally, this is achieved by using a standard sync pulse generator (SPG) which connects to each of the video sources and keeps them all in time with each other. Doing it digitally is quite different though and the need for genlocking is not as important although still preferable. This is because if the picture is stored as numbers in a memory device it is possible to read them back at a different time. In other words, a degree of time slippage can be catered for by temporarily delaying one of the signals until it falls in line with the other. The memory device takes up the slack. There is a limit to the length of delay that can be used as at some point the memory device will fill up. That's why it is still important to lock sources if possible, the memory allows for minor time shifts but as it is being written to and read from simultaneously, it will never fill up if the sources are relatively close together.

Without getting bogged down with formulas, here are lines of 'pseudo code' that a computer manipulating video might use. I stress these are not real programs and would be very unlikely to work as they are but the idea behind the code will hopefully be apparent.

Figure 5

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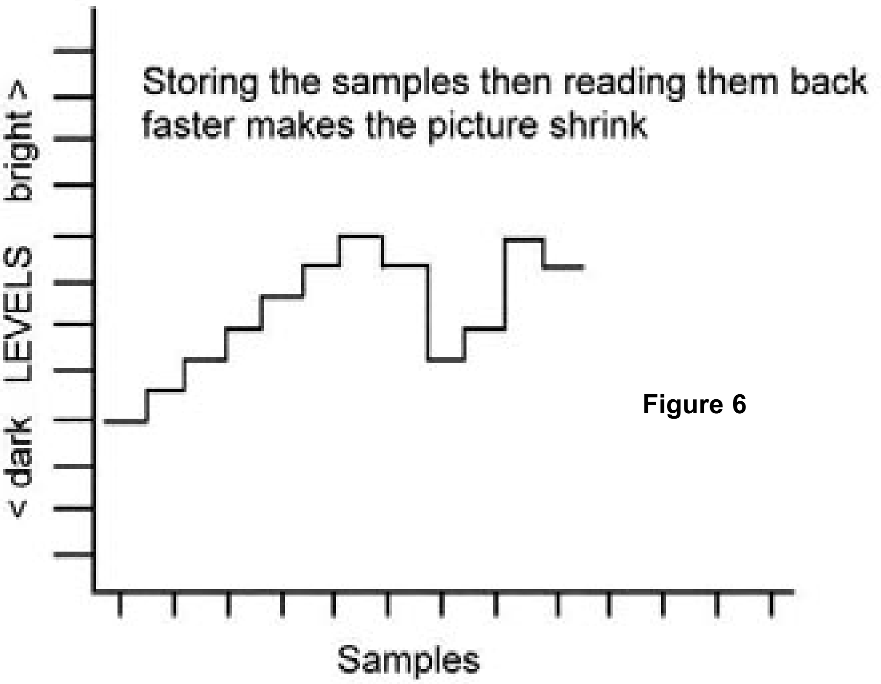



**Figure 6**

ADC to show exactly the same image as was stored. Now imagine what would happen if the memory addresses were read back in reverse order; the picture would also be reversed. Try doing that with an analogue circuit! In fact, there is no reason why the addresses need to be in sequence at all, forwards or backwards, they can even be completely random. Those who can remember the Videocrypt pictures that used to be used by BskyB satellite broadcasts will have noticed that even when the picture was 'scrambled' it was possible to tell if subtitles or scrolling credits were being shown. That was because each line was stored in a memory device and replayed in a different horizontal position according to a secret sequence of memory address lines. The trick was known as 'cut and rotate' because each line had several 'cut' points where the playback addresses switched and between each 'cut' the picture was 'rotated' or reversed. Reading the samples differently to the way they were stored is not only used for encryption though. If a fixed number is added to the memory address, the recovered picture will move across the screen. Adding a number equal to the length of each line will move the picture up or down. Reading the data back quicker than it was stored makes the picture narrower and the reverse, reading back slower makes it wider (fig.6).

Brightness control: new level = old level +/- amount to change brightness by.

Contrast control: new level = old level * amount to change contrast by.

Overlay : if position in picture is right, source = A, otherwise source = B.

Chroma key: if ( a < red < b) and (c < green < d) and (e < blue < f) select source A, otherwise select source B. Here abcde and f are the min and max for each colour.

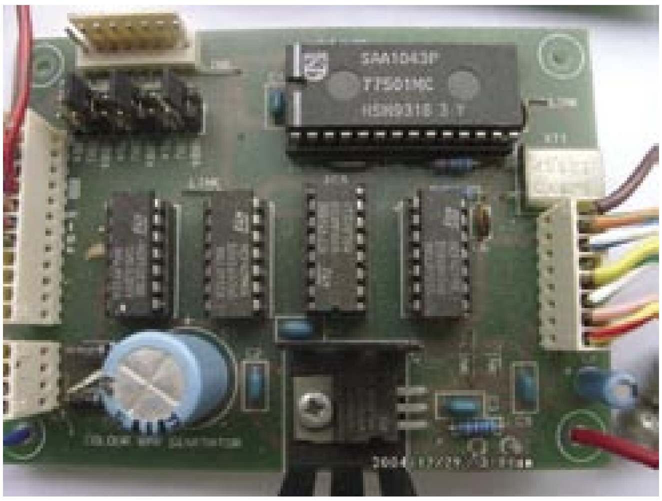
Luma key: if level of A > threshold, select source A, otherwise select source B.

Mix: new level = (source A * fraction) + source B * (1 – fraction).

Hopefully that makes sense, there are of course many more formulas used to create special keying effects.

All the digital methods mentioned so far have had some sort of effect on the picture in a fixed place on the screen, whether changing its level or origins. Digital offers a whole new selection of 'spatial' effects as well. While it is true that these can also be done using analogue circuits, they would be tremendously complicated and tedious to adapt to different situations. The 'spatial' word simply refers to something's position relative to the space around it. Crucial to digital spatial effect is the memory device and the fact that once stored, video samples can be retrieved in a different order. Ordinarily, as the DAC produces its samples they would be stored in the next available memory address. If retrieved in the same order and at the same rate, the picture could be reproduced through an

As you can see, it is possible to perform all sorts of video position and level changing by just tweaking a few numbers. Digital pictures are much more resilient and versatile than their analogue counterparts. The downside to digital is that massive amounts of numbers are produced. In the next part I'm going to explain the trick called compression which reduces the volume of digits without appreciably reducing the picture quality.



**Main board from the Maplin Colour Bar generator kit published a few years ago. Picture by Graham Hankins G8EMX**

# The Ampex/Nagra VPR-5 video tape recorder

**by Gino Mancini.**

This is a discussion (well more of a rambling essay actually) about a remarkable example of late 20th century technology, by Gino Mancini.

## Introduction

I can still recall a certain slackness in my jaw as I first came across a picture of the VPR-5 in Nagra's Audio & Video product line catalogue of June 1988. I had been well bitten by the video equipment bug by then, and together with a good like-minded friend had already travelled to various far-flung corners of the UK in search of old (and thus very cheap) bits of video kit. I particularly remember enjoying a few glasses of good Port in quite a posh hotel in York while they closed the bar around us, having filled a van with ageing IVC equipment earlier in the day. Later I was quite glad they had grab rails along the corridor to our rooms, but I digress...

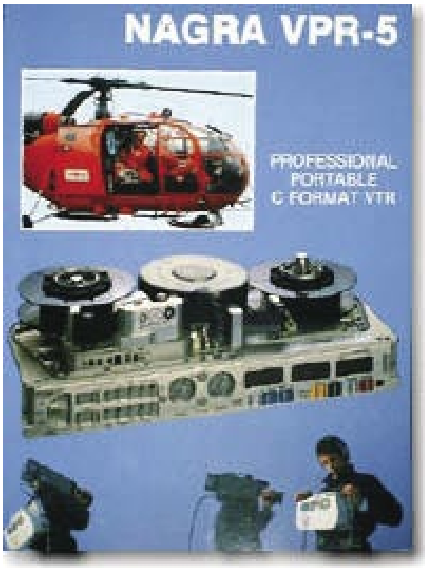
That Nagra catalogue rather changed my aspirational goalposts, and my mind wanders back to an even earlier time in the mid 1960's when having proudly just spent 30 shillings on a new stereo pickup cartridge (that's 1.50 in UK Pounds, and yes I am that old), I found out that an outfit called Ortofon made pickup cartridges at over ten times that, and you needed a special 9 quid transformer just to be able use it.

So one learns that everything is relative, and It's a bit like that with this little Nagra video recorder, for when Kuldelski were building them you could get a very respectable domestic portable video setup for say £1,000, or you could re-mortgage your house (and sell the family) to get a VPR-5 for over thirty times that, and you still needed a camera and lens of matching quality at perhaps another twenty five thousand quid. Better sell the Porsche (and the BMW)...

Actually I didn't know when I was staring with lust at all those unattainable toys in Nagra's 1988 catalogue, that in fact their stunning miniature video recorder was already quite obsolete by then, and had been replaced by something much more convenient, of slightly lower quality, and of vastly lower romance; Betacam (but there again I don't get out much).

It's a bit like reel-to-reel and Compact Cassettes (remember those?) Valves verses Transistors and Betamax verses the dreaded VHS, all nearly forgotten now. And so perhaps with the long monologue that follows I am fighting (well perhaps just bleating) a sort of minor rear guard action for yet another nice bit of discarded technology. Perhaps as might a steam railway enthusiast have done thirty years ago when the nice Dr Beeching closed all those branch lines and brought in the Diesel-Electrics. Well I am a person of a certain age...

If you already know what a Nagra VPR-5 is, you won't need an amateur like me to tell you how nice it was,




if you don't but you do like old or interesting technology I hope you find what follows worth to your taste. Sorry about the writing style but I'm no technical author, and the whole thing started out as a sort of personal user-manual almost before the Internet was invented (and I can't face a complete re-write). I have though tried to include some nice pictures of the machine and other items mentioned as I go along.

Fade up from black to perhaps six years later, times change; the BBC has moved on from reel-to-reel video recording on 1 Inch tape, and after quite a few telephone conversations, some racking of brains and a much lighter wallet, one of their Nagra VPR-5s is mine, all MINE!!

Ahem...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In 1994 I acquired an Ampex/Nagra VPR-5 portable 1 Inch C Format video recorder. I had been aware of this interesting machine for some time, though for obvious financial reasons it was to be a good few years before I was able to get my hands on the example you mostly see on these pages.

Since childhood I have been attracted to technical things and in later life collected various bits of unwanted old technology that included a few items of broadcast television equipment. Hi-Fi was also a consuming interest once, and while it seemed difficult enough to reproduce an audio frequency response of say 20 to 20 kHz with a good degree of 'fidelity', to do the same with a video bandwidth some 250 times wider seemed a very interesting proposition. Indeed because of the many technical challenges involved, broadcast television equipment was until recently forced to embrace many truly state-of-the-art engineering values. Though happily for the impecunious collector such as me, the relentless changes in technology and format provided a happy hunting ground for the many interesting and often beautifully made things that were mostly just thrown away. It then became just a simple race between the land-fill site or one's own private 'museum' (and later perhaps back to the land fill site anyway!).

And so for perhaps a 50th of what that little silver machine probably cost the BBC, my VPR-5 became a valued item in a modest collection of other obsolete 'junk'. And over the decade that I have enjoyed this complex and glittering little box, I have tried to learn about the machine's background and about the circumstances that brought it about. Unfortunately though with rather limited success so far, as while some technical documentation remains, virtually nothing seems extant regarding how or why this rather unique video recorder came into being in the first place.

Michael Mailes's comments seem to suggests that Ampex refined an already built Nagra prototype, but what caused Kudeleski to make such an extraordinary machine in the first place? We know that the Nagra SNN was built originally to record White House conversations (as stated elsewhere on the Web), and that they built other specialized surveillance recorders for the Americans as well as the Russians. Nagra also built all sorts of advanced instrumentation recorders as well, some of which one might find lurking inside a prototype missile or torpedo. Could therefore the VPR-5 have started out as part of some airborne military or scientific instrument package that was later developed for broadcast TV use with the help of Ampex? Or did Nagra perhaps bite off more than they could chew and have to get Ampex to help them iron out the bugs? It is interesting to speculate how such a lavishly engineered and (outrageously?)costly device seemingly rather suddenly came on to the broadcast television market in the early 1980's. But if it was a by product of the cold war we may never know the full story. However as this machine does seem to be so unusual, I thought it would be worth sharing what little I have found out about it.

Not being a professional but just interested, much of my knowledge of broadcast video equipment was obtained by studying various trade publications, in particular old copies of the S.M.P.T.E. Journal (very informative if you're into old film or video technology). Also with a bit of detective work, other moderately obscure sources such as American Cinematographer, Video, Televisual, and even early issues of Studio Sound were found to contain quite a lot of useful information. I spent time at the libraries of University College London (adjacent to the Science Museum), Reading University, and at Surrey University in Guildford. Here I was able to do quite a bit of 'time travelling', and gleaned much interesting information about the development of television technology in general during the 1970's and 1980's. Interestingly though, my 'book learning' was no substitute to talking to those people who actually used or serviced these machines for a living, I am therefore most grateful to those knowledgeable and supportive professionals that I have been fortunate to come across at various times over the years, in particular Andy Shakeshaft, Joe Driver, Bob Smith and Tim Blackham.

I think it is fair to say that the Ampex/Nagra VPR-5 is regarded by those 'in the know' as something of a minor legend in its own lifetime. During my research, a number of people I discussed the machine with knew of the existence of this little Swiss wonder though many had never actually seen one. One professional owner and user said (and this had already been demonstrated by Mr Mailes) that it was so tough that you could stand on it without causing it harm, which is quite true provided that the cover was locked-on. Though the reason why one would want to be able to do this might be open to conjecture. There was also a consensus that the VPR-5 recorded the best quality pictures of all the Ampex C Format video recorders. This was no small achievement considering its minuscule size in comparison to studio and the other so-called portable 1-Inch machines. A respected ex-BBC sound recordist while highly praising the Nagra's sophistication, did however make remarks to the effect that the machine could be rather tricky and unpredictable to work with, because 'you never knew what it was actually doing Gino'.

Such are the differing perceptions between the knowledgeable professional user and the enthusiastic amateur collector. His opinion I well respect, and while the BBC also deemed it necessary to make one or two minor 'improvements' I am still though inclined to conclude that this little recorder is one of the finest examples of late 20th Century electromechanical engineering to be found anywhere. It is an object lesson in how form can follow function and not just mere fashion; it's not perfect of course but does certainly have a high 'wow factor'.

There are now doubt even better examples of this sort of uncompromising 'glittering gothic' engineering to be found in things space or military. But the writer knows of no other real world piece of remotely obtainable kit that directly compares to this complex little silver box. Of course there are other Nagra devices that are not too far off the mark, and I am thinking here in particular of their full-sized T-Audio tape recorder or perhaps at the other end of the scale the tiny and watch-like SN series machines.

To my mind the VPR-5 has to be a strong candidate for Nagra's masterpiece and the more one delves into it's workings the more this impression is confirmed, as inside that CNC milled, anodized, aerospace alloy box, there is a feast of engineering and electronics to please the eye. Here exquisitely done mechanical features mingle with once state-of-the-art electronics. This is a real engineering tour-de-force quite unlike most anything else. Even compared to all other Nagra machines it is very apparent that this video recorder exists on a completely different level of achievement. It's rather as if Breguet himself decided to get into the broadcast equipment business. This little machine belongs in a museum as the definitive example of the heyday of Swiss electro-mechanical

Front view of the Nagra VPR-5 in 20 minute configuration. (The 35mm film cassette to the same approximate scale.) The 3 LCD panels show (left to right): VU / PPM audio record / limiting levels, machine status,tape / battery time left or time code.
The 4 buttons under the right reel select: load-tape, cue 1, cue 2 and edit modes.

The one inch magnetic tape pays out from the right reel and is taken up by the left reel. (This is opposite to normal C format machines.)

The left hand row of toggle switches enable (or lock out) audio channels 1-4 record, video record, and insert or assemble video editing.

engineering. Never mind their watches, this really is an ingenious and well made object. (Well, reputedly one is already in The Metropolitan Museum of Modern Art.)

Described as a third generation C Format video recorder by William F. Carpenter's of Ampex, in his article published in the September 1983 issue of the S.M.P.T.E. Journal. The VPR-5 was probably engineered in the early 1980's by Kudelski S.A. of Switzerland, and was refined by Ampex Corp. of America. These two companies were in their different ways THE most respected and experienced manufacturers of magnetic tape recording equipment. Ampex was at that time arguably the world leader in magnetic recording technology. They had after all developed audio tape recording from the captured war time German AEG Magnetophon equipment and had gone on to invent the Quadruplex television recorder, which was of course the first successful video tape format. Later Ampex would develop (though did not invent) far cheaper and more compact 1-Inch, Omega-wrap helical-scan machines which would become known afterwards as the A Format.

These machines became widely used in industrial and the then rather fashionable educational-TV environment. Ampex also produced the rather epic TM-7 self-lacing computer tape drives that became so popular as props in old science fiction films of the 1960's and 70's. Ampex also made high technology 'Winchester' disk drives, as well as fiendish ferrite-core computer memory plains. American technology and 'know how' ruled, but this was a while ago when computers were real computers and men were real men etc, etc.

In those days Kudelski was by contrast a much smaller Swiss company that produced the famous and highly regarded Nagra range of portable audio tape recorders. These rather unique looking machines were without parallel for quality-of-build, performance and reliability (the late version Stellavox recorders possibly excepted). Highly expensive, remarkably well engineered, but no 'nonsense', the Nagra (which means 'it will record' in Polish!), was for many years 'the' standard portable audio recorder as used by the film industry. As Francis Rumsey wrote in the November 1991 issue of Studio Sound: ' The Nagra 1/4 inch tape recorder has held its place firmly in the film industry as the machine of choice for portable high quality work in the most inhospitable conditions. This analogue recorder has a reputation for reliability and solidity inspiring confidence in the film recordist for a number of years, although the weight of all this solidity has affected many a shoulder.'

In the late 1970's the co-developed Ampex / Sony 1-Inch C Format was becoming the de-facto broadcast videotape standard. While the media and the equipment was more compact and had a much lower cost of ownership than the older 2 inch Quadruplex system, the newer C Format machines still remained much too bulky for portable use. Ampex, Sony and Hitachi had already produced a few what might be described as transportable C Format recorders. But in reality one could hardly carry any of these bulky machines with ease or comfort, as they all weighed around 20kg and were the size of large suitcases. Bosch in Europe had developed what became known as the 'B' 1-Inch format slightly before Ampex's C system. This was a sort of cross between Quadruplex segmental recording and the single field 'slices' of Helical Scan. They seemed to have taken a Quadruplex head wheel, removed 3 of the video heads and mounted it horizontally in the transport, then wrapping the tape around this 'scanner' in an 'alpha wrap' rather like IVC used to do.

The end result was a rather more compact transport that was said to produce better quality pictures than the Ampex system. But because the B Format still made a segmental recording the TV picture had to be 'assembled' electronically back together again and therefore was not much of an advantage over Quadruplex for editing or slow motion playback. B Format did though have an advantage for portable use because the much smaller head drum allowed very compact and light-weight recorders (in reel-to-reel and even cassette form), that were much 'handier' than any of the big C machines. Unfortunately the B Format while becoming popular in Europe did not compete successfully in the all important American market, because perhaps it wasn't invented there. This forced many broadcasters in the States to employ inferior quality though quite portable High-Band versions of Sony's U-Matic cassette system (though this was also not invented there) for electronic news gathering or electronic field production. However, it is well known that American broadcasters would and did use almost anything for news gathering, even VHS. It would have therefore seemed highly logical in the early 1980's, for the two major players in the professional video and portable audio recording business to team up and built a truly portable, truly broadcast video recorder, and so they did...

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While wishing to learn more (do please do help if you know the full story) how this transatlantic collaboration came about and how things went during the gestation of this complex project, I now know that Ampex acted as consultants for video circuit refinement and that Kuldelski designed the mechanics, built and assembled the machine. Certainly there is nothing inside the recorder to indicate a source of manufacture other than Nagra, although one would expect items such as the video head tips would have been sourced from Ampex or their sub-contractors. (VPR-5 video heads are not interchangeable with Ampex equipment) As the writer has had some years peripheral experience with medical electronics product development, it is a wonder to him that this complicated creation actually got to see the light of day at all. Not surprising then that it was introduced into the marketplace too late, and remarkable that it actually worked as well as it did.(Though one does have this nagging suspicion that the machine may have started out for use in a somewhat more exotic environment than the broadcast television industry...)

Ampex Corp. were to market and service the machine outside Switzerland. The term ‘badge engineering’ comes to mind, though perhaps a little unfairly. But Ampex’s part numbering system for spares and accessories was to take precedence. Quite sensible perhaps considering the American company’s market reputation and highly established customer base. The VPR-5 was though quite unlike any other Ampex product and indeed was quite unlike any other video or audio tape recorder. Lacking the usual vacuum-formed or moulded plastic casework, this machine was somewhat ‘Swiss’ in looks; lots of glittering silver-anodized machined alloy with an apparent manufacturing philosophy of ‘let’s not use plastic when we can CNC machine everything from solid chunks of aerospace alloy’. But as we will perhaps see, there were probably some perfectly valid reasons for this uncompromising approach.

The VPR-5 was introduced to television professionals at the 1982 International Broadcasting Convention at Brighton on the South Coast of England (of all places). But series production did not start until April of 1984. One wonders how the machine was received by its prospective customers apart from shock at the cost perhaps. Also by 1984 it was getting rather late in the life of the C Format, and was at a time when various 1/2 inch cassette-based ‘tuned-up’ domestic camcorder systems were starting to appear. Indeed the all conquering Sony Betacam format had already been shown to the industry in its first incarnation some 18 months before the announcement of VPR-5, and naturally these new cassette / component based video formats would have a significant negative impact on the success of the Nagra. In addition, the VPR-5’s considerable cost even in comparison to other portable 1-Inch machines did no doubt limit its use for anything other than very top end broadcast E.N.G. or E.F.P. Surprisingly though a few corporate and industrial video producers also bought them. And even the odd ‘pop star’ was known to use VPR-5’s while ‘hanging out of helicopters and climbing mountains’. (Actually, a VPR-5 and Ikegami HL79d camera were rather lighter than an equivalent all-in-one Betacam ‘camcorder’ of those days - but the cameramen did not like being tied by a length of cable to the recorder’s operator though.)

The publicity ‘literature’ for the introduction of the machine displayed a fairly depressing lack of imagination. The S.M.P.T.E. Journal copy and the first leaflet shows the usual pretty girl with a camera on one shoulder and the recorder draped over the other, just like it was some cheap amateur portable ‘video’ of the time. If one is charitable one might suppose that they wished to


Two views of the machine in 20 minute (above) and 1 hour (below) configurations.

To change from the 20 minute mode (the standard cover fits over the machine in thismode) to a 1 hour recording mode is very simple: 1) Push the spring-loaded levers(rod-like projections from the hubs) towards the rear of the machine and hold. 2)Rotate the hubs to the back of the machine, and allow the levers to lock into place.Remember that DC motors, gearboxes and parking brakes are actually built into thosehubs.

These images show the ‘delicate tracery’ of the weight-saving, and the simplicity of thescrew-down reel holders. Naturally the disks that hold the reels on, are machined-from-the-solid, though this time it IS plastic!

draw parallels with the convenience (such as it was then) of contemporary domestic equipment. But to the writer this approach just looks weak. Later they used un-captioned drawn images of planes, cameramen and operators, and even a 'cartoon' of an harassed jungle explorer carrying his VPR-5 while being pursued by irate spear throwing natives (!). This half-hearted rather muted approach in retrospect suggests that Ampex were a little ambivalent towards 'their' superb though alien product. They probably did appreciate the quite remarkable intellectual design and manufacturing achievement that this little box represented, trouble was it wasn't actually theirs (but there again neither were any of 'their' cameras).

At its introduction the VPR-5 was priced in the USA at 'about $45,000'. This significant amount of money can be placed in the context of other C Format machines such as the preceding VPR-80 at $36,000, or the slightly later and higher specified VPR-6 at $60,000. Both these machines though were very much larger studio 'work horses' that needed two strong people to lift them. While I am not sure of the exact Dollar / Pound exchange rate in those days or of the prevailing marketing strategy in the UK, it does however seem that a VPR-5 in basic trim was about 50,000 in modern GBP's. So it took very 'serious money' to kit oneself out with 'proper' broadcast television equipment in those days. In addition to the Nagra recorder one would also need a camera of comparable quality, say a 3 tube Ikegami HL79D at about £25,000, a Canon 13 to 1 zoom lens at say £6,000, and a studio playback machine at another 30 to £40,000 just to view the tape properly (all 1984 prices). Today it seems that things are much cheaper with the current confusing plethora of digital stuff.

The VPR-5 together with the preceding Ampex VPR-20, the Sony BVH500, and a surprisingly sophisticated device produced (but possibly never sold in the UK) by Hitachi, seem to have been the only C Format portables ever made. They appeared perhaps between 1978 and 1984, but Nagra' machine was by a very large margin the smallest and lightest of them all. It was also the last portable C Format recorder introduced and was probably the most sophisticated, having in addition to its remarkably 'Lilliputian' proportions a number of highly advanced operational features. Some of these in fact proved to be many years ahead of their time, and included an 'intelligent' power

**An enlargement of the Ikegami HL79D camera interface module type NV-ICP-AG.**
**This image shows the machined-from-the-solid casing of these interface modules.**

management system, extensive onboard self-diagnostics, and an elaborate automatic audio level control. But despite its small size, light-weight and advanced features, it really was too late and (much) too expensive.

That it is of course no matter at this distance now that video recording itself has become just to do with the manipulation and storage of digital bits. To those who appreciate 'old fashioned' engineering values it is likely that we will not see the like of these machines again. The passing of professional reel-to- reel recorders (both for video and for audio), together with other now historical objects such as the mechanical chronometer and the precision 35 mm still-camera, means that objects such as these will probably become the last monuments to the aesthetic and art of proper engineering; artefacts of a lost mechanical age. It is ironic that the new popular fashion for 'silver' home technology is in reality just the cheapest sprayed moulded plastic and folded tin, while the likes of Nagra's obsolete machines described here are quite simply the real thing. I suppose it is a by product of middle age that one becomes rather tired of constantly being told that what is new is better. As they used to say in London when I was young - do me a favour!

The prevailing conditions some 20 years ago must also have been rather depressing for Ampex and Nagra, as Sony were finding that their new Betacam camcorders, which were originally aimed at the rather poorer industrial users, were in fact rapidly gaining favour with serious broadcasters. Indeed this much more convenient though of slightly lower quality (SP version included) system, was to have a very significant impact on the long term American manufacture of broadcast television equipment in general. The technological high ground in broadcast video was, as with so many other things, being taken by those from the other side of the World. One may imagine that the vast amount of domestic product churned out from the Far East was and continues to finance lavish R&D into ever new generations of professional video stuff. Though for most everyone else this sort of funding could not be generated from the limited niche markets that many a western manufacturer was forced (by stock market enforced short-termism mostly) to retreat into. I suspect that inept management also had a significant part to play as well - but what's new eh?

The machine featured here is an ex-BBC (of which there were 16) 'first version' with 'round' control buttons. The approximate date of manufacture is probably the 1st quarter of 1985. A

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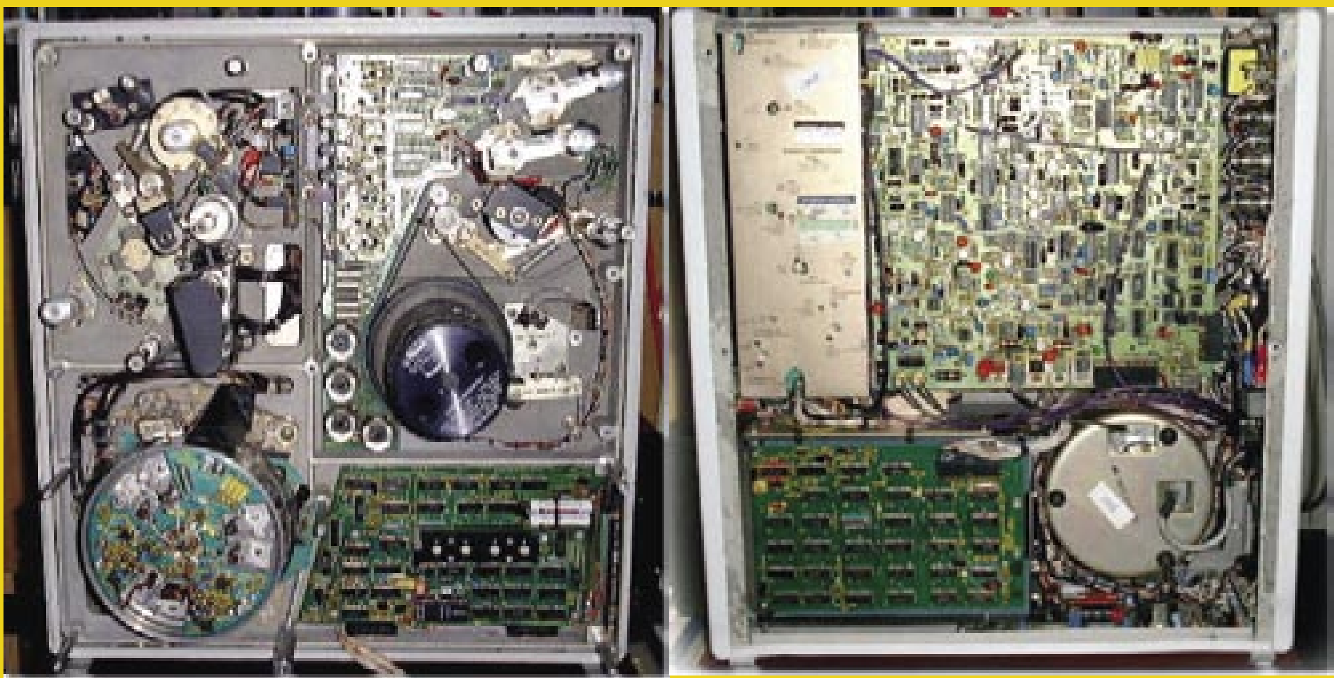
## The Ampex VPR-20

This was a 'portable' C format recorder before the arrival of the VPR-5.

Actually it weighs about 20 Kilos and is not the sort of thing one would actually want to carry around much. It is though quite an impressive recording device, and looks just like someone took a studio VPR-2 video recorder and stuffed it into a suitcase. It comes with a simple non-broadcast colour adapter, though it may be connected up to a proper TBC for use in a studio or for simple editing.

The contra-rotating co-axial reel configuration is rather elegant and is similar to that used by Ampex in their various airborne instrumentation recorders (of those increasingly far of days). The hub-locks are particularly fun (but better read the instructions if disasters are to be avoided!).



**VPR-20 wiht its' various covers removed**

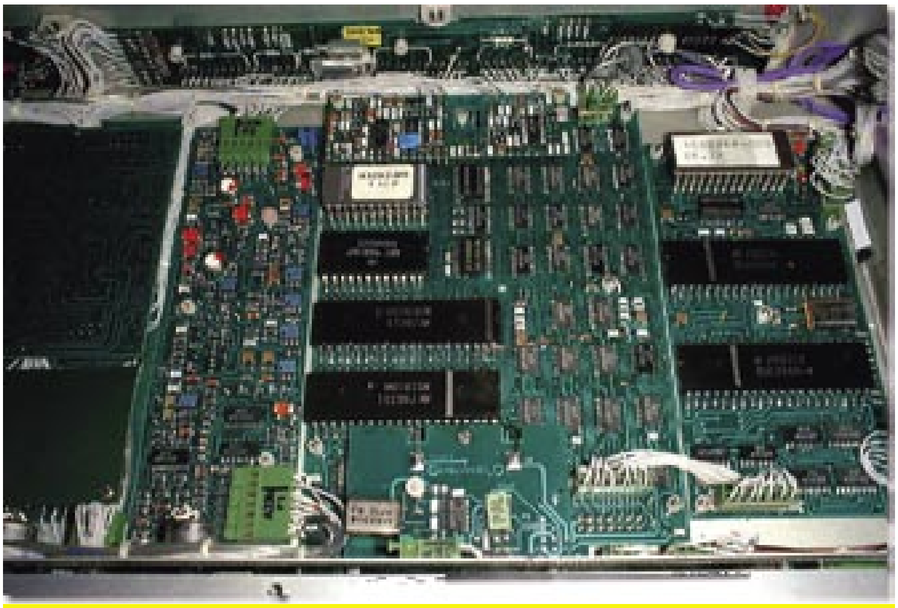
**Machine with weather-proof cover in place.**

second version of the machine with larger ‘oblong buttons’ and a number of minor soft and hardware enhancements was introduced perhaps a year or so later. I am advised that the control buttons were changed so that they could be operated by users with gloves on. The second version also has a pair of nice bright red recording L.E.D’s, which look like a pretty good idea...

This type of machine is known as a direct colour recovery video recorder, and it records the whole bandwidth of a composite video signal onto the tape without the compromise of any form of heterodyne colour-under (or digital for that matter) signal processing. When fitted with its standard cover and in its normal padded working bag, the VPR-5 could record for a nominal 20 minutes. The Ampex helical 196 magnetic tape it used came wound on small and rather donut like plastic reels which were unique to the machine. These were supplied in either single or double cardboard boxes. Standard 1 Hour reels of 196 tape could also be fitted, though this required the machine’s reel hubs to be rotated and locked into their outer positions. An optional weather-proof large (‘Mickey Mouse’) reel cover could also be fitted, but this was not needed if you were working inside and on a table perhaps. The small 20 minute VPR-5 reels could quite happily be accommodated for playback by both the VPR-80 and VPR-6 studio recorders (and I also expect by the VPR-3 as well).

The VPR-5’s (PAL) frequency response was quoted as ‘flat to 5Mhz’, which in contrast to other analogue formats such as VHS, S-VHS, 8mm, Hi8, and U-Matic, gave a recorded resolution of at least 600 horizontal lines. The downside of the 1-Inch format was that you needed a direct colour recovery time base corrector (TBC) to get stable and ‘broadcastable’, pictures from the tape deck. At this cost level though it was normal for individual studio play back machines to be equipped with their own TBCs. (TBCs were once very costly and elaborate items. These days they supposedly can put them on a single chip.)

The VPR-5 has both video and audio ‘confidence playback’ (real time off-tape monitoring of the recorded signal). This is in monochrome though, and is for use with an attached camera’s B&W viewfinder to inform the cameraman that nothing ‘nasty’ is going on with the recording. A separate colour adapter with comprehensive powering and nice



**Audio 1 & 2 AGC    Time code system    Machine syscon CPU**

**This view shows some of the circuitry mounted on the lower surface of the ‘upper’ electronics compartment, directly under the tape transport. There’s a lot of hand wiring in this machine..**

internal battery charging facilities was available for playback in-the-field. This adapter was no replacement for a ‘proper’ time base corrector though, and only provides colour-under type performance (which equals about 250 line resolution with no drop-out compensation). The VPR-5 could of course be used with a studio TBC such as a TBC-6, and is equipped with advanced sync inputs and an off-tape RF output for dropout compensation. But, it was not made to be a broadcast playback machine and its replay electronics do not have the performance of a ‘full sized’ studio machine.

The VPR-5 has a very comprehensive linear time code generator and reader that can be referenced to external generators or to other similarly equipped recorders. This alows for multi-machine synchronized recording of a live event. The linear time code track is fitted in place of one of the 4 pre-wired audio channels (usually channel 4). Continuous or sequential time code recording is available. The machine’s internal reader displays hours, minutes, seconds and frames on the right hand L.C.D. The machine also has a ‘normal’ digital tape counter driven from an optical encoder built into the take-up tension roller. (These articulated tension rollers can also pivot vertically by about 5 degrees.)

For editing, the built-in single machine edit controller provides frame-accurate insert and assembly edits of colour-framed video and the various audio channels. There are 18 individually controlled magnetic heads in this machine: 2 video, 8 audio (2 time code), 1 control track and 7 erase. Back-spaced edits are automatically carried out, and on entering the stop mode the machine sets up a 5 second pre-roll ready for the next assembly edit. When placed in edit mode, the feed spool hub ‘web’ can be used as a manual ‘jog’ control wheel for the simple setting of in and out edit points. Various edit preview and rehearse modes are also available to help with live recording situations. This expensive machine was after all intended to make (very) expensive television programmes day in, day out.

The video and audio interfacing is essentially modular in concept. Plug-in pre-configured ‘personality modules’ were available for various differing television camera types and makes. These interfaces consist of a small quick-release rail-mounted box, usually fitted with a captive multiway umbilical camera cable. Three types of audio input modules were also available to interface a pair of 48 Volt phantom powered capacitor microphones, a pair of moving coil microphones, or a pair of 600 ohm balanced line inputs.

A comprehensive microprocessor driven wired remote control and character generator was also an option. This provided in-the-viewfinder machine status and operating information. A basic module with advanced sync input, composite video input and output, and off-tape RF was available for video playback through a TBC.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The machine can have up to 4 audio channels, though channel 3 or 4 was usually reserved for the linear time code track. As with the audio Nagras the audio recording system has a selectable turnover high pass filter with 'knee' frequencies, together with a two stage peak limiter. Interestingly, an 'intelligent' automatic recording level control system (that seems to have been unique to this machine) was also provided. As the writer understands it, this system combines the limiter with a frequency shaped peak hold memory. This senses the amount of attenuation required based on the intensity of the incoming audio, its frequency spectra and the previous peak levels detected. It is designed that transient short-term high frequency sounds such as jangling

keys etc, will not upset the overall record gain settings. Apparently this system senses trends in wide-band audio levels and adjusts gains rather like a human operator might do. The expected prevailing sound intensity level (in dB's) may be set by the user on the calibrated front panel controls, and the real-time level of limiting is displayed on the left trailing ends of the LCD peak level bargraphs (peak levels on the right). These bargraphs themselves may also be internally set to give either V.U. or P.P.M. ballistics. (P.P.M. is the default setting.)

Because this is a portable and self-contained machine, the powering system is very flexible and also has some 'intelligence'. All internal power supplies are of an advanced switched-mode type and the CPU insures that only relevant circuitry is powered up for each specific operating mode. The 4 DC electronically-commutated motors (Hall-effect sensing; no brushes to wear out) have their own individual highly efficient switched-mode powering systems.

The fast-charge NiCad battery system seems to have been at least 10 years ahead of its time. Two types of battery pack can quickly be attached or disengaged from the rear of the machine, and contain circuitry that provides data to the recorder's CPU on cell temperature, battery past discharge performance, current level of charge and previous run time. This means that the machine can calculate an accurate estimate of battery run-time left for any battery pack attached in whatever state of charge and in any mode of use. This information I have found to be accurate to the minute, and is displayed on the right hand LCD.

**Rear view of the machine.**
**The various intelligent nicad battery packs lock into the rectangular area at the back of the video recorder just under the deck plate, and are securely held in place by a peg on one end and a spring-loaded plunger on the other (this can be seen on the right).**
**The compact 44 minute battery did not project beyond the rear face of the machine, though the 4Ah battery type NV-2ACC as shown here was a rather deeper and very much heavier unit. (Click on the picture to see the 1.5Ah battery packs.)**
**(When the scanner is powered down, its high rotational inertia allows it to act as a generator to feed power back into the batteries.)**

The separate charging systems consisted of a 6 battery pack slowish charger and a 2 battery pack fast charger. These use the battery's in-built cell temperature sensors to prevent overheating when on charge. If running from the mains PSU the recorder's in-built 'toping up' charger also updates the battery's state of charge data and increments the estimated run-time. An accurate estimate of tape remaining time is also available to the operator. This is calculated from take-up and supply reel rotational data when transporting tape, and has proved also accurate to the minute. When in fast wind mode, the machine automatically slows the tape down on nearing the end of the reel to avoid damaging the tape or the video heads as it comes off the spool. All not too bad for 20 plus year old technology?

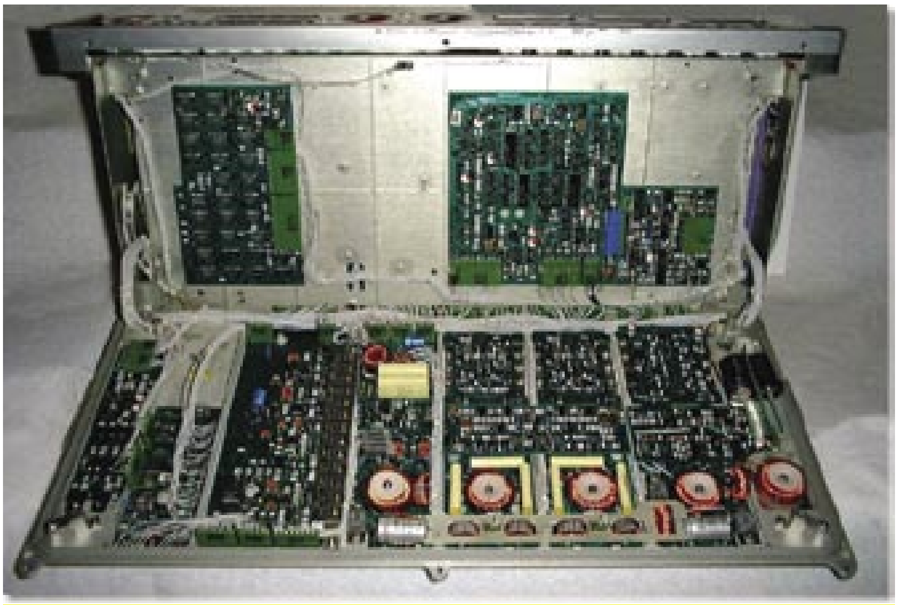
The syscon CPU (1 MHz clock) performs a number of on-going house keeping tasks: checking general 'health' parameters, calculating battery remaining time, tape remaining time, and powering subsystems in the configuration relevant to the operating mode selected. The whole machine is very consistent in its actions and handling of tape, and is also extremely reactive to user commands. The various watchdogs and self-diagnostics help to ensure the continuing 'good health' of the recorder. If any out-of-range conditions occur the CPU. will safely shut that section of the machine down and display an applicable error code on one of the LCD's. This is intended to prevent any inclination to self-destruction. In addition, a knowledgeable user may access a fairly wide range of user defined options and self-diagnostic modes. The numeric key pad and the LCDs may be used as a simple 'terminal' to communicate directly with the syscon and time code CPUs. The user may select various day-to-day functions, such as setting time code user-bits or the various display modes, or can delve much deeper into the machine's operating system. By keying in various coded instructions, most subsystems may be individually evaluated for their current state of health. Therefore a knowledgeable user may quickly ascertain his VPR-5's overall condition, including (with the 'Mk2 version) the machine's power on time and the video head running time. However information is lost if the Lithium backup cells go flat, and despite all this cleverness I know of one case of near total self-destruction when a machine caught fire internally. This underlines the sobering fact that (even Nagra) high current switch-mode power supplies and DC motor drivers can sometimes ‘let go’ in dramatic ways.

These many advanced features might though be expected from a professional broadcast tool, but it is the physical design and construction of the VPR-5 that I think makes this 1980’s artifact even more special. Because inside that beautifully sculpted exterior there is quite a lot to appreciate. Seemingly free of sane engineering values, Kudelski produced a remarkable statement in aircraft alloy and surface-mount electronics.

To minimize weight ‘Aerospace design and machining techniques’ were used. This is not mere advertising hype, as the VPR-5 shows mechanical design and fabrication philosophies that are to be found in any item of state-of-the-art avionic or space exploration equipment of the time. To save weight, most of the machine’s mass - perhaps over 90% in some places, was meticulously C.N.C. machined away. The resulting high strength lightweight components were then assembled with considerable skill and ingenuity. Fortunately all this effort was eventually recognized by the industry, as Ampex applied for and was granted an ‘Emmy’ for their (and Nagra’s) work of art.

Why to the writer this entire fine precision and machined alloy seems so satisfying and pleasing to the eye is not known. Another aspect of attraction is perhaps that open reel tape machines perform their business in public, and one wonders if the rotation of the reels and the movement of tape might perhaps cause subtle positive psychological effects. At any rate, in contrast to ‘inanimate’ machines where the business of recording is performed ‘secretly’, all reel-to-reel equipment has a certain life and presence when ‘doing its thing’. And this is especially true of the VPR-5 when that big 5 Inch head drum spins up to its 3,000 rpm running speed, taking 1 second and some 16 Amps from the battery to do so.

Enough of the metaphysics though. This machine was carved from solid metal for entirely pragmatic reasons, because (of course) the chosen raw material for its structure dictated this particular way of working. The aluminium alloy used is the increasingly well known ‘aerospace grade’ type 7075-T6. This artificially aged material approaches the tensile strength of steel and is unaffected by cold working (machining), it cost though about 4 times the price of less exotic aluminium alloys. It is also quite unsuitable for casting or welding, but again, no cast light-alloy structure could approach the strength of a machined-from-solid annealed plate of the stuff. Where joins had to be made they used stainless steel screws, rivets, or a very nice metal-loaded epoxy glue. Machined 7075, rivets and nice glue was by the way what the Saturn 5 ‘Apollo Moon Rocket’ boosters, and probably many ICBMs were mostly made out of.



**A view of the lower electronics compartment with the base plate un-screwed and lowered for access.**
**The circuits shown on the vertical section of the machine in this picture are (from leftto right): Digital Bus control, capstan and reel servo system (US patent 4,513,229, filed 15th September 1983), and the small board on the right is the scanner servo system.**
**The circuits on the base plate of the machine are (L to R): more bus control electronics, the main Switched-mode P.S.U., scanner, capstan and reel switched-mode motor drivers. (The recorder’s base plate acts as a heat sink for all this power conversion circuitry.)**

All the internal and external surfaces of this machine are anodized to protect against corrosion and to increase strength. Though how they got that perfect graining in all those various hidden recesses is a mystery. This is probably a by product of the anodising process that highlights the grain of the metal. All ledgending is in anodic print, so it won’t wear off. One could believe that this machine was the very height of what is known in management speak as ‘best practice’, though the extremes that Nagra went to in some instances does seem rather too much of an overkill sometimes.

Take for example the audio and video interface modules. These light weight little boxes that lock so easily into their respective locations on each side of the machine have cases that seem to be machined from solid blocks of alloy. Indeed it seems that perhaps 90% of material has been removed to leave just the thin outer skin and some narrow mounting flanges. Could these not have been cast in aluminium, or even moulded in a suitable plastic? Perhaps Nagra got a good deal on all that swarf. They do seem quite tough and look very nice though...

The front panel is also machined from the solid, and possibly represents less than 20% of the original material present. In fact the inside surface of this panel is a more complex milled surface than the outside. Each control button is a solid CNC carved and colour-anodized component retained in position by an individual leaf return-spring. To help prevent accidental damage and inadvertent operation, the controls and buttons are all well recessed into the front panel. The heads of many of the exterior fixing screws are fitted with small Nitrile O rings, presumably for retention as well as water proofing.

The locking lid assembly seems to be a rather complicated paradox. The top surface is another machined-from-the-solid alloy plate with three O ring-sealed

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**A selection of VPR-5 interface modules.**
**Left to right: 600 ohm balanced line audio input module type NV-1L. Moving coil microphone input module type NV-IMDN. (With attached minature Cannon connectors.) Composite video and T.B.C. interface type NV-VIO.**

polycarbonate (?) viewing windows. Underneath this lid are undercut girder-like strengthening features ('integrally machined T stiffeners'). The lid contains a marvellous over-center cable locking system, operated by a beautifully milled recessed stainless steel and alloy folding handle. (I counted over 150 separate components in this lid.) The top plate is bonded to the riveted thin-alloy side walls with a metal-loaded epoxy resin, and the whole thing locks down and seals to the recorder's deck plate with 5 individual spring-loaded latches. A quite remarkable structure, probably proof against the elements and you can stand on it (as Mr. Willetts has demonstrated). But would not a transparent vacuum-formed plastic cover as used on their audio machines have been a rather more sensible approach? Well apparently not for heat sinking reasons I am advised, though how you get inside this wonderful lid if that complex locking system should fail looks an interesting challenge. Ah, but (of course) there is a procedure for doing this described in one of the manuals.

After removing the 3 screws retaining the central boss of the head drum and lifting off the thin cover plate, you will find that this particular scanner is rather different. In place of the usual fairly simple machined light-alloy item, you will find a delicately lightened, triangulated and undercut cylinder of aircraft alloy with a special hard wear-resistant coating. Mounted within this drum are 3 individually user-replaceable video heads (record, play and erase), 3 'dummy' video sync heads, as well as the video drive amplifier, video playback pre-amplifier, and video erase oscillator. Again, the complex 'star of David' form of this head drum suggests CNC machining-from-the-solid. The flat drum servo-motor is actually built inside the lower half of this scanner assembly and like the rest of the motors in this recorder uses powerful (and costly) rare-earth magnets.

By carefully releasing the 7 O ring-sealed screws retaining the top plate of the recorder, you are able to lift the transport and the whole upper surface of the machine upwards on two small hinges. This surface is made up of two separate machined plates one within the other; the inner tape transport chassis itself and the surrounding top cover of the electronic package, there is a small gap between them. The transport chassis is supported within the surrounding cover plate by 3 strategically placed short stainless steel pins. This I imagine defines the external stresses placed on this critical component. The top cover is sealed onto the rest of the machine by a large elastomer O ring. Surprisingly few mechanical components project below the lower surface of the transport. The scanner, capstan and reel motors are either situated within the deck assembly itself, or are built into their own respective areas above the transport. Normally reel and scanner motors are quite bulky items especially on 1 Inch tape machines. But in this recorder the reel motors together with their reduction drives and parking brakes are actually built inside the NAB-type reel hubs (US patent 4,542,663 filed Sept 15 1983). What makes this all the more impressive is that despite their minimal volume, these complex 'powered hubs' have no trouble at all in driving the big and quite massive 9 Inch, 1 hour reels at high speeds. The reel motor commutation and drive electronics are built into the machine's substantial base plate.

Also provided within the machine, (as with most Nagra products) is a small plastic tube of basic spare parts. How thoughtful.

The whole of the interior of the VPR-5 is virtually filled with multi-layer surface-mount printed circuit boards, together with a miniature wiring loom. The electronics are in roughly four layers;

1) Fixed under the transport (audio and video record and replay).

2) Above the middle central dividing plate (audio AGC, time code, system control).

3) Below the central plate (reel, capstan and scanner digital servos).

4) Built into the upper surface of the base plate (PSU, bus, reel, capstan and scanner commutation).

There are 17 main circuit boards and another 20 smaller sub-boards, and all of these are interconnected by means of a very nicely done avionics style wiring loom which employs a mixture of flat miniature 'headers' and hand-soldered lay-on joints. The loom's connections number over 1,000, and each of the 500 wires is marked at both ends with various references and even the volts carried. There are over 435 transistors and 285 surface-mount I.C.s in this beast, together with a further circuit board and 15 I.C.s in each battery pack.

The main electronics package is divided horizontally by a milled and anodized alloy plate. This is bonded to the machine's thin wrapped sheet alloy side wall by metal-loaded epoxy cement. This dividing plate one assumes is for both structural and screening purposes. The upper electronics compartment situated directly under the transport contains the audio record-replay, video record-replay, time code, DC power distribution, and syscon printed circuit boards. The lower compartment under the dividing plate contains the electrically more noisy systems of the switching power supplies, motor


**This is the remote control and viewfinder character generator module type NV-ICA.**
**(This module slots into the video/camera position on the machine, and a standard type camera cable the plugs into this unit.)**
**As with the rest of the machine, both of the casings are machined from-the-solid 7750 alloy.**
**The connector panel on the interface/control module hinges out about 30 degrees to help with mating the connectors, and then locks back once they are in place (shown open in the picture).**

commutation, digital bus, and reel, capstan and scanner servo system power drivers. All these surface-mount circuit boards are 'bolted' to the various surfaces with the usual white Nagra slotted plastic 'nuts'.

The base plate itself is another example of the interesting manufacturing values employed in this machine. No simple plate this, but a complicated nest and heat sink for all the power circuitry built onto its inner surface. Around the periphery of this plate is another large elastomer O ring seal, and nesting within are 13 circuit boards, a selection of torridial inductors and power transformers together with 46 TO220/MJE packaged power transistors and assorted MOSFETS. The special Lithium 6 Volt battery pack for time code and syscon backup also lives here. The circuitry is very neat and compact, though must also have been a nightmare if any dimensionally-critical component became un-available. The transport surround and base plate form a stressed box section structure for the machine and must have the various fixing screws tightened and released in an incremental way, rather like cylinder head bolts of a car engine. In fact when tightened up, the whole machine becomes a very tough metal sandwich. (I wouldn't like to drop it though!)

On the under surface of the machine there are no simple mounting feet as such, but an undercut rectangular recess at each corner. These are designed to accept various special mounting fixtures. For field use, the padded working case has 2 alloy fixing strips that turn-lock into these recesses to hold the machine securely. Or one can by similar means lock the machine into a special back-pack harness frame. In a mobile 'scanner', in the studio (or aircraft?), one might be expected to fix the machine on to its own special anti-vibration table mounting plate, or slot the machine into a special rack-mount box. (The recorder slides in sideways on rails.) Naturally, the machine's carrying strap which is rather like part of a military jet's seat belt harness has its own special spring-loaded, machined-from-the-solid-and-anodized fixing locks. (But what else?)

My conclusion is that the Ampex / Nagra VPR-5 has to be one of the finest examples of electro-mechanical design there is. It has a purity of form that reflects the considerable intellectual achievement invested in it. Highly expensive and exotic when new and now obsolete and nearly forgotten, it does though remain a very pleasing and wonderfully tactile sculpture in anodized alloy. (Actually it would probably look quite at home in a modern minimalist apartment!) Vastly in advance of their audio recorders of the time it is a bit of a mystery how it came to be made at all and remains an anachronistic statement of true engineering values, made all the more impressive for the quality of results that it is still quite capable of. Described by one owner 'as a work of art', and another as 'the eighth wonder of the World', it was rendered too soon un-viable by unfavorable external circumstances. Deserving perhaps to have been more long lived than it was, it is now rare and of currently moderate value.

You don't have to have any interest in old television kit to appreciate or perhaps desire to own one of these beautiful little boxes, just have some seriously good taste.

Bravo Nagra and Ampex! - and my compliments to you having got this far...

## Thanks to:

Ray Barron
Tim and Will Blackham
William F. Carpenter
Bob Craige
Joe Driver
Bob Marriott
Andy Shakeshaft
Robert Smith
Michael Willett

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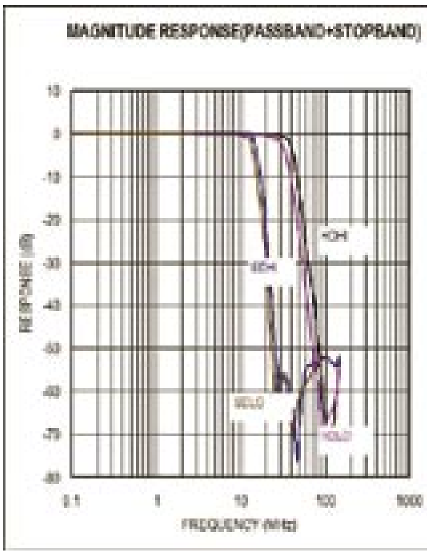
# Video filter/buffer chip

Maxim Integrated Products Inc. introduces the MAX7454 and MAX7455 3-channel, switchable high definition (HD)/ standard definition (SD) video-reconstruction filters and buffers for 1080i, 720p, 480p, and 480i video scanning-system standards.

Each channel of the MAX7454 and MAX7455 combines a lowpass filter with a video buffer capable of driving a standard 150Ω video load with a 2-V peak-to-peak signal. The magnitude response of the lowpass filter can be switched between a 10-MHz and 30-MHz bandwidth through a control pin, which allows optimal filtering for HD, standard definition interlaced (SDi), or standard definition progressive scan/ noninterlaced (SDp) encoder digital-to-analog converter (D/A converter) outputs. The input and output signals are DC-coupled to the MAX7454 and MAX7455, eliminating AC-coupling caps that consume board space and add cost. These devices are ideal for anti-aliasing or D/A converter-output video-reconstruction applications in digital video devices such as HD STBss, as well as HDTVs as CRTs, LCDs, plasmas, and DLPs.

The MAX7454 has an output buffer gain of +6 dB and the MAX7455 has an output buffer gain of +12 dB. The 3-channel devices are ideal for RGB or Y Pr Pb component video signals in interlaced, progressive scan, or high-definition formats. In HD mode (fc = 30 MHz), each filter channel achieves -55 dB of attenuation at 74.25 MHz, with -2.3 dB of attenuation at 30 MHz. In SD mode (fc = 10 MHz), each filter channel achieves -62 dB of attenuation




at 27 MHz, with -0.40 dB of attenuation at 10 MHz. A fine-adjustment control pin is available to optimize the corner frequency of the filter response by 15%.

The MAX7454/MAX7455 save significant board space and design time, while providing increased performance at a cost comparable to the discrete high-definition L-R-C filter and buffer solutions typically used today. The MAX7454/MAX7455 are offered in a 20-TSSOP package and operate over the upper commercial temperature range (-0 degrees Celsius to +85 degrees Celsius).

Prices start at $2.75 (1000-up, FOB USA).

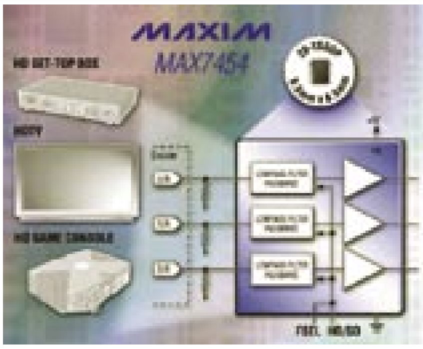
Think of the MAX7454 and MAX7455 triple switchable HD/SD video reconstruction filters and buffers as the aspirin designers can avoid by using Maxim's devices, instead of designing their own filters and buffers using some 40 to 50 different discrete components.

Filter designs can be very tricky, said Ken Fields, a member of Maxim's technical staff. "I don't want to say it's black magic, but it borders on that if you don't have the experience to do this," he said. Making these filters work properly can be a problem because of all the parasitics that exist on the board, which comes from taking a bunch of discrete capacitors, resistors and inductors and putting them into a small space — making it difficult to get good performance, Fields said.

Maxim has taken all of these discrete components, which are subject to noise and component variations, and replaced them with a single device that is simpler to use than an op amp, Fields said. "You don't need to set the gain or anything. Just plop it on the board and use it."

Furthermore, Maxim's device can be used for both high definition (HD) and standard definition (SD) video signals, Fields said. While Maxim is no stranger to video filters, this is the company's first filter aimed at the HDTV market, he said.

These new products are extensions of a very large family of filters that Maxim has had for a number of years, Fields said. Typically, the market for this type of device has been dominated by the




older standard definition video format. "These are our first devices aimed at the new emerging high definition standard," Fields said. "High definition TV has been in the public consciousness for a while but it's only recently that people are starting to buy them," he added.

Designers can easily switch one pin on the filter and it changes from the original standard definition to the high definition standard. That makes these devices backward compatible, Fields said. Some designers are using two totally different filters — one for the old standard and one for HDTV and switching between them.

Highly integrated filters weren't available until recently. Historically, discrete components have been used to achieve the same functionality. There are some integrated parts out there but they don't offer very good performance, Fields said.

Another advantage of using this part is that it allows the designer to tweak or optimize performance with a fine-adjustment control pin. If the designer wants better passband, he adjusts the setting to one position. If the stopband performance is more important, he sets it to a different position. It gives the engineer the freedom and flexibility to get further optimization in the system, Fields said.

The architecture Maxim chose minimizes all external components and specifically eliminates AC-coupling capacitors. Most filter and buffer designs use AC coupling, which results in performance degradation and line time distortion. "We figured out a way to match the DC levels out of the DAC or encoder perfectly with the MAX7454 and MAX7455 for a completely DC coupled circuit eliminating these performance limitations," Fields said.

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# Turning Back the Pages

**By Peter Delaney**

A dip into the archives of CQ-TV, looking at the issue of 50 years ago.

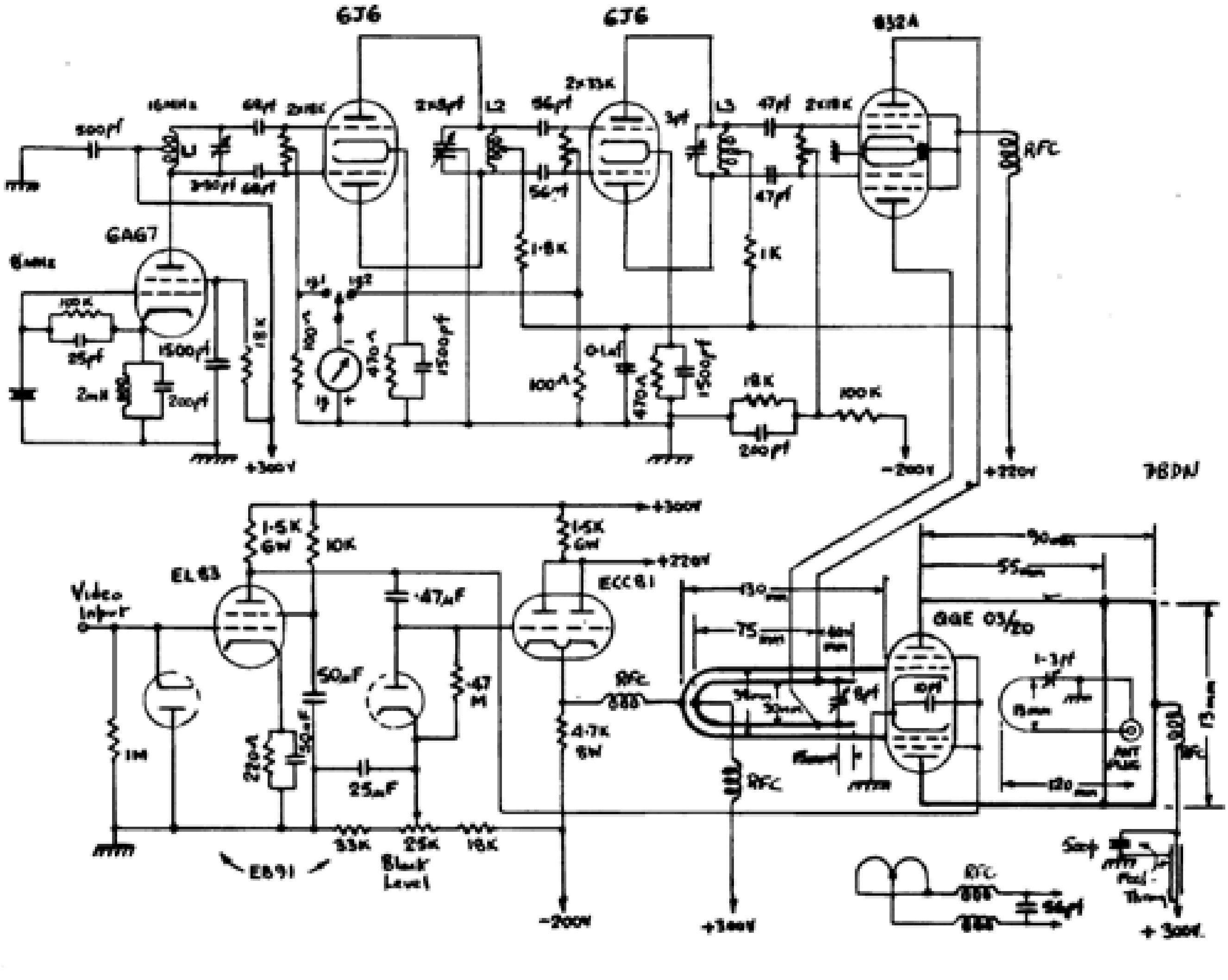
## CQ-TV 23 - December 1954

The Club had not had a stand at the RSGB Exhibition in 1954, but “two of our better cameras were on display, doing great credit to Amateur Television in general. G2WJ/T was there, and so was Ian Waters, both with complete camera chains. In addition, Mr Attew, a friend of Ian’s displayed a very fine Monoscope unit (Test Card F).” After a detailed description, the report continued “this being the first show of its kind where two cameras of roughly equal capabilities and vision mixing facilities were available, several points occurred which will be of interest to others. Firstly, the use of standard outputs and fittings was a great help. All the gear was assembled and tested together several days before the show opened. ... Lack of a fast cut between pictures was a little inconvenient, not too noticeable to the writer’s eye, but causing acute pain to a professional visitor standing with him at the time. .... The microphone in the studio is always a sore point; ... the physical size of the microphone and its stand, and the limited area over which it will pick up sound, make one think that an overhead boom with a directional microphone ... is probably the best answer. We hope to have a new one built by next year”.

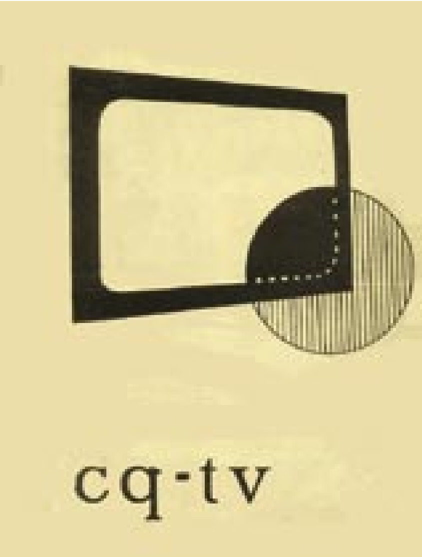
More technical articles covered the operation of the (vidicon) camera tube, and the design of power supplies for television use, including stabilised supplies. Instead of a 78 series regulator, this comprised a QS70/20 neon and two valves - an EF91 and 6AS7 - physically much larger and generating more heat than the ‘complete circuit’ now-a-days.

A design for an amateur television transmitter for 70cm appeared. The design had been developed by the Groningen ATV group, and first put to use when they used a mobile, jeep-mounted, camera. It was said to ‘combine simplicity with efficiency and economy”. The editor drew attention to the fact that the “modulator is for NEGATIVE modulation” - with a note on the changes needed for the positive modulation then standard in the UK.

A novel way to generate a picture very simply, without a separate sync generator was also featured. This was based on the ‘flying spot’ principle, with a ‘mask’ in front of a scanned crt creating a pattern of light to be detected by a photo cell. The ‘trick’ was to use stage lighting type gelatine sheets to cover the ‘image area’, but not two ‘slots’ along the right hand and bottom sides of the ‘mask’. This created three different light outputs - zero, where the mask was, 100%, where the ‘slots’ were, and a level at 70% of the maximum, where the gelatine covered image lay. When the output was ‘inverted’, this would generate an output of black letters on a white background, and with



the sync pulses ‘blacker than black’. It was even suggested that an unmodified domestic tv set could be used in this way as a ‘picture source’.



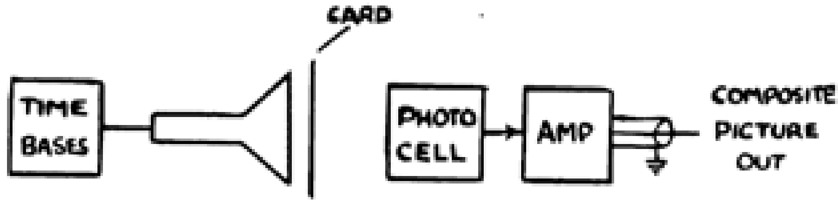




Figure 1: General arrangement of the system.

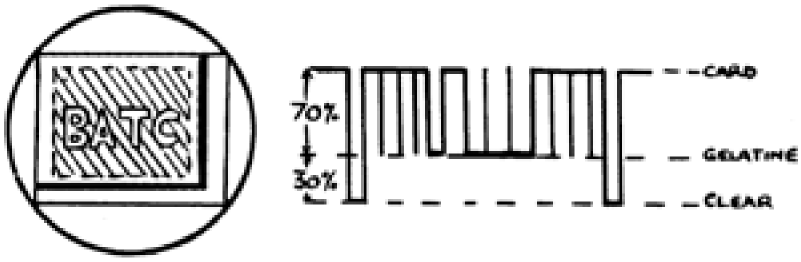



Figure 2: (left) A typical pattern showing the sync slots; (right) a typical photocell output waveform for one line, showing the three levels of output.

## GB3BH

I thought that you might like to know that our new 13cm ATV repeater *GB3BH* was switched on yesterday (7th November 2004). The repeater is run by the South West Herts. UHF Group.

| | |
|---|---|
| Locator: | IO91TP, Bushey Heath in Hertfordshire |
| Frequency: | 2440 MHz |
| ERP: | 100 W |
| Antenna: | Omni Directional, horizontal polarization. |
| Antenna height: | 200 m a.s.l. |

It is just transmitting a test card at present. We hope to be in full repeater mode before christmas. We have already had good reception reports from as far away as Stanstead in Essex and Luton in Bedfordshire.

We believe that this is the most powerful active 13cm ATV repeater in Europe and we look forward to some interesting propagation tests over the coming months. Unfortunately the frequency that we have been allocated is in the middle of the wireless LAN, cctv fta link, and microwave oven band which does not help! We have requested a change of frequency to the RSGB RMC lower down the 13cm band but we have not yet heard the results of this request.

Please see our web site http://www.gb3bh.com for more details.

The 23cm voice repeater which was at the same site has

now been closed down to make room for the ATV repeater equipment. This voice repeater was rarely used.

I would be very pleased to answer any questions or receive any reports via E-Mail to g8adm@gb3bh.com.

Regards, Dave G8ADM

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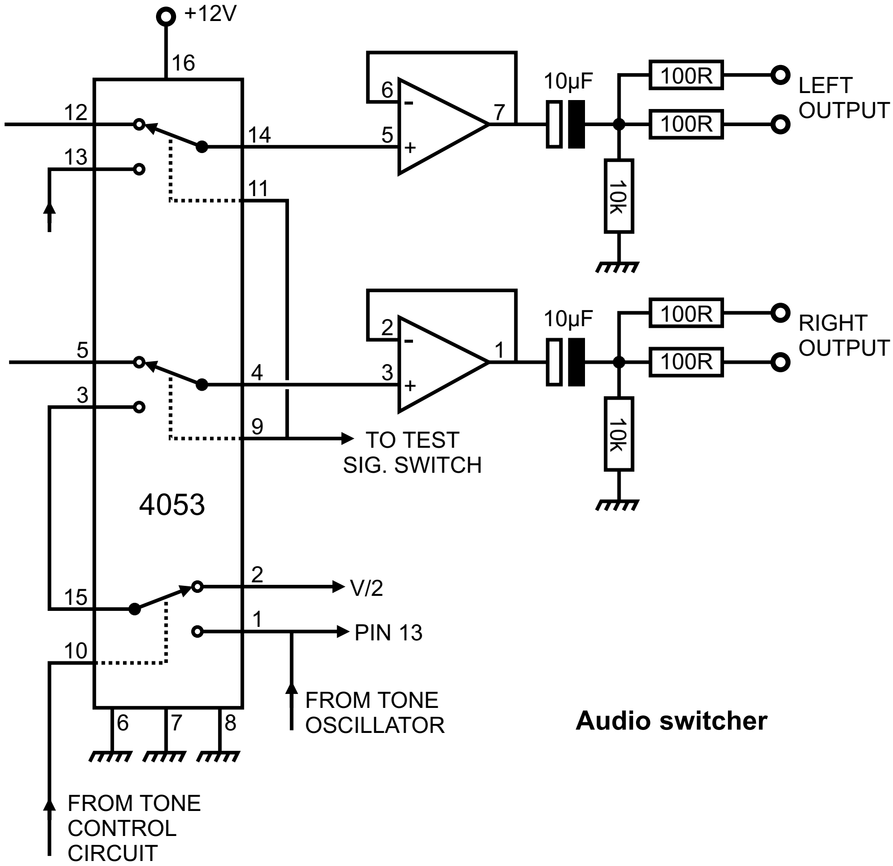
# ITS Generator (part 2) - Audio

**By Richard L. Carden VK4XRL**

When designing the above unit and because we also wanted multiple audio outputs, I have combined them into the one unit. This has allowed some extra features such as stereo tone, with continuous tone on the left channel and interrupted tone on the right channel, the tone being switched when full field test signal is selected. It was also decided that we should provide some form of audio AGC that could be switched in or out as required. This was added due to varying audio levels from different sources when no audio mixer was available or you are unable to increase the levels sufficiently.

During the course of this design varying pieces of equipment levels have been checked. Some satellite receivers (used for 23cm and 13cm) and VCR's only produced 350mV p-p while others produced 1000mV p-p output. I have used 1V p-p output as standard in my setup as that's what my mixer gives out when set to 0 VU on the monitoring meter. Looking at the block diagram the unit is dived into four main sections as follows.

1. Audio Oscillator
2. Audio Switching / Output Amplifiers
3. Oscillator Control
4. Input amplifier




Audio switcher

## Audio Oscillator

This is a simple twin tee op-amp audio oscillator set to around 400 Hz. This frequency was chosen as pre-emphasis has not come into effect. Other frequencies can be selected by applying the formulae as follows;

F=½*Pi*R*C For f=400 Hz

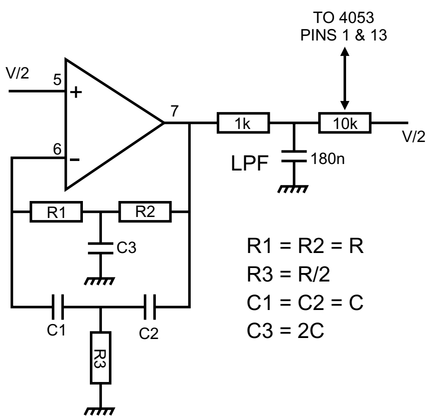
Where R1=R2=R = 39k

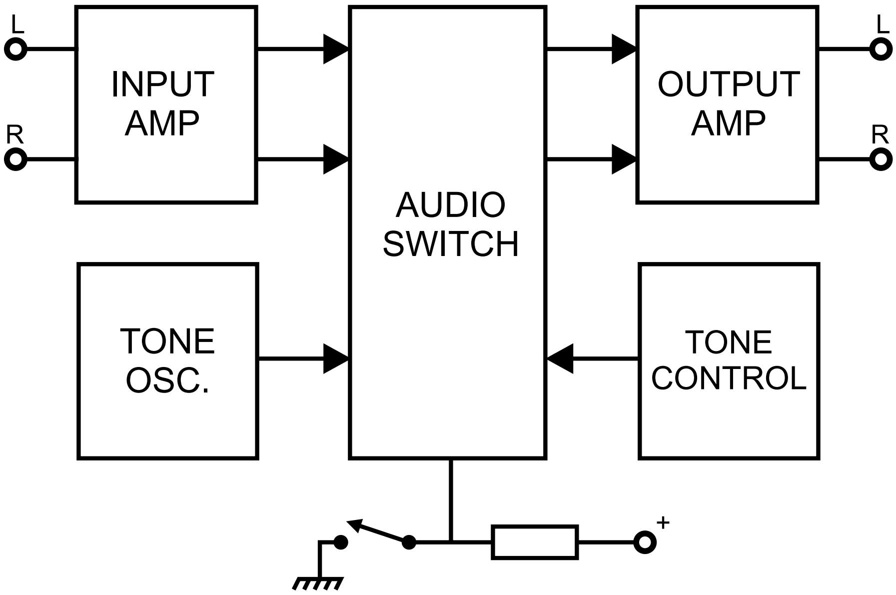
R3=R/2 = 18k

C1=C2=C = 10n

And C3=2C = 22n

For f= 800 Hz then R=20k and C=10n

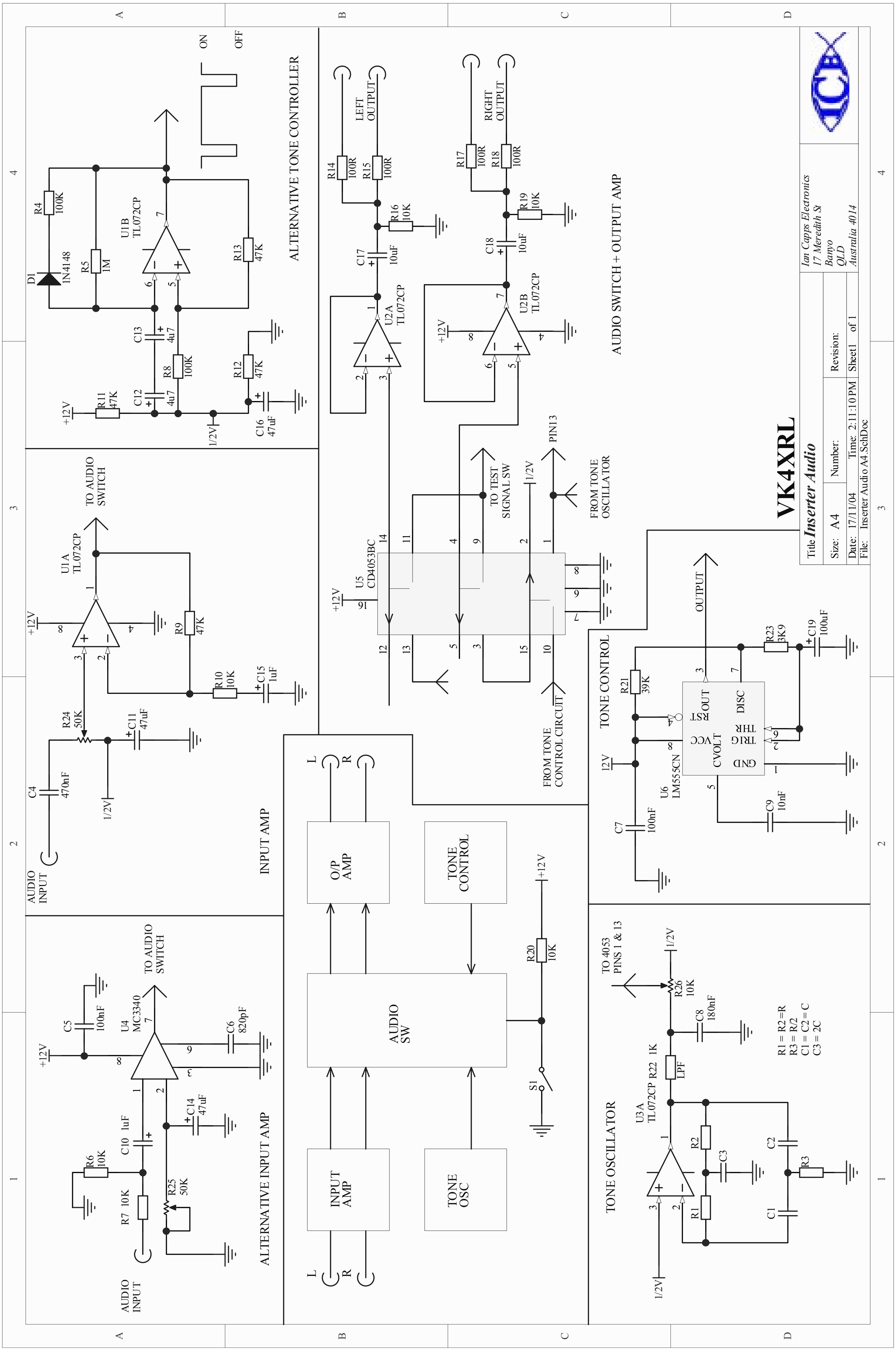



The output from the audio oscillator is fed via a simple LPF to the level control before feeding the audio switcher.

## Audio Switcher

This circuit consists of a triple two channel analogue multiplex/demultiplex IC, a 4053. The audio oscillator is fed to pins 1 & 13, while pins 11 & 9 are connected to the test signal SW and allows the audio tone to be switched to the outputs. The signal to pin 1, and hence its output pin15, is controlled

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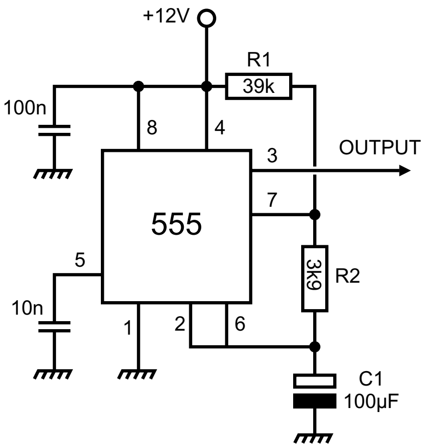
from pin 10 - the oscillator control circuit. The output, pin 15 is then routed to another input, pin 3. The output amplifiers are source followers with multiple outputs, therefore with 1V p-p from the tone oscillator all outputs will be 1V p-p. Pins 12 and 5 are fed from the input amplifiers.

## Oscillator Control Circuit

This circuit can be constructed in two ways - the choice is yours. The first is using a 555 timer with varying duty cycles or an op-amp wired as a astable multivibrator.




First let's look at the 555 timer, nothing complicated here. The tone is switched ON for 3sec and OFF for 0.25sec, therefore applying the formulae as follows;

T1 = 0.693 * (R1 + R2) * C1

And

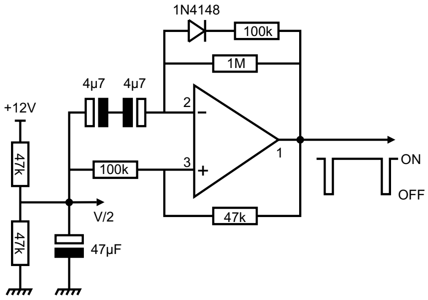
T2 = 0.693 * R2 * C1

Where T1 = 3sec and T2 = 0.25sec

Then selecting C = 100uf

R2 = 3k9 and

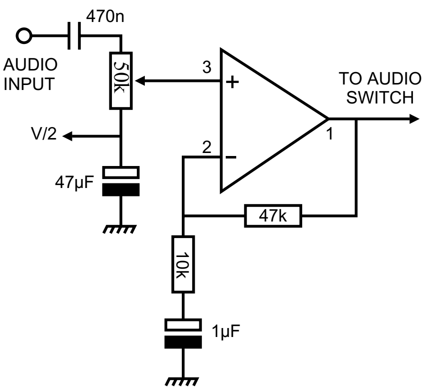
R1 = 39k




## Input Amplifier

As stated in the introduction, it was the intention to provide an audio AGC amplifier that could be switched in or out of circuit as required. So far I haven't been able to find one that works well in this application. Therefore, at this stage I have provided an amplifier that can have + or - 6db of gain which should satisfy most situations. If anyone has a circuit that they think would suit the requirements, then please drop me a line.

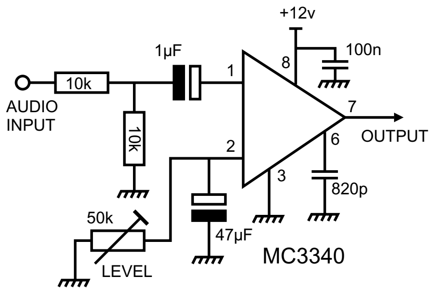
The op-amp is wired as a non-inverting amplifier where the audio is applied to




a level control, which is tied to the half rail voltage to satisfy the single supply connection of the op-amp. R1 and R2 form the gain determined components giving a gain of around 5.

The capacitor isolates the bias supply from pin 2 and ground. Components can be changed to suit other level requirements.

Another approach is to use an audio attenuator IC, the MC3340. These devices are harder to obtain, at least here in Australia. They are also getting a little old in the tooth now, but should be suitable in being adapted to audio AGC control vary easily. The distortion figures are not that good by today's standards (around 1%). Max input is quoted at 0.5Vrms (1.4V p-p max). An input attenuator is used to reduce the input level, and the unit has a gain of approx 13dB.




## Conclusion

So far both units have proved themselves to be very useful in the setting up of both vision and audio levels within the ATV system. I am sure many variations can be added to both systems to improve the performance. My thanks to the editor, Ian Pawson, for his time in making this printable - it's greatly appreciated.

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CQ-TV is published quarterly in February, May, August and November each year. The deadlines for each issue are as follows: -

| | |
|---|---|
| February | *30th December* |
| May | *30th March* |
| August | *30th June* |
| *November* | *30th September.* |

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

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**Bob Platts GunMod 2 pcb, feeding a Gunn diode Tx. picture by Graham Hankins G8EMX**

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Pictures courtesy Dave Hall G8VZT (Telford)

Leicester Rally 2004 - Harold Skelhorn G8BPU visits the BATC stand to discuss ATV transmitters with Graham Hankins G8EMX

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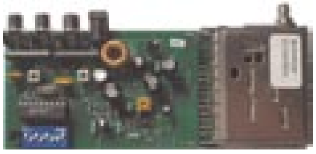

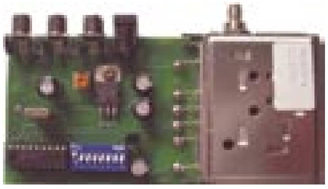

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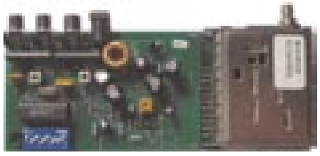

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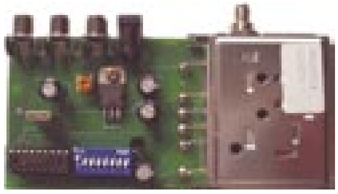

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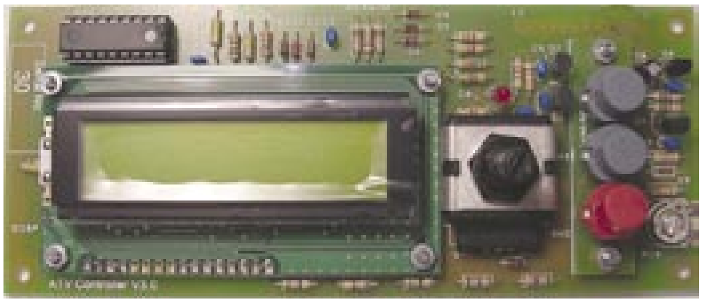

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