NBTV

Vol. 39 No. 3

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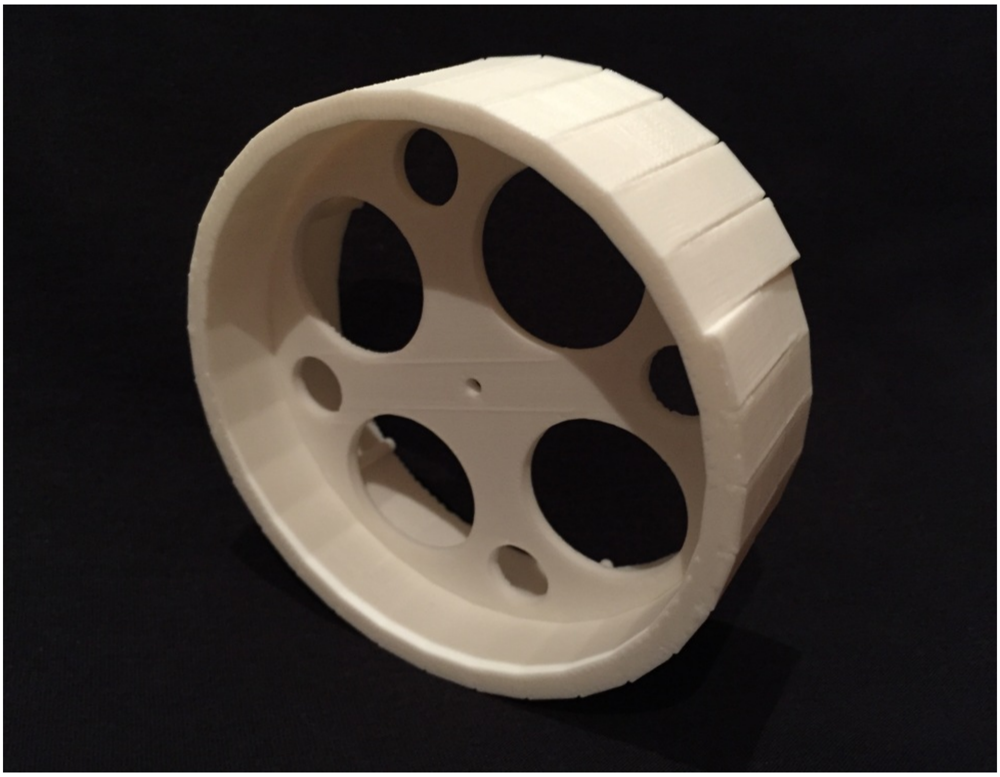

NEWSLETTER OF THE NARROW BANDWIDTH TELEVISION ASSOCIATION

NBTV
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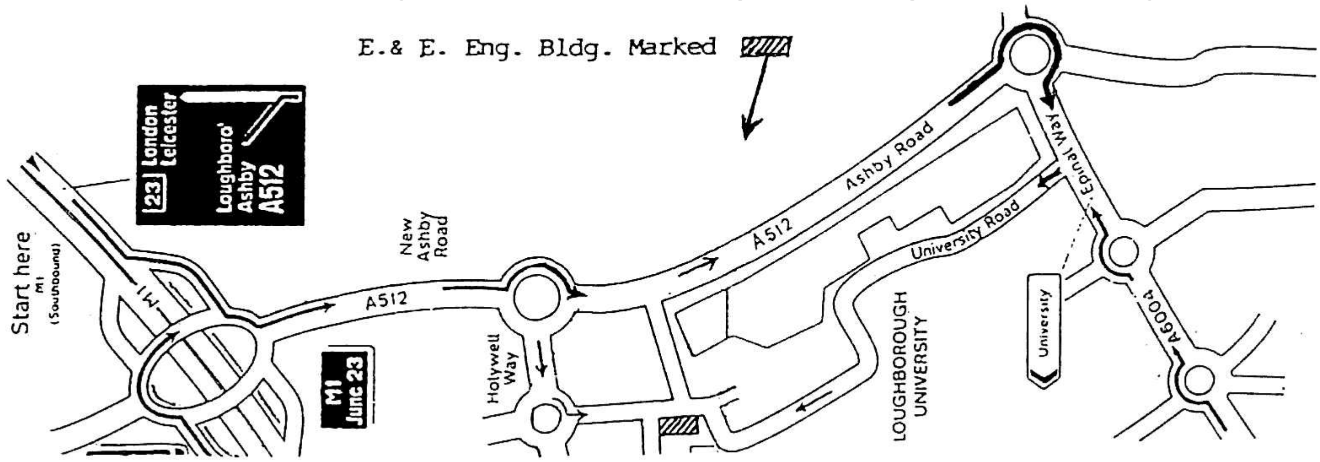
MARCH 2015

Cover: Prototype three-dimensional printed mirror drum by Brandon Inglis – see report on ongoing project, page 3

NBTVA CONVENTION 2014

Saturday 12th April, Loughborough University



We are very grateful to the School of Electronic, Electrical & Systems Engineering for once again allowing us to hold our main annual gathering at this attractive location. Do bring along a guest if you can.

Access: Loughborough lies on the main London to Leeds railway line, one stop north of Leicester, and close to Junction 23 on the M1 motorway. To reach the University from the M1 at Junction 23, follow the A512 (Ashby Road) towards Loughborough. Simply follow this road for a few miles until you reach a roundabout with no left turn indicated. Thus right here (Holywell Way - see map). Then take the first turn left. This leads to the security checkpoint where you pick up a pass. The Elec Eng. Dept. is a short distance further; the building is on the right, just after a 'bridge' structure over the road. **Important: note that car-clamping is in use** - so after unloading your vehicle, please use the official car park, the nearest being at the end of the north-pointing side-road almost opposite the building and close to the gates on the A512.

Public transport: A shuttle bus service - yellow & blue, marked 'University' starts from near the rail station and will drop you outside the building we use. Eventually the bus passes along a straight road lined both sides with buildings and trees. Bus stop (the final one on the route) and concrete steps with handrail to the Engineering block become visible on your left. Pensioners' etc bus passes may be accepted, but a charge may still be made on all passes. Washrooms are below the block facing road. The return bus stop (marked) is nearly opposite.

The Convention building is reached by climbing the steps - there's also a ramp - and entering by a door on the right. The entrance hall and reading room are ahead. Conference badges will be available to facilitate introductions. Note that **canteen lunches are not available** and we advise you to bring packed lunch – but Chris Lewis (01509 829 806, or chris@nbtv.org) can inform you about local hotels & pubs.

If you've recently joined, this may be your first chance to visit our Convention. As well as meeting members, it's an excellent way to acquire a basic knowledge of NBTV techniques. **Doors will open at 10am** - please set up any apparatus brought as soon as you've signed in, as table space is limited. Bring cloths and mats to protect tables (and our reputation with our hosts!) We must move everything back as found.

The day will start with displays of apparatus, literature, antiquities etc, and finish with a conference to record progress and plan for the future.

What to bring ... Something to look at, whether unfamiliar or not. Antique literature counts as a good exhibit. Folding tables, mains extension leads and multi-sockets are most welcome. If you have any surplus items, equipment or components useable by other members, bring them along and give them a new home.

Resolutions to AGM & suggested debating topics to Jeremy Jago 0115 9621 453 or jeremy@nbtv.org
Membership reminder ... to save time on the day, renew now! If uncertain of your status, ring Dave Gentle on 01332 842 052. Finally, to repeat - remember to use the car park. *Beware – clamping!*

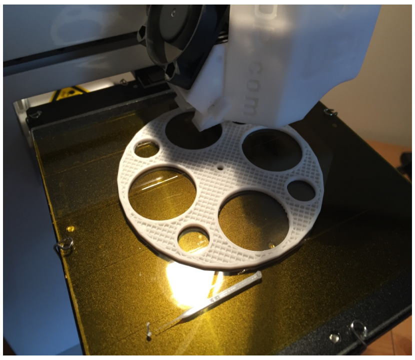
3D PRINTING MIRROR DRUMS
Brandon D. Inglis

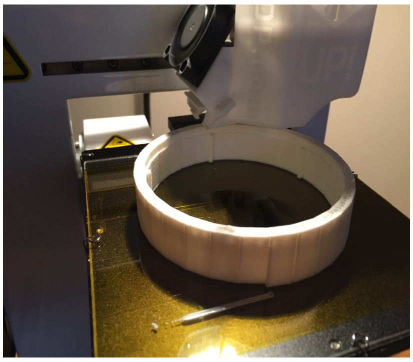
3D printing has the potential to change completely the way people interact with early television technology and engage new audiences and enthuse them about the subject that we love. Most people know little, if anything, about Narrow Bandwidth Television and the origins of television which plays such a central role in their lives. The ability easily to manufacture early television machines themselves could revolutionise public interest in this technology.

Collaboratively, NBTVA members have built a half-scale model of the 1933 Baird-Bush 30-line mirror drum. From the original castings held by the National Media Museum in Bradford, the dimensions of the original mirror drum were measured using vernier calipers and appropriate technical drawings made. These were then turned into CAD (Computer-Aided Design) drawings to then produce a 3D digital model, supplied in *.stl format by club member Vic Brown. This digital model was used to produce the 3D print.

The finished 3D print features a modification to improve on the original Baird-Bush mirror drum. The first mirror on the original was at a 0° angle, and the 30th mirror was set for maximum beam deflection of +12°. This was necessary to allow the removal of the casting from the sand cope and drag. However, it resulting in the mirror drum being imbalanced. As a result, holes had to be drilled into the edge of the hub to counter the imbalance and ensure the mirror drum rotated true at speed. With 3D printing technology, this is no longer necessary and instead the first mirror can be set for -6° and the 30th mirror for +6°. This, therefore, ensures the 3D printed mirror drum is perfectly balanced in a way that was impossible with the technology available at that time.

For ease of printing and to reduce wastage from unnecessary support structures, it was decided that the inner core of the drum would be printed as a component separate from the outer rim. The central hub could then be slid into place to form the finished 3D print. The accuracy of the print was such that this fitted perfectly and formed a tight interference fit, therefore not requiring adhesive. Five cylindrical ribs are printed on the inner face of the drum. These have been modelled in to allow the hub to be screw-mounted to the rim on the full-size version in due course.





The finished 3D printed mirror drum is as shown on the cover and is ready for the mirrors to be attached to the facets, without further need for machining or milling of the surfaces, as would be required with the original aluminium casting.

Once the complete mirror drum has been assembled, it will be tested to confirm that it performs as the original and produces a 30-line raster without overlaps or gaps. Once the testing is completed, it is planned to use a 'prosumer' grade *Ultimaker2* machine to produce full-size mirror drums, which could be used for mirror drum receivers, or as templates for casting aluminium drums.

This was the first time such a file had been produced, and is the first time a mirror drum has been 3D printed successfully. It opens a whole new world of opportunities to reproduce accurately Baird television technology which can then be endlessly reproduced, without loss of accuracy, at very low unit cost. For the first time ever, Baird mirror drum technology is available to anyone, no matter what their level of technical skill. 3D printing technology has the potential to open up interest in NBTV and early television technology to whole new audiences - and an exciting future of accessible early television awaits!

A NIPKOW DISC IN PINHOLE MODE
Jeremy Jago

Question ... since a Nipkow disc is full of holes, could a camera use them to create images directly, without a lens? Member Alan Short carried out a lot of work on this, constructing several cameras in the eighties (see Newsletter Archive 1/41, 2/7, 11/1/4, 11/2/11). Since that time the principle has been often discussed, less often tried.

In the usual Nipkow camera, a lens focusses an image onto the disc's raster area, with a large photosensor directly behind. The disc scans as its holes sweep over the image. Conversely, in a pinhole

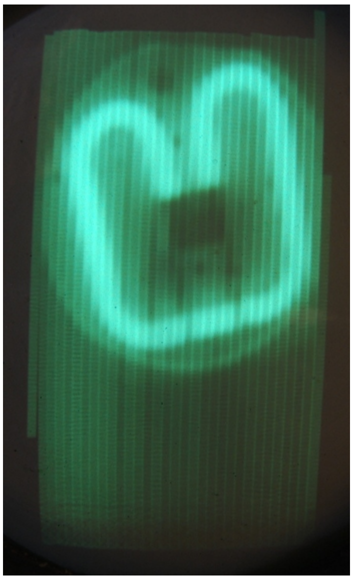
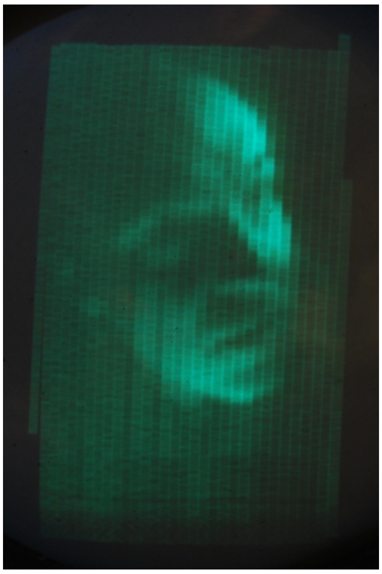
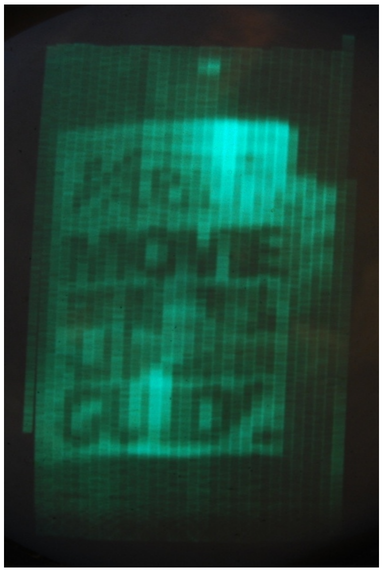
Nipkow camera each hole forms an image directly, so as the disc turns, a succession of images sweeps over the frame area spaced some distance behind. Scanning in this case requires a static single point photosensor, which undergoes the same relative effect as if it were itself moving over a fixed image.

This is an attraction of the idea, since modern silicon photosensors are far more common in small sizes. It cuts out the problems of providing a large area photosensor, or a light-concentrating condenser lens assembly for a medium size sensor.

The pinhole scanning mode has a lot in common with the lens disc (as sometimes used by Baird) which has a lens in place of each hole. In that the image itself sweeps over a static sensor, the principle also resembles an ambient light mirror drum camera, used by Baird for outdoor work and later built by members such as Stan Kujawinski.

Two disadvantages of the pinhole principle look unpromising. The lesser one is definition - in forming an image, a hole cannot resolve detail as fine as its own size. But a greater snag is dim image. The f-number works out as the ratio of hole diameter to image distance, and in still photography often exceeded f/200 ! This seems hopeless alongside a typical camera lens of f/2.8. But even in its orthodox mode, the Nipkow disc itself passes only one hole's worth of light at any time, so the difference may not be enormous.

I tried a Club 490mm Nipkow disc in pinhole mode. The normal frame mask and sync take-off were used. A photo of the front would be the newsletter's dullest: merely showing the raster mask without lens. The light sensor was an SFH 2030 photodiode (Siemens). Its lens end was sawn off, the package filed flat and repolished clear with Brasso, making the sensitive area visible at its actual size of about 1mm square (removing too much material would cut the internal gold wire!) A transimpedance preamp as in V38/1 was used, but with a TL071 as first chip to further lower the noise on suggestion of Keith Vickers. To screen hum and stray light, an earthed can (no top or base) was fixed behind frame area. Inside it the sensor was supported on a bendable metal bracket.

For an undemanding first test subject I tried a 2D fluorescent light ... an image appeared! An interesting characteristic described by Alan Short was apparent - the sensor distance from the disc governs the camera's viewing angle. Superficially the effect is like a zoom lens, but the alteration also alters the f/number, thus image brightness, in proportion. Sensitivity and viewing angle increase as the sensor approaches the disc.

Leaving the sensor at 50mm, it proved possible to make close-up portrait shots by the light of two 18 watt CFL bulbs in metal reflectors. The holes on this size of disc are oval, equivalent in area to a round hole of about 0.8mm diameter. On this basis, the aperture of the system would appear to be roughly 50/0.8 = f/63. The sensitivity is more than expected and further experiment with pinhole mode, including outdoor daylight, seems well worthwhile.

DOME SENSOR

A note from USA member **Byron Ake**

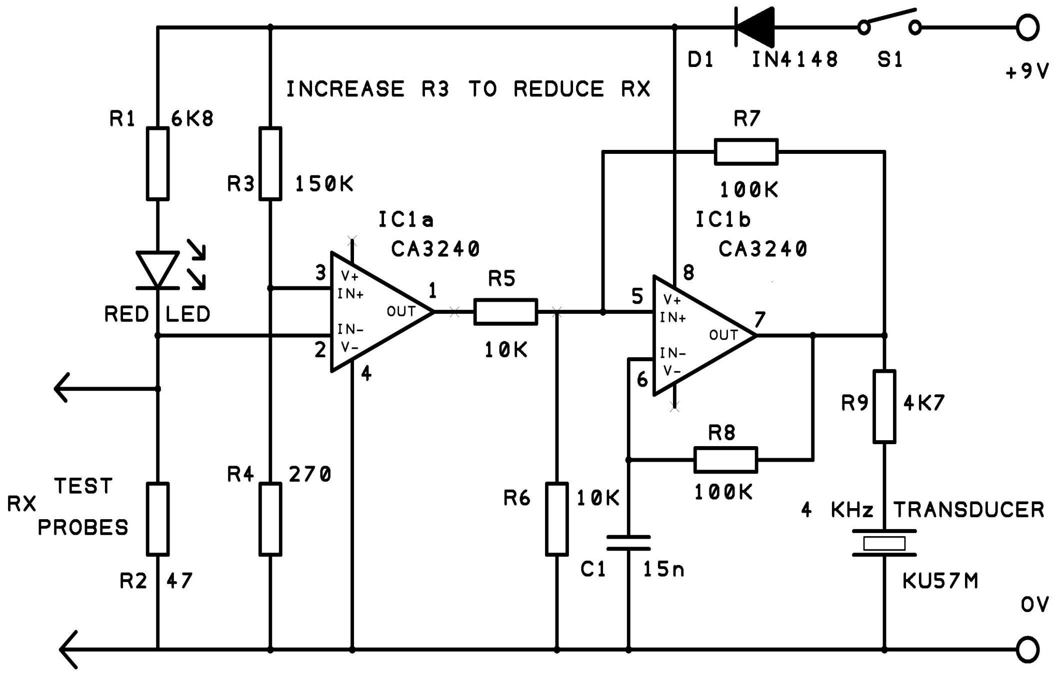
Hi Jeremy. I remember a while back you were looking into replacement photosensors for the Club shop. I wanted to let you know that I think I found the original part number for the Club's dome sensor. Here is what I posted in the NBTV forum:

Gentlemen, I believe I have finally located a part number for the Club's beloved dome sensor. It appears to be a **VTP1188SH**. More info here:
http://www.excelitas.com/Lists/Photodiodes%20and%20Phototransistors/DispForm.aspx?ID=46
and here:
http://www.newark.com/excelitas-tech/vtp1188sh/diode-photo-925nm/dp/79K2522

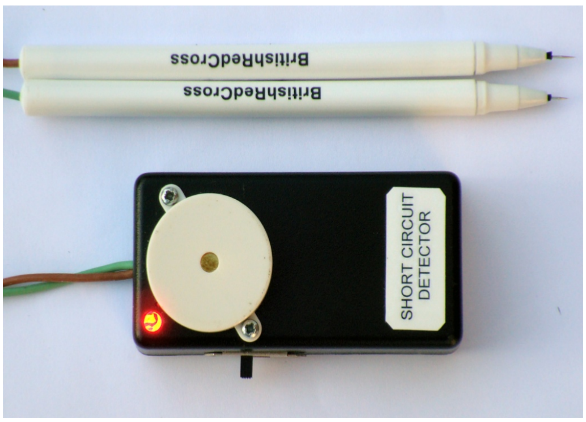
SHORT CIRCUIT DETECTOR
Peter Smith G4JNU

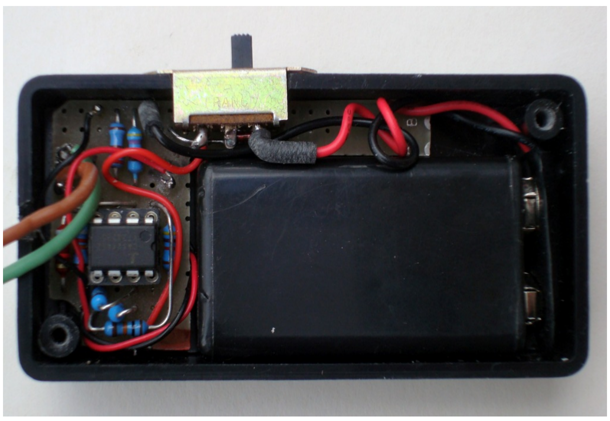
With the increase in the assembly of printed circuit boards using surface mount components, there is a need for a short circuit detector that will not damage sensitive low voltage semiconductors. It was decided to construct a tester with a maximum voltage of 50 mV and a current of 1 mA. This could be changed easily by altering the two input potential dividers R1, R2 and R3, R4. Integrated circuit 1a is configured as a voltage comparator so that when the probes are shorted together the output on pin 1 will go high thus switching on the square wave generator I.C.1b which is set to a frequency of 4 kHz by C1 and R8. The output drives a ceramic transducer with a resonance of about 4kHz. This is available from Maplin for less than £2. The potential divider resistor values are chosen so that the resistance of the “short circuit” has to be less than about 25 ohms to activate the tone. This is so that low resistance board components will not cause a false detection. The tolerance errors in resistor values and the variation in the input offset voltage of the comparator can be corrected by changing the value of R3. A value between 82k and 470k gives a 20 mV shift in the reference voltage on pin 3 which should be more than enough. The red LED has been added to indicate when the unit is switched on. If this is not required it can be omitted, but R1 should be changed to 8k2. For the perfectionist, a 470k resistor can be connected between pins 1 and 3 of the CA 3240 to eliminate indecision at the point of switching. The probes are constructed from ball point pens. The ink refills are removed and replaced with pins soldered to flexible cables.

If a self-oscillating transducer can be found, then the 4 KHz oscillator section around IC1b can be omitted and IC1a can be changed to the CA3140. Note that the pin numbers will change. The resistor R5 in series with the transducer should not be less than 1k.



COMPONENT VALUES SHOULD GIVE A DETECTION RX BETWEEN 20 TO 30 OHMS





NBTV AND RB-TV COMPARED
Vic Brown G3SDQ

At the time of writing the 'hot topic' in amateur television circles is **Reduced Bandwidth Television** (RB-TV), i.e. digital fast-scan television transmitted in bandwidths of less than 1MHz. In the UK, interest in this subject has been spurred on by additional spectrum at 146-147 MHz becoming available to radio amateurs for a limited period for experimental purposes. In the band plan the segment 146 – 146.5 MHz has been allocated to 500kHz-wide digital communication systems, including television. NBTV enthusiasts will notice that this amount of bandwidth is similar to that required for 'intermediate' definition television (i.e. around 180 – 240 lines), and the question will naturally arise as to whether traditional analogue technology would produce comparable (or even superior) results in a much simpler manner. Thus there is an overlap of interest in this subject.

Digital amateur TV (DATV) is said to be 90% computing, and so it would seem that there is not much room for those who lack the necessary skills (or interest) in computer programming. DATV was originally introduced in 4 MHz, and later, 2 MHz bandwidths using the DVB-S system with MPEG2 coding as used by satellite broadcasters, which enables readily available consumer equipment to be used for reception. A much greater degree of bit rate reduction is required for RB-TV and most experimental systems are currently concentrating on the MPEG4 coding system. Fortunately, for those who wish to explore the possibilities of DATV, a program called 'UglyDATV' [ref.1 below] has been written for the Raspberry Pi and its matching camera, which enables it to be configured as a RB-TV signal source with selectable formats. Conventional set top boxes cannot handle low bandwidth formats and so the reception of RB-TV presents a receiver equipment problem. Currently the only available method is to use the Tutioune [ref. 2 below] software on a Windows computer together with a specific type of satellite receiver IDE card. The following observations are based on some initial experience with this combination of equipment.

Tailoring a conventional analogue TV system into a specific bandwidth involves juggling with the number of lines, aspect ratio and frame rate. The Baird 240-line/25 fps system requires a baseband bandwidth of nearly 1 MHz, which unfortunately rules it out for this application (although it could easily be accommodated in the 70cm amateur band). The 180-line/25 fps system requires 540kHz, which again is too wide. Rather than dropping the number of lines still further (e.g.120-lines), my recent experiments have been with a 180-line/16.6 fps system that requires a 360 kHz bandwidth.

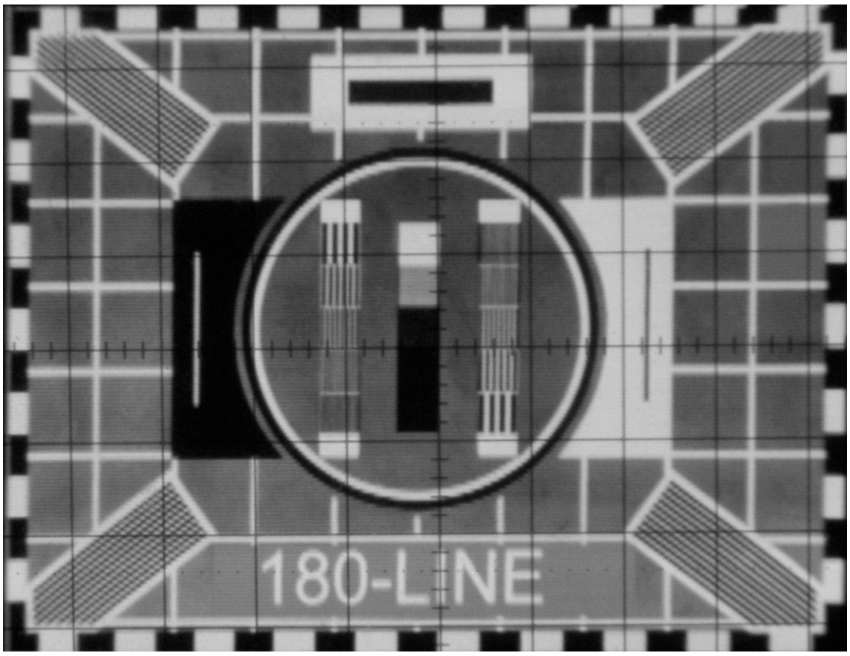
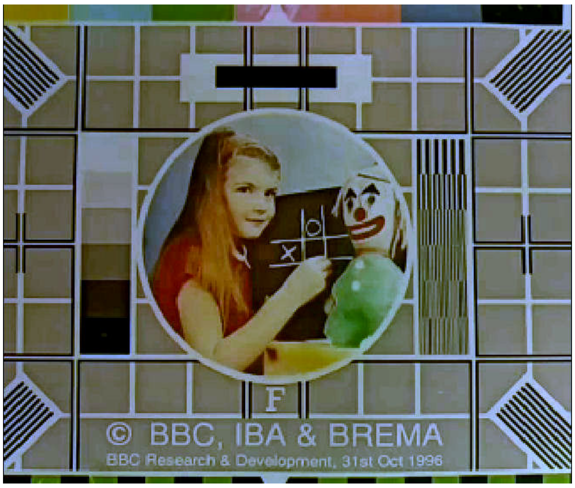


Photo 1 gives an idea of the picture quality achieved using an EPROM picture generator and displayed using a 'scope adapter. The 16.6 Hz flicker was found to be too uncomfortable for direct viewing, and so this has been changed to a 179-line/33.3 fps interlaced system that overcomes the flicker problem and produces the same picture quality without requiring extra bandwidth. Note that this signal would need to be transmitted using a vestigial sideband to fit it into a 500kHz RF bandwidth.

When configuring the Raspberry Pi for low bit rate digital TV the important parameters include the picture format, camera frame rate and the symbol rate. The symbol rate refers to the quadrature phase shift keying (QPSK) modulation system, where the carrier can adopt any one of four carrier phases, each phase representing two bits of information. The total necessary RF bandwidth is always greater than the symbol rate by an amount that depends critically on the quality of the Nyquist filter used to shape the keying waveform prior to modulation.



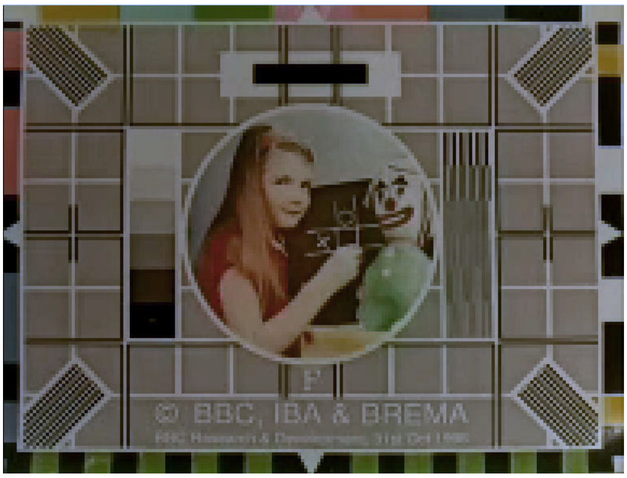
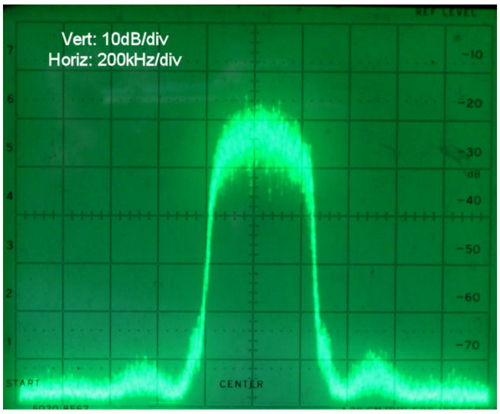


Photo 2 gives an idea of the static picture quality using a 320x288 picture format and a camera frame rate of 15 fps. Using a 333kS/sec QPSK symbol rate it was found that there was a transmission delay of 15+ seconds and there was noticeable jerkiness and freeze-framing of the picture caused by too rapid movement. With the picture format reduced to 192x144 there was a similar transmission delay but the movement was much smoother, although the picture was rather more ‘pixelated’ (Photo 3). It must be stressed that these results do not necessarily represent the best that could ultimately be achieved with further development.

The target specification for communication systems in the new band is that unwanted radiation should be 60dB down at the channel limits. For analogue TV this is a tough specification, but probably achievable using conventional filtering methods as used in the past for analogue ATV. For digital TV, with its noise-like spectrum, this is an extremely challenging specification that depends mainly on the quality of the filtering of the base-band signal prior to modulation and the subsequent linear amplification up to a useful power level.



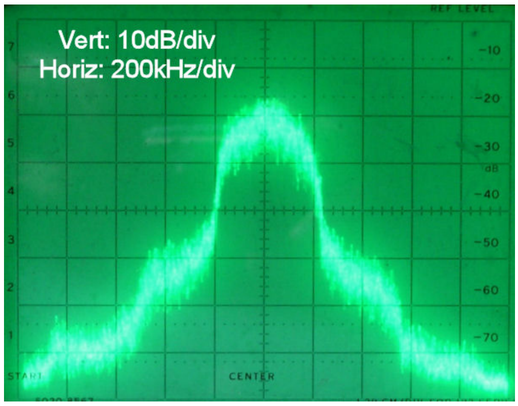


Photo 4 shows the driver level RF output of a 333kS/sec QPSK modulator using an analogue LC filter for the base-band Nyquist filter, which (almost) meets the required specification. Photo 5 shows the rapid increase in unwanted sidebands due to non-linearity in the RF power amplifier, even when operated well below maximum output. The solution to this is probably going to involve a complex technique of negative feedback of the demodulated waveform back to the base-band modulator input.

Development of an analogue system to meet the bandwidth constraints would involve construction of all the components of the system from the picture pick-up to the display device, as well as the transmission equipment. The inclusion of colour, if desired, would require further development. Perhaps the biggest advantage for analogue TV is that it is instantaneous ‘true’ television without motion or sound synchronisation problems.

The development of digital RB-TV will draw on image pick-up, signal processing techniques, display equipment and software from the world of computing. The biggest challenges lie in the development of more efficient coding, filtering and modulation techniques, together with overcoming the transmitter linearity problem. The inclusion of lip-sync sound also presents a problem, since at low video bit rates the sound requires a large proportion of the available bandwidth. With digital TV there will always be a noticeable processing delay.

The above review is, of course, by no means all-inclusive. For example, a hybrid analogue/digital system using an entirely different modulation scheme might be envisaged. Although it is not traditional NBTV territory, RB-TV does represent a new approach to the general problem of transmitting television in a narrow bandwidth, which some NBTVA members may wish to take part in.

1) www.F5oeo.fr/UglyDATV01.pdf   UglyDATV by Evariste F5OEO
2) www.vivadatv.org   Tutioune software by Jean Pierre F6DZP

PHOTOGRAPHING NBTV AND OTHER SLOW DISPLAYS

Steve Anderson

Preamble There has always been a desire to be able to display the fruits of our NBTV labours in the form of still photographs. It sure would be nice to do video too, but that's not so easy, especially with a frame rate different from conventional TV. The following requires practice and patience.

There are huge advantages with digital still cameras, such as immediacy and the ability to manipulate the image on a computer. But how to get that base image in the first place from a flickering NBTV screen?

A long exposure time The first consideration is exposure time. Basing this on the club standards a complete frame is done in 1/12.5ths of a second, so it is necessary for your exposure to be at least this duration. This is not a speed that can be used hand-held: the camera needs to be mounted securely so it doesn't move during the time the shutter is open (or the electronics captures the image). A tripod is the answer - they're not expensive, but moving furniture around to provide a stable support is a valid alternative.

The next point is camera shake. This is simply that when you push the shutter release you move the camera body. If your camera has a delayed shot (most do) of say ten seconds, use it. The wobbles (even on a tripod) will have died out by then. Better still is a remote control - some models do have this, mainly Canon and Olympus.

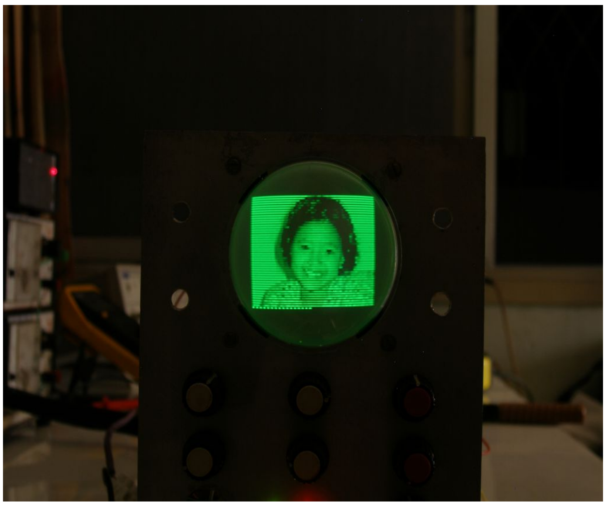
Going back to exposure time, it is tricky capturing a single frame even if your camera does have a 1/12.5s exposure setting (unlikely). It's better to get the average of several frames, say at least ten. This requires the camera to be set in exposure time mode, usually an 'S' on the mode wheel, which with the correct controls can be set to at least one second, or better still, two or more. This will require a still image on the display.

Make a larger picture Next is exposure light levels - don't zoom in to the flickering display only - include a reasonable portion of the surrounding, err, apparatus. Set the ambient light levels to a similar visual level to the display brightness or slightly less. Use average exposure metering and you should get a reasonable result. You might have to adjust the exposure time such that the iris is within range to get a good picture. With the generally low levels of light output from NBTV monitors and the long exposures needed the flash on the camera needs to be disabled. This is usually found within the menu system.

More advanced is to use exposure bracketing, this is where the camera determines the nominal exposure and takes a snap, then it takes (usually two) that are differently slightly under-exposed and two in the same manner over-exposed. You then choose the best of five. Most digital cameras have this feature.

Focusing and sensitivity Some cameras will auto-focus on an NBTV display, some won't. If your camera has manual focus, use it. If your display or the area you wish to capture is quite small you'll need to put the camera into Macro mode for taking very close-up pictures, say less than 300mm. Just as with film cameras there is the speed / sensitivity to be considered. With film it's the ISO/ASA number of the film loaded, with digital you can change it from shot-to-shot. Most digital cameras will start up in 'Auto mode', the camera selecting a speed usually between 80 and 400. Just as with film, it's a trade-off between sensitivity and noise/grain.

Post processing Once you have an acceptable raw image then some simple software is all that's required to crop it and convert it into greyscale, if you wish. The nub of all the above is to experiment and read the camera manual. It will also help you with the family snapshots too! After all this, it might be a good idea to read the manual and find out how to get it back to 'Factory Presets' - undoing all the above takes some patience.



Steve's CRT monitor (48 lines) pictured in workshop setting

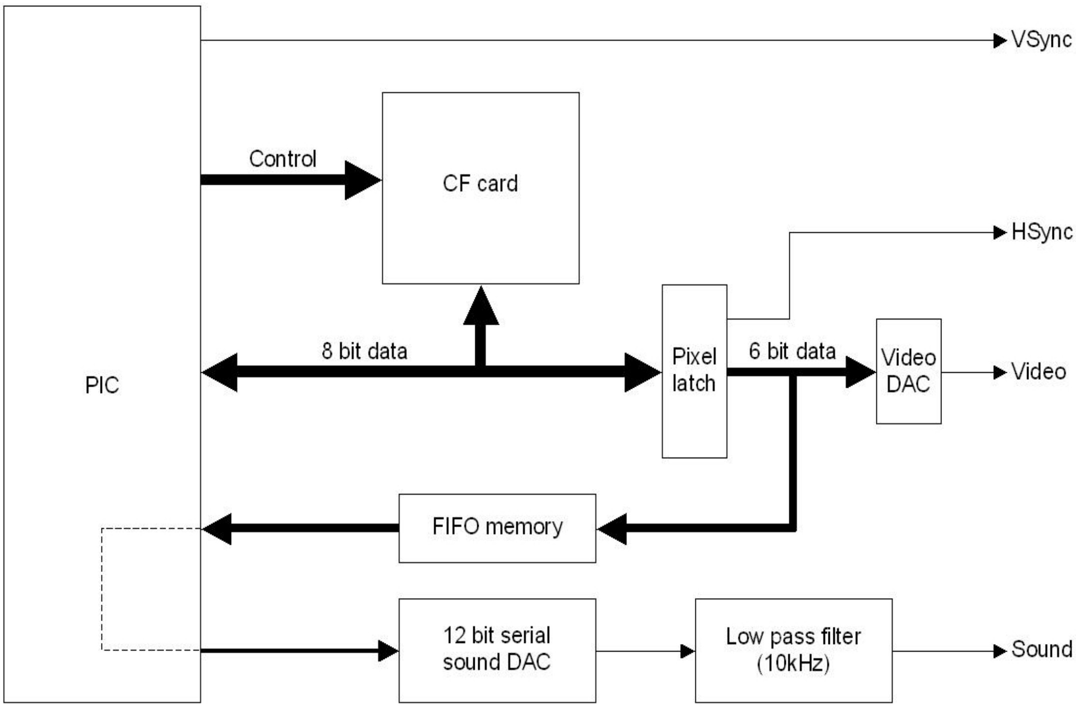
The screen photo converted into a monochrome greyscale

A COMPACT FLASH PLAYER FOR INTERMEDIATE TELEVISION STANDARDS
Karen Orton

There are a number of intermediate television standards (my own terminology) which are difficult to investigate due to a lack of suitable recording and replay equipment. The highest sample rate of the best computer sound cards is 96kHz - just enough for 60 line replay but inadequate for higher resolutions. A few years ago I experimented with **Compact Flash** (CF) cards as a medium for wide bandwidth signal recording and playback. These are rather old technology but are nonetheless making something of a comeback. The result of this replenished interest in CF is that newly manufactured cards are incredibly fast. They are also fairly easy to drive from a microprocessor because they are based on a very old disk interface (IDE). The result of this work was a very simple PIC-based device for the playback of 405 line material for my 1951 Pye television. I say 'playback' because my device does not record. Instead, material is deposited on my CF cards by a Linux computer program, support for which comes in the form of the excellent media conversion program 'ffmpeg'.

The key to the simplicity of my compact flash player is the total lack of buffering. Video data is transferred directly from the CF card to a pixel latch without passage through the PIC. The PIC only paces the transfer of pixel data, courtesy of a PIC timer which furnishes a stream of pulses. The PIC's only burden is maintenance of the much slower audio channel. The downside of this zero buffer technique is the need to interrupt the data transfer periodically in order to issue fresh 'read sectors' commands to the CF card (a CF card can read a maximum of 256 sectors in a single transfer). This makes continuous replay impossible. I get around this limitation by aligning the interruptions with the frame blanking period of the replayed video.

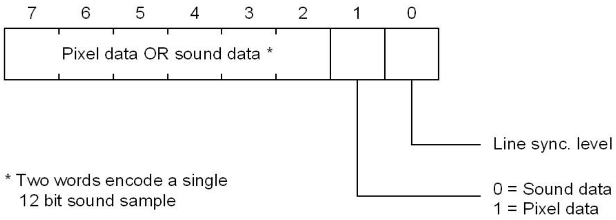
Telecine was the prime signal source for intermediate television standards and so 25 frames per second has been adopted by my new player. I use a frame blanking period of around 2 milliseconds during which line synchronisation pulses are suspended (i.e. as per Baird 240 line practice). I do not use flywheel synchronisation in my monitor so this suspension is not a problem. I have taken a more flexible approach with this new player: line synchronisation pulses are encoded in the CF contents, along with pixel values. In addition, sound samples are encoded in the pixel data during line synchronisation pulses. I can thus easily change the frame structure and therefore line count and frequency to pretty much any value I choose. A pixel clock of 3MHz is employed, this being sufficient for an effective 500 pixels per line when replaying Baird 240 line material. The sound channel uses 12 bit PCM samples at 40k samples per second.

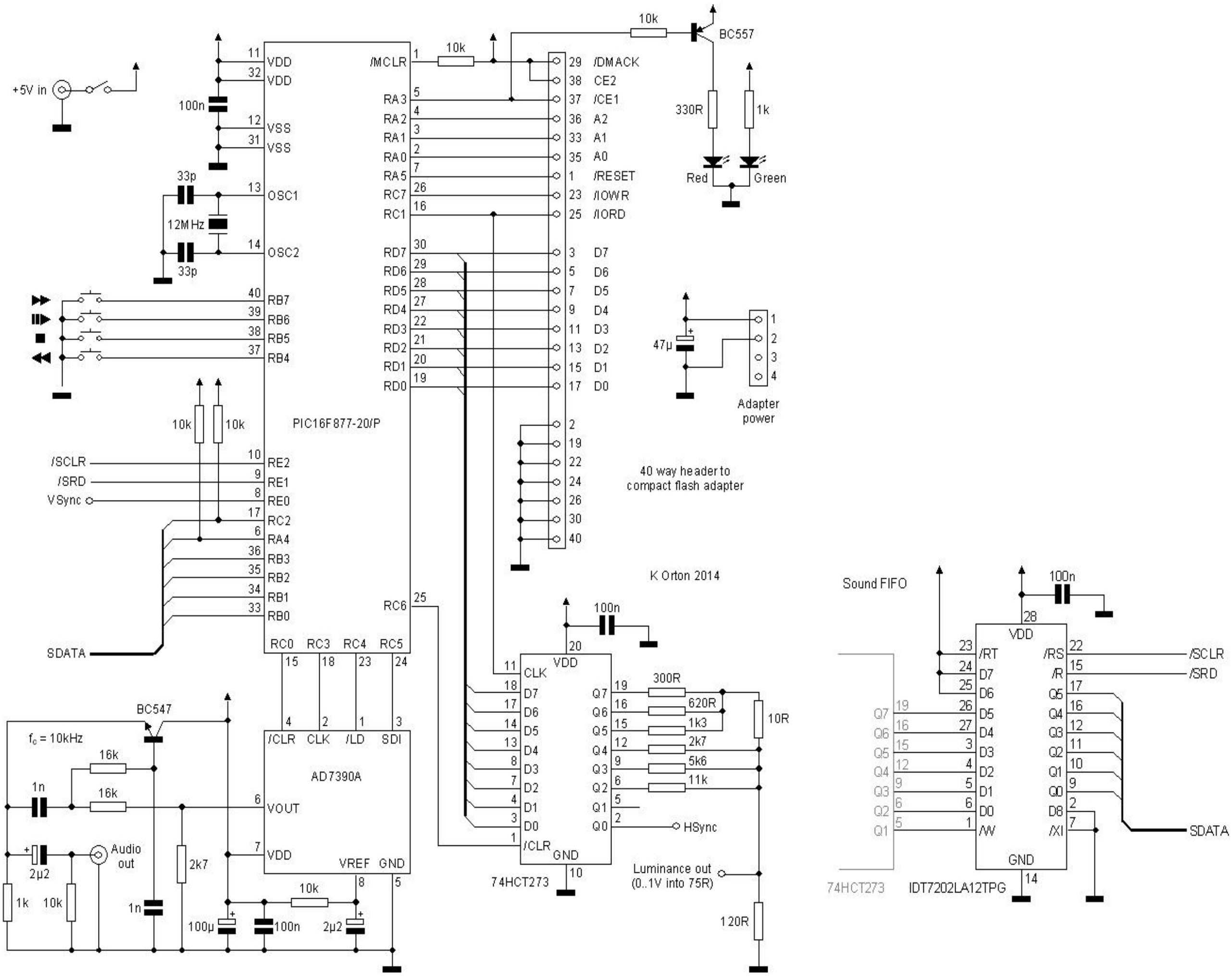


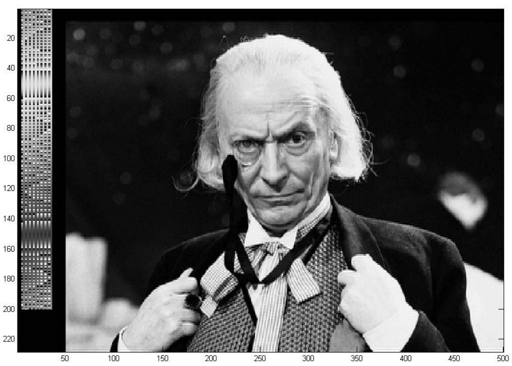
The diagram above shows the structure of my player. The illustration overpage shows how pixel data, sound data and line synchronisation pulses are encoded in the 8 bit word that is read from the CF card. Sound samples are diverted to a first-in-first-out (FIFO) memory device, and are subsequently read out by the PIC and delivered to an audio digital to analogue converter at a smooth rate. Due to the uncompressed nature of the video data used by my player, my video files consume much more space than equivalent MPEG-encoded video files. A full 24 minute Dr Who episode for example, would consume 4.8 gigabytes. In addition, my player uses no file system structure and so only a single video clip can be recorded onto each CF card.

...continued overpage

Compact flash data word encoding







This illustration of a single frame of 240 lines shows how sound samples are secreted in the line sync. period.

A future article is planned to describe the actual experience of 180/240 line viewing. Design details will be made available to interested members. The circuit uses just four DIL ICs and the CF card receptacle is a CF/IDE adapter (available cheaply on the internet) which connects through a standard 40 way header. In other words, there is none of that horrible surface mount involved!

PEAK-FOLLOWING SLICER
Garth Porter

This article describes a simple circuit which may help solve a potential problem in NBTV, as well as having more general applications.

A particular application of a peak-following slicer is assisting the aligning of an opto-fork on the sync holes round the edge of a scanning disc. The traditional Club Darvic ones, from more than one manufacturer, suffered from the sync holes being very near the edge of the disc; in the case of one of mine, some of the holes almost break into the edge of the disc. This leads to a non-obvious problem; one might assume that when there was no sync hole in the fork optical path, the phototransistor current would fall to zero (or at least, its published dark-current value). The Club sales forks are GE type H13A1; datasheets are obtainable from the web (it's on datasheetarchive.com, but not Alldatasheet.com) wherein it is somewhat self-aggrandisingly called a "Photon-coupled interrupter module".

At the end of the last sheet is a most interesting graph relating the fraction of fully-illuminated phototransistor collector current to the depth of penetration of the vane, which in our case is the edge of the disc and not containing a hole. Full current is maintained up to 0.1" penetration (I am translating the American habit of "mils"), so I take it that's how far in the optical axis is, and so where the holes ought to be to fully uncover the infra-red beam. Thereafter, current falls off rapidly, falling to 1/100 of full value at 0.13" penetration, and is 1/10 at 0.125" penetration. And here is the fundamental problem; the edge of our traditional Darvic discs is not at least 30 thou" beyond the centre of the holes.

This leads to a difficulty in setting-up the opto-fork position; if the disc doesn't penetrate far enough into the fork, the phototransistor current will stay too high when it ought to go low; and if, in an attempt to compensate for this, the fork is moved further into the disc, the sync holes may come out-of-line with the optical axis and so the phototransistor current will not rise high enough. Most significantly, both (alleged) light & dark currents will vary wildly while the opto-fork is being moved.

I suggest that this is where a peak-following slicer would be most helpful; certainly it worked for me. Its circuit is described further on in this article. If the hole-present current is arranged to pull a voltage downwards (Fig 1), then the capacitor will charge down from the positive rail to that value. On my monitor, with an optimally-set opto-fork, that voltage was 3.6V, operating off a +8V supply. The no-hole voltage varied between 6.8 & 7.6 volts, probably indicating the varying distance between the disc-edge and the sync-hole radius. The capacitor voltage was thus 8 – 3.6 = 4.4V; I had already decided from previous work that a slice-level divider consisting of 33k at the bottom and 68k at the top would be suitable (see Fig 2), so the slice level is 4.4V peak x (68k / 33k + 68k) = 2.96V down from +8V, = 5.0V. This gives a margin of 1.4V to the hole-present voltage, and around 2.2V to the no-hole voltage. If, during adjustment of the opto-fork, the hole-present voltage shifts, then the capacitor will re-align to that new (-ve) peak voltage and thus establish a new slice level, usually without losing any pulses.

I would of course agree that once set up, the opto-fork voltages are not going to vary continuously; I think the major benefit is easier setting-up.

The Club Handbook does intimate that there may be some problems with setting-up the opto-fork because "light can leak round the edge"; there is another mechanism where the somewhat unpredictable opto-fork voltages might cause trouble. The Club motor driver circuit shows the sync-hole input directly-coupled to the 4046 phase-lock ic. This is perfectly in order; but the opto-fork voltages must then comply with the usual CMOS input logic levels of low <0.3 of supply voltage and high >0.7 of supply voltage. For the regulated +12V supply shown, this amounts to <3.6V & >8.4V; and my opto-fork (admittedly, running off +8V) wouldn't meet either limit. I emphasise that the opto-fork voltages obtained depend on the value of phototransistor load resistor chosen, and the handbook allows significant latitude in this; the circuit diagram specifies 1Megohm, and the text suggests starting with 47kilohm. I **do not** intend a criticism here – merely a warning of possible non-obvious reasons if your hole-sync circuits won't work properly.

Another solution to this problem is that 4046 pin 3, PCBin – and not pin 14 PCAin – has a self-bias feature, so it can be capacitively-coupled; 1nF is suggested in the datasheet for a frequency of 50kHz, but the input resistance is very high, so the capacitor value shouldn't be at all critical. With ac-coupling a pk-pk signal amplitude of 400mV (on 10V supply) will then suffice.

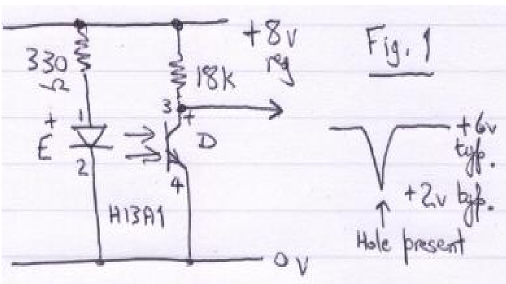
To explain the origins of a peak-following slicer, and my particular version of the circuit: very often an analog part of a system (I'm adopting the American spelling throughout) outputs a waveform which is intended to be used by logic circuitry. This means that, whatever corruptions the analog part might have introduced, a decision needs to be made about whether at any given moment the level of the waveform is meant to be describing a logic 0 (low) or 1 (high). If you know the peak height of the waveform, it suffices to feed it to a comparator, with the reference voltage of the comparator set to ½ the waveform peak height. This reference level is known as the slice level.

However, problems arise when the amplitude of the waveform coming out of the system may be variable; on a radio path for instance, it may vary with the carrier strength received. What we can still be sure of is that, if we could establish the waveform peak height in some ongoing way, we would still set the slice height to ½ the peak height (for a 2-level system).

All that is needed is a peak detector, to measure the instantaneous height of the waveform; this is then stored for a suitable period of time on a capacitor. "Suitable" means long enough to get a steady capacitor voltage, but not so long that it fails to track the varying levels of the waveform. Obviously, "suitable" depends on both the nature of the waveform and the nature of the disturbances to its height.

The LM393 is an excellent little comparator; dual, in a 8-DIL package, and low consumption. It also has a rather unique feature – the output is open-collector, not the usual totem-pole. (This gives the opportunity for either comparator to pull a commoned output low, without level conflicts and is therefore very useful in linear power supplies, to implement both voltage- & current-limiting). The inputs can be taken rail-to-rail and in fact will work a few hundred millivolts below zero. I would remark that the front-end of the LM393 is identical to the front-end of the LM324 quad & LM358 dual op-amps, and so it is also a very competent op-amp as well as a comparator, although requiring an output load resistor.

The open-collector output enables a circuit trick to achieve peak rectification without using a diode, provided you don't mind the capacitor charging downwards from the +ve supply rail. The open collector can quickly pull the capacitor lower terminal down, but when the output transistor turns off (i.e. attempting to take the output high) the charge remains on the capacitor until discharged by a resistor placed across it. The lower terminal of the capacitor therefore long-term tracks the varying height (in the –ve direction) of the waveform. A proportion of the capacitor voltage – its discharge resistor can conveniently be tapped off – is decided on as the slice level and fed to the reference input of the comparator proper. The original pulse input is also fed to the comparator, and depending on which way round the inverting & non-inverting inputs are used, the output can be a +ve- or –ve-going pulse. Importantly, it will swing rail-to-rail, thus removing any voltage uncertainties. I should say that I haven't used any hysteresis, as the input voltage swings are large compared with any input-offset voltages.



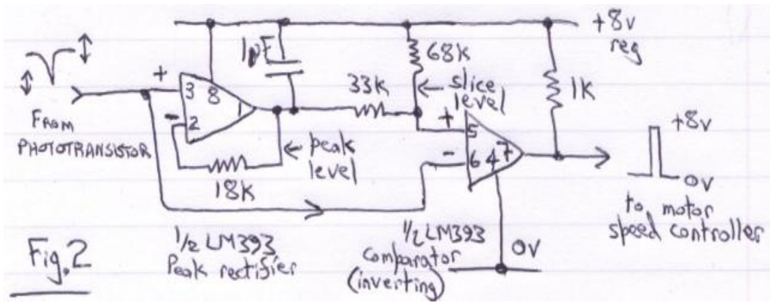


Fig 1 shows the opto-fork connected to get a –ve-going sync-hole pulse. 330ohms feeding the IR emitter passes around 19mA, in accordance with the datasheet; the 18k load resistor was chosen from the 400uA output current quoted, but for the reasons discussed above the current wasn't actually that high.

Fig 2 shows on the left the peak rectifier; it's basically a voltage-follower, with the 18k in the inverting input balancing the 18k in the non-inverting input. The open-collector output charges the 1uF capacitor down from the supply rail. The 33k + 68k discharge resistor keeps the capacitor discharge droop to 5% over 5mS, to allow for 2 lines gap between sync pulses if missing-pulse sync is used. On the right is the comparator, with the junction of the resistors providing a varying bias voltage (the slice level) to the non-inverting input. The –ve-going sync-hole pulse is connected to the inverting input, and so produces a +ve-going +8V pulse at the bottom of the 1k load resistor, which is then fed to the motor controller.

I should mention that all my monitor circuits work off regulated 8V; this is because long ago Doug suggested that it would be convenient if NBTV equipment would work off 12V batteries for demonstrations. Equipment working off nominal 12V lead-acid batteries should be designed to work down to 10.5V; and the headroom of 78xx-series regulators is 2V, leaving 8.5V. 8.0V is the nearest manufactured, and was standard to feed the low-power circuitry in all mobile CB sets.

Therefore, if the Fig 2 circuit (running off 8V) is connected to a motor speed controller running off 12V, then the comparator load resistor should be changed to 1.5k and connected to the +12V supply, thus preserving logic levels.

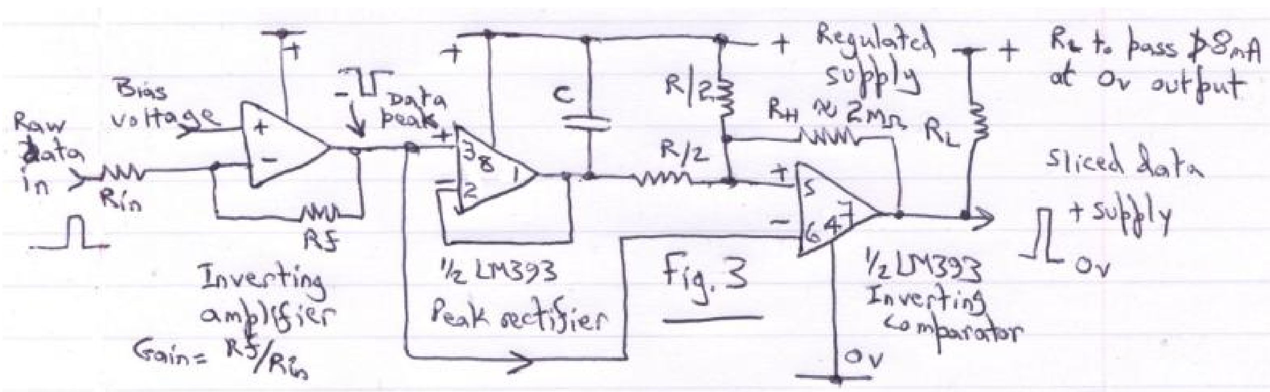


Fig 3 shows a possible more general application of the peak-following slicer. Here, a binary data stream has been sent over a light-beam, using a modern sensitive photodiode detector. The head amplifier can cope with the widely-varying signal levels resulting from atmospheric disturbances etc, but the amplitude of the data recovered will very a lot, and rapidly. The sliced data must be the same way up as the raw data.

The first stage on the left is an inverting amplifier, because the peak rectifier trick can only handle -ve-going peaks. It might be unity-gain, or it may have considerable gain, depending on the photodiode head amplifier. The middle stage is the peak rectifier, and the capacitor is sized so as to quickly charge (i.e. in about 1/2 of the data bit period) from the 8mA nominal maximum sink current of the LM393. There is no need for a balancing resistor to the inverting input, because the non-inverting input is fed from the low-resistance output of the preceding op-amp. The discharge resistor is chosen to hold the capacitor droop to 5% over, say, 5 data bit periods. The discharge resistor is split into 2 equal halves, because the slice height is ½ the peak in a binary (2-level) system. On the right is the comparator, again arranged to invert the sliced data, to reverse the effect of the input data inverting amplifier. Because the recovered input signal levels might descend towards the noise, a small amount (say 15mV) of hysteresis is introduced by connecting a high-value resistor from the output of the comparator to its non-inverting input (i.e. slight positive feedback).

NBTV ARCANA

Karen Orton

A seldom talked about aspect of Nipkow disc televisions is the centripetal forces exerted on the disc material as a result of rapid rotation. This can not only distort the disk but can actually cause slow migration of material towards the edge of the disc. Not surprisingly, this migration includes the holes themselves.

Several ingenious solutions were found to this problem, perhaps the most effective of which was invented by the late great engineer Lawrence Dagbone. In his system a specially positioned spring-loaded pin was able to engage with hole number 29 (the second most inner hole). Should migration result in hole 30 achieving this position, then the pin allowed the disk to be held still while a second spring-loaded device stamped a new hole 30 in the disk. In this manner a raster could be maintained within a half hole width of the nominal viewing region.

Of course, the vast majority of sets did not have such a facility - and, slowly but surely, the holes would make their way to the edge of the disc in these televisions. It is suspected, though not as yet proven, that greater problems were not caused and reported by this phenomenon because disc-based sets were very rapidly superseded by CRT-based ones.

However, there was an American city where use of Nipkow discs became so great that hole migration happened frequently and often with fatal results. On reaching the edge of the disc, a hole was inclined to fly off at dangerous speed and embed itself in any nearby object, including a person. This explains why so many deaths were recorded in Chicago in the 1930s, newspaper headlines describing the victims as being found 'full of holes'.

One might ask why the problem isn't apparent today. Certainly, no warnings have ever been issued regarding the dangers of projectile scan holes. The answer lies in recent advances in the cosmological model, in particular, the introduction of dark matter in the 1980s. Dark matter was added to the physicists' model in order to explain why stars did not fly away from the galaxy and shoot off into inter-galactic space. It seemed that some unknown force was holding them back. The invention of dark matter explained all of this but in so doing simultaneously provided a once and for all time solution to the problem of Nipkow hole migration.

But there is no free dinner in science and that is why Aldi stays open until 9.00pm on weekdays. For further reading and a list of references on this and other little known aspects of NBTV history please write to the Lawrence Dagbone Trust c/o Voxel Astravan, 27 Letsby Avenue, Rasterskan, Cloud Cuckoo Land.

MIDLANDS UK LOCAL MEETING REPORT

Pictures by John Fletcher, Zoe Bremer, Jeremy Jago

Welcomed by Zoe Bremer at her house, nine members attended our rescheduled meeting in Nottingham on 31 January.

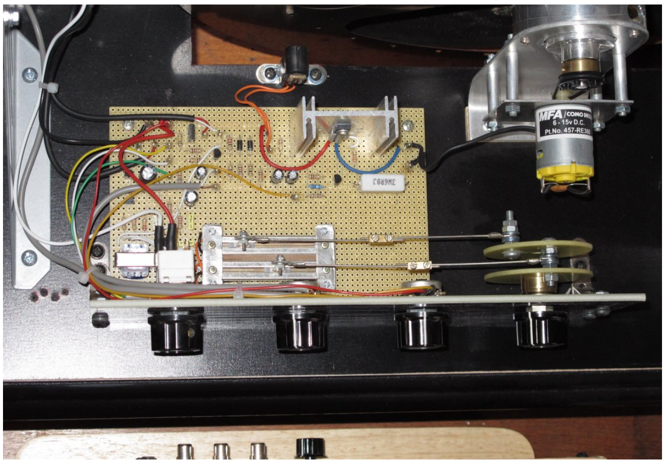
Eddie Greenough shows 'Stookie Bill' on 32 to 625 converter. Right picture shows Colin Sanderson's reconstructed Baird 'Noah's Ark'

As people and equipment occupied both front room and breakfast room, the household's two cats trustingly relaxed in front of the fire as we avoided their tails. The largest item was Colin Sanderson's new reconstruction of the original Baird 'Noah's Ark' televisor at full scale (the working scale models were seen at last year's Convention). It was a tight squeeze in and out of Colin's large car. The authentic metal chassis has a rheostat-fed mains series brush motor driving the disc, the light source an orange LED matrix accurately simulating a plate neon, driven from an Aurora downconverter, synchronised from a once-per-frame pulse contactor on the shaft.

'Noah's Ark' Baird Televisor with front panel removed to show motor control parts.

Spoked metal Nipkow disc seen from rear.

Eddie Greenough showed his 32-line to 625 line display converter built to Karen's Mk2 design (V38/1). Garth Porter demonstrated a precision test card generator based on the BBC TC57 pattern adapted for 32 line, built on the standard Club generator PCB. Jeremy Jago showed his Mk2 adapter for oscilloscopes without Z-modulation, using the same HF shift idea as Mk1 (V31/4) but with fewer chips and, as suggested by Graham Lewis, modulating the Y (line) axis instead for wider compatibility.

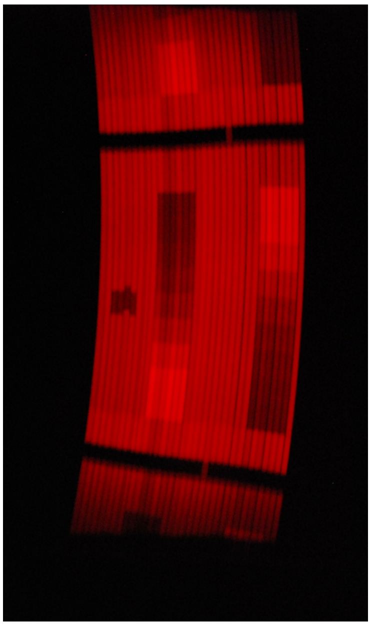


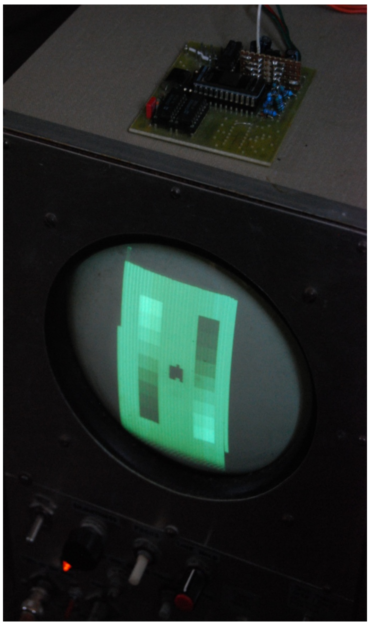
'Banquo' monitor in action. On the right, detail of control panel with slider pots worked in sine-cosine from cranks on fourth knob.

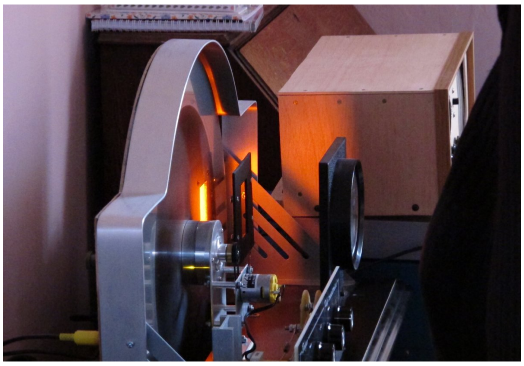
Karen Orton demonstrated her 'Banquo' disc monitor (V38/4) whose sync circuitry uses an ingenious phase technique. The material chosen was 'Kansas City Confidential', a film already noted for its clarity converted to 32 lines. She also showed her new CRT monitor for the Baird 240 line standard as described last issue, with converted images played from memory card.

Dave Gentle showed the capabilities of his laser signal sender, built around a green low power pointer (V36/4) and carrying an NBTV CD playback. Previously shown working into the sensor of a camera-monitor, this time the beam was picked up by a dome photodiode feeding a CRT monitor after a 1-transistor amp. A strong, steady picture resulted, even with a beam set to a just-visible intensity. Interestingly, no interference came from the 'CFL' room light which no one thought to turn off! Running from the pointer's intended supply volts, the modulator can't overload the laser. Further trials will be over appreciable distance. No beam spread occurs with distance, of course, but someone suggested a larger sensor would ease line-up. (Cheap garden-ornament solar cells seem OK for 32 line providing you use a very low Z preamp). Colin urged the laser be modulated at a higher intensity nearer normal, as the light source for a mirror drum display.

Much discussion followed the demonstrations and several new ideas evolved. Thanks to everyone connected with this enjoyable gathering, particularly Zoe for her hospitality - *Jeremy Jago*





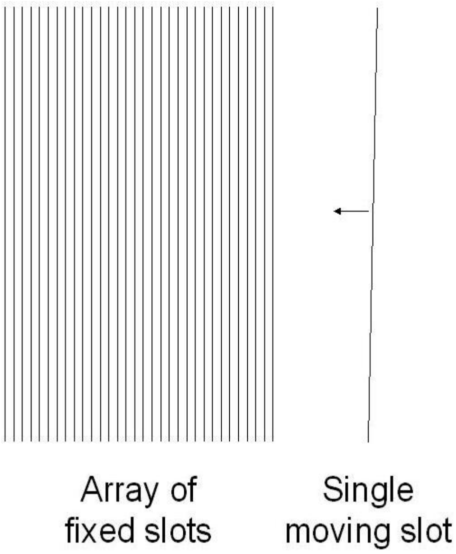


Garth's Testcard on Banquo and a radar-tube. Banquo using VCR head as bearing. Thanks to Possum and Bramble for putting up with us.

A STORY OF FAILURE - A GRATING BASED MONITOR

Karen Orton

An important principle of the NBTV spirit is, in my opinion, being able to report failures as well as successes. Such reports add to the knowledge base and seed the creative process. What follows is one such failure.



Fixed grating using film carrying inclined slots

Rotating drum with LEDs

Some time ago I experimented with a monitor idea which used intersecting gratings as a scan method. This seemed attractive because, like the mirror screw, the patterns generated by intersecting gratings (e.g. Moire patterns) produce much optical movement for little mechanical movement. The basic approach is illustrated in the associated diagram. A fixed grating of 32 narrow slots is scanned by a single, inclined slot thereby producing a raster scan at the single intersection point.

All this started around the time I discovered I could generate accurate aperture sheets using transparencies in my printer - a time which culminated in my very successful transparency monitor. The fixed grating was on such a transparency which was wrapped around a rotating drum. The inclined slots, of which there were four, were provided by the drum which had internal LED illumination (see picture of drum internals).

The whole thing had the appearance of one of those barber poles, except my precision fell a long way short of the average barber pole!

One constraint of this sort of monitor is close proximity of the intersecting slots as otherwise the parallax introduced would be unacceptable for two eyed viewing. This is the case at least for vertical line scanning - I believe horizontal line scanning would be much less critical in this respect. A less obvious obstacle to satisfactory performance from this monitor is the relatively leisurely rotation speed of my drum - 187.5rpm - which belies the incredible precision needed of the drum and the grating.

I failed completely to get any kind of picture out of this monitor which was not surprising considering my poor mechanical skills. But I did succeed in getting seven segment digits displayed on a 5 line version although they were very jittery. This monitor has been dismantled now and the parts re-purposed for my Line-O-LED monitor. Perhaps one day someone with much better mechanical skills than I might get a monitor like this working successfully.

SYNCHRONISING THE AURORA CONVERTER

Aurora TV standards converters, designed by Darryl Hock, are used by many mechanical TV owners. They convert an incoming video signal of ordinary 525 or 625 line broadcast standard to a variety of other signal formats, such as 30 or 32 line NBTV (for details of Aurora Converters see www.tech-retro.com)

A sophisticated and very useful facility is **synchronisation to an external source**. This provides a video signal whose scanning rate is synchronised to the motor speed of the display device itself – a reverse of traditional methods, but with several advantages. For this purpose a reference input is provided. The socket can, for example, accept a low voltage sinewave at mains frequency to allow the use of mains synchronous motor television monitors, an important type of historic receiver in the USA. The Aurora manual explains the two main sync methods used with mechanical TV in its pioneer era. In one method, a portion of the video signal itself was used to control a toothed wheel etc on the televisor (this was the method chiefly used in Europe). The other method, quite widely used in the USA, employed a mains synchronous drive motor in the home receiver, working on the same power grid system as the studio.

Much discussion has taken place recently on ways to utilise this external sync facility, which as well as working with 50 or 60 Hz mains frequency, can also be configured to work with pulses at frame rate. As mentioned in the report above, Colin Sanderson uses a frame contactor on the motor shaft of his large Baird replica televisor. Two springy metal contacts bear on a smooth non-metallic cylinder containing a brass segment which completes the circuit once per revolution. The brushes link to a simple pulse circuit incorporating a low-pass filter, which then feeds the Aurora unit. Colin reports reliable steady running for long periods – the reconstruction is undergoing finishing touches and we hope to publish details soon.

Another approach is used by Steve Ostler for his 120 line mechanical display, which is driven by a mains induction motor. Steve writes:

Here is the mirror screw's pulse processor section. This provides clean frame pulses suitable for the Ref Input of my WC-01 converter.

In my system, the photodiode is irradiated by light from a red LED reflected by a strip of foil on a black disc, which comes round once per rotation. VR501 should be adjusted so the pulse on the 555's input is as large and devoid of a noise floor as possible. Its setting may vary with the ambient light level - not a problem if the sensor is properly shielded.

'R extra' and 'C extra' round off any switching sprogs on the output generated by the 555.

The Mirror Screw runs up to speed. When it gets within 7% of the frame speed for the converter standard (25Hz in this case), the picture snaps into frame and line sync. The frame phasing is pre-set by the position of the foil strip, and can also be set via a menu on the converter.