Using a domestic VCR to record NBTV video

By Steve Anderson.

Introduction

The trigger for this item was Doug Pitts' "That Missing Pulse" in the NBTVA newsletter Vol. 29 No. 1 in which he gives an insight as to why the 'missing pulse' system came into being for NBTV frame synchronization as opposed to the 'broad pulse' system used virtually everywhere else. The nub of it being the low frequency performance of the transmission or recording media. As Doug mentioned, it's not usually a problem in closed-circuit or even RF based communication, however recording the signal still remains a headache to this day.

Although the maximum frequencies are only in the order of 10-12kHz; it's the low frequencies that pose a problem. Consider a worst-case signal; say 16 lines of white followed by 16 lines of black. Ignoring the NBTV sync pulses for a moment, that's a square wave of 12.5Hz. If we take into consideration the NBTV sync pulses we also have a 400Hz square wave with a mark-to-space ratio of about 16:1.

A rough rule of thumb for passing a square wave through an AC coupled system is that the signal path should have a frequency response down to approximately one hundredth of the square wave signal to preserve the low frequency waveshape, although not the DC value, in this case either 4Hz or 0.125Hz! Few audio recording systems go below 10Hz with any fidelity. Ideally we need a recording system that goes down to DC.

Initial thoughts

One of the conventional ways of dealing with this is DC restoration; sadly this is not reliable (Photo1). This is the aforementioned 16 white lines followed by 16 black lines (top trace, this time showing the 'missing' frame sync) passed through a single CR high pass filter which is -3db at 16Hz (centre trace). The restorer just cannot cope (bottom trace) and it gets worse the more stages the signal passes through, i.e. record and playback. It's doing its job by not letting the signal go negative as can be seen in the last few lines of white, but not quite what we require. Reliable sync detection is virtually impossible and line tilt becomes excessive.

A FM sub-carrier system would seem ideal (akin to SSTV), however the sub-carrier would need to be at least 20-30kHz and the sidebands could extend well beyond 40kHz. This rules out all conventional audio-recording formats.

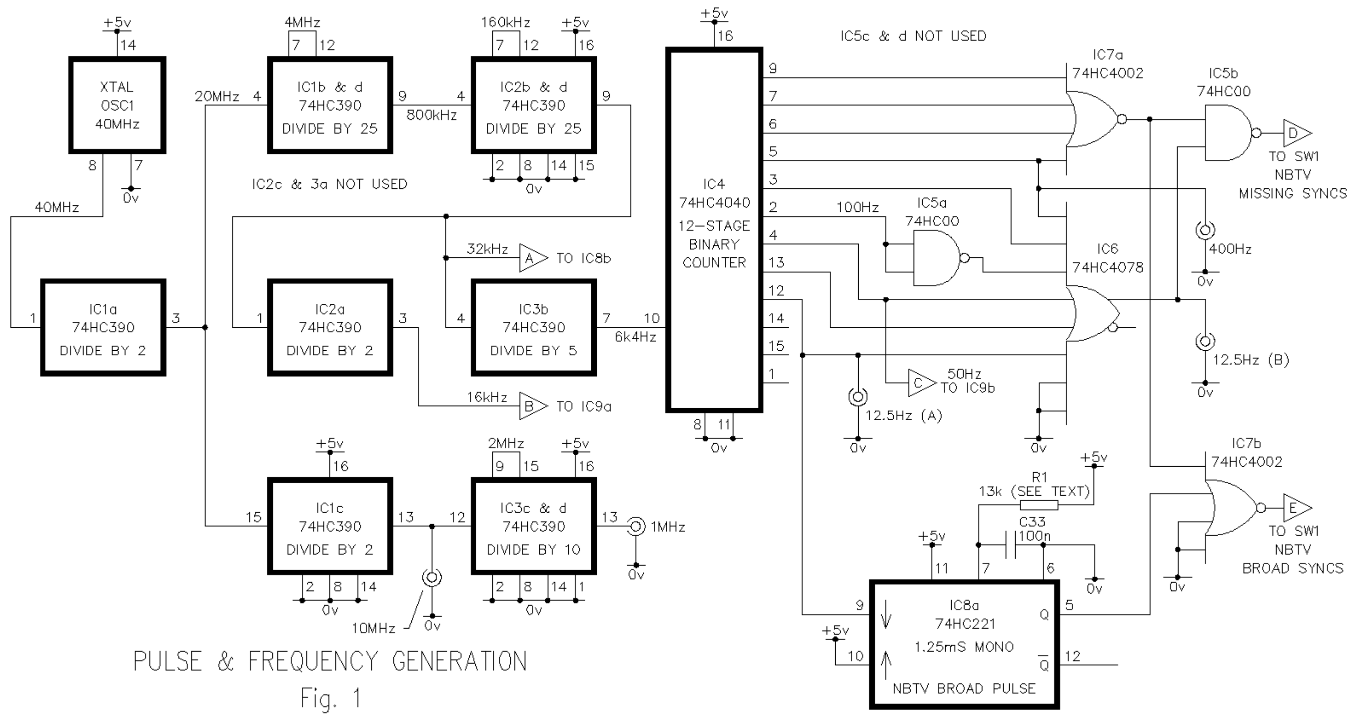
The domestic VCR has a luminance bandwidth up to some 2MHz and would seem ideal for a FM sub-carrier system. But the VCR needs as a minimum 50Hz field pulses to lay down the control track and most require the standard 15.625kHz line pulses and blanking for setting the gain of the AGC circuit and clamping. The head-switching and clamping circuits in the VCR could also corrupt the subcarrier (it was tried, and they did).

One solution of probably several…

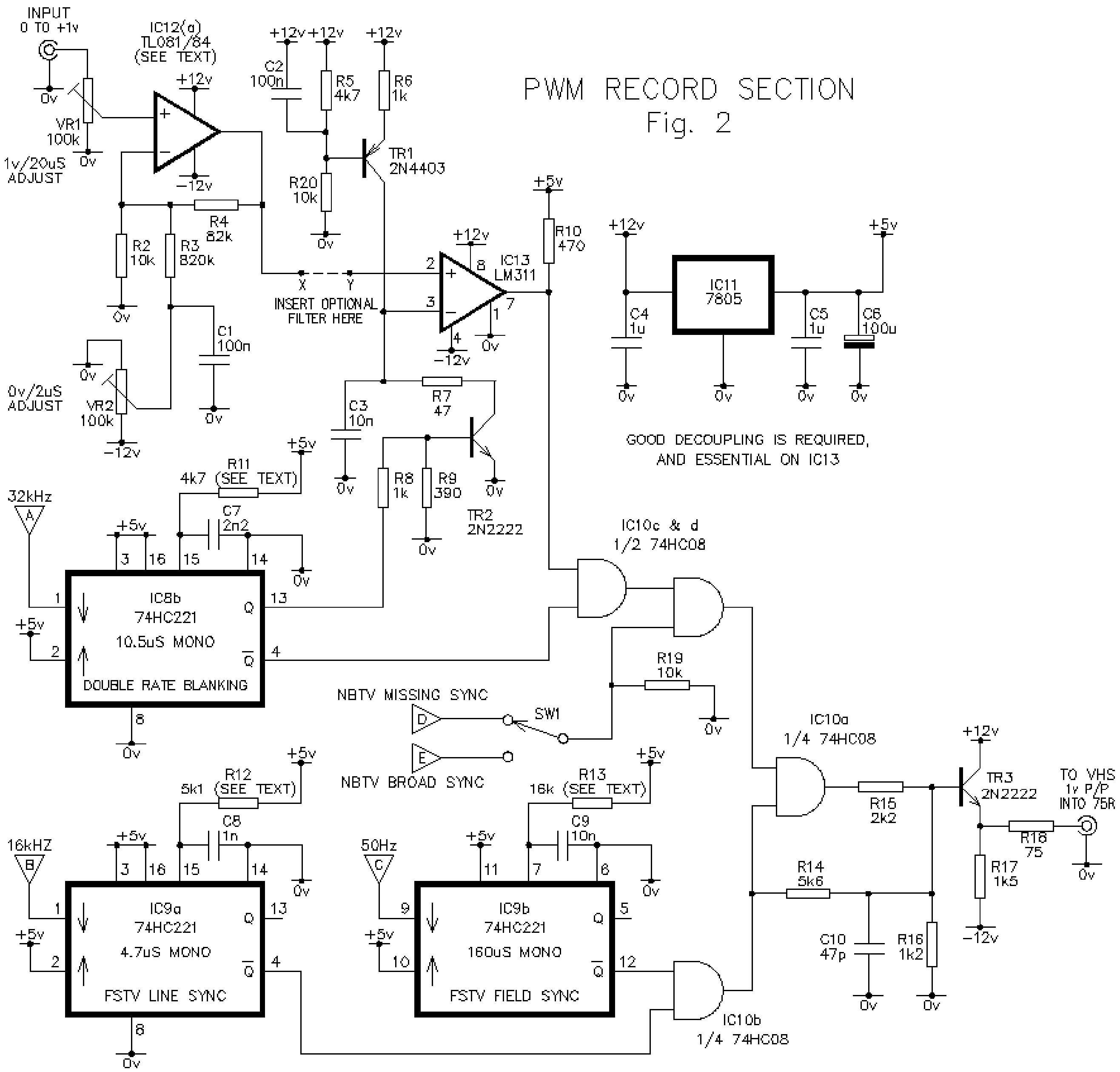
This system retains the FSTV sync and blanking and converts the NBTV video waveform into a Pulse Width Modulated (PWM) signal. This is then inserted into the active FSTV line period, the NBTV signal being sampled at twice FSTV line rate yielding a theoretical bandwidth from DC to 15 or so kilohertz.

NBTV sync information is handled by simply gating the PWM signal on or off. If there's no PWM signal then this is NBTV sync, if there is, then this is video, even if it's black. This allows handling of the 'missing sync' system.

However, during the FSTV field pulse there can be no pulses present, and if the NBTV signal is synchronized to this system as it needs to be, the NBTV (missing) frame pulse would normally occur at the time of 1 in 4 FSTV field pulses. So a delayed 12.5Hz output is generated that places the 'missing sync' pulse within the active FSTV picture area, the FSTV field pulse always being



PULSE & FREQUENCY GENERATION
Fig. 1



PWM RECORD SECTION
Fig. 2

a NBTV line sync, where no pulses are required.

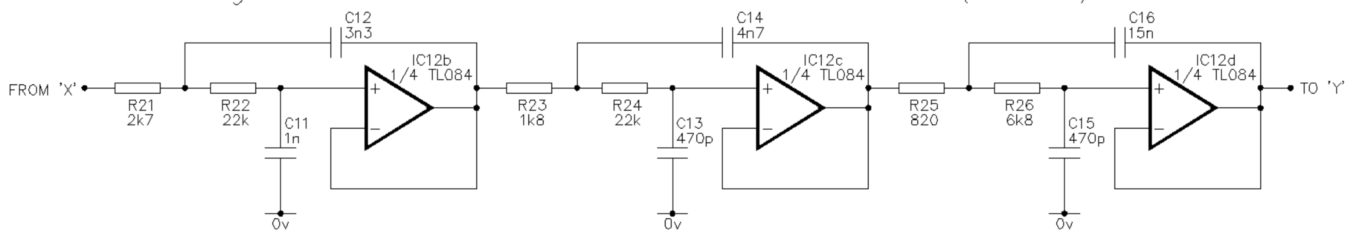
The inference is that the source follows the pulses generated by the circuits described here. With a mechanical source, it should listen to us, and follow our instructions (timing), we don't follow it. Those that have used Phase Locked Loops (PLLs) with mechanical cameras or monitors will be familiar with this.

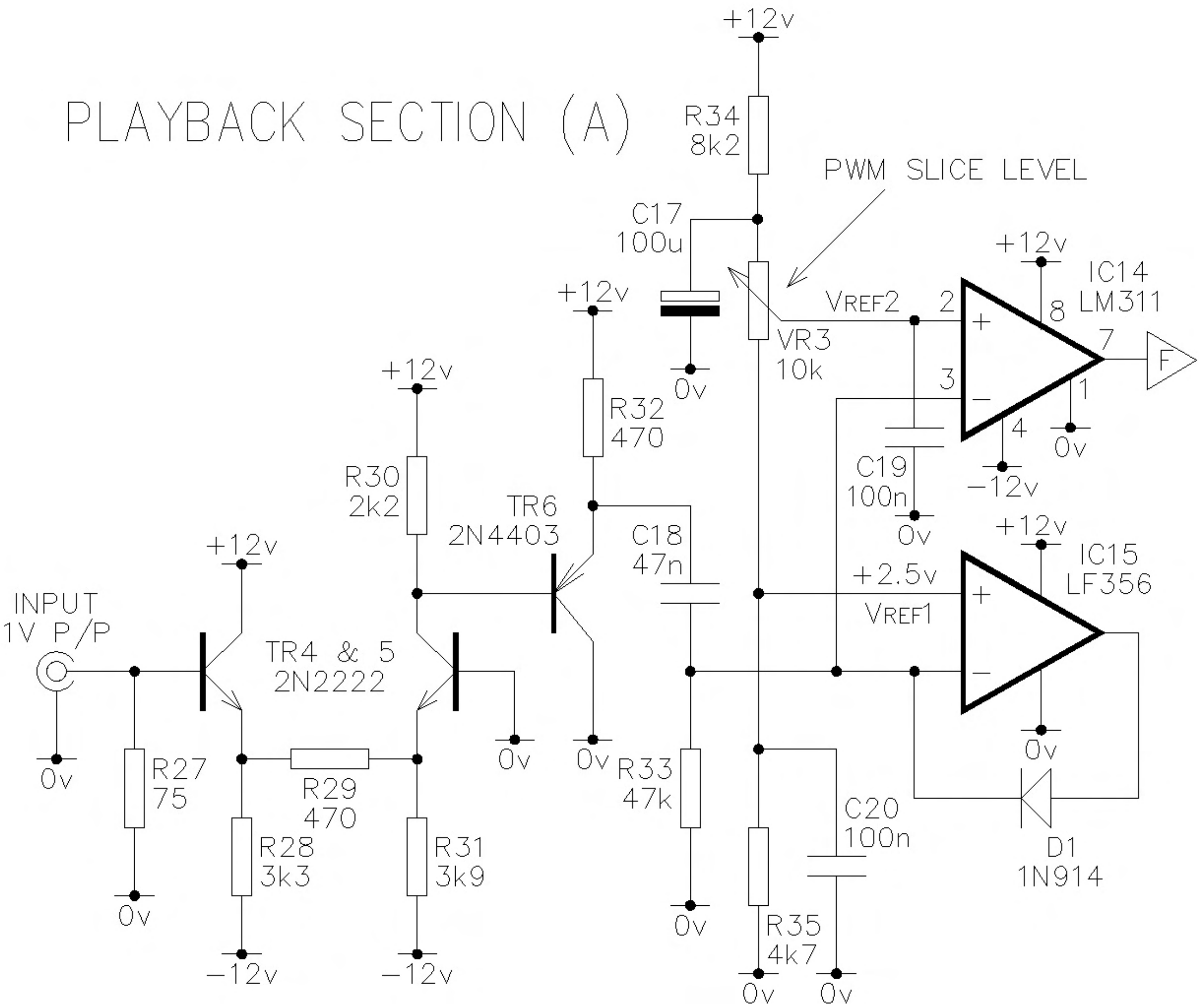
The audio tracks within the VCR, both longitudinal and Hi-Fi, are still available for recording sound.

Record section

The record section is based on a crystal oscillator module and a bunch of dividers to generate the necessary frequencies all locked together (Fig. 1). Many oscillator frequencies could be used, as this system only needs frequencies from 32kHz downwards, but a crystal-based primary source is recommended. 400Hz, 12.5Hz and the delayed 12.5Hz (when required) are outputted for NBTV source synchronization. The 1

Fig. 3 OPTIONAL ANTI-ALIASING FILTER (SEE TEXT)





& 10MHz outputs are for future use and are optional.

The FSTV line rate is altered slightly in frequency from the usual 15.625kHz to 16kHz to keep the number of samples per NBTV line to an integer, in this case 80. At the usual line rate there would be 78.125 samples per line which could result in erratic NBTV sync handling and corruption of the first and/or last PWM pulse in a NBTV line.

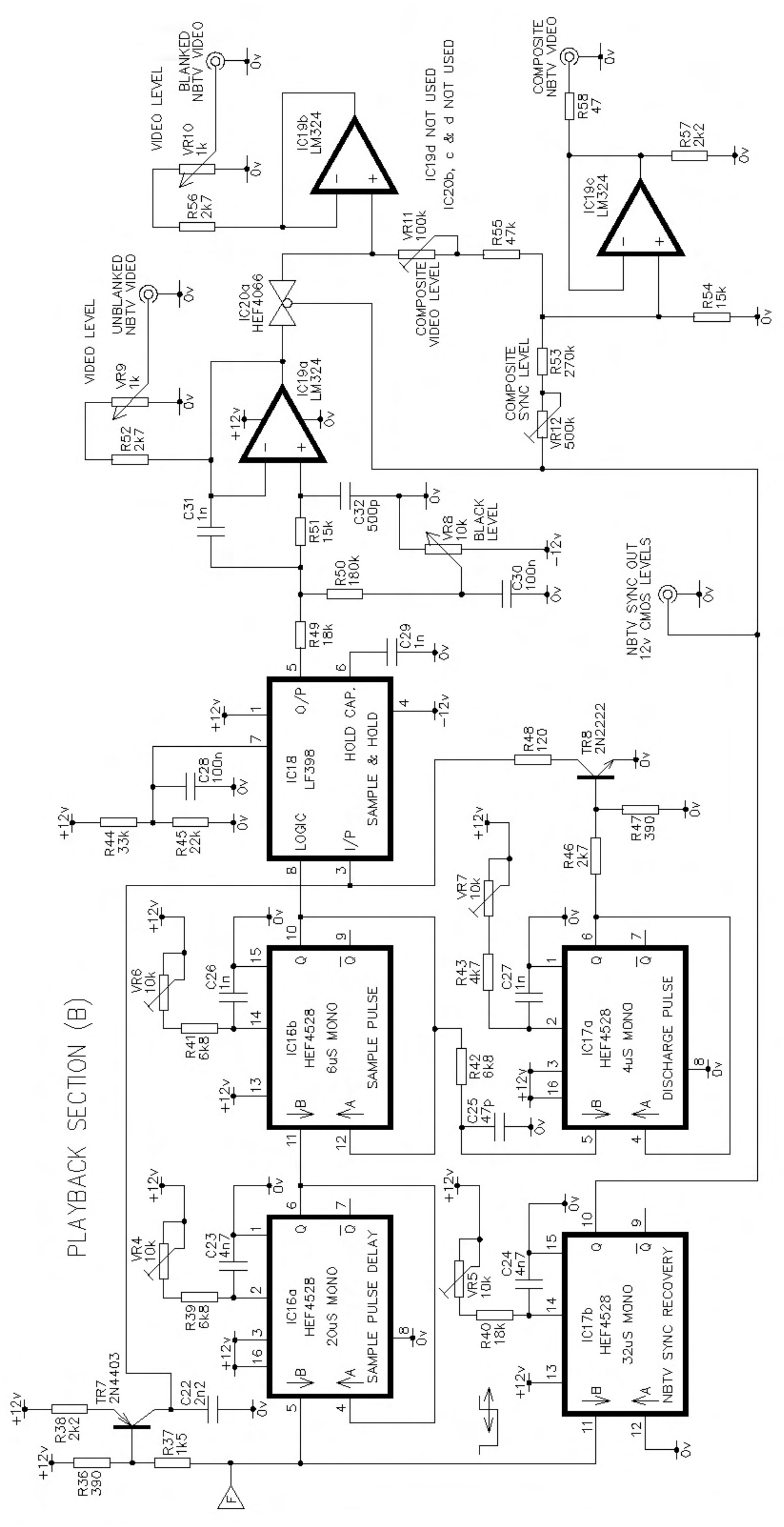
Most VCRs won't care about this as long as the field rate stays at 50Hz, this system has been tried on three basic domestic VCRs and all worked fine. High-end machines with Timebase Correctors (TBCs) might have a problem with this and the fact that the FSTV frame is now non-interlaced. In addition the FSTV field sync is just a simple pulse without the usual FSTV broad and equalizing pulses.

The delayed 12.5Hz (B) output with respect to the FSTV field pulse is generated by IC6, the delay is 5mS, placing the NBTV frame (missing) sync pulse 25% of the way through 1 in 4 FSTV fields. Synchronizing the camera or other source using the 'missing sync' system to the delayed 12.5Hz (B) should ensure that it is handled correctly. The video source doesn't have to go to black during the missing pulse, but conventionally it does. This system will output the missing sync pulse train whatever the value of the video, it's only of concern if a composite NBTV signal is required on playback.

If using the 'broad pulse' system where there would simply be a longer interval without PWM pulses, the delayed 12.5Hz (B) would not be required. In fact the 12.5Hz (A) output could be omitted, the 'broad pulse' can occur anywhere within the FSTV field as long as NTBV picture information isn't coinceident with a FSTV field pulse, phase locking the source to the 400Hz output would satisfy this requirement.

It might be tempting to use some of the other logic derived signals but caution is required as some have very narrow 'glitches' within the pulse train. This is of no concern in this system as the glitches occur at a time when the PWM signal isn't present, but might cause external logic to behave erratically. This is due to the propagation delays in the binary counter and the following gates. The 12.5Hz (A) output and the 400Hz output are glitch-free and the negative-going edges should be used for timing reference. The 12.5Hz (B) signal does have some glitches within it, but a simple low-pass filter followed by a Schmitt trigger will remove them. Changing IC5 to a 74HC132 and using the spare sections is suggested. IC10d is used to gate off the PWM signal during the NBTV sync period, the type of NBTV sync being selected by SW1.

The 0 to 1V NBTV video (only) waveform is converted into a 32kHz PWM signal that varies in duration between 2 and 20µS long, inserting two pulses into a single active FSTV line. IC12(a) (Fig. 2) amplifies the input signal to 0.6 to 6.3V, the offset provided by VR2 & R3 ensures that there is a minimum pulse width of 2µS with a



0V input, VR1 sets the pulse length to 20µS with a 1V DC input.

As this a sampling system an anti-aliasing filter might be needed if the signal source has fast edges from logic-generated pulses, or other high frequencies within it. A Bessel or linear-phase filter as part of the record stage is suggested, replacing IC12 in Fig. 2 with one quarter of a TL084 or similar, the other three sections used for the filter proper. Fig. 3 shows one implementation of a 6-pole linear-phase version. The –3db point is about 11.5kHz, the resistors should be 1% and the capacitors 5% or better, the delay through this filter is about 40µS.

As configured, only positive input signals are handled, so the input needs to come from a DC-coupled camera or other source without sync pulses, as they are derived from this system and handled separately. However a small amount of negative and excess positive values are allowed for internally to encompass any minor ringing from within the optional filter.

IC8b is triggered at 32 kHz which in association with current source TR1, C3 and discharge transistor TR2, generates a linear ramp from 0V to 6.6V twice during the active video part of a FSTV line. The following comparator, (IC13), compares the signal voltage from IC12(a) with the ramp and produces a proportional width positive pulse that is gated by IC10c ensuring correct blanking, IC10d suppresses the PWM pulses during NBTV sync to generate the final PWM signal. When mixed in with the FSTV composite syncs by R14, R15 and R16, a composite FSTV signal is produced that is buffered by TR3 to the input of the VCR at 1V peak-to-peak.

Playback section

The playback section starts with a 75Ω termination (Fig.4a) followed by a simple

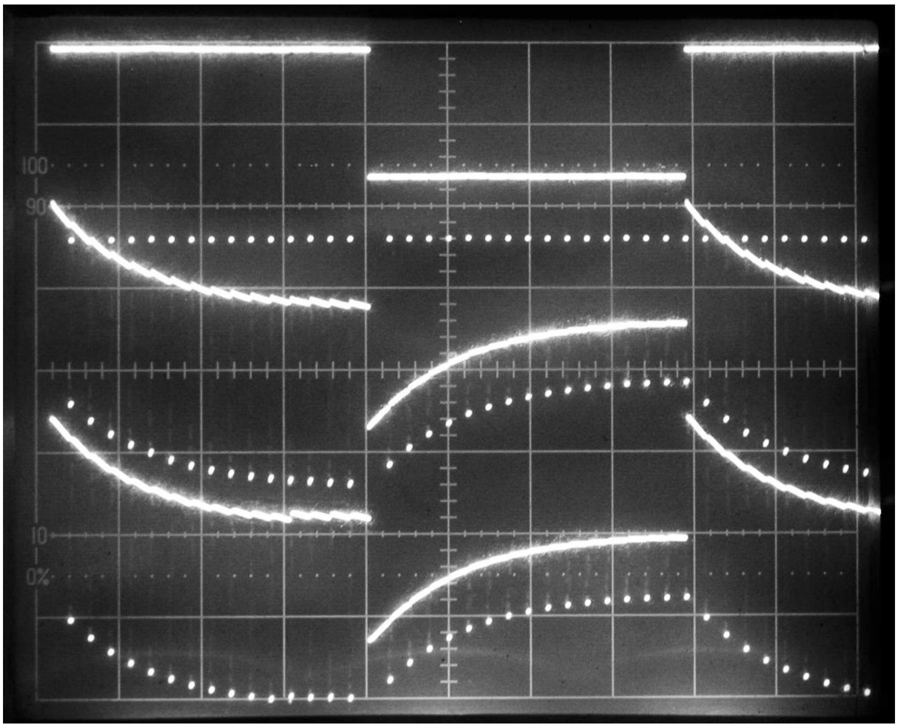


Photo 1

amplifier with a gain of about 4. This feeds an active clamp IC15 bolting the FSTV sync tips to VREF1, about +2.5V. IC15 is deliberately powered from only +12V and 0V minimizing the delay in the clamping action due to the slew-rate limitations of the LF356. IC14 is the PWM pulse separator using VREF2 and the clamped video waveform to reproduce a clean 12V PWM signal. It was noted that individual VCRs handled the edges of the PWM signal differently so VREF2 was made adjustable to suit the particular model being used, aiming for the cleanest recovered PWM signal.

The PWM signal varies from 2µS to 20µS at this point (when present) and the leading edge triggers IC16a, (fig 4b), a monostable set to run for 20µS. At the same time the PWM signal turns on then off a constant current source, TR7, which charges C22 to a voltage proportional to the pulse duration. At the end of the 20µS sample delay monostable (IC16a), a further one is triggered (IC16b) providing the sample pulse for the sample and hold amplifier IC18.

The ramp capacitor (C22) is then discharged by TR8 driven by yet another monostable, IC17a. The RC network at the input of IC17a is to introduce a short delay of about 500nS between the end of the sample period and the start of C22s' discharge, needed 'Aperture Time' as National call it.

The output of IC18 feeds IC19a configured as a 15 kHz low-pass filter to remove any remaining glitches from the sample-and-hold process, the residual DC offset is cancelled by VR8 and R50 to set the black level at 0V.

IC17b is a monostable set to run slightly longer than the PWM signal spacing, it is retriggered by the PWM signal and whilst the PWM signal is present the Q output remains high enabling IC20a allowing the output of IC19a to be passed to IC19b. When a PWM signal is not present the video output goes to 0V, and the output of IC17b is now our recovered NBTV sync pulses.

Using the Mark I eyeball the signal-to-noise ratio was estimated to be about -46db, not bad considering the use of VHS, but not even as good as an audio cassette. Even so, solid recovery of the NBTV syncs and video down to DC is probably worth the trade-off.

If needed, a composite NBTV signal can be generated by mixing the recovered syncs and video with R53, 54 & 55. Photo 2 shows the recovered 16 line white/16 line black raw NBTV video during playback without blanking or syncs on the top trace. The centre trace shows the recovered composite NBTV signal on playback, this time using a 'broad pulse' frame sync of 1.25mS duration. All the low frequency information is present, and as this system separately outputs the NBTV syncs, sync-stripping/detection is no longer required and is therefore no longer a problem (bottom trace). Sync separation is still required however, to differentiate between NBTV line and frame sync, but the task is now much easier with solid DC coupled pulses.

General

All of the above makes one large assumption, mentioned above, that the NBTV video source is locked to one or more of the frequencies generated by the circuits above. For an electronic source this is easy, but for a mechanical camera it's a bit trickier.

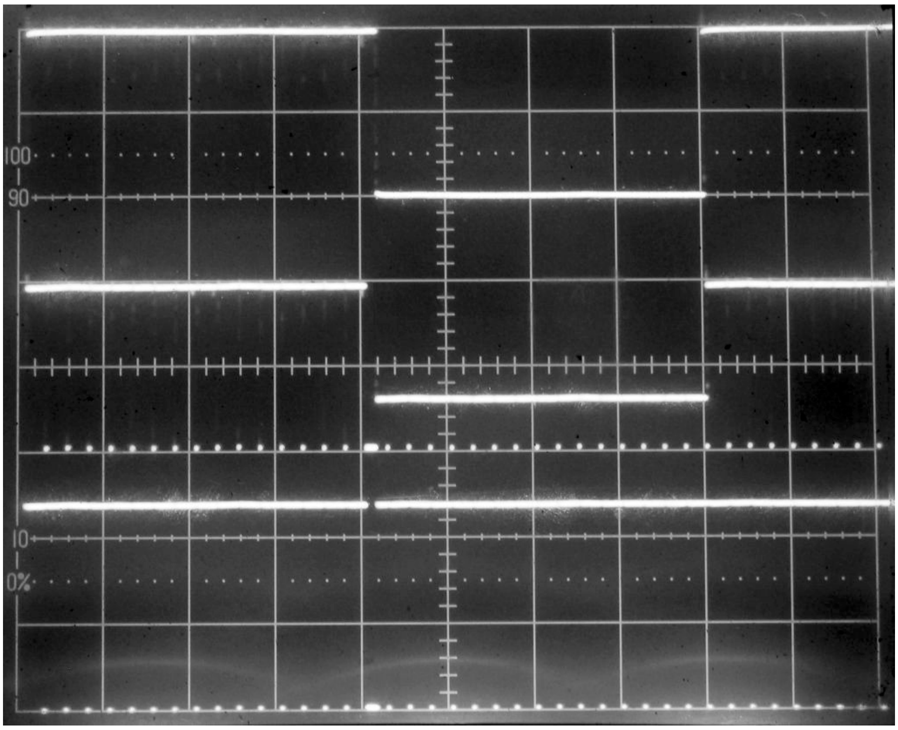


Photo 2

If the disc or drum of the camera uses a synchronous motor similar to those used in millions of record players from the 40s to the 80s either geared down and/or cajoled to work at a frequency different to 50Hz, then a simple phase shift network would allow the matching of the mechanical to electronic phase. An alternative is a DC brushless motor (Newsletter Vol. 29 No. 1).

If this were a production unit (or if sufficient members were interested) an E(E)PROM or PAL could have saved a lot of the logic and monostable circuitry, primarily in the frequency and waveform generation. It would also remove the narrow glitches on some of the timing signals.

There is some industry confusion as to the calculation of pulse widths of the 74HC221 monostables. The formula that Philips put forward is Tw=0.7.C.R, whereas Fairchild and STM leave out the 0.7 factor. The Toshiba chips used here measured at a factor of 0.93. Values of the resistors could well be one of the few AOTs' (Adjust On Test) required in today's world.

This system was tried on basic standard analogue VHS machines; it's uncertain how digital systems like DV, VCD or DVD etc. might handle the waveform. Copying, editing or the use of LP mode has not been tried either.

At this stage it is not suggested that this system be reproduced, it is not optimal, and requires further work done on it, particularly in the playback section. Critique, ideas and suggestions are welcome.

Further thoughts

Consideration was given to using the reproduced PWM signal to gate a clock waveform into a counter, latch, and then a D-A, this would remove all the monostables and the sample-and-hold amplifier in the playback section, but it's doubtful if it would actually reduce the chip count.

Further, this could have all been done in the digital domain, converting the raw NBTV video into a serialized data stream and inserting it into the FSTV video waveform. Keeping the sampling rate the same with eight bits locked to the FSTV syncs would lead to a bit rate that would fit into the bandwidth of a domestic VCR. Something like an ADC08831 (National Semiconductor) doing it almost all in one jump, in one eight pin package.

Of concern are dropouts corrupting the data, simple parity checking would flag the majority of errors, which could then be replaced with the previous valid value. This would be particularly important where the VCR does its head switching.

Footnote

For those in the US and other 60Hz countries, you might have a problem. Unless you have a multi-standard VCR, or somehow can get a 50Hz (PAL, often 220V only) model, there is no easy way that I can see around the conflict of the FSTV field pulse rate of 60Hz and the NBTV frequencies.

Switch your Hard Drives

By Reg Moores G3GZT

I still use a BBC B computer, it does many things not possible with the Laptop or PC, and one mod I use on this can be applied to my PC.

The mod. I did on the BBC, was to switch the double disc drives (these are equivalent to hard drives), which means quick access to either drives.

This is done, by simply using a DP C/O switch, to transfer the 5 and 12 volt supplies to either drive.

On my PC, I have "2 Caddies", one was in use, the second, just used for the storage standby one.

This meant, unplugging and swapping, when required, but does cause wear & tear on the contacts, not a good thing!

So I connected both caddies, IDE wise, the power cables being cut and connected to the C/O switch. Only the Red and Yellow (5V, 12V) the other black cables, paralleled together bye passing the switch.

The C/O switch is fitted on the side, as illustrated, all HDs being "masters", it makes easy changeovers, XP-W98 SE etc. Of course with PC on standby, or off!