

Ground Isolation when the Video Feed has a DC Component

Picture stability problems have been encountered in the field when video isolation transformers were fed from signal sources that contained a dc component. The problems disappeared when the dc component was removed by inserting a filter in the feed line.

What happens when a video signal is dc coupled to a video isolation transformer is the subject of this application note.

Video line driver circuits usually work from a single-ended positive supply which can only output positive signals. The output signal consists of the picture content and sync information. Its dc value will vary as picture content changes.

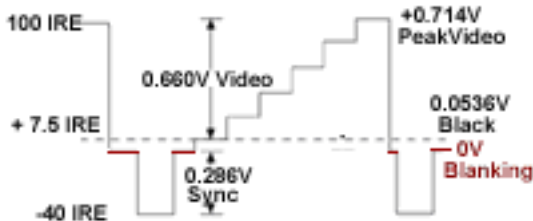


Fig. 1. NTSC Signal

The RS-170A NTSC video signal is shown in Fig.1. Its amplitude is 1Vpp with the sync signal at the bottom. The 1Vpp signal is across a 75ohm line termination fed from a source of 75ohm internal impedance. The source voltage is then 2Vpp with the tip of the sync level a bit above zero.

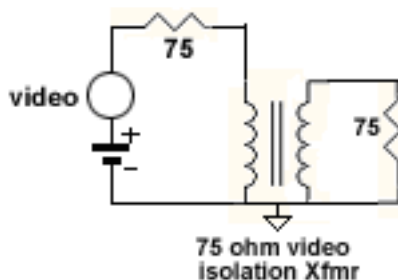


Fig. 2. Transformer Circuit

Fig. 2 shows the schematic of a video isolation transformer directly coupled to a video line driver. Since, at dc, the transformer winding presents a short across the line

termination, the dc current flowing through the transformer winding is limited only by the 75ohm internal impedance of the driver.

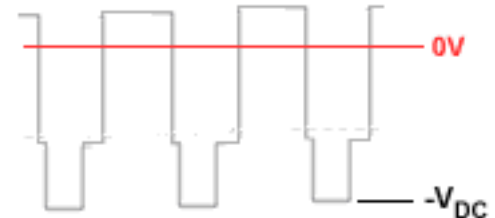


Fig. 3. White Signal across Transformer Winding

The transformer winding cannot support dc voltage, so that, as shown in Fig. 3, the video signal across it will be offset in the negative direction by an amount equal to V_{dc} .

The dc current through the transformer is

$$I_{dc} = V_{dc} / 75$$

and, as picture content changes, V_{dc} and I_{dc} will change accordingly. However, current through an inductor cannot change instantaneously, so the transition from the initial to the final current value will require a period of time determined by the circuit constants. To investigate these transient effects, we shall evaluate the dc levels for various picture conditions.

WHITE PICTURE

The horizontal sweep interval of the NTSC video signal is 63.5 μ s, the sync pulse width 4.7 μ s and blanking 10.9 μ s. As a result, the duty cycle is 82.8% for picture information and 92.6% for the sync pulse region. We then arrive at the following dc values for different portions of the signal:

white signal area:	546.48mV
black signal area:	44.38 mV
sync area:	264.84 mV

A white picture will have a dc level equal to the sum of the three area values, i.e 855.7mV. The dc current flowing through the transformer primary will be 22.8mA,

i.e. 1.71 / 75.

Again refer to Fig 3. for the signal across the transformer primary. It has no dc component since it is offset by -0.8557V.

CHANGING PICTURE CONTENT

Let us assume that, after a white picture has been transmitted for a while with 22.8mA dc flowing through the transformer primary winding, the video signal suddenly disappears. The new dc voltage and current values are both zero, but they will be reached only after some time since the 22.8mA current cannot change instantly.

To sustain it momentarily requires $-0.8557V$ across the transformer winding. That voltage will decay exponentially to zero according to the formula

$$0.8557 e^{-(t/T)}$$

where $T = L/R$, L being the inductance of the winding and $R = 37.5\text{ohm}$

Similarly, a black picture has a dc level 309.22 mV resulting in 8.25mAdc. When the picture changes from white to black, the winding has to generate

$$855.7 - 309.22 = 546.5\text{mV}$$

and the decay formula becomes

$$0.546.5 e^{-(t/T)}$$

Many applications utilize North Hills' 117CC video transformer to provide ground isolation and eliminate noise. The 1117CC has of the order of 20mH inductance at 22mA, so that $T = 533\mu\text{s}$. The sync tip following the first horizontal sweep period of the black picture will move up 61mV, the second 54mV, the third 48mV etc. The dc restore circuit in the display circuitry will have to realign the sync tips in a straight line. The restore circuit is limited with respect to the magnitude of voltage increments it can correct for. The change from $-0.86V$ to $-0.31V$ takes places at a rate where the sync tip level changes as much as 60mV/horizontal sweep period which is much beyond the restore circuit's response capability.

As a result there would be a loss of sync and one would see a series of gray lines rather than an abrupt change from white to black.

Also the 1117CC has a low frequency cut-off of 10Hz. However, with 22ma flowing through the primary winding that frequency is raised to close to 300Hz. The increase in low frequency response causes further degradation of the video image.

This problem can be easily corrected if one removes the dc component. North Hills NH 16130 does this by incorporating an internal filter. The filter removes the offending dc component, which preserves the 10Hz low frequency response regardless of picture content. The absolute sync tip levels will also rise and fall, but the maximum change per horizontal period will be limited to a manageable 2mV.

Please don't hesitate to contact us to discuss your particular applications and needs.