ANALOG DEVICES

AN-205
APPLICATION NOTE

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Video Formats and Required Load Terminations

by Bill Slattery

A number of international standards exist for specifying video levels used in television and video monitors. This application note describes some of the more common standards and compares their similarities. It also details the required load terminations for Analog Devices video RAM-DACs and explains how alternate video standards can be implemented by altering the load termination.

VIDEO STANDARDS

The NTSC standard is the one most commonly used in North America and Japan, while Europe uses PAL and SECAM video standards. Figure 1 shows an RGB video waveform, and Table I shows the associated current, voltage and IRE relationships for the various video standards.

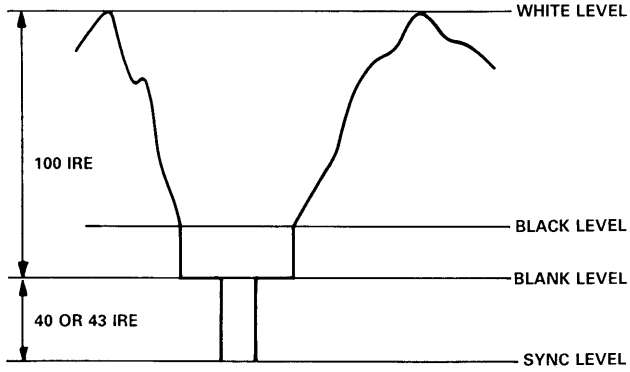

Figure 1. RGB Video Waveform

Table I. Levels Associated with Various Video Formats

	Video Output Levels	IRE Units	Volts	Singly Terminated Line mA (typ), 75Ω Monitor	Doubly Terminated Line mA (typ), 75Ω Monitor
NTSC RS-343A	Blank to White	100	0.714 ±0.1	9.52	19.04
	Blank to Black	7.5 ±5	0.054 (typ)	0.714	1.43
	Blank Level		0	0	0
	Blank to Sync	40 (typ)	−0.286 ±0.05	−3.81	−7.62
NTSC RS-170	Blank to White	100	1.0 ±0.05	13.33	26.67
	Blank to Black	7.5 ±2.5	0.075 (typ)	1	2
	Blank Level		0	0	0
	Blank to Sync	40 ±5	−0.4 (typ)	−5.33	−10.67
PAL	Blank to White	100	0.714 (typ)	9.52	19.04
	Blank to Black	0	0	0	0
	Blank Level		0	0	0
	Blank to Sync	43 (typ)	−0.307 (typ)	−4.09	−8.19
SECAM	Blank to White	100	0.714 (typ)	9.52	19.04
	Blank to Black	0 to 7	0 to 0.049	0	0
	Blank Level		0	0	0
	Blank to Sync	43 (typ)	−0.307 (typ)	−4.09	−8.19

NOTE
This table indicates the Blank Level as being the zero reference level while the Sync Level is given a negative value. In the case where composite sync is asserted using the DAC, Analog Devices video RAM-DACs have the Sync Level as the zero reference level; the Blank, Black and White Levels are all offset positively by the value of Sync Level. This will have no effect on the implementation of a particular standard as this is determined by the relative magnitude of the Blank Level relative to the White Level. The Blank to White Level remains unchanged whether or not sync is being asserted by the DAC.

The composite video waveform illustrates the relationship between the white level and blank level (gray scale or video portion) as well as the black and sync levels. The amplitude level between the blank level and white level is defined to be 100 IRE units. This corresponds to a voltage level of either 1V or 0.714V. The newer international standards specify the lower voltage level of 0.714V. The RS-343A, PAL and SECAM standards all specify a blank to white level of 0.714V, while RS-170 specifies a level of 1V. The blank to black level, also known as the setup or pedestal, is used to ensure a blacker than black beam level during retrace. The amplitude of the blank to black level varies between 0 and approximately 7.5 IRE units, depending on the video standard used. An additional 40 to 43 IRE units are required to drive the beam to the sync level. The sync levels of 40 IRE units for NTSC and 43 IRE units for both PAL and SECAM are close enough in tolerance to the 40 IRE levels of Analog Devices video RAM-DACs, thus enabling Analog Devices parts to output either NTSC, PAL or SECAM video formats. Table I illustrates the various amplitude levels and their tolerances for the video formats outlined above.

The most common of the four video standards used in computer graphics is RS-343A. The three RGB (red, green and blue) signals are individually generated, each one containing video, blanking and sync information. In many cases however, sync information is only encoded onto the green channel.

LOAD TERMINATIONS

Analog Devices video RAM-DACs are capable of driving 75Ω monitors using either doubly terminated or singly terminated loads. Table I shows the currents associated with the various video standards, for both 75Ω load termination and 37.5Ω (doubly terminated 75Ω) load termination. Figures 2 and 3 show the electrical connections between the video RAM-DAC and monitor. Any of the video standards listed in Table I can be implemented using either of these two terminations. Note that for singly terminated loads, I_{OUT} will have to be changed by adjusting I_{REF}.

IMPLEMENTATION OF RS-343A AND RS-170

Analog Devices video RAM-DACs can implement either RS-343A or RS-170. This is achieved, in the case of a doubly terminated configuration, by varying the value of the source termination resistance Z_S. Figures 4a to 4d show the required terminations as well as the associated RGB video waveforms for both RS-343A and RS-170 implementation when using the ADV478/ADV471. The assertion or nonassertion of sync is also distinguished in these diagrams. The advantage of using this technique to implement the different video standards lies in the fact that the output current level of the DAC need not be altered. The relationship between DAC output current, load termination resistance and voltage across the monitor is given by

$$V_L = \frac{I_{OUT} \cdot Z_S \cdot Z_L}{Z_S + Z_L}$$

V_L = voltage developed across monitor
I_{OUT} = DAC output current
Z_S = source termination resistance
Z_L = cable/monitor impedance

Since the relevant video standard is determined by the voltage developed across Z_L, altering the value of Z_S is a simple method of selecting any of the video standards.

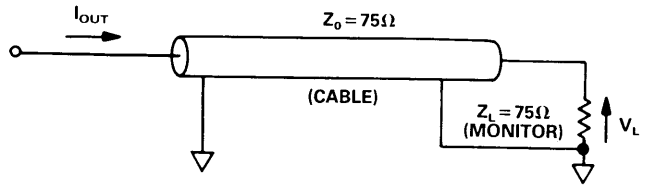

Figure 2. Singly Terminated 75Ω Load

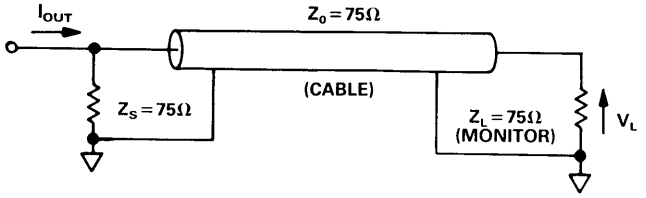

Figure 3. Doubly Terminated 75Ω Load

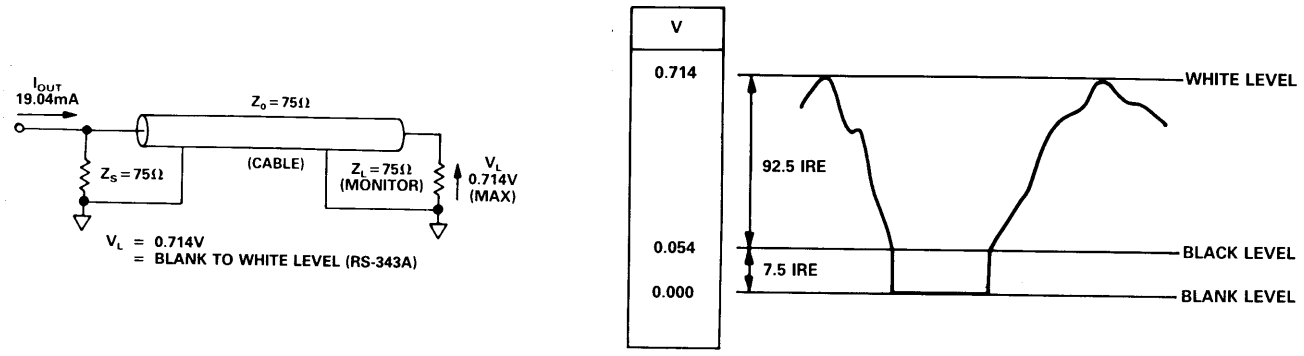

Figure 4a. RS-343A Load Termination & RGB Video Waveform (SYNC Not Asserted)

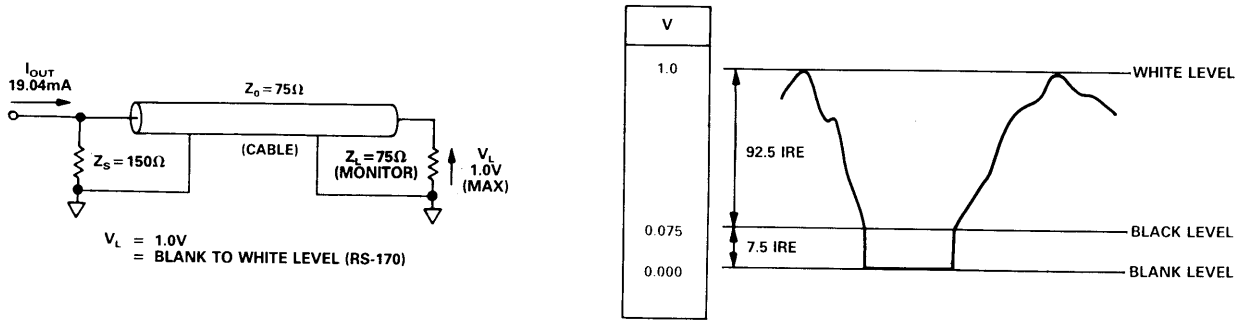

Figure 4b. RS-170 Load Termination & RGB Video Waveform (SYNC Not Asserted)

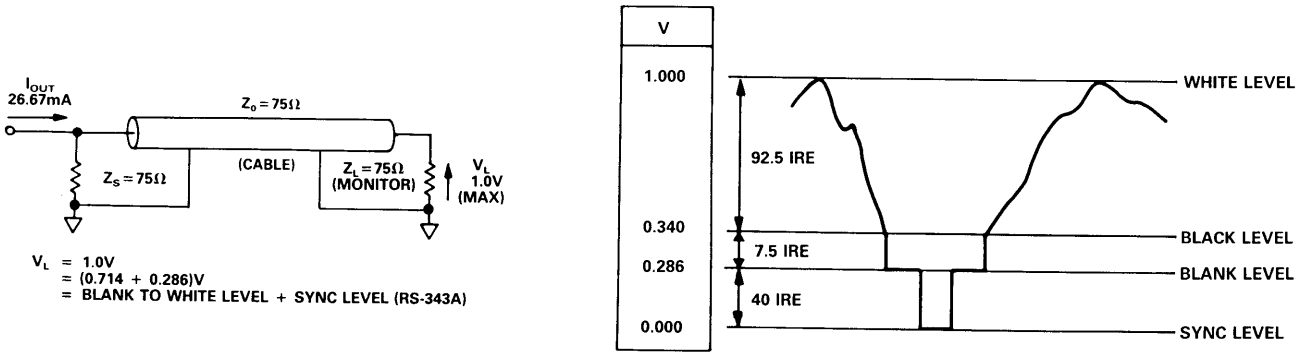

Figure 4c. RS-343A Load Termination & RGB Video Waveform (SYNC Asserted)

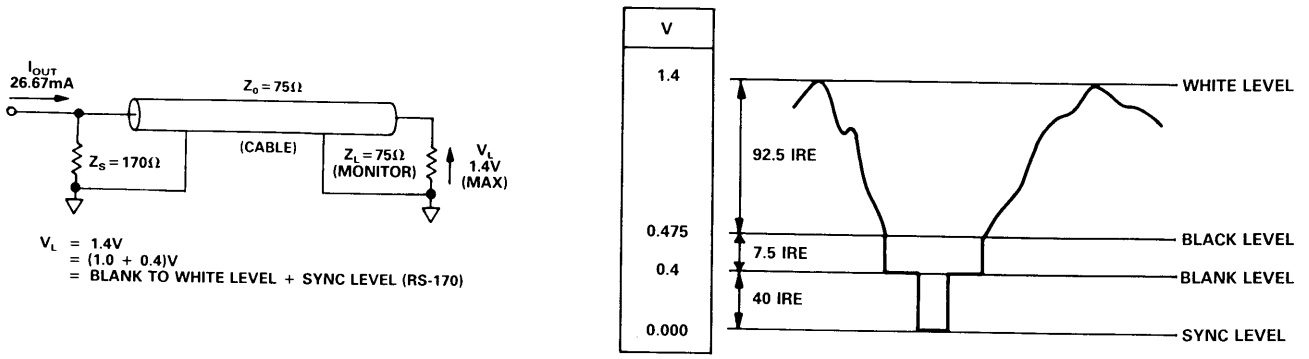

Figure 4d. RS-170 Load Termination & RGB Video Waveform (SYNC Asserted)

SELECTABLE TERMINATION

Figures 5a and 5b illustrate an interesting load termination technique which allows the user to select either RS-343A or RS-170. If the switch is in the closed position, RS–343A is implemented. If the switch is in the open position, a blank to white voltage level of 1V is developed across the 75Ω monitor load, corresponding to RS-170. In the case where sync is not asserted by the DAC, the termination is as shown in Figure 5a. When sync is asserted by the DAC, the output must be terminated according to Figure 5b.

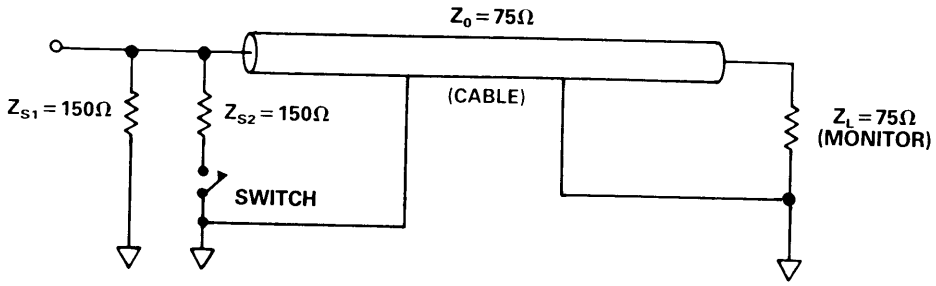

Figure 5a. RS-343A & RS170 Selectable Termination (SYNC Not Asserted)

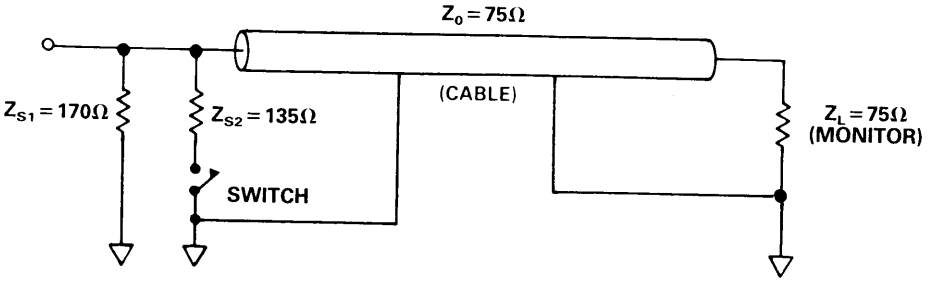

Figure 5b. RS-343A & RS170 Selectable Termination (SYNC Asserted)