

Agilent
Television Power Consumption Testing

Application Note



Introduction

Today, there are many types of televisions (TVs) on the market: the cathode ray tube (CRT) TV, liquid crystal display (LCD) TV, and plasma display panel TV. Which one has the least power consumption? And which one uses the most power? Are they running at the power consumption levels stated in their specifications? This application note will simulate the real use case of TV power consumption testing using Agilent products.

All TV manufacturers publish the TV power consumption specifications. Typically, two types of power consumption are published: normal mode and standby mode. Manufacturers must measure the TV power consumption when they are running in these two modes and estimate how much power a TV uses when displaying different video patterns (images).

TV Power Consumption Test Setup

The power consumption test is set up using three types of TVs — CRT TV, LCD TV, and plasma TV with the Agilent 6811B AC power source/analyzer, the Agilent U8101A display tester, and a few connection cables.

The TV power consumption test setup is shown in Figure 1 below. The 6811B power source/analyzer and the U8101A display tester is directly connected to CRT, LCD, and plasma TVs. The 6811B AC power source/analyzer acts as a power supply to provide 110 V and 240 V of electricity at 60 Hz frequency to each TV and the U8101A display tester provides signals with different video patterns via HDMI, S-video, DVI, component, and composite cables. The 6811B AC power source/analyzer then acts as a meter (analyzer) to make the power consumption measurement.

This test shows the difference in power consumption for different types of TVs. Three different types of TVs have been selected for this power consumption test, namely 29" CRT TV, 19" LCD TV, and 42" plasma TV.

The U8101A display tester is able to send different video patterns (images) with different formats and resolutions via different interfaces such as HDMI module, DVI module, TV module, and VGA module. For CRT TV, the display tester can only use the TV module card for this test, whereas all four module cards have been selected for the LCD and plasma TV testing.

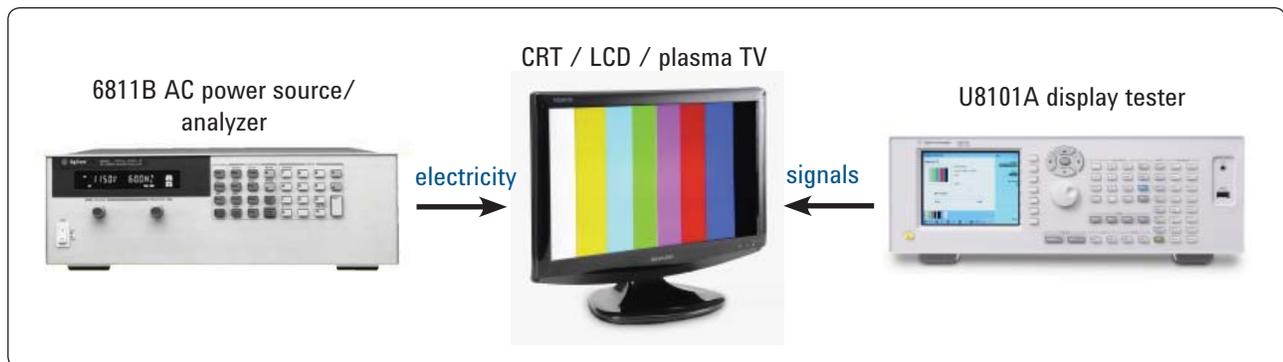
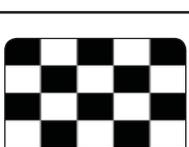


Figure 1. TV power consumption test setup

Table 1. Video patterns selected for testing

Video Pattern	Images
Black	
White	
Gray	
Blue	
Red	
Cyan	
Chessboard	
Colorbar	

Results

When the U8101A display tester sends a signal to the TV, there is not much difference in power consumption when different cable connections, formats, and resolutions are used. Only differences in video patterns affect the power consumption.

The video patterns chosen for testing are full-field signals (black, white, grey, blue, red, and cyan), chessboard, and colorbar. These video patterns have been selected to show different full-field signals with different brightness; the chessboard is the combination of black and white, and the colorbar is the combination of many colors. All TVs will first be operated in standby mode, and then turned on in operation mode with different video patterns.

In standby mode, all TVs are simply ready to turn on. The power consumed is shown on the front panel of the 6811B power source/analyzer. All TVs show results of less than 1 W.

However, when the TV is in operation mode, the power consumption is different than shown in standby mode. Table 2 shows the power consumption comparison of TVs during operation mode. Even though the TVs used in this testing vary in size, we can compare the TV performance in watts-per-square-inch ratings. The LCD TV has the lowest power consumption of 0.227 W/square inch, followed by the CRT TV rating of 0.322 W/square inch, while the plasma TV requires the most power, which is 0.444 W/square inch.

Table 2: Power rating comparison for different TVs

TV types	TV size (format)	Power (W)	Wide (inches)	Height (inches)	Square inches	W /Square inch
LCD	19 inches (16:9)	35	16.56	9.32	154.26	0.227
CRT	29 inches (4:3)	130	23.20	17.40	403.68	0.322
Plasma	42 inches (16:9)	335	36.61	20.59	753.76	0.444

CRT TV uses electrons to excite chemical phosphors and cause them to light up inside a glass tube, whereas plasma TV uses gas made up of free-flowing ions and electrons to create colors in millions of pixel cells. LCD TV uses a fluorescent backlight as source and activates the display panel through liquid crystals and polarized glass. Each of these three TVs uses a different architecture, so the amounts of power used are different.

Table 3, Table 4, and Table 5 show the power consumption results as compared to the published specifications. The CRT TV and plasma TV are not running at 100% of power consumption, while the LCD TV is running at almost 100% power consumption during operation mode.

The power consumption levels of CRT TV and Plasma TV are more dependent on the brightness of screens. Comparing the full-filled signals of black, grey, and white, the white uses more power than gray, while black uses the least power.

The LCD TV power consumption is at or near 100% of specified levels because the fluorescent backlight or bulb is always turned on. The exception is the black full-field signal, for which the fluorescent backlight or bulb is turned off.

Table 3. Power consumption of a 29" CRT TV

Mode	Video Pattern	Specifications	110 V, 60 Hz	240 V, 60 Hz
Standby	NA	< 1 W	0.8 W	0.8 W
Operation	Black	130 W	85.0 W	86.0 W
	White		130.4 W	129.5 W
	Gray		106.8 W	106.3 W
	Blue		120.0 W	119.0 W
	Red		129.1 W	128.0 W
	Cyan		128.8 W	127.7 W
	Chessboard		128.2 W	127.2 W
	Colorbar		126.9 W	125.9 W

Table 4. Power consumption of a 19" LCD TV

Mode	Video Pattern	Specifications	110 V, 60 Hz	240 V, 60 Hz
Standby	NA	0.6 W	0.2 W	0.4 W
Operation	Black	36 W	16.2 W	19.5 W
	White		36.1 W	36.2 W
	Gray		36.5 W	36.2 W
	Blue		35.5 W	36.1 W
	Red		36.1 W	36.0 W
	Cyan		36.0 W	35.9 W
	Chessboard		36.0 W	36.1 W
	Colorbar		35.9 W	36.0 W

Table 5. Power consumption of a 42" plasma TV

Mode	Video Pattern	Specifications	110 V, 60 Hz	240 V, 60 Hz
Standby	NA	< 0.7 W	0.5 W	0.6 W
Operation	Black	335 W	334.9 W	335.2 W
	White		206.3 W	206.5 W
	Gray		274.7 W	274.6 W
	Blue		309.2 W	309.0 W
	Red		332.5 W	332.4 W
	Cyan		329.9 W	330.1 W
	Chessboard		328.3 W	328.1 W
	Colorbar		324.0 W	323.6 W

Another method to check the TV power consumption is to run two different movies on the same type of TV and obtain the average power consumption using the 6811B power source/analyzer respectively. In this application, the two movies used are “Star Wars” and “Eight Below”.

When watching on CRT and Plasma TVs, power consumption for these two movies is different because the background of the “Star Wars” movie is darker while the “Eight Below” is brighter. The power consumption is lower with the “Star Wars” movie and higher with “Eight Below”. This is because more power is required for brighter movies when using CRT or plasma TV.

When using an LCD TV to watch these two movies, the power consumption turned out the same. This is because the fluorescent backlight or bulb is turned on all the time, so the LCD TV power consumption is always the same as the power consumption specified. Refer to the results shown in Table 6.

LCD TV uses power at almost 100% of specified power consumption, while CRT and plasma TVs do not. The power consumption specification shown on the CRT TV and plasma TV represent only the peak usage. Even though CRT and plasma TV are not used at 100% power consumption, the LCD TV still uses less power than CRT and Plasma TV. Plasma TV generally is still considered the TV that requires the most power of the three types of TVs used in this study as shown in Table 3, 4, and 5.

Table 6. TV power consumption comparison for different movie brightness

Types of TV	Movie	
	Eight below	Star Wars
CRT TV	92% of its power consumption	84% of its power consumption
Plasma TV	93% of its power consumption	87% of its power consumption
LCD TV	99% of its power consumption	99% of its power consumption

Conclusion

The Agilent U8101A display tester, with the combination of the 6811B power source/analyzer, provide a complete solution for TV power consumption testing.

The U8101A is able to test many video patterns with different formats and resolutions via different connections. With customizable module cards installed, the U8101A enables testing across a broad range of analog as well as digital CRT and flat-panel displays. It is also suitable for many testing environments such as production line and research and development (R&D). The level of troubleshooting depends on the module cards installed. Intuitive graphical user interface (GUI), hotkeys, and 16 memory sequences provide faster speed, and easier setup for users.

The 6811B power source/analyzer not only provides electrical power to the TV but also acts as a meter to check the power consumption of the TVs. Used as power source, the 6811B can work as a power amplifier and an arbitrary waveform generator. If the 6811B is used as an analyzer, it has the capabilities of multimeter, oscilloscope, harmonic analyzer, and power analyzer. These combinations make it easy for users because 6811B power source/analyzer can meet many application needs without using additional instruments.



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