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tech tips

How To Test Projection CRTs With Your CR7000 "Beam-Rite"

Projection television sales have shown steady increase throughout the 90's and they are expected to continue climbing. There is a good opportunity for servicers willing to do installation, alignments, and repair on projection televisions. This Tech Tip will explain how to test and restore the key components in a projection system, the CRTs. The ability to accurately test the CRTs in a projection system is very important due to their large expense. A projection TV with a bad CRT will not track properly and unless the CRT can be restored, many times all three tubes have to be replaced to obtain a satisfactory picture.

Figure 1 shows the basic methods used to project an image on a large screen. As illustrated, one method uses a single standard color CRT to produce the image. This method is rarely used since it produces a picture of limited brightness. To make the picture bright, most projection systems use three CRTs.

Three Tubes are Working Together to Make the Picture

A tri-color CRT contains individual red. green, and blue electron guns. The main elements in each gun are the cathode, the control grid, and the screen grid. The cathode is the material that emits electrons when heated by a filament (often referred to as a heater). These electrons are formed into a beam, which changes intensity according to the signal voltage applied to the cathode.

The first grid, called the control grid, is negative with respect to the cathode and limits or controls the amount of electrons that flow from the cathode. A second grid, the screen grid, helps form the electrons into a finer beam, and begins accelerating the beam towards the CRT's high voltage anode as illustrated in figure 2. The electron beam from each gun strikes its corresponding red, green, or blue phosphor. When struck, the phosphor gives off light in proportion to how many electrons hit it. The three beams are then converged to produce a very small dot on the screen. Different colors are displayed by making the phosphors glow in varying proportions.

To change the overall picture brightness, more electrons from each gun are allowed to strike the phosphors. For example, to make a picture brighter, the G1 voltage can be made more positive with respect to the cathode. This will allow more electrons to flow through G1 and hit the phosphors. The color tint will stay the same as long as the proportion of electrons striking each phosphor stays the same. This proportion should stay the same unless the signal is changed at the cathodes.

Think of each CRT in a projection system as a single gun or cathode in a direct view color CRT,

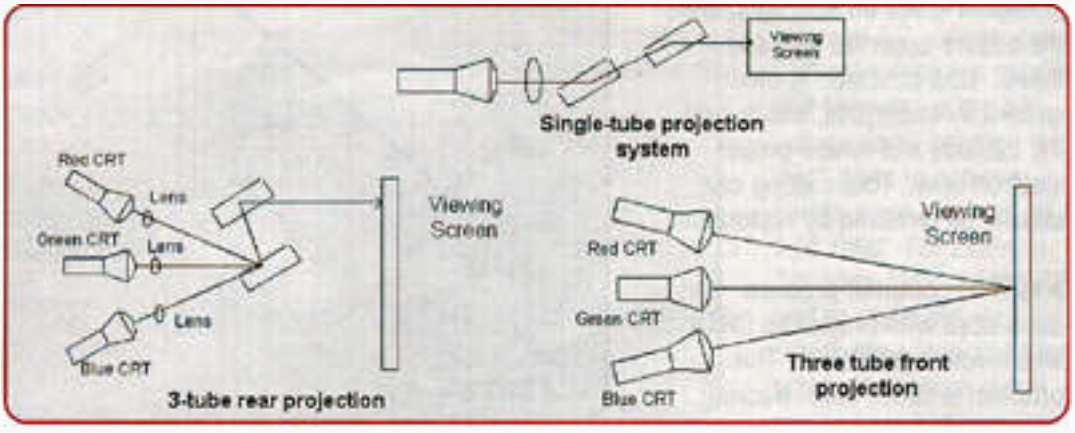

Fig. 1: While several methods may be used to produce the large picture in projection television systems. most projection systems use three CRTs.

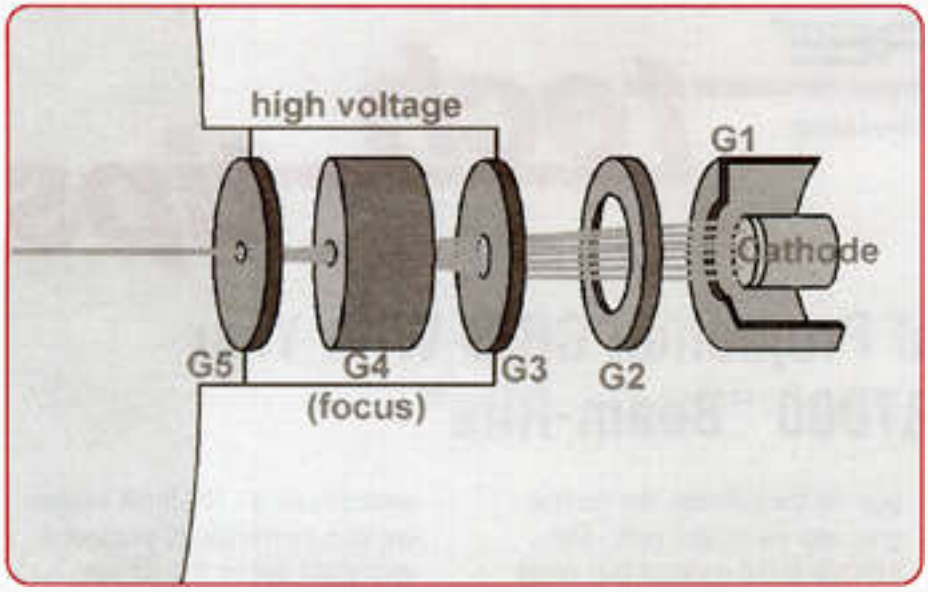

Fig. 2: The positive voltage at G2 pulls the electrons from the cathode, through G1, and sends them towards the high voltage.

complete with its own phosphor. The projection CRTs are coated with just one color of phosphor instead of being coated with all three phosphors. Some projection systems use three black and white CRTs and run the produced light through a color filter. In either case, each CRT produces just one color of light red, green, or blue. The light from each tube mixes with the light from the other tubes at the projection screen.

How Projection CRTs Fail

Projection tube failures are similar to non-projection CRT failures. First, projection CRTs may develop low cathode emission. As the emission level decreases the phosphor gives off less light, and the picture becomes dim and faded. Low emission is often caused by impurities, which coat the cathode and inhibit proper electron flow. This coating can usually be removed by restoration.

A second common problem associated with projection CRT's also involves emission. This problem is called color tracking. Poor color tracking is caused when the individual guns in a projection system degrade at different rates. Equal light output from each gun is required to produce the color white and all shades of gray.

If the emission from any one tube drops below the level of the remaining two, pure white and other shades of gray cannot be produced. Cutoff and Drive controls in the television chassis compensate for small differences, but they have limited range. Often, the tube ends up being replaced.

Why You Need A Projection CRT Restorer

Many times replacing only one CRT in a projection system makes color-tracking problems even worse. This is because the new tube has much more emission than the two old tubes, which remain in the set. See figure 3 for an illustration.

One way to cure color-tracking problems is to replace all three tubes. This is an expensive solution since most projection CRTs cost $150 to $500 each. Add in the labor for installation and alignment, and you have a repair bill of around **$1500.** Many customers are unwilling to pay that much for a repair.

The CR7000's seven levels of restoration is reliable alternative to replacing all three tubes and a big reason the CR7000 is a necessity for projection television servicing. With the CR7000 you can safely restore your weak CRT using only the smallest amount of restore current necessary. You can also test all three CRTs after restoration to see if they will properly track.

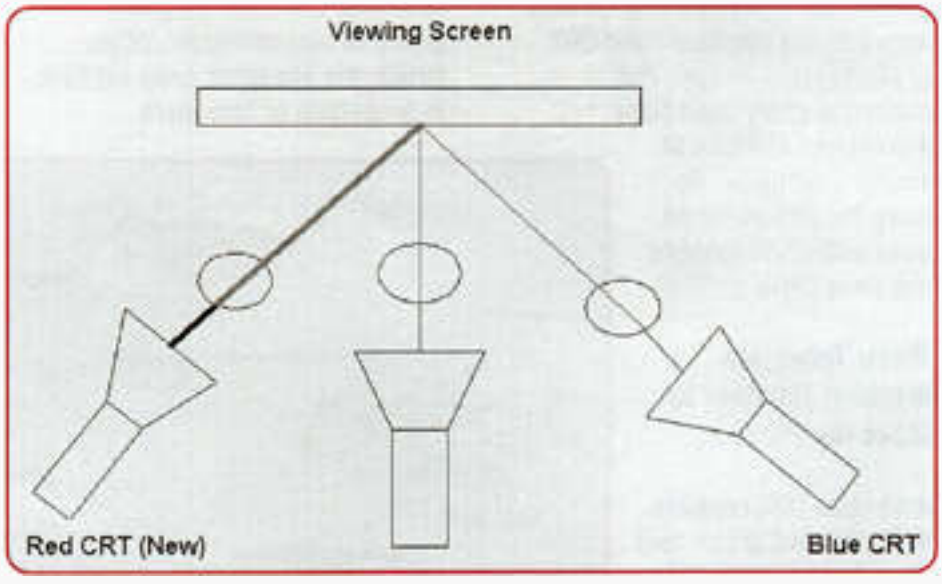

Fig. 3: One tube in a projection system with too much emission causes a color tracking problem, because its light output is too great compared to the other tubes.

Why Projection CRTs Require a Special Tester

Projection CRTs operate with a very high beam current of 800 uA or more. The higher beam current is needed to drive the phosphor hard enough to produce a bright picture on a large screen. Most CRT testers do not have enough emission range to test these tubes accurately. The CR7000 can accurately test these high emission tubes with its exclusive "sliding scale" emission test. The CR7000's emission scale is set by the CRT's bias. This allows you to accurately test any CRT at its actual emission range.

Bias Voltage	IK max (New emission)	CR7000 Good/Bad
-20	268 uA	134 uA
-36	648 uA	324 uA
-52	1125 uA	563 uA
-68	1682 uA	841 uA
-84	2310 uA	1155 uA
-100	3000 uA	1500 uA
-116	3748 uA	1874 uA
-132	4550 uA	2275 uA
-148	5401 uA	2700 uA
-164	6301 uA	3150 uA
-180	7245 uA	3622 uA

Fig. 4: The CR7000 can accurately test a CRT with emissions as high as 7245 uA.

A second problem with testing projection systems is limited space. Because the three tubes in a rear projection TV are pointed up, there is very little space between the chassis and the CRT. To connect to this type of a CRT a small flexible adapter is needed. Sencore has designed the sockets to be used with these hard to reach CRTs.

Using the CR7000 is Fast and Easy

To use the CR7000 to test or restore a CRT, you only need some basic setup information. You can get the setup information from the Sencore CRT setup book. The setup book will give the correct bias range and socket to properly test the tube. Once the bias voltage is set, the CR7000 will automatically change the emission range to accurately test the CRT. The second and third CRTs will use the same socket and settings as a first one; therefore only one CRT needs to be looked up in the setup book.

Exclusive Tests Tell You Exactly What is Wrong With the CRT.

You should always test a tube before doing any restoration. The CR7000 provides a series of tests to isolate what is wrong with a CRT. Do the tests in the order that they appear on the function knob. See figure 5 for an illustration of the function knob. Each test checks a different aspect of the CRT's operation, such as shorts, cutoff ability, emission, and the ability of the colors to track one another. If the CRT fails any one of these tests it is bad. The individual tests allow you to see which tube or tubes need restoration. The tests also tell you exactly what is wrong with a defective tube. Following is a brief description of each test.

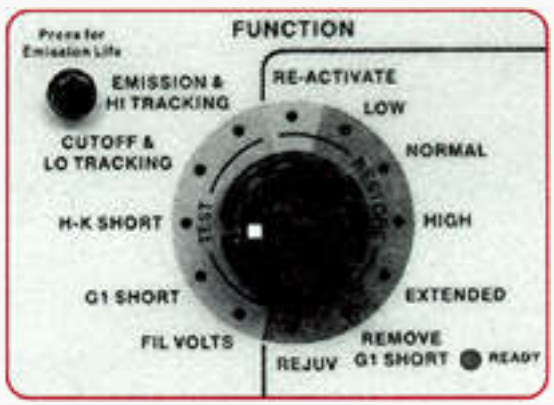

Fig. 5: The CR7000's function test should be performed in the order they appear around the function knob.

1. The H-K Shorts and G1 Shorts tests - gives a positive indication of shorted gun elements in the tube. The CR7000 shows a short on a meter that can indicate the severity of the short instead of giving you a good/bad LED.

2. The Cutoff Test - The cutoff test dynamically reproduces the point where the electron gun comes out of cutoff and starts to conduct current. The CR7000 has 11 different bias ranges from -20V to -180V so that the CRT is always tested according to manufactures specifications. This cutoff point is the normal "black" picture level. A good tube can be adjusted into the Grey cutoff area when the CUTOFF LEVEL CONTROL is adjusted. A CRT that cannot be brought into cutoff area will have poor contrast. The picture may still look OK but it lacks the dynamic range it had when it was new.

3. The Low Tracking Test - In addition to specifying that each gun reach cutoff within a certain bias and G2 voltage, color CRT manufactures specify that the ratio of the G2 voltage used between the three guns to achieve cutoff, must meet a 1 to 1.25 ratio. For example, if it takes 100V on the G2 grid to make red reach cutoff; the green and blue tubes must reach cutoff somewhere between 75 - 125 volts.

4. The Emission Test - The emission test measures how much current the electron gun can produce at zero bias. During the emission test, the negative bias is removed from G1; the G2 voltage that was set during the cutoff test is then applied to the tube. This will simulate maximum video drive (white picture levels). The CR7000 uses a sliding good/bad scale which tests the CRT at the manufacturer's specified level.

5. The High Tracking Test - The high tracking test stores the emission readings from the three separate guns and compares them to each other. CRT manufactures have established a ratio of 1 to 1.55 as the greatest allowable variance between the strongest and weakest guns. If the guns fall out of tolerance, the picture will have poor gray scale or improper colors. The CR7000 High Tracking test automatically calculates the tracking ratio as it displays the emission readings.

Restoring the CRT

A tube should always be tested before restoration is attempted! The first five Restore functions (RE-ACTIVATE, LOW, NORMAL, HIGH, and EXTENDED) bring fresh emitting material to the cathode surface by removing old emitting material and contamination from the cathode's surface. Five levels of restoration are provided so that **no unnecessary strain will be put on the CRT.** The difference between the levels is the amount of current drawn and the duration of time the current is being drawn. Always begin with the lowest level of restoration (RE-ACTIVATE) and move to a higher level only if the lower level does not return acceptable results. Keep in mind that restoration does not add any emitting material to the CRT. **Always use as** little **restoration as possible.** In many of the restore settings the filament voltage is increased to soften the contamination on the cathode. To get the most accurate results when testing a CRT after restoring, allow a little time for the filament to cool and the readings to stabilize.

In addition to the five restore functions the CR7000 also provides a Remove G1 Shorts and a REJUV function. The Remove G1 Shorts feature should be used only after a G1 short has been detected with the shorts test. The REJUV function should only be used after all five restore functions have failed work on the tube.

Summary

As you can see, the CRT is a very important component in the projection TV system. The CR7000 is one of the instruments that should be used to make profits when aligning or repairing a projection TV. Color balance is also a very important when aligning these systems. A color meter like the Sencore CP290 or CP288 should always be used to check and set color temperature when installing or calibrating a projection television. Servicers with the right knowledge and tools will make large profits in the future with the advent of HDTV. Anyone interested in these opportunities should contact Sencore at 1-800-736-2673 and ask how you can take advantage of these opportunities. Sencore is dedicated to providing test equipment and training solutions both now and in the future.

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