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tech tips

# How To Test Projection CRTs With Your CR70 Universal CRT Analyzer And Restorer

Projection television system sales are showing tremendous growth. Sales of projection systems has increased from 139 thousand units in 1981 to over 300 thousand in 1986, and sales are expected to continue climbing. In this Tech Tip we'll take a look at what is needed to test and restore the key component in a projection television, the projection CRT.

Figure 1 shows the three basic methods used to project a large picture onto the viewing screen. As illustrated, one method uses a single, 3-gun color CRT to produce the large screen picture. This single-tube method is the least common since it produces a picture of limited brightness. To make a bright picture, most projection systems use three tubes.

## Three Tubes Work Together To Make The Picture

A tri-color CRT contains individual red, green and blue electron guns. The main elements in each gun are a cathode, a control grid and a screen grid. The cathode emits electrons when it is heated by a filament. These electrons are formed into a beam which varies in intensity according to the video signal voltage applied between the cathode and control grid.

A second grid, the screen grid, helps form the electrons into a still finer beam, and begins accelerating the beam towards the CRT's high voltage anode, as figure 2 illustrates. The electron beam from each gun strikes its corresponding red, green, or blue phosphor which is located just behind the anode. The phosphor gives off light in proportion to how many electrons hit it. The beams are converged to produce a very small dot on the screen. Different colors are produced 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. The color tint stays the same as long as the proportion of electrons striking each phosphor remains the same.

Think of each projection CRT as a single gun in a tri-color CRT, complete with its own phosphor. Instead of being coated with all three phosphors, however, the face

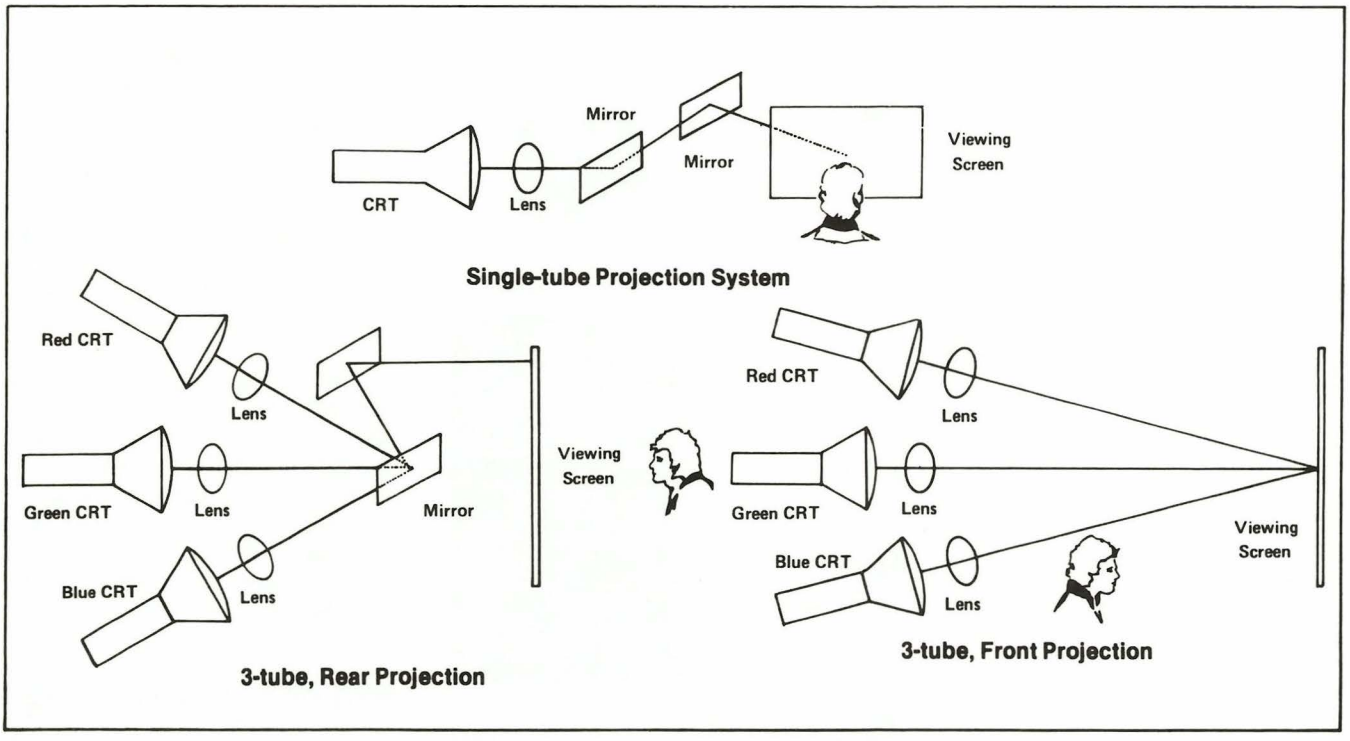



*Fig. 1: While several methods may be used to produce the large picture in projection television systems, most projection systems use three separate CRTs.*

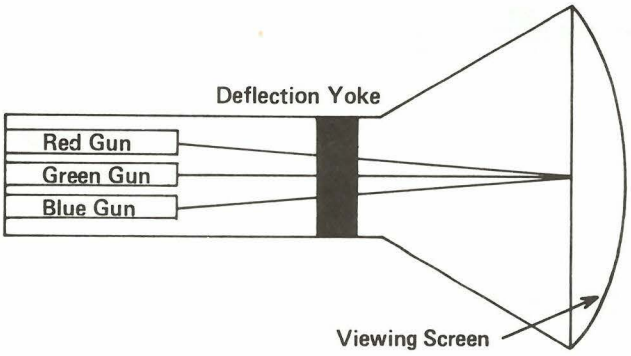



*Fig. 2: The individual electron beams in a tri-color CRT are converged at the viewing screen to produce a color picture.*

of each projection tube is coated with just a single phosphor. Each CRT gives off just one color of light, either red, green or blue. The light from each tube mixes with the light from the other tubes at the projection screen.

## How Projection Tubes Fail

Projection CRT failures are similar to non-projection CRT failures. First, projection CRTs (or the guns in a tri-color CRT) may develop low cathode emission. As the emission level decreases the phosphor gives off less light, and the picture becomes too dark to watch. Low emission is usually caused by the cathode becoming coated when gases inside the tube oxidize with the cathode material. As the coating builds over the cathode, it prevents electrons from leaving the surface.

Perhaps the most common problem associated with projection CRT systems also involves emission. This problem is called color tracking. Just as the guns in a tri-color CRT don't always degrade at the same rate, neither do all three CRTs in a projection television system. Equal light output from all three tubes is required to produce white.

If the emission from one tube drops below the level of the remaining two tubes, pure white and many other colors cannot be reproduced. Setup controls in the television chassis compensate for small differences in the tubes, but they only have limited range. Often, the bad tube ends up being replaced.

## Why Projection CRTs Require A Special Tester

Non-projection CRTs supply an average of about 300 microamps of beam current and this is the level most CRT testers and restorers are built for. As figure 5 shows, projection tubes operate with an average of 800 microamps of beam current and may even supply over 1 milliamp occasionally. This higher beam current is needed to drive the phosphor hard enough to produce a bright image at the projection screen. Your CR70 can test these higher current tubes.

The CR70's unique CRT TYPE switch, shown in figure 3, allows you to choose high current projection CRTs, medium current video CRTs and low current scope CRTs and test them for rated beam current. The correct bias voltages, restoring current levels, and meter scales are automatically switched in, matching the CRT you're testing.

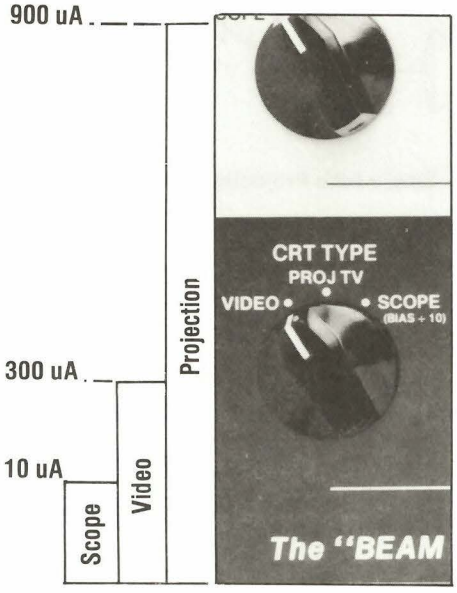
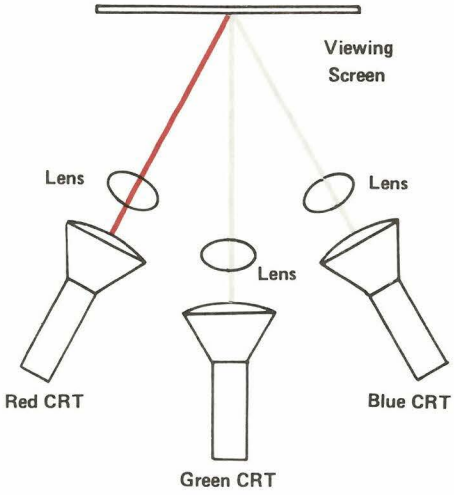



*Fig. 3: The CR70 tests all CRTs, regardless of the level of beam current. You simply set the CRT TYPE switch to the type you are testing.*

## Why You Need A Projection CRT Restorer

Replacing one bad tube in a 3-tube projection system usually makes color tracking problems worse, however, as figure 4 illustrates. This is because the new tube has much more emission than the old tubes which remain in the set. Again, we have a problem balancing the light output from the tubes.




**3-tube, Front Projection**

*Fig. 4: 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.*

One way to end a color tracking problem is to replace all three tubes. This is an expensive solution, however, since a single projection tube typically ranges in price from $135 to $300 (dealer cost). Because of the difficulty in removing the old tube and installing and realigning the new tube, you must add an additional labor cost of nearly $80, bringing the cost of replacing the three tubes to about $1000!

The CR70's five levels of restoration is a welcome, reliable alternative and one reason the CR70 is a necessity for projection television servicing. With progressive restoration, you start with a small amount of restoring current and work your way to higher levels as needed to restore the tube. You supply the CRT with only the amount of restoring current required to return the tube to normal.

## Using The CR70 Is Fast and Easy

To use the CR70 to test or restore a CRT, you only need some basic setup information. You can get the setup

information out of the setup book, or directly off a schematic. This information includes the pin numbers of the filament, cathode, control grid (G1), and screen grid (G2). The switches on the CR70 are set to correspond with these numbers. The setup for each tube in a 3-tube projection system is the same. Therefore, as you test each tube you simply need to connect the CR70 socket to each tube without resetting the setup switches.

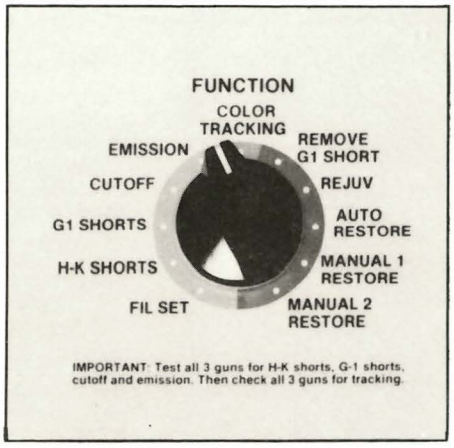



***Fig. 5: The CR70 provides a series of separate, inter-related tests which dynamically check a CRTs' condition.***

*NOTE: If the set-up requires the use of the Universal Adapter, refer to the Operation and Application Manual for the CR70 or Tech Tip 129 on ''Using the Universal Adapter''.*

To test high-current tubes with the CR70 you simply set the CRT TYPE switch to PROJ. There are a few projection tubes that do not operate at higher beam current. These tubes are called ''Schmidt Valves'' or simply ''Schmidt'' tubes. They operate at 300 uA of beam current as most non-projection, tri-color CRTs do. The shaded box in this Tech Tip explains how Schmidt tubes work and how you can identify them. If you are testing a Schmidt projection tube, simply set the CRT Type switch to the VIDEO position.

## Exclusive Tests Tell You Exactly What's Wrong With the Tube

You should always test a tube before you restore it. The CR70 provides a series of separate, inter-related tests on the CRT. You do the tests in the order they appear around the function switch shown in figure 5. Each test checks a different aspect of the CRT's operation, such as shorts, poor cutoff, low emission, bad life, and tracking ability. If the CRT fails any one of the tests, it is bad.

Individual tests allow you to know exactly what is wrong with the tube, so you can use the best method of restoration for the particular failure. Briefly here's what the tests do:

1. The H-K SHORTS and G1 SHORTS tests give a positive indication of shorted gun elements in the tube.

2. The CUTOFF test checks the low level output of the tube. If you cannot adjust the meter into the CUTOFF SET area with the CUTOFF SET control, you know that the tube will not produce a picture that has good contrast.

3. The EMISSION test gives the true beam current of the tube from the cathode to the G2 grid. This test can identify if a tube produces a weak or dark picture, but multi-tube systems must also be able to produce comparable emission levels between the tubes.

4. The COLOR TRACKING circuits inside the CR70 are designed to ''remember'' the emission level of each tube for at least 15 minutes. This is important because it allows you enough time to connect to and test each tube in a 3-tube projection system. For the tubes to track properly, the ratio of the highest emission to the lowest emission must fall within a 1.55:1 ratio. Only if the emission falls within this industry standard ratio will the setup controls inside the television allow the tubes to be balanced for equal light output.



## Tech Talk

### Schmidt Projection Tubes

Most CRTs are very similar in their operation. Each focuses an electron beam onto a phosphor surface which in turn gives off light. The light output of these tubes is not as great as it could be, however, because the electron beam strikes the back side of the phosphor while the light comes off the front side.

For normal-view picture tubes, a sufficiently bright picture is produced using 300 microamps of beam current. In projection tubes where high light output is required, the beam current must be increased to strike the phosphor harder.

Schmidt projection tubes do not require a higher beam current to produce a bright picture. Schmidt tubes use a first-surface phosphor and a concave mirror to project a bright picture. The light does not pass through the phosphor in a Schmidt tube. Instead, the light comes off the same side of the phosphor that the electron beam strikes. Then the light goes back into the tube where it hits a mirror and is projected out.

This is important to know if you're testing a Schmidt projection tube since their setup is slightly different than conventional projection tubes. You can easily identify a Schmidt projection tube. Other projection tubes have a flat, rectangular-shaped face that you can see a raster on when the set is operating.

A Schmidt tube, however, has a long, thin neck and a round face. The inside of the tube looks a little bit like a car headlight because you can see the concave mirror. In the center of the mirror is the hole where the electron beam passes through, and suspended in front of it is the small, phosphor target.

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