Narragansett imaging

Technical Information

PLUMBICON IMAGING TUBES: OPERATIONAL NOTES

April 2004

Narragansett Imaging 51 Industrial Drive North Smithfield, RI 02896
Tel: (401) 762-3800 Fax: (401) 767-4407
www.nimaging.com

PROPERTIES OF THE LEAD OXIDE PHOTOCONDUCTIVE LAYER

The Plumbicon tube has a lead oxide photoconductive layer. In tubes with an extended red response a small amount of sulfur is added to the lead oxide.

Sensitivity

Since the Plumbicon tube has a linear light transfer characteristic, its sensitivity can be specified completely by the number of μA/lumen (d.c. value).

Sensitivity increases with target voltage, but at the recommended voltage (45V) it is almost at maximum and rises only slightly with further voltage increases.

For a given target illumination, the signal current is a function of the scanned area; but it can be shown that in the Plumbicon tube with its linear transfer characteristic, camera sensitivity is independent of tube size for the same depth of field and viewing angle.

Spectral Response

1-inch Plumbicon tubes with extended red sensitivity, such as the XQ1073, have somewhat lower red and deep red sensitivities compared to the XQ1560A due to a smaller amount of sulfur in the photoconductive layer. For correction of the color response therefore less filtering is needed.

Resolution

The resolution of Plumbicon medical tubes is higher than that of broadcast tubes. A thinner photoconductive layer with extended-red response increases the resolution.

Figure 1 shows typical modulation transfer characteristics of some Plumbicon tubes, measured in green light, as a function of the number of line pairs per mm.

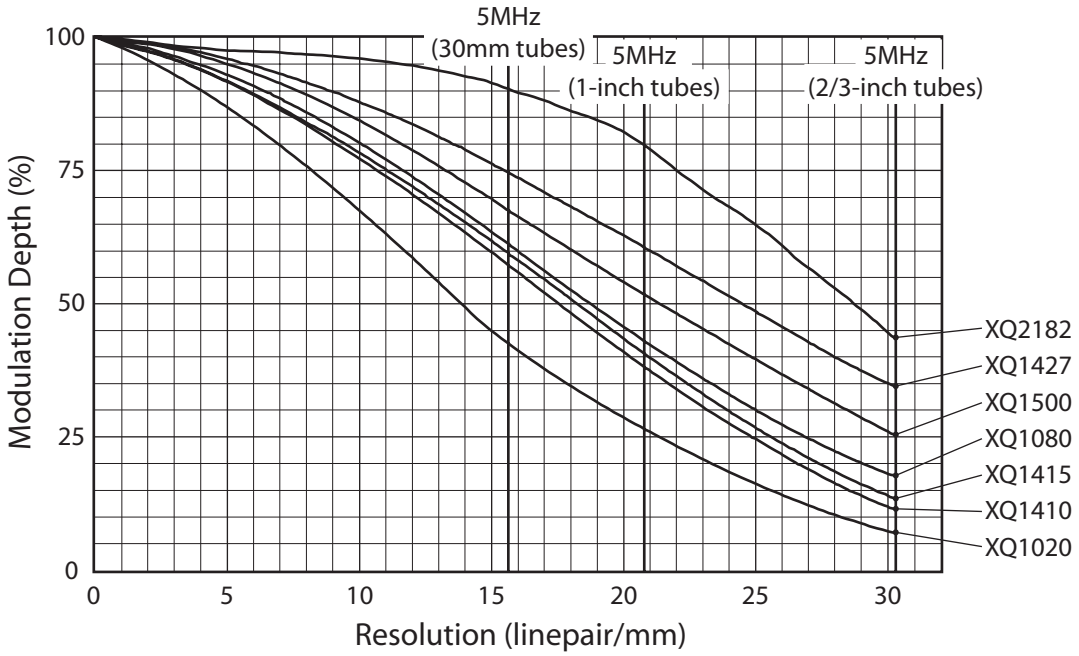

Figure 1. *Typical square-wave modulation transfer function of some Plumbicon tubes.*

The vertical line sin the figure correspond to 400 TV lines for 30mm (15.6 lp/mm), 1-inch (20.8 lp/mm) and 2/3-inch (30.3 lp/mm) tubes. It can be seen that at 400 TV lines (5Mz) resolution increases with increasing tube size (increased scanning area). For a given number of line pairs per mm the smallest tube has the highest resolution.

Lag

The photoconductive lag of the lead oxide layer is practically negligible. Due to the fact that the photoconductive layer is relatively thick (10 to 18µm, depending on tube type), Plumbicon tubes show very little discharge lag at normal signal currents.

Discharge lag becomes evident under low key conditions, when signal currents are small. This type of lag depends on layer capacitance and beam resistance. The effective beam resistance is decreased by applying light bias and thereby the discharge lag is reduced. Figure 2 shows an example of the effect of light bias on discharge lag.

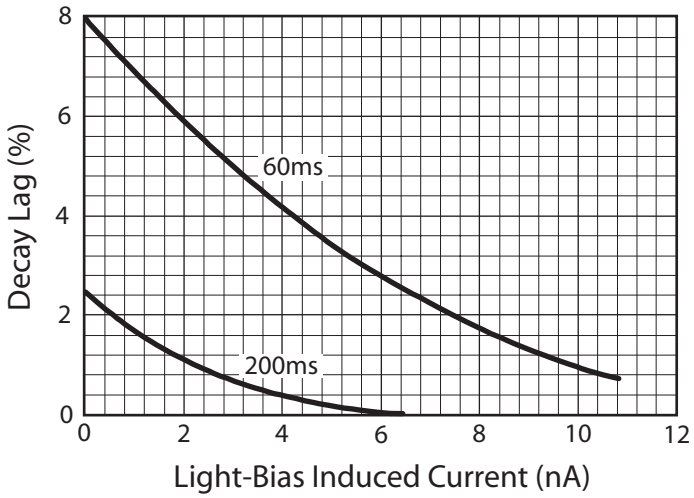

Figure 2 *Typical influence of light bias in on decay lag in XQ1073 (25mm Plumbicon tube type XQ1073, signal current of 40nA, green light, beam setting 600nA).*

In some types of Plumbicon tubes means are available for applying light bias on the gun side of the photoconductive layer (internal light bias). Figure 3 shows how this is achieved in the 25mm Plumbicon tube XQ2182.

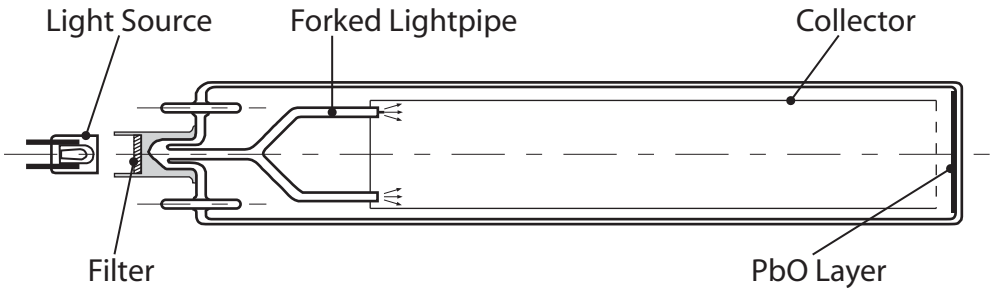

Figure 3 *Light bias in the XQ2182*

Light from a small lamp falls on the pumping stem of the tube and is conveyed by a forked glass light pipe into the collector space. It then falls directly or via reflection against the collector wall on the target. The light source (fixed or adjustable) fits in a metal sleeve fixed on the pumping system.

Gamma

The light transfer characteristic of the Plumbicon tube has a gamma near unity. It may be desirable to incorporate a gamma correcting circuit in the video amplifier system with an adjustable gamma of 0.5 to 1.

PLUMBICON IMAGING TUBES: OPERATIONAL NOTES

Sensitivity Control

Plumbicon tubes do not permit automatic sensitivity control by means of a regulation of the signal electrode voltage. Adequate control is therefore to be achieved by other means (iris control and neutral density filters).

Beam Current

The beam current of a Plumbicon tube is set at twice the value required for stabilization of normal peak white. Highlight handling is improved by using higher beam currents. Very high beam currents, however, cause increased lag, some loss of resolution, geometry shifts and reduction of tube life.

Alignment

Alignment currents are used to correct for slight mechanical and electrical misalignments encountered in tubes and coil assemblies.

Alteration of alignment settings influences corner focus, geometry, beam size and registration. Poor alignment can moreover cause lag problems or a degredation of picture quality with regard to spots and blemishes.

Stand-by

During long standby periods, the following procedure should be adopted:

- Cap the camera lens.
- Adjust the grid 1 voltage to its maximum negative value to cut of f the beam.
- Reduce the heater voltage to about 4V.

To resume normal operation, reverse the above sequence as follows:

- Increase heater voltage to 6.3V.
- After allowing heater to operate at 6.3V for at least 1 minute, adjust the grid voltage to restore the beam current to its required level.
- Uncap the camera lens.

The Diode Gun and Dynamic Beam Control

In the conventional triode gun, grid 1 and the anode converge the electrons emitted by the cathode to produce a crossover in the electron beam. Electron interaction in the beam, particularly in the vicinity of the crossover, increases the differential beam

resistance and so increases beam-discharge lag. In the diode gun grid 1 is made positive with respect to the cathode. This reduces beam convergence and so eliminates the crossover. The result is reduced differential beam resistance and a larger beam reserve. The consequent reduction in lag permits the use of thinner photoconductive layers to improve resolution (particularly in smaller tubes).

Moreover, with the larger beam reserve of the diode gun tube, excessive highlights can be handled using Dynamic Beam Control (DBC). Figure 4 shows the principle of DBC. When the beam encounters a highlight, the sharp rise is signal current is detected by a feedback network which then increases the control gid voltage (Vg1), so raising the beam current to read out the highlight.

N.B. Avoid continuous operation at high beam currents since this will shorten tube life.

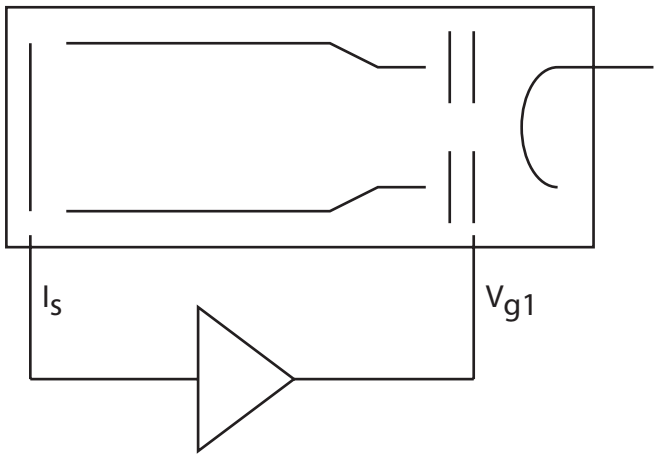

Figure 4 *Diode Beam Control*

Low Output-Capacitance Tubes

An important factor governing the performance of an imaging system is its signal-to-noise (S/N) ratio; the higher the S/N ratio the better the operation sensitivity of the camera. One way of increasing the S/N ratio is by reducing the total output capacitance of the tube/yoke assemblies within the camera.

In the range of low output-capacitance (LOC) Plumbicon tubes the capacitance of the tube in the deflection yoke is reduced by reducing the size of the transparent conductive film in the target.

Burn-In or Picture Sticking

The target of a Plumbicon tube has a high resistance to picture sticking but some sticking may occur at target voltages lower than specified.

Temperature Effects

Plumbicon tubes tolerate short excursions of temperature up to 70°C. Prolonged use at temperatures above 50°C will, however, adversely influence tube life. It is therefore advisable to ensure that the faceplate of a Plumbicon tube in an imaging system does not exceed 50°C under normal ambient temperature conditions.

RECOMMENDATIONS

Transport

During transport, handling and storage the axis of the Plumbicon tube must be either vertical, with faceplate up, or horizontal. The faceplate should be covered with the hood provided.

Base Pins

To avoid damage to the base pins, the Plumbicon tube should be inserted into its socket with care. Shocks, excessive force and bending loads on the pins are to be avoided.

Prolonged Idle Periods

During prolonged idle periods – weeks or months – gas pressure may slowly build up in the tube due to residual gas molecules emerging from the electrodes and the glass wall. There is then a slight risk that the pressure is sufficiently high to cause cathode damage by ion bombardment if the cathode current is drawn immediately after switching on the camera.

A cathode heating time of at least a minute before drawing cathode current is therefore recommended. After very long idle periods – e.g. years – it is advisable to extend this pre-heating time to 30 minutes.

In isolated cases the properties of a Plumbicon tube may deteriorate slightly when it is kept idle for long periods such as may occur:

- Between the factory's pre-shipment test and the actual delivery to the customer;
- Between receipt of the tube and its installation;
- When the camera is not used for a long time.

Although the chances of such a deterioration are remote it is advisable to operate the tune for some hours at intervals not more than 4 weeks apart.

The following procedure and conditions are recommended then:

- Set grid g_1, bias control, to maximum negative bias (beam cut-off).
- Allow a heating-up time of the cathode of at least 1 minute before turning up the grid g1 control to produce a beam.
- Set scanning amplitudes to overscan condition.

Apply an even illumination to the target to obtain a signal of approximately 0.15λA and adjust the beam current for correct stabilization

Storage

During long-term storage the ambient temperature should not exceed 30°C.