



Use of Miniature Power Pentode RCA-6CL6 in Video Output Stages

This Note discusses the use of power pentode RCA-6CL6 in video output stages. The 6CL6, a nine-pin miniature equivalent of the metal type RCA-6AG7, is intended primarily to drive large kinescopes requiring a peak-to-peak video voltage of approximately 120 volts. This tube offers several advantages over the 6AG7: its miniature construction saves space, its smaller mass reduces microphonic output, and its lower input and output capacitances result in higher gain.

Fig. 1 shows a typical video output stage employing the 6CL6 and designed to have a bandpass of 4.0 megacycles. In this circuit, a peak-to-peak output voltage of approximately 130 volts is obtained with a peak-to-peak driving voltage of approximately 3.0 volts. Because of this high sensitivity, the 6CL6 can be driven to full output directly from the detector stage.

Shielding Considerations

When the 6CL6 is used in a video application, consideration must be given to the "Miller Effect", that is, the effect of the grid-plate capacitance in increasing the effective input capacitance. This effect can be expressed by the formula

$$C_{in} = C_{in}' + (M + 1) C_{gp}$$

- where C_{in} = effective input capacitance in micromicrofarads,
 C_{in}' = "hot" value of input capacitance in micromicrofarads,
 M = stage gain (approximately equal to transconductance in mhos times load impedance in ohms),
 C_{gp} = grid-plate capacitance in micromicrofarads.

The tube capacitance values, however, are affected by the presence of an external tube shield, as shown in the following tabulation.



6CL6 Capacitances

	<i>Unshielded</i>	<i>Shielded</i>	
C_{in} (cold)	11.0	11.3	$\mu\mu f$
C_{in} (hot)	14.0	14.3	$\mu\mu f$
C_{gp}	0.1	0.06	$\mu\mu f$
C_{out}	5.5	10.5	$\mu\mu f$

In the 4-megacycle amplifier shown in Fig.1, the stage gain is approximately 43. Thus, the effective input capacitance with the tube unshielded is 18.4 micromicrofarads; of this value, the incremental capacitance due to the "Miller Effect" is 4.4 micromicrofarads ($43 + 1 \times 0.1$). When the tube is shielded, the effective input capacitance is reduced to 16.9 micromicrofarads. This slight reduction is hardly sufficient to warrant the use of a shield in this circuit solely to reduce the effective input capacitance.

In the case of a narrow-band video amplifier, however, in which the load impedance is approximately 10000 ohms, the stage gain is approximately 110 and the effective input capacitance with the tube unshielded is 25.0 micromicrofarads. In this case, the incremental capacitance due to the "Miller Effect" is 11.0 micromicrofarads. Shielding the tube reduces the effective input capacitance to 20.9 micromicrofarads. This reduction is of sufficient magnitude to justify the use of an external shield.

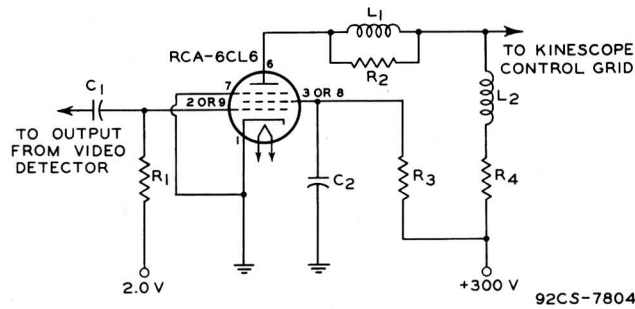
The substantial increase in output capacitance due to the use of an external shield may require a reduction in the maximum allowable plate-load impedance for the required bandwidth. Because video-output tubes usually work into loads having high circuit capacitance, produced by long leads from the output stage to the kinescope, the increase of output capacitance due to shielding probably will not materially reduce the performance.

A further consideration is the effect of a shield in increasing envelope temperature. The maximum envelope-temperature rating for the 6CL6 of 200 degrees Centigrade should not be exceeded. In circuit-design work, the envelope temperature may be measured by means of temperature-resistive paint or crayons*. When an external shield is required, the use of a blackened shield is helpful in reducing the envelope temperature.

Tube Ratings and Characteristics

When the 6CL6 is substituted directly for the 6AG7, the differences in the ratings of the two tubes must be considered. Due to the smaller envelope of the 6CL6, its plate-dissipation rating is 7.5 watts, as compared to 9.0 watts for the 6AG7. The plate-dissipation rating of 7.5 watts is adequate for most video-amplifier applications because such amplifiers operate with resistive loads and, therefore, with low values of plate voltage. A higher dissipation may be required for some video applications, such as studio "chain" amplifiers or cathode-follower

* Such as Tempilaq or Tempil Stik, made by the Tempil Corporation, 132 W. 22nd St., New York 11, N. Y.



C1: 0.1 μ f, 400 volts	R1: 100000 ohms, 0.5 watt
C2: 4 μ f, 400 volts	R2: 47000 ohms, 0.5 watt
L1: Peaking Coil, 180 μ h	R3: 24000 ohms, 2 watts
L2: Peaking Coil, 120 μ h	R4: 3900 ohms, 5 watts non-inductive type

Fig.1 - Typical Video Output Circuit Having Bandwidth of 4 Megacycles.

circuits, or for some types of voltage-regulator service. In these applications, the 6AG7 should be used or the equipment design should be modified to permit operation of the 6CL6 within its ratings.

The maximum permissible values of grid-No.1-circuit resistance for the 6CL6 are 0.1 megohm for fixed-bias operation and 0.5 megohm for cathode-bias operation, as compared to 0.25 megohm and 1.0 megohm, respectively, for the 6AG7. The lower values of resistance are specified for the 6CL6 to provide added protection against the possibility of grid-emission effects.

When the 6CL6 is used unshielded, its grid-No.1-to-plate capacitance is about twice that of the 6AG7; its input and output capacitances, however, are lower than those of the 6AG7. The use of an external shield with the 6CL6 increases its input and output capacitances and decreases its grid-to-plate capacitance to approximately the same values as the 6AG7.

The envelope-temperature rating of the 6CL6 must also be considered, especially in equipment operating at high ambient temperature. Although the 6AG7 has no envelope-temperature rating, it is obvious that it too has a practical limit to its permissible ambient temperature.

It should be noted that the 6CL6 has two base pins connected to grid No. 1 and two to grid No. 2. In applications in which the tube operates at maximum ratings, or in equipment in which abnormally high temperatures prevail, it is advisable to connect circuit leads to both grid-No.-1 and both grid-No.-2 socket terminals.

Because it is desirable to operate the 6CL6 with an unbypassed cathode resistance in some applications, a separate base-pin connection to the suppressor grid is provided to permit this method of operation without feedback problems.

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