# New Tubeless Convergence Circuit for RCA-21AXP22-A Color Kinescope

This Application Note describes a new tubeless convergence circuit for the RCA 21AXP22-A Color Kinescope. The new circuit utilizes a revised control system, and permits complete dynamic-convergence correction. It includes controls for the operation of electromagnetic static-convergence components, and permits simpler, more rapid convergence setups. The circuit is shown in Fig. 1.

The excellent dynamic-convergence performance of the new circuit is the result of the following features:

(a) Currents having parabolic, sawtooth, or mixed parabolic-sawtooth waveforms are provided at both the horizontal and vertical scanning frequencies. These currents are adjustable and may be mixed in any desired proportion.

(b) A high degree of isolation between horizontal and vertical dynamic-convergence circuits is obtained by the use of separate horizontal and vertical windings on the radial-converging magnet assembly. Because the horizontal windings have very low impedance, the new circuit requires relatively little driving power at the horizontal scanning frequency. The resulting reduction in the amount of current available from the high-voltage supply is approximately 35 to 45 microamperes.

(c) Dynamic-convergence setup is simplified by the use of a system of "master" and "balance" controls providing simultaneous horizontal correction for the red and green beams.

The use of an electromagnetic static-convergence system also provides several advantages. These include:

(a) All convergence controls may be concentrated at one convenient location.

(b) Static-convergence adjustments may be made in terms of rectangular coordinates. Consequently, static convergence can be achieved more rapidly than in PM systems or EM systems utilizing separate controls.

(c) Undesirable interactions between static-convergence controls are minimized.

## Static Convergence

The direct current required for the static-convergence portion of the circuit is obtained from a resistance-capacitance network in the cathode



TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

12/56
Printed in U.S.A.

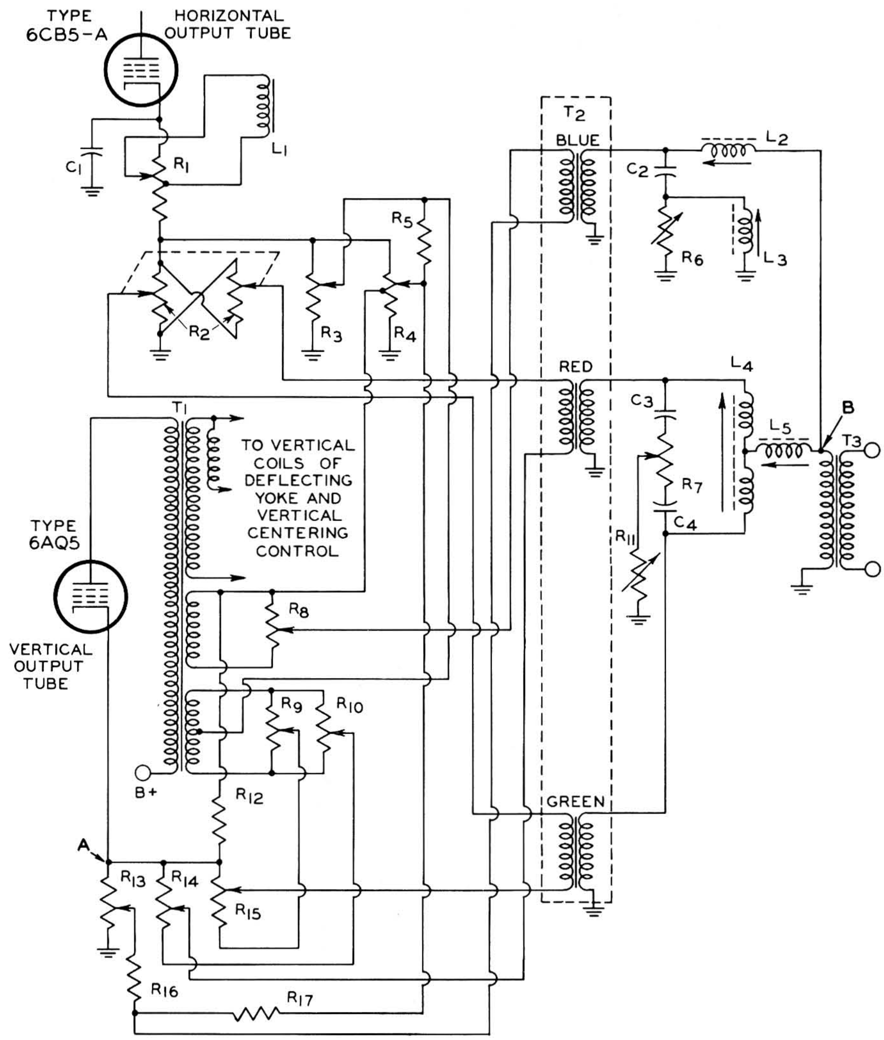


*Fig. 1 - New tubeless dynamic-convergence and electromagnetic static-convergence circuit.*

circuit of the horizontal-output tube. Reversible current for an electromagnetic lateral-converging component is provided by a center-tapped 30-ohm potentiometer (R1). (This potentiometer can be omitted when a PM-type lateral converging component is used.)

The static-convergence currents are applied to the vertical windings of the radial-converging magnet assembly. The dual red-green vertical static control R2 varies the strength of the red and green static-convergence currents simultaneously but in opposite directions, and, therefore, controls the spacing between associated red and green horizontal bars. The red-green horizontal static control R3 varies the current supplied to the red and green windings simultaneously and in the same direction, and, therefore, controls the spacing between associated red and green vertical bars.

## Circuit Parts List

C1: 4 $\mu$f, 50 V.

C2 C3 C4: 0.5 $\mu$f, 200 V.

L1 (optional): Electromagnetic Lateral Beam Converging component; current range for ultor voltage of 25 Kv, ±37 ma dc approx.; dc resistance, 55 ohms, approx.

L2: Blue Horizontal Tuning Control, ferrite core, 0.5 to 4 mh; dc resistance 4.8 ohms, approx.

L3: Blue Horizontal Phase Control, ferrite core, 0.05 to 0.5 mh; dc resistance 1 ohm, approx.

L4: Red-Green Horizontal Amplitude-Balance Control, ferrite core, each winding 0.2 to 1.2 mh, approx., 0.5 mh, approx. with core centered; dc resistance each winding 1.75 ohms, approx.

L5: Red-Green Horizontal Master-Amplitude Control, same as L2.

R1 (optional): Lateral Static-Convergence Control, 20-ohm potentiometer, center-tapped, 2 watts.

R2: Red-Green Vertical Static-Convergence Control, dual 100-ohm potentiometer, 2 watts.

R3: Red-Green Horizontal Static-Convergence Control, 100-ohm potentiometer.

R4: Blue Vertical Static-Convergence Control, 100-ohm potentiometer, center-tapped.

R5: 150 ohms, 1 watt.

R6: Blue Horizontal Amplitude Control, 30-ohm potentiometer, 2 watts.

R7: Red-Green Horizontal Phase-Balance Control, 20-ohm potentiometer, 2 watts

R8 R9 R10: Blue (R8), Green (R9), Red (R10) Vertical Phase Controls, 100-ohm potentiometers.

R11: Red-Green Horizontal Master-Phase Control, 20-ohm potentiometer, 2 watts.

R12: 470 ohms, 0.5 watt.

R13: Blue Vertical-Amplitude Control, 100-ohm potentiometer.

R14 R15: Red (R14), Green (R15) Vertical-Amplitude Controls, 250-ohm potentiometers.

R16: 270 ohms, 0.5 watt.

R17: 56 ohms, 0.5 watt.

T1: Vertical Deflection Output Transformer; primary impedance at 32 ma dc with 30 volts, 60 cps superimposed, 7000 ohms; core, 7/8-inch, 24-gauge Super Dynamo iron, 7/8-inch butt stack, 0.005-inch gap; winding order: primary 3200 turns No.35 enameled, dc resistance 400 ohms, approx; red-green phase winding, 50 turns 2 No.31 enameled in parallel, tapped at 32 turns, dc resistance 2.8 ohms, approx; blue phase winding, 25 turns, 2 No.31 enameled in parallel, dc resistance 0.8 ohms, approx; deflection secondary, 396 turns, 2 No. 31 enameled, bifilar wound, dc resistance (each section) 13 ohms, approx; 60-cps high-potential test (windings to core), 1500 V.; ambient temperature, 60 degrees C. max.

T2: Radial-Converging Magnet Assembly; ferrite pole pieces; approximate inductances at 1 volt, 1000 cps, zero dc: vertical windings, 500 mh; blue horizontal winding (with vertical windings shorted) 0.26 mh; red and green horizontal windings, 0.4 mh; approximate dc resistances at 25 degrees C.: vertical windings, 87 ohms; blue horizontal winding, 2.4 ohms; red and green horizontal windings, 3 ohms; peak voltage between vertical and horizontal windings or between either winding and core, 1750 V. max.

T3: Horizontal-Deflection Output, High-Voltage Transformer, provided with separate winding or tap delivering 100-v peak-to-peak, positive-going pulse. If pulse is obtained from a tap on the primary or deflection-output winding, a suitable blocking capacitor should be inserted in the circuit at B.

---

The blue vertical static control R4 is used to obtain coincidence between associated blue, red, and green horizontal bars. It also supplies currents, through R5, to the red and green windings of the radial-converging magnet assembly which produce fields of opposite polarity to the stray fields introduced by the blue-beam convergence field. The interaction of these opposing fields tends to prevent changes in the spacing between associated red and green bars, which would otherwise result when R4 is varied. This feature considerably simplifies static-convergence setup.

### Vertical Dynamic Convergence

The driving voltage for the vertical dynamic-convergence portion of the circuit is an approximate sawtooth voltage (see Fig.2) obtained from the cathode circuit of the vertical output tube. The variable sawtooth voltages provided by the three vertical-amplitude controls R13 (blue), R14 (red), and R15 (green), are integrated by the windings of the radial-converging magnet assembly T2, so that the resulting currents have a parabolic waveform. Sawtooth currents for phase control of the vertical dynamic-convergence currents are obtained from two secondary windings on the vertical output transformer T1, through the vertical-phase controls R8 (blue), R9 (green), and R10 (red). A separate secondary winding is used to supply the blue sawtooth current in order to provide isolation of the dc control circuit.

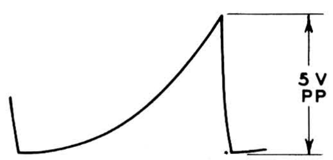


*Fig. 2 - Waveform of the driving voltage for the vertical dynamic-convergence circuit (measured at "A" in Fig. 1).*

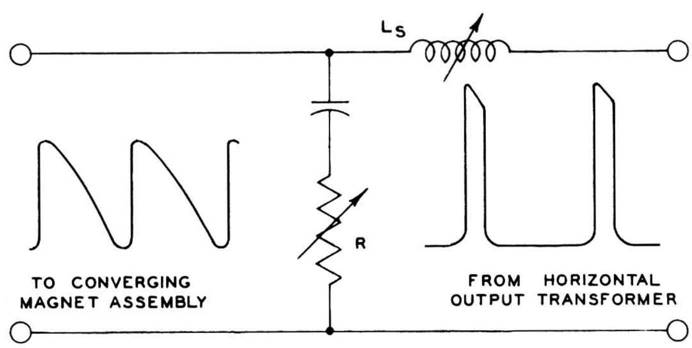


*Fig. 3 - Basic integrating network used in the red, green, and blue horizontal dynamic-convergence circuits, showing approximate input-and output-voltage waveforms.*

Experience has shown that, in some cases, best results are obtained when the parabolic component of the blue vertical dynamic convergence current is removed so that only a sawtooth current is present in the blue-vertical winding of the radial converging magnet assembly. Because of the interaction of the vertical convergence currents in the static-convergence controls R2, R3, and R4, the parabolic current component cannot be reduced to zero by adjustment of the blue vertical amplitude control R13. In order to cancel the remaining parabolic current component, therefore, an additional sawtooth voltage is obtained from the cathode circuit of the vertical output tube and applied through R12 to the center-top of the blue static-convergence control R4. This arrangement permits complete cancellation of the residual parabolic component when required, leaving only an adjustable current having the required sawtooth waveform.

The use of separate amplitude and phase controls for each beam in this portion of the circuit does not create a setup problem, because the blue vertical bar in the center of a video test pattern can be used as a reference for red and green vertical dynamic-convergence adjustments (see Convergence-Setup Procedure).

**Horizontal Dynamic Convergence**

The horizontal portion of the new dynamic-convergence circuit is shown at the right of Fig. 1. The driving voltage for this portion of the circuit is a positive-going pulse, having an amplitude of approximately

100 volts peak-to-peak, obtained from the horizontal-deflection and high-voltage transformer T3. This pulse is applied to red, green, and blue integrating networks having the basic form shown in Fig.3. The integrated voltage appearing across the RC portion of such a network has an approximate sawtooth waveform, the amplitude of the sawtooth being determined

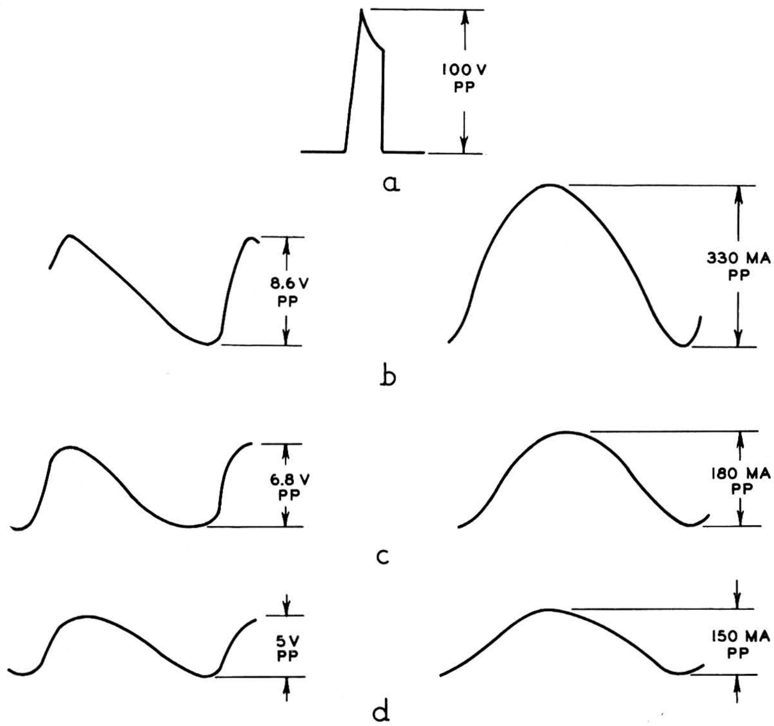


*Fig.4 - Typical voltage and current waveforms in the horizontal dynamic-convergence circuit: (a) driving voltage (measured at "B" in Fig.1); (b) voltage and current, blue horizontal winding; (d) voltage and current, green horizontal winding.*

by the series inductance $L_S$, and its phase by the resistance R. The sawtooth outputs of the red, green, and blue integrating networks are, in turn, integrated by the appropriate horizontal windings of the radial converging-magnet assembly, so that the resulting currents have substantially parabolic waveforms.

The use of an inductor in parallel with the blue horizontal phase-control resistor, as shown in Fig.1, improves the waveform of the blue horizontal-convergence current and permits more precise matching of the blue raster to the red and green rasters. For this arrangement, the resistor (R6) is used as the amplitude control, the shunt inductor (L3) as the phase control, and the series inductor (L2) as a "tuning" control.

Note that "master-amplitude" (L5), "master-phase" (R11), "amplitude-balance" (L4), and "phase-balance" (R7) controls are used in the red and green section of the horizontal-convergence circuit. Although the number of controls employed (four) is the same as in the separate-control system, experience has shown that this method of control substantially reduces the time required for horizontal dynamic-convergence adjustments. Voltage and current waveforms at principal points in the horizontal-dynamic convergence circuit are shown in Fig.4.

**Loading Effect on the High-Voltage Circuit**

Driving voltage for the horizontal dynamic-convergence section of the new circuit, like that for most tubeless circuits, is obtained from the horizontal-deflection and high-voltage transformer. The resulting loading of the high-voltage circuit reduces the regulated current available for the kinescope ultor, the reduction depending upon the amount of convergence correction required for the particular yoke and kinescope employed. In sine-wave type horizontal-convergence circuits this loading is approximately 15 to 50 microamperes; in the circuit described in this note it is approximately 35 to 45 microamperes.

## CONVERGENCE SETUP PROCEDURE

Because the static- and dynamic-convergence requirements of a color-kinescope installation vary with the ultor voltage used, with the size, linearity, and centering of the raster, and with the initial color purity, convergence adjustments should not be made until all adjustments for these kinescope operating parameters have been completed. Purity adjustments for the 21AXP22-A are described in Application Note AN-167.

The convergence-setup procedure described below is for the circuit shown in Fig.1, and is based on the use of a bar or cross-hatch video test pattern, such as can be obtained from the RCA WR-36A and WR-46A Dot-Bar Generators. Adjustments involving two beams are most easily made if the third beam (when not required for reference) is cut off, and if associated bars of the test pattern are first separated slightly by adjustment of the appropriate static-convergence controls. "Touch-up" static-convergence adjustments, which may be required on final installation, may be made with "off-the-air" television picture signals.

**Horizontal Dynamic-Convergence Adjustments**

1. Set the "blue horizontal-amplitude" control at its maximum-resistance (minimum-amplitude) position.

2. Adjust the "red-green horizontal amplitude-balance" and "phase-balance" controls until the associated red and green horizontal bars in the center of the screen are either parallel or coincident.

3. Adjust the "red-green master-amplitude" and "red-green master-phase" controls until all associated red and green vertical bars are equally spaced or coincident along the horizontal center line of the screen. (Note: It is not necessary that the vertical bars be parallel at this time, because parallel alignment is accomplished by subsequent vertical dynamic-convergence adjustments.)

4. Set the "blue horizontal-amplitude" control at its minimum-resistance (maximum-amplitude) position, and adjust the "blue horizontal-tuning" control until the blue horizontal bar at the center of the screen is displaced the maximum amount below its associated red and green bars,

and is symmetrical with respect to the vertical center line of the screen, as shown in Fig. 5.

5. Adjust the "blue horizontal-amplitude" and "blue horizontal-phase" controls until this central blue horizontal bar is parallel to its associated red and green bars.

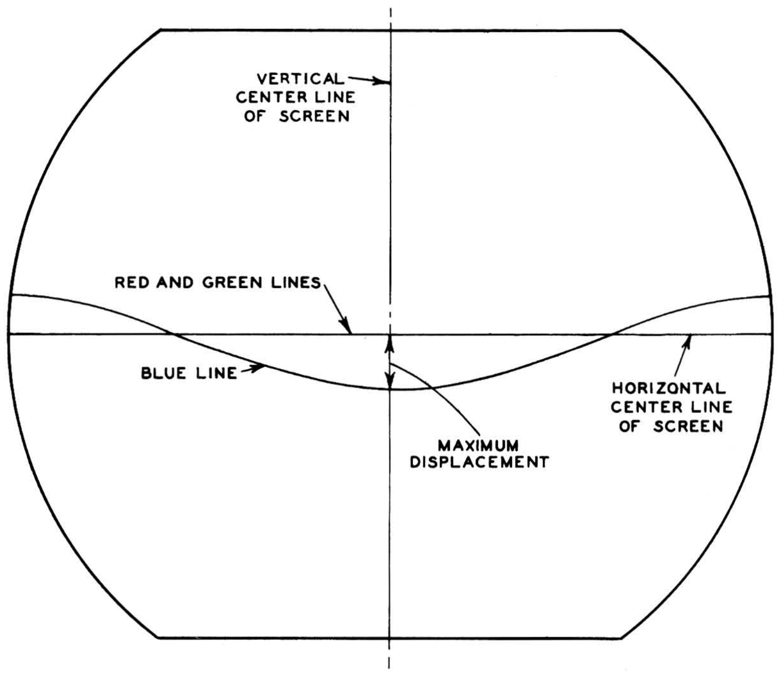


*Fig. 5 - Position of central blue horizontal bar when "blue horizontal-tuning" control is properly adjusted (see Horizontal Dynamic-Convergence Adjustments, Step 4).*

**Vertical Dynamic-Convergence Adjustments**

1. Using the blue vertical bar nearest the center of the kinescope screen as a reference, adjust the "red vertical-amplitude" and "red vertical-phase" controls until this blue bar and its associated red vertical bar are parallel or coincident.

2. Adjust the "blue vertical-amplitude" and "blue vertical-phase" controls until all horizontal blue bars and their associated horizontal red bars are uniformly spaced or coincident along the vertical center line of the kinescope screen.

3. Using the red vertical bar nearest the center of the kinescope screen as a reference, adjust the "green vertical-amplitude" and "green vertical-phase" controls until the red reference bar and the green bar are either parallel or coincident. (Note: if the red vertical amplitude and phase adjustments described in Step 1 were properly made, this adjustment also results in uniform spacing between associated red and green horizontal bars.)

**Static-Convergence Adjustments**

1. Adjust the "red-green vertical-static" control until associated red and green horizontal bars are coincident.

2. Adjust the control for the lateral-converging magnet until the blue vertical bar at the center of the screen is midway between its associated red and green vertical bars.

3. Adjust the "red-green horizontal-static" control until associated red and green vertical bars are coincident.

4. Adjust the "blue vertical-static" control until the central blue horizontal bar is coincident with its associated red and green horizontal bars.

5. Examine the resulting screen pattern for evidence of improper static convergence. If any is present, repeat the step or steps necessary to correct the condition.

For best over-all convergence, the entire setup procedure may be repeated, although careful examination of the test pattern will usually indicate the particular controls requiring readjustment. In most cases, only slight readjustments of these controls will be necessary. Such readjustments, however, should be made in the order prescribed above for the original adjustments.