Instructions

COLOR ALIGNMENT GENERATOR

MODELS
4ST16A1
4ST16A2
4ST16A3

EBI-7045

GENERAL ELECTRIC

CONTENTS

ILLUSTRATIONS

GENERAL SERVICE INFORMATION

SAFETY NOTICE

WARNING

VOLTAGES USED FOR THE OPERATION OF THIS EQUIPMENT ARE DANGEROUS TO HUMAN LIFE.

This instruction manual is written for the general guidance of maintenance and service personnel who are familiar with and aware of the dangers of handling electric and electronic circuits. It does not purport to include a complete statement of the safety precautions which should be observed in servicing this or other electronic equipment. The servicing of this equipment by inadequately trained or inexperienced personnel involves risks to such personnel and to the equipment for which the manufacturer can not accept responsibility. Personnel servicing this equipment should familiarize themselves with first-aid treatment for electrical burns and electrical shock.

PRODUCTION CHANGES

From time to time it becomes necessary to make changes in the equipment described in this book. Such changes are made to improve performance or meet component shortages and are identified by a revision letter following the model number stamped on the nameplate. The changes in the equipment as they affect the instruction book are listed on a Production Change Sheet included in the book. If no Production Change Sheet is included, no changes have been made. The revision letter appearing on the title page indicates the equipment revision to which the book corresponds.

This information is provided as a servicing aid; it should not be used to modify earlier equipments to incorporate later revisions except under specific instructions. Please mention the revision letter in any correspondence.

REPLACEMENT PARTS

The parts list contained in this book includes all principal replacement parts. The symbol numbers are the same as those appearing on elementary and other drawings. Whenever possible, replacement parts should be obtained from a local electronics supply dealer. If it is necessary to order a part (other than a tube) from the General Electric Company, please include the symbol number, description, and drawing number of the part and model number of the unit. Orders may be sent to the nearest Electronics Division office appearing on the list at the end of this book or the General Electric Company, Technical Products-Communication Products Department, Electronics Park, Syracuse, N.Y.

REPLACEMENT TUBES

In all cases replacement tubes must be ordered from a local tube distributor.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

INDUSTRIAL ELECTRONICS DIVISION

GENERAL ELECTRIC

ELECTRONICS PARK, SYRACUSE, N. Y.

EBI-17B 4/60 (10M)

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WARRANTY

The General Electric Company (hereinafter called the Company) warrants to the Purchaser that the equipment will be free from defects in material, workmanship, and title, and will be of the kind and quality designated or described in the contract. The foregoing warranty is exclusive of all other warranties whether written, oral, or implied (including any warranty of merchantability or fitness for purpose). If it appears within one year from the date of shipment by the Company that the equipment described in this instruction book does not meet the warranties specified above and the Purchaser notifies the Company promptly, the Company shall thereupon correct any defect, including non-conformance with the specifications, at its option, either by repairing any defective part or parts or by making available at the Company's plant, a repaired or replacement part. In lieu of the foregoing, the standard published tube warrranties in effect on the date hereof shall apply to new electronic tubes. If the equipment is installed, or its installation supervised, by the Company, said one year shall run from the completion of installation provided same is not unreasonably delayed the Purchaser. The conditions of any test shall be mutually agreed upon and the Company shall be notified of and may be represented at all tests that may be made. The liability of the Company to the Purchaser (except as to title) arising out of the supplying of the said equipment, or its use, whether on warranty, contract or negligence, shall not in any case exceed the cost of correcting defects in the equipment as herein provided and upon the expiration of said one year, all such liability shall terminate. The foregoing warranty does not apply to any used equipment supplied under contract or any equipment supplied under contract which bears a trademark of a manufacturer other than that of the Company. Because of the more restrictive warranties expressed by other manufacturers, the Company under contract can only make available to the Purchaser the warranty of the manufacturer on all such equipment. The Company will secure for the Purchaser at his request copies of the manufacturer's standard published warranty applicable to all such equipment. Used equipment is sold as is without warranty unless otherwise specifically provided in writing in the sales contract. The foregoing shall constitute the sole remedy of the Purchaser and the sole liability of the Company.

PRODUCTION CHANGE SHEET

COLOR ALIGNMENT GENERATOR

MODEL 4ST16A1

REVISION A

Parts List and Elementary Diagram

Symbol	Was	Changed To
CR2 thru CR5 and CR14	Germanium diodes. Hughes Cat. #HD2120 or Type 1N90.	Germanium Diodes. Hughes Type 1N67-A.
R59	Composition, 330 ohms ± 10%, ½ w. G-E Drawing C-3R77-P331K.	560 ohms ± 5%, ½ w. G-E Drawing C-3R77-P561J.
R61	Composition, 0.10 megohm ± 10%, ½ w. G-E Drawing C-3R77-P104K.	91,000 ohms ± 5%, ½ w. G-E Drawing C-3R77-P913J.
R69	Composition, 330 ohms ± 10%, ½ w. G-E Drawing C-3R77-P331K.	620 ohms ± 5%, ½ w. G-E Drawing C-3R77-P621J.
R71	Composition, 0.10 megohm ± 10%, ½ w. G-E Drawing C-3R77-P104K.	75,000 ohms ± 5%, ½ w. G-E Drawing C-3R77-P753J.
R121	Composition, 1000 ohms ± 10%, ½ w. G-E Drawing C-3R77-P102K.	330 ohms ± 5%, ½ w. G-E Drawing C-3R77-P331J.
R145 and R149	Composition, 0.33 megohm ± 10%, ½ w. G-E Drawing C-3R77-P334K .	0.33 megohm± 5 %, ½ w. G-E Drawing C-3R77-P334J.
R170	Composition, 0.33 megohm ± 10%, ½ w. G-E Drawing C-3R77-P334K.	0.33 megohm ± 5%, ½ w. G-E Drawing C-3R77-P304J.

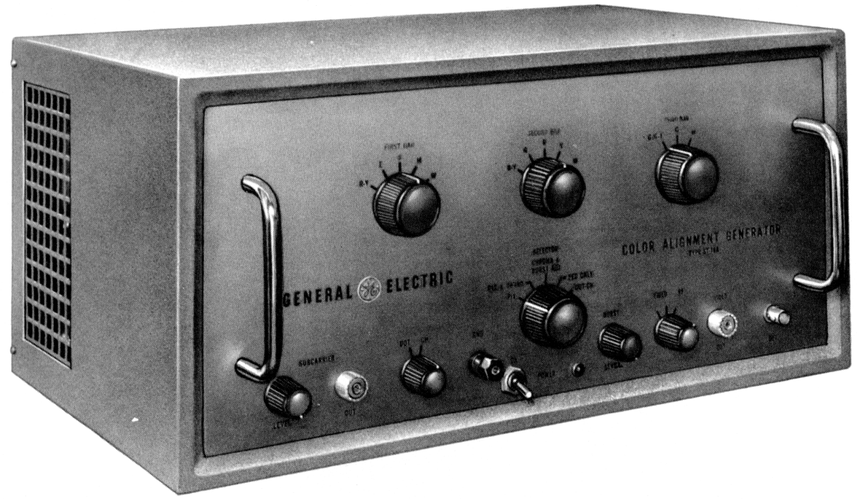


Fig. 1 Front View, Color Alignment Generator, Type ST-16-A (5-5143)

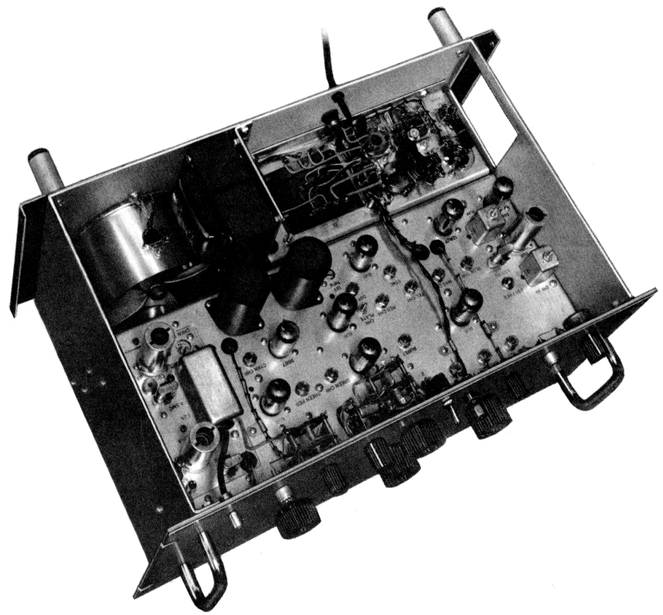


Fig. 2 Bottom View with Cover Removed (5-5745)

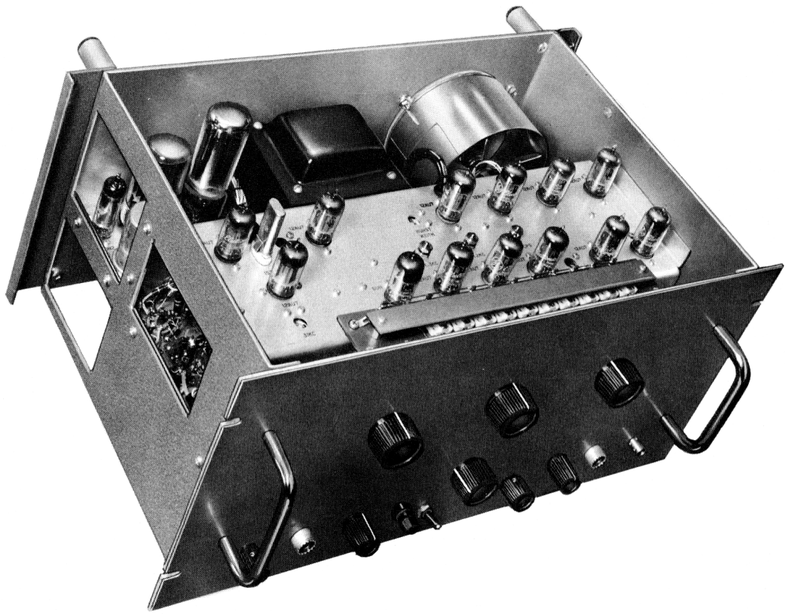


Fig. 3 Top View with Cover Removed and Hinged Chassis Secured (5-5144)

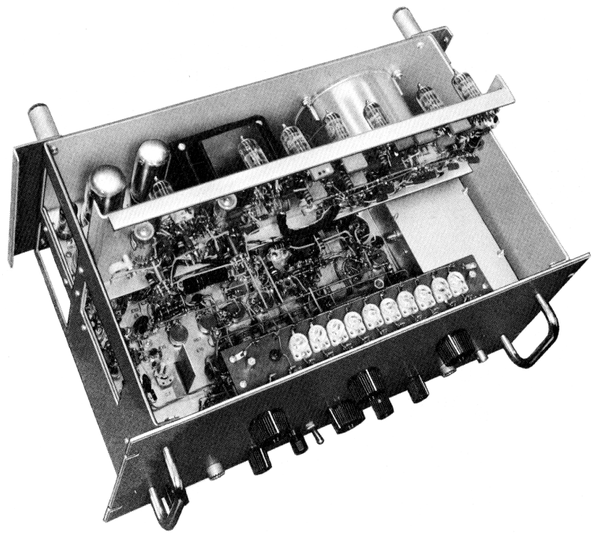


Fig. 4 Top View with Hinged Chassis in Service Position and Delay Line Cover Removed (5-5142)

INTRODUCTION

The Color Alignment Generator, Type ST-16-A, is intended for use in alignment and trouble shooting of NTSC color television receivers and NTSC color monitors.

Outputs of video only, or video-modulated RF are available from the Models 4ST16A1 and 4ST16A2. The video consists of composite color bars, chroma test signal, pedestals, dot pattern, or cross-hatch pattern; any one of which is selectable by means of a front panel switch. In addition, a sound carrier oscillator is provided to function as an RF tuning reference, and a variable amplitude 3.58 mc CW signal is available for various chroma test applications.

The Color Alignment Generator, Model 4ST16A3, is the same as the other two models, except that the RF output section is disabled.

The video output impedance of the Model 4ST16A1 is 90 ohms, while the video output impedances of the 4ST16A2 and 4ST16A3 are 75 ohms. The latter two models are intended for use with broadcast type equipment which uses 75-ohm impedances.

TECHNICAL SUMMARY

Electrical

Power Input

117/234 volts a-c, 50/60 cycles, at 250 watts.

Signal Output

1. Video Output

a. Positive or negative polarity.

b. The output impedance is 90 ohms or 75 ohms*, and must be terminated. The furnished cable performs this function and, by means of the built-in attenuator, may be used to adjust the amplitude from approximately 0-1.5 volts peak-to-peak.

c. The video signal may be any of the following:

(1) Cross hatch consisting of eight vertical and six horizontal stripes approximately three lines wide.

(2) Dots arranged to give eight across and six up and down (48 dots total).

(3) Composite color signal consisting of sync, burst, and three color bars plus a wide black reference signal.

(4) Chroma test signal consisting of chroma (without pedestals) with an adjustable amplitude burst signal.

*The Model 4ST16A1 output impedance is 90 ohms, while the 4ST16A2 and the 4ST16A3 have output impedances of 75 ohms.

(5) Pedestals only, without chroma.

2. Subcarrier Output (Crystal Controlled)

Chroma Signal (3.58 mc CW) variable from 0-0.5 volt peak-to-peak for use as 3.58 mc marker and chroma circuit trouble shooting.

3. RF Output*

a. Video-modulated crystal controlled RF, single channel (2 through 5).

b. The RF output impedance is 90 ohms and should be terminated. The furnished cable (with adapter) performs this function, and may be used to attenuate the signal over a range of 50 to 1. The maximum output is approximately 10,000 microvolts (see the INSTALLATION section).

c. Crystal controlled sound channel carrier generator with on-off provision for checking receiver fine tuning reference point.

d. All previously mentioned video signals may be selected as modulation of the RF carrier.

e. All video and RF outputs contain complete crystal controlled, interlaced sync.

Tube Complement

7 Type 6U8 (V1, V2, V3, V4, V5, V6, V17)
13 Type 12AU7 (V8, V9, V10, V11, V13, V14, V15, V16, V18, V19, V20, V21, V22)
3 Type 6BK7A (V12, V27, V28)
1 Type 5687 (V7)
1 Type 12AX7 (V25)
1 Type 5U4GA (V23)
1 Type 6080 (V24)
1 Type OB2 (V26)

Tube Functions

V1 3.58 mc oscillator and delay driver.
V2 Sync and cross-hatch gate.
V3 Pedestal and chroma gate.
V4 Pedestal and chroma gate.
V5 Pedestal and chroma gate.
V6 Burst gate and chroma pedestal adder.
V7 Video output.
V8 Pedestal and chroma keyer.
V9 Pedestal and chroma keyer.
V10 Pedestal and chroma keyer.
V11 Pedestal and chroma keyer.
V12 Cross-hatch.

*Note that the RF section is disabled in the Model 4ST16A3.

V13 Cross-hatch.
V14 thru V22 Sync generator.
V23 Rectifier.
V24 Regulator.
V25 DC amplifier.
V26 Regulator reference.
V27* Sound (4.5 mc) oscillator and video amplifier.
V28* RF output oscillator and RF harmonic amplifier.

Fuse

F1 Type 3AG, a-c line, 2.8 amp, 125 volt, Slow Blow (similar to Bussman MDL 2.8)

Mechanical

Height: 9 inches
Width: 19-1/4 inches
Depth: 13 inches
Weight: 37 pounds

DESCRIPTION

The Color Alignment Generator is constructed in an enclosed cabinet finished in gray wrinkle except for the brushed aluminum front panel. The unit (see Fig. 1) matches other equipment in the General Electric instrument line.

All controls are clearly marked on the front panel and all major components on the chassis are marked, where possible, with symbol numbers. Figs. 2 and 3 show the constructional details and locations of major components.

The unit is portable and is adaptable for standard 19-inch rack mounting.

INSTALLATION

See the Elementary Diagram, Fig. 11.

If the Color Alignment Generator is to be used with color television receivers and is to be operated from the 117-volt a-c line, the installation is extremely simple. Check that fuse, F1, is of the proper rating and insert the line cord plug into an outlet capable of supplying 250 watts at 117 volts, 50/60 cycles.

*These tubes are not included in the Model 4ST16A3.

If the unit is to be used with a 234-volt power source, connect the power transformer primary windings in series as follows:

Remove the two jumpers between terminals 1 and 3, and 2 and 4. Connect a jumper between terminals 2 and 3 and connect the incoming line to terminals 1 and 4. Leave the fan motor connected to terminals 1 and 2.

Before using the Color Alignment Generator with studio broadcast equipment, it is necessary to change the value of R91 and R209 from 91 ohms to 75 ohms*. Be sure to connect the video output to a 75-ohm load, if this change is made.

In some applications it is desirable to insert the video signal into a color receiver at some point after the RF and IF sections. To do this follow the procedures in the APPLICATIONS section below.

The RF output of the Color Alignment Generator is controlled by a quartz crystal, CR17, whose frequency may be on any one channel, 2 through 5 (specified when ordering the equipment). Output on other channels may be easily accomplished if a Marker Generator, Type ST-5-A, is available, since it employs marker crystals which are suitable for use in the Color Alignment Generator. (The additional crystals may be ordered extra if an ST-5-A is not available.) See the MAINTENANCE section for installation of crystals.

Note that the SUB-CARRIER OUT jack and the VIDEO OUT jack are of the UHF type while the RF OUT jack is a BNC type. If a General Electric Sweep Generator, Type ST-4-A, is available, its cable may be used at the RF OUT jack. Otherwise, the supplied cable, equipped with a UG-255/U adapter, may be used. The General Electric Drawing number for the adapter (use for ordering purposes) is 7897507-P1.

The Type ST-4-A and ST-16-A output cables are identical except for cable length and connectors. Both cables act as 90-ohm loads on the RF output and have built-in attenuators. The Balanced Output Adapter, Type ST-8-A, frequently used on the Sweep Generator, Type ST-4-A, may also be used at the RF output of the ST-16-A. It acts as a 90-ohm load on the RF output but has a 300-ohm output balanced to ground. It also has a built-in attenuator with a ratio of approximately 50 to 1.

OPERATION

Controls

A list of the operating controls and their functions follows:

Control	Symbol	Function
FIRST BAR	S2	Selects either R-Y, I, Blue, Magenta or White
SECOND BAR	S3	Selects B-Y, Q, Red, Yellow or White

*The Color Alignment Generator, Model 4ST16A2 incorporates 75-ohm terminations, as shipped.

Control	Symbol	Function
THIRD BAR	S4	Selects Green/G-Y, Cyan or White.
SUB-CARRIER LEVEL	R5	Adjusts amplitude of 3.58 mc subcarrier output.
DOT CH	S6	Selects either dot or cross hatch video signal.
POWER ON	S7	Controls a-c power to equipment.
SELECTOR	S1	Selects the following signals*: 1. PIX 2. PIX & SOUND 3. CHROMA & BURST ADJ 4. PED ONLY 5. DOT-CH
BURST LEVEL	R56	Sets burst amplitude when the SELECTOR switch is in the CHROMA & BURST ADJ position.
VIDEO + -, RF	S5	Selects positive or negative vide, or RF output in Models 4ST16A1 and 4ST16A2.

Control Manipulation

See Fig. 1.

The first control to be considered is the SELECTOR switch, S1, which selects the mode of operation of the Color Alignment Generator. Note that whatever type of signal is selected by the SELECTOR switch, it is available as video of either polarity or as modulation of the RF carrier. Video or RF is selected by means of the VIDEO + -, RF switch, S5; except in the Model 4ST16A3, which has no RF output.

The SELECTOR switch has five positions which allow selection of signal outputs as follows:

1. PIX

In the PIX position the signal consists of vertical and horizontal sync, burst, and three color bars plus the black reference bar. The three color bars are selected with the FIRST BAR, SECOND BAR, and THIRD BAR controls. The black reference bar is wide (almost 1/2 of the presentation) and therefore permits easy identification of the color bar sequence, while viewing the presentation on an oscilloscope.

*Note that the Model 4ST16A3 has no RF output.

2. PIX & SOUND

In the PIX & SOUND position the signal is the same as in the PIX position described above, except that a crystal controlled sound carrier is added to provide an RF tuning reference point for the receiver, provided that the VIDEO + -, RF switch is in the RF position. If the VIDEO + -, RF switch is in one of its video positions the signal output at the video jack will be the same as when the SELECTOR switch is in the PIX position. In the Model 4ST16A3 only, the RF section is disabled, resulting in no RF or sound carrier output.

3. CHROMA & BURST ADJ

In the CHROMA & BURST ADJ position the signal consists of sync, burst, and chroma information, the Y pedestals being absent. This is the only position of the SELECTOR switch in which the BURST LEVEL control will adjust the amplitude of the burst. The chroma information is of course centered about the black reference level since the Y pedestals are absent.

4. PED ONLY

In the PED ONLY position the signal consists of sync and Y pedestals, the chroma information being absent.

5. DOT-CH

In the DOT-CH position the signal consists of vertical and horizontal sync and either dots or cross hatching as selected with the DOT CH switch, S6.

When the SELECTOR switch is in the PIX, PIX & SOUND, or the CHROMA & BURST ADJ positions, the 3.58 mc CW subcarrier signal is available at the SUB-CARRIER OUT jack. The subcarrier amplitude is adjustable by means of the SUB-CARRIER LEVEL control, R5.

In cases where the ratio of contrast gain to chroma gain is improperly set up for a color receiver, it will be noted that the background brightness level will change slightly when switching color bars. The condition is exaggerated in the CHROMA & BURST ADJ position of the SELECTOR switch. This indicates that further adjustments of the contrast and chroma controls in the receiver are required to display properly saturated bars. A similar background shift may also be noted when switching between the I, Q, R-Y, and B-Y detector reference bars. This change results from the arbitrary pedestal level assigned to these bars in the Color Alignment Generator, but since the bars in question are intended only for detector phasing adjustment, the shift is of no consequence.

APPLICATIONS

This section is an outline of the more obvious and important applications of the Color Alignment Generator. In all cases it is recommended that the manufacturer's instructions be followed when aligning or trouble shooting a color television receiver or broadcast monitor. Since the equipments of the various manufacturers differ considerably in circuit details, no attempt has been made to outline universal

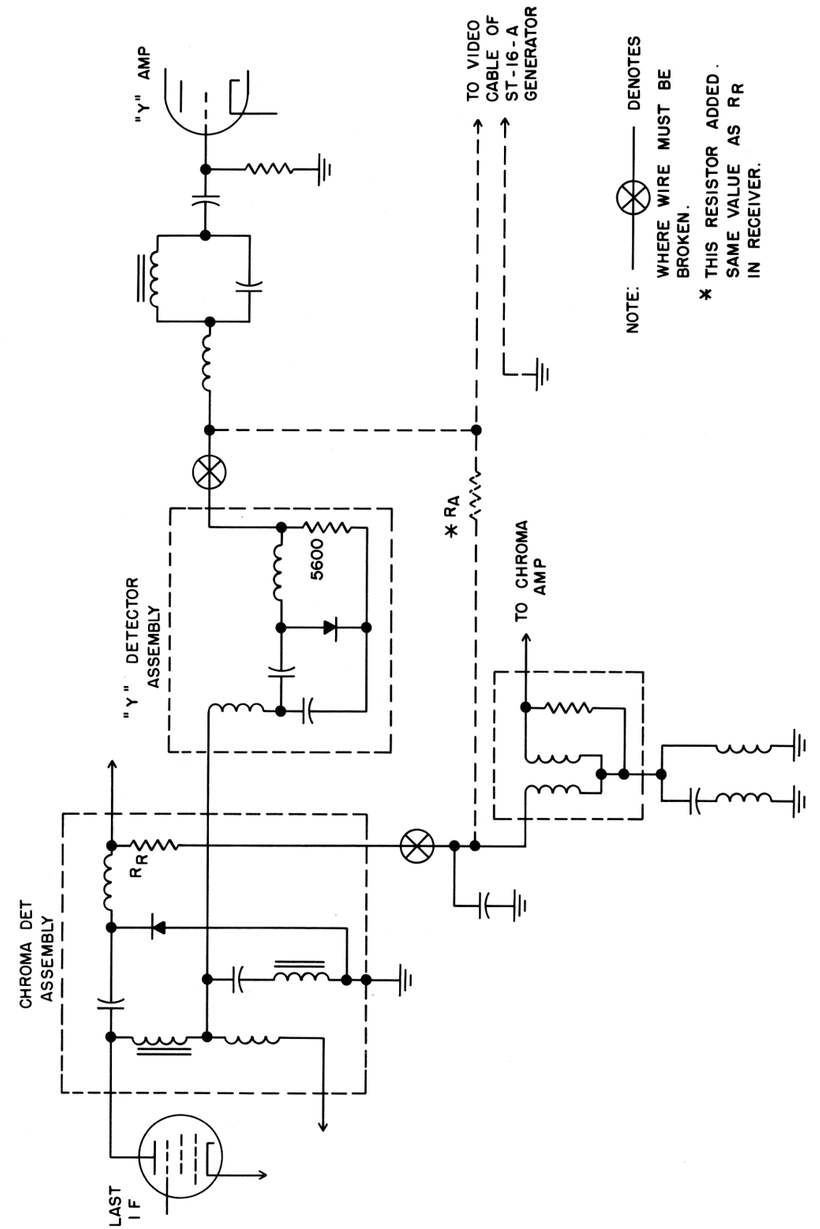


Fig. 5 Video Connection in Receivers Employing Separate Chroma and "Y" Detectors

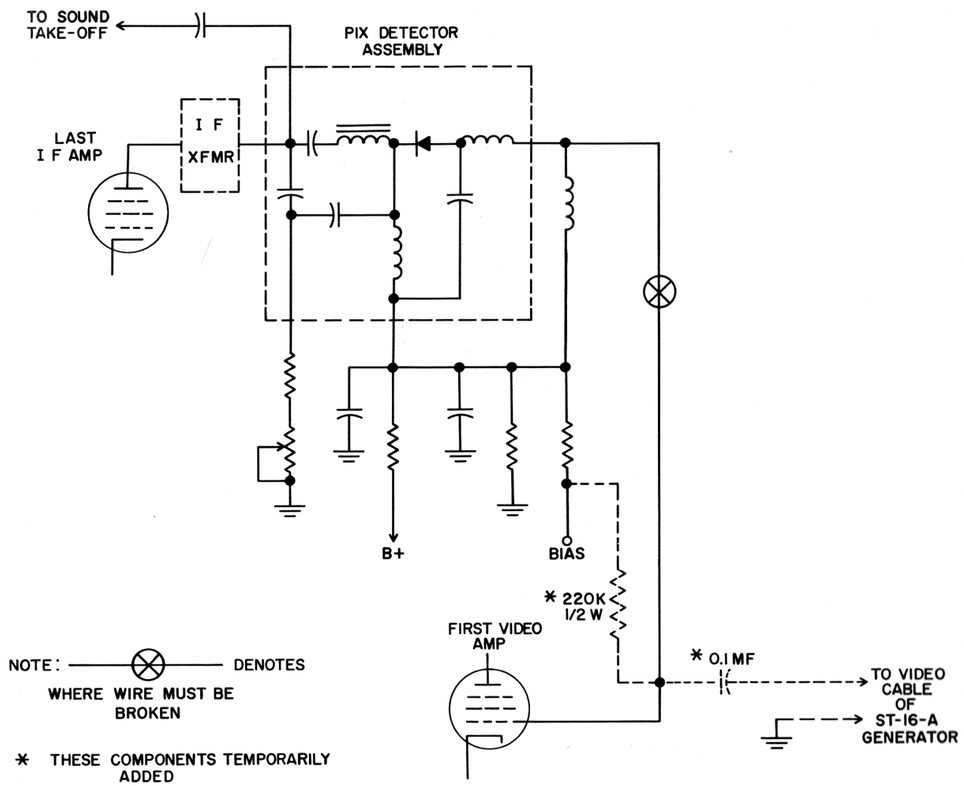


Fig. 6 Video Connection in Receivers Employing Single Second Detectors

adjustment procedures. The discussion below will serve as a starting point to acquaint the user of the Color Alignment Generator with the alignment procedures presently used with color television receivers and monitors.

Fig. 5 shows a typical direct-video connection for a receiver employing separate Y and chroma detectors while Fig. 6 depicts the connection required in a receiver using a single detector for both chroma and Y.

Convergence

In order to converge most tri-gun picture tubes, a dot signal like the one produced by the Color Alignment Generator is required. The object of convergence adjustments is to insure that the point where the red, blue, and green beams come together, or converge, is at the plane of the shadow mask, as shown in Fig. 7A. Fig. 7B illustrates the geometrical requirement within the picture tube for dynamic convergence corrections. Since the shadow mask is not curved to follow the convergence arc, the beams do not converge properly at the edges of the mask if the static convergence is set up correctly at the center of the screen area. With some tube types, the horizontal and vertical dynamic convergence waveforms (parabolically shaped) modulate a d-c convergence voltage applied to the tube, resulting in the maintenance of convergence over the entire picture tube area.

Note that the convergence point moves farther from the electron guns as the beam sweeps toward the edges of the tube face. Of course the amount of parabolic correction added to the d-c convergence voltage must be properly proportioned to prevent under or over compensation.

Also for dynamic convergence, some receivers utilize magnetic dynamic phasing and dynamic amplitude controls, which result in red, blue, and green parabola and sawtooth fields. In either case, however, the objective is the same; to provide static and dynamic convergence of good uniformity over the entire picture tube screen.

Normally it is most convenient to use the RF output* of the Color Alignment Generator modulated with the dot and/or cross hatch signal. If a broadcast color monitor is to be converged, the video output signal should be used. The correct method for connecting the video output of the Generator directly into a receiver is explained in the APPLICATION section and in Figs. 5 and 6.

Gray Scale Adjustment

When the SELECTOR switch of the Color Alignment Generator is in the PED ONLY position, the pedestal output signal provides a means for checking the gray scale tracking of a color receiver or monitor. The receiver may be checked over a wide range of Y signal levels simultaneously. Select blue, yellow, and green, since these pedestals provide a suitably stepped gray scale signal.

*Note that the Model 4ST16A3 has no RF output.

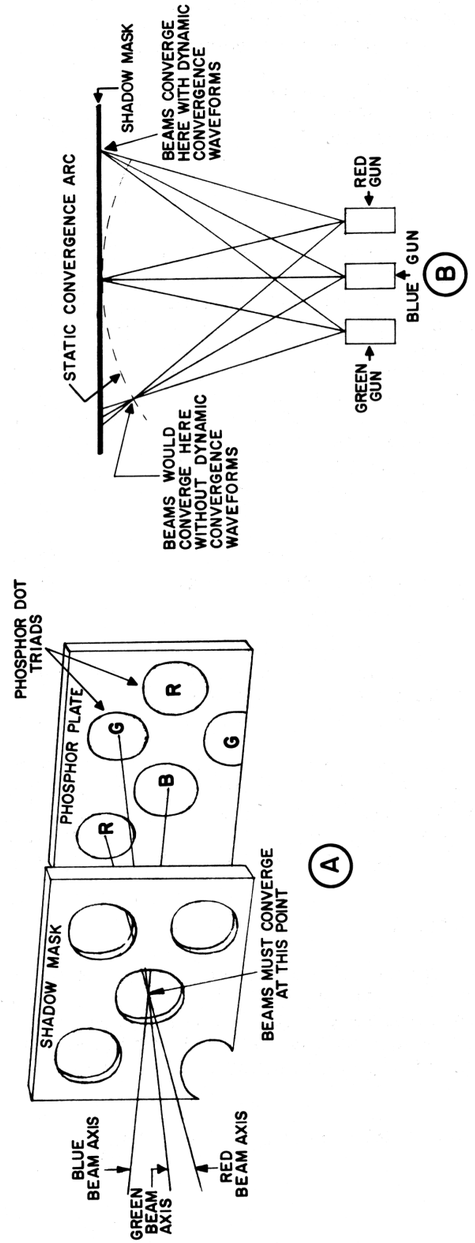


Fig. 7 Picture Tube Convergence

Detector Phasing

The Color Alignment Generator produces the signals required for adjustment of synchronous detectors (chroma demodulators). Four types of detector systems are commonly used; I and Q, R-Y and B-Y, R-Y and Q, and R-Y and G-Y. The first two are quadrature systems (detectors operate 90 degrees out of phase), while the last two mentioned are not in quadrature. An examination of the FIRST BAR, SECOND BAR, and THIRD BAR control markings will show that the Color Alignment Generator produces the various bars required for detector phasing adjustments. The third bar control permits selection of G-Y. This signal is actually located at 302 degrees, just between the green and G-Y phases. (Green is normally at 299.3 degrees, while G-Y is at 304.3 degrees. Since they are only 5 degrees apart, G/G-Y is set half way between them and the resulting discrepancy is of no consequence.)

The manufacturer's instructions for detector phasing of an I and Q type receiver might follow the outline below, for example.

If the head-end and RF sections are properly aligned, connect the RF output* of the Color Alignment Generator to the receiver antenna input terminals and set the SELECTOR switch of the generator to the PIX & SOUND position. Turn the channel selector switch of the receiver to the Type ST-16-A channel frequency. Select I with the FIRST BAR control, Q with the SECOND BAR control, and W with the THIRD BAR control. Fine-tune the receiver into the visible audio beats and then back off the fine tuning slightly to the point where a good picture is obtained. At this time adjust the receiver contrast, chroma and brightness controls and set the hue control to midrange.

Connect an oscilloscope, such as the General Electric Type ST-2-A, to the output of the I detector. Now adjust the I detector phasing control for zero Q bar output as observed on the oscilloscope presentation.

Connect the oscilloscope to the output of the Q detector and adjust the Q detector phasing control for zero I bar output as observed on the oscilloscope presentation.

For setting the detector phases of receivers other than the I and Q type, the same general procedure usually applies except that the technician selects color bars as follows; R-Y, B-Y, and W, from left to right respectively. When observing the output of the R-Y detector he adjusts the R-Y phasing control for zero B-Y bar and vice versa.

In receivers using the R-Y and Q or R-Y and G-Y system of detection, the procedure is again similar except that the R-Y and Q or R-Y and G-Y bars are used as the phasing references.

It is important to note that if the RF and/or the IF sections of the receiver are thought to be badly misaligned, the video output of the Color Alignment Generator should be fed directly into the receiver video section or the receiver should first be properly aligned with the Type ST-4-A Sweep Generator, Type ST-5-A Marker Generator, and the Type ST-2-A Oscilloscope.

*Note the the Model 4ST16A3 has no RF output.

Matrix Adjustment

The process of matrix adjustment is for deriving the proper proportions of the color difference signals at the point wherein they are mixed with the Y brightness component. That is, so that a saturated magenta bar, for example, will contain the same amount of red as appears in a white bar. In an R-Y and B-Y receiver the R-Y and B-Y signals are adjusted to the proper amplitude first, and from these proportioned signals the G-Y signal is formed and adjusted in amplitude.

The Type ST-16-A Color Alignment Generator has provisions for three color bars at a time (plus the wide black reference bar) to facilitate oscilloscope interpretation. If the output were to contain more than three bars, considerable confusion might arise in the matrix procedure because of the difficulties in attempting to keep track of the color bar in question while shifting attention from the receiver to the instruction manual and then to the oscilloscope screen.

To use an example, consider the Y, B-Y matrix adjustment of a typical color receiver. The manufacturer's instructions direct us to adjust the chroma control until the cyan and blue bars simultaneously reach an amplitude equal to the white bar at the picture tube blue gun. With the Color Alignment Generator, we proceed as follows:

Select Blue with the FIRST BAR control, White with the SECOND BAR control, and Cyan with the THIRD BAR control. Now adjust the chroma control of the receiver until the Blue and Cyan bars (first and third) simultaneously reach the amplitude of the White (middle) bar. As a further check, select White with the FIRST BAR control, Yellow with the SECOND BAR control, and White with the THIRD BAR control, when the amplitude of the Yellow bar will be at zero (black level) as required. Further, if the SECOND BAR control is changed to its Red position, the amplitude of the Red bar will also be at zero.

In the manner illustrated above it is a simple matter to check the waveforms for proper adjustment throughout the remainder of the matrix adjustment procedure at the red and green guns of the picture tube.

Visual Matrix Adjustment

In some color receivers the matrixing is accomplished within the picture tube. That is, the R-Y, G-Y, and B-Y signals are applied to the grids while the Y pedestals are applied to the three paralleled cathodes. The General Electric Matrix Filter, Model 4ST19A1, which is available as an accessory to the Color Alignment Generator, provides an excellent method for adjustment of the matrix circuits in this type of receiver. The procedure is applicable to all color receivers, but particularly to those which employ picture tube matrixing.

In general, the process of visual matrix adjustment is as indicated in the following example. Select Magenta with the FIRST BAR control, Yellow with the SECOND BAR control, and White with the THIRD BAR control. Observe the picture tube presentation through the red filter section of the Matrix Filter and adjust the R-Y gain control until the yellow, magenta, and white bars appear the same in brightness.

Now select a series of White, Yellow and Green bars and observe the picture tube presentation through the green filter section of the Matrix Filter. Adjust the G-Y gain control until the three bars appear the same in brightness.

Last, select Blue, White and Cyan bars and observe the picture tube presentation through the blue filter section of the Matrix Filter. Adjust the B-Y gain control until the three bars appear the same in brightness.

In an I and Q type receiver the procedure is similar except that the I gain control and the brightness and contrast controls are used. First set up the contrast and brightness controls so that blue, white and cyan bars appear equal in brightness as observed through the blue filter section of the matrix filter. Next adjust the I gain control until red, white, and yellow bars appear equal in brightness through the red filter section of the Matrix Filter. More detailed instructions for use are supplied with the Matrix Filter, Model 4ST19A1.

Burst Gate Adjustment

Many color receivers provide a control for phase adjustment of the horizontal gate pulse which is used to open the burst gate during the burst interval.

To perform this adjustment, turn the Color Alignment Generator SELECTOR switch to the CHROMA & BURST ADJ position and connect an oscilloscope such as the General Electric Type ST-2-A* to the burst gate. Now adjust the horizontal detector phasing control until the burst is positioned at the peak of the burst gate pulse. (This requires the use of the Color Compensator, Model 4ST17A1*, in conjunction with the Oscilloscope.) The burst level control may be varied while noting the amplitude change on the oscilloscope presentation. This aids in the proper positioning of burst with respect to the burst gate.

Miscellaneous Applications

1. When the Generator SELECTOR switch is in the CHROMA & BURST ADJ position, the output signal may be used to provide a relative indication of the sensitivity of the subcarrier generator or AFC circuits of the receiver. Note that the BURST LEVEL control permits adjustment of the burst amplitude when the SELECTOR is in this position, so that the technician can drop the level of the burst to the point where the crystal ringer circuit (if the receiver is so equipped) ceases to function. If the receiver utilizes a subcarrier AFC system, the circuit may be checked with respect to color sync sensitivity.

2. By using the technique outlined in step 1 above, the color killer circuit may be checked for proper operation, keeping in mind that the picture should be black and white only when no subcarrier is present. This is assuming, of course, that all receiver circuits are functioning properly.

*A Color Compensator, Model 4ST17A1, and a Chroma Detector Probe, Model 4ST18A1, are available as accessories to the General Electric Oscilloscope, Type ST-2-A.

3. When the SELECTOR switch is in the PED ONLY position, the output signal of the generator contains Y pedestals with no chroma. When the SELECTOR switch is in the CHROMA & BURST ADJ position, the output signal of the generator contains chroma information with no pedestals. By properly utilizing these two conditions, the technician can isolate troubles in either the Y or chroma channels of a receiver, particularly when troubleshooting the matrix circuits.

4. The SUB-CARRIER OUT jack provides a variable amplitude CW signal at 3.58 mc which can be used to advantage in receiver alignment and trouble shooting. By tee-connecting the output of the subcarrier oscillator into the interconnecting cable between the General Electric Sweep Generator (Type ST-4-A), and the Marker Generator (Type ST-5-A), a 3.58 mc marker pip will appear on the oscilloscope.

The subcarrier signal may also be used in alignment of 3.58 mc tuned circuits and traps, and for signal tracing in the chroma sections of receivers.

Note that the subcarrier at the SUB-CARRIER OUT jack is available only when the SELECTOR switch is in the PIX, PIX & SOUND, or the CHROMA & BURST ADJ position. The SUB-CARRIER LEVEL control varies the amplitude of the signal between 0 and approximately 0.5 volt peak-to-peak.

5. When the SELECTOR is in the DOT-CH position, the DOT CH switch may be used to select a cross hatch signal which is an invaluable aid when setting up picture size and horizontal and vertical linearity controls.

THEORY AND CIRCUIT ANALYSIS

General

The circuit analysis of the Color Alignment Generator may be more easily understood by referring to the Block Diagram, Fig. 8, and the Elementary Diagram, Fig. 11. The diagram shows the basic sections of the unit and how they are switched in various combinations to produce the many types of output signals which are available.

Examination of Fig. 8 will show that all signals are available as either positive or negative video or as RF, the sound carrier being present, of course, only with the RF output. Note also that complete synchronizing signal is present at all times; that the burst amplitude may be adjusted only when the selector switch is in the CHROMA & BURST ADJust position; and that the 3.58 mc CW output is present only when the selector switch is in the PIX, PIX & SOUND, or CHROMA & BURST ADJust position.

As Fig. 8 indicates, the pedestals are added to the sync, and the resulting signal is combined with the chroma information at the filter and adder tube, V6B. The composite signal is then applied to the grid of the video output stage, V7. Note that during the time when the unit is putting out dot or crosshatch signals, the pedestals and chroma information are switched out. Fig. 9 shows the waveforms of the various output signals as observed at J1 with an oscilloscope.

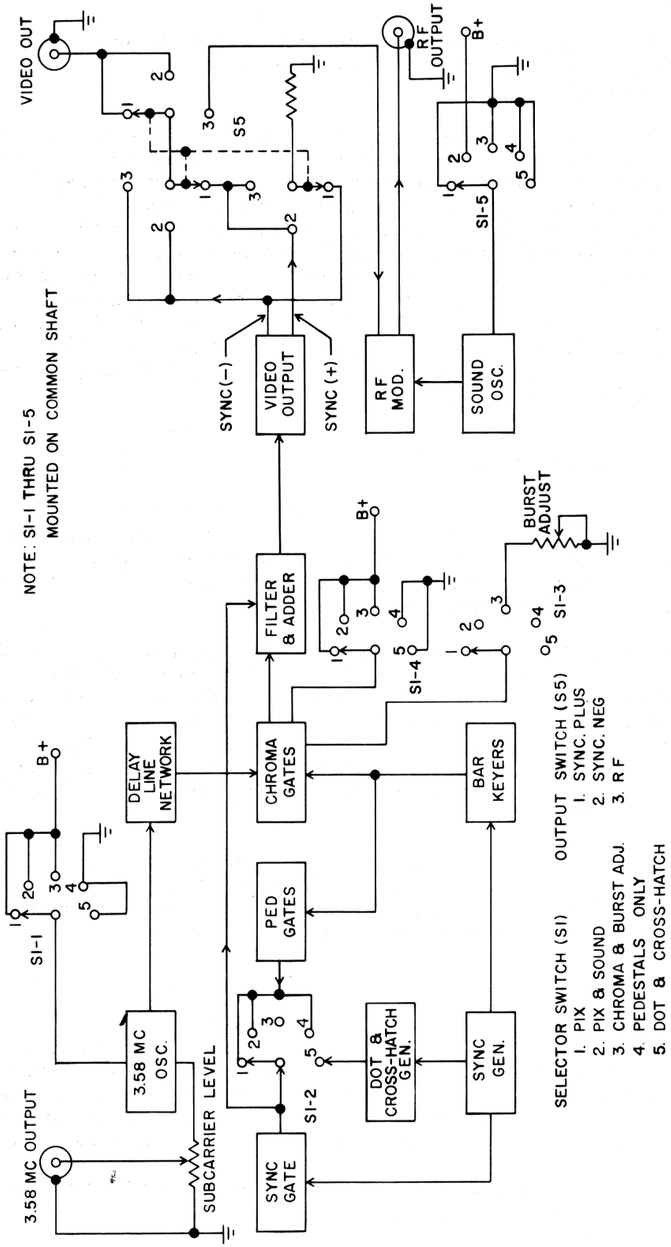


Fig. 8 Block Diagram (M-7491025)

Sync Generator

The sync generator circuit includes tubes V14 through V22 and generates a nearly complete interlaced sync. Note that no equalizing pulses are present during the vertical interval, however.

A crystal controlled multivibrator, V14, operating at a frequency of 157.340 kc provides a standard frequency from which the other frequencies shown on the Elementary Diagram, Fig. 11, are derived. Each tube and its circuitry is a free running multivibrator which is synchronized with the stage next higher in frequency. The desired frequencies are 157 kc, 31.5 kc, 15.7 kc, 420 cps, and 60 cps; the remaining ones being present only as by-products of the count down process. The 157 kc, 15.7 kc, 420 cps, and 60 cps signals are used in the dot-crosshatch generator circuit. The 15.7 kc signal is used for horizontal sync and is fed to the grid of V2A. The 60-cycle signal gates the 31.5 kc at V17B, which produces the vertical interval, also appearing at the grid of V2A. Fig. 10 (c) shows the gating of the 31.5 kc signal by the 60-cycle signal at the grid of V17B. Figs. 10 (a) and 10 (b) show the proper waveform at the grid of the sync gate stage, V2A.

Dot and Cross-Hatch Generator

The dot and crosshatch generator circuit includes tubes V12, V13, and V2B, and switch S6. The plates of V12, V13A, and the diode CR11 are connected in an adder circuit, that is, the three grid signals and the cathode signal of the diode are combined to produce the signal at the grid of the cathode follower, V13B. The networks at the three grids are for waveshaping purposes.

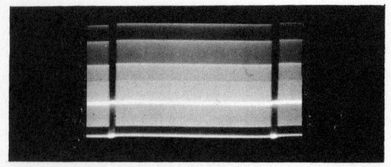
The dot-crosshatch signals are generated by adding 157 kc pulses to 420 cps pulses. The 15.7 kc pulses at the grid of V13B are used to remove the 157 kc pulses that would otherwise occur during the horizontal sync interval. The 60 cps pulses from V22 through CR11 remove the 420 cps pulses that would otherwise occur during the vertical interval. Since 157 kc is equal to ten times the horizontal rate, there are either eight vertical bars or eight vertical columns of dots. In the same way, since 420 cps is equal to seven times 60 cps, there are six horizontal bars or six horizontal rows of dots*.

The combined signal is then presented to the grid of V2B. S6 inserts a resistor in series between the cathode follower and the grid of V2B, and also increases the current through CR12 which, in turn, produces the dot signal as shown in the waveforms of Fig. 10 (d), or the cross-hatch signal shown in Fig. 10 (e).

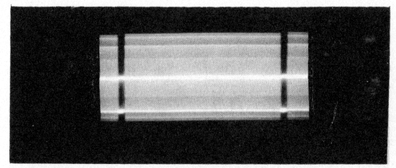
Bar Keyers

The bar keyers, V8 through V11, generate the signals which operate the pedestal and chrominance gates. The keyer stages are one-shot multivibrators; that is, they start out in their normal state, switch to their on position when triggered, and then return to their normal state in a length of time determined by their internal time constants. The multivibrators are arranged in a manner such that when V8 is triggered

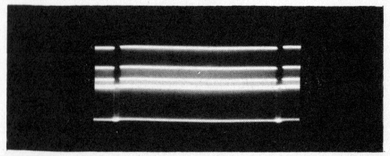
*Two pulses are lost during the previously mentioned H sync time and one pulse is lost during the V interval.



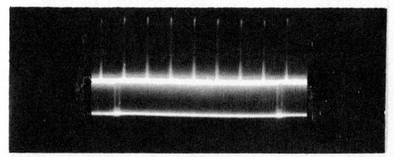
(a) Composite color bar signal. V Rate. Selector switch in PIX or PIX & SOUND position.



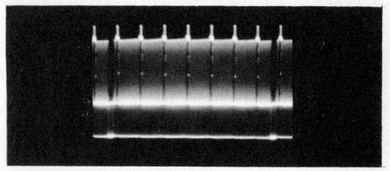
(b) Chroma only. V Rate. Selector switch in CHROMA & BURST ADJ position.



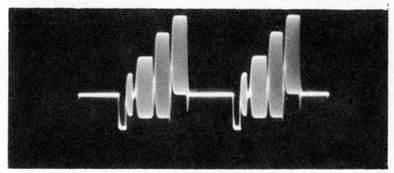
(c) Pedestal only. V Rate. Selector switch in PED ONLY position.



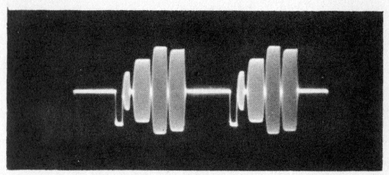
(d) Dot signal. V Rate. Selector switch in DOT-CH position and DOT CH switch in DOT position.



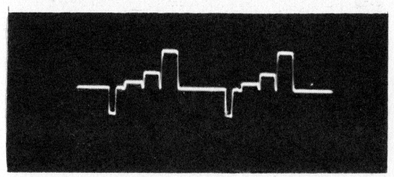
(e) Crosshatch signal. V Rate. Selector switch in DOT-CH position and DOT CH switch in CH position.



(f) Composite color bar signal. H Rate. Selector switch in PIX or PIX & SOUND position.



(g) Chroma only. H Rate. Selector switch in CHROMA & BURST ADJ position.

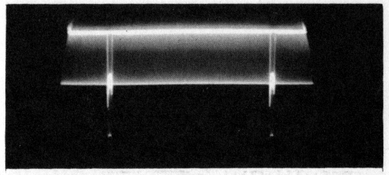


(h) Pedestals only. H Rate. Selector switch in PED ONLY position.

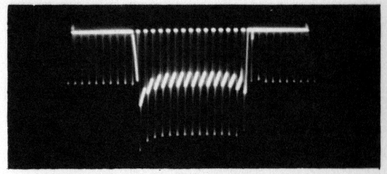
NOTE: All signals are sync-negative, and color bar order is blue, red, and green.

Fig. 9 Output Signal Waveforms at J1

Editor's note: scan and edit for best possible waveforms readability.

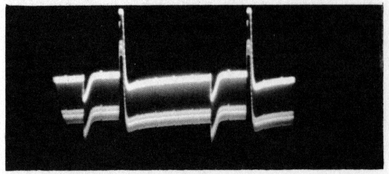


(a) Grid of sync gate stage, V2A; two vertical intervals.

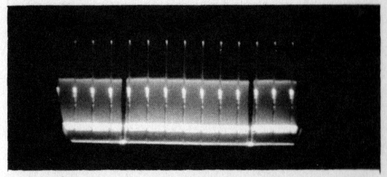


(b) Grid of sync gate stage, V2A; one vertical interval expanded.

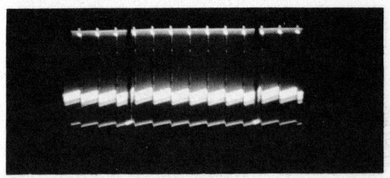
The above signals are clamped to ground (top of waveform) and are of such amplitude that the cut-off level of V2A is about half of the amplitude of the 15 kc signal.



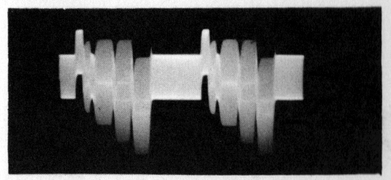
(c) Grid of V17B, showing gating of 31.5 kc by the 60-cycle signal. V Rate.



(d) Grid of V2B, showing waveform during formation of dot signal. V Rate.



(e) Grid of V2B, showing waveform during formation of crosshatch signal. V Rate.



(f) Plate of V27B, showing the composite signal at horizontal rate, with sound (4.5 mc) added.

NOTE: All signals are sync-negative, and color bar order is blue, red, and green.

Fig. 10 Waveforms; V2A, V2B, V17B, V27B

it switches on and then returns to its original condition in the proper length of time to generate the burst gate pulse. The return of V8 triggers V9, in turn, which in a similar fashion forms the gate pulse for the first color bar. The return of V9 then triggers V10 in like manner, and so on, the entire cycle occurring in approximately 2/3 of the time between successive horizontal sync pulses (approximately 40 microseconds).

Note that V8 is triggered by the horizontal sync multivibrator, V16. In order that color bars and pedestals are not generated during the vertical interval, V8 is biased below the trigger level during the vertical interval by a 60 cps pulse from V22.

Pedestal Gates and Plate Adder

The pedestal stages are V3A for the first bar gate, V4A for the second bar gate, and V5A for the third bar gate. The outputs of the three stages are added in the common plate circuit. The combined outputs are then added to the output of the sync gate in those positions of the selector switch that require pedestals in the Color Alignment Generator output.

The positive pulse from the first bar keyer, V9, is shaped and clamped to ground at the grid of V3A. It is then amplified by V3A and added to the signal in the V3A plate circuit. Since each color requires a different pedestal amplitude, the FIRST BAR switch, S2, selects the cathode circuit for V3A which results in the proper pedestal amplitude for each color.

V4A and V5A, the second and third pedestal gate stages, function in a similar manner.

Note that all of the color bars and the white bar have individual gain controls with the exception of the third white bar, which is used as a reference signal.

When the selector switch is in the dot and cross-hatch position, the signal at the plate of V2B is added to the signal at the plate of V2A instead of the pedestal gates.

Subcarrier Oscillator and Delay Line

V1A is a Pierce type crystal oscillator operating at a frequency of 3.579545 mc, the frequency assigned by the FCC to the color subcarrier. The circuit is designed so that the tuning of L1 has little effect on the frequency of operation, which therefore is practically as stable as the crystal itself. There are two outputs from the crystal oscillator; one is taken from the plate of V1A through the SUBCARRIER LEVEL control and appears at the SUBCARRIER OUT jack, J2. The other output is applied to the grid of V1B. Both of the subcarrier oscillator outputs are fed to their respective loads through high impedance capacitors which results in good isolation. The selector switch turns the subcarrier oscillator on or off as required by the output signal of the Generator.

V1B is the delay line driver stage which serves to isolate the delay line circuit from the oscillator and also acts as an impedance transformer. The delay line, which is of the lumped constant type, has many output taps which furnish subcarrier

signal, delayed by the proper amount for each color bar. Each tap has an isolation network and a trimmer capacitor so that each color may be set precisely to the correct phase. The various color signals are sent from the isolation networks to the three color bar selector switches, S2, S3, and S4.

CAUTION

THE DELAY LINE ASSEMBLY IS TO BE CONSIDERED AS A COMPONENT AND SHOULD NOT BE DISSASSEMBLED OR ADJUSTED, EXCEPT AT THE FACTORY. THE ADJUSTMENTS ARE EXTREMELY CRITICAL, AND REQUIRE THE USE OF ACCURATE TEST EQUIPMENT, WHICH IS NOT USUALLY AVAILABLE IN THE FIELD. FIG. 4 SHOWS THE DELAY LINE CONSTRUCTION.

Chroma Gates

The shaped and clamped signals from the bar keyers at the grids of the pedestal gate stages are applied to the grids of the chroma gate stages through isolation resistors. The gating signal at the grid of the burst gate arrives from the bar keyer, V8, from a nearly identical circuit. The chroma signals from the burst tap of the delay line and the bar selector switches, S2, S3, and S4, are fed to the chroma gate grids through capacitors, and are gated by the gate tubes, V6A, V5B, V4B, and V3B. The plates of the gate tubes are connected together so that the signals may be added, and are turned on or off by the selector switch, S1-4, according to whether chroma information is to be present in the Generator output signal.

The chroma gate outputs are applied to the filter and adder stage, V6B.

Filter and Adder

The outputs of the chroma gate stages, explained above, are applied to the grid of the adder stage, V6B, through the filter composed of L3, C27, and R83. The purpose of the filter circuit is to pass the 3.58 mc chroma components while discriminating against the 15.7 kc gating signal.

The output from the sync gate-plate adder is applied through a trimmed RC voltage divider to the grid of the output stage, V7. The chroma information also passes through V6B and is added to the signal at this point. The RC voltage divider also establishes the proper grid bias voltage for V7 which is direct coupled.

Output Stage

The video output stage, V7, is a phase inverter with a low impedance output circuit (91 ohms in the 4ST16A1, and 75 ohms in the 4ST16A2). The VIDEO (-) output (sync of negative polarity) is obtained by capacity coupling the plate of V7 to the output load, and connecting the cathode to a resistor. The VIDEO (+) output is obtained by reversing these connections. The 10,000-ohm resistor, R92, is present to act as a bleeder to make certain that the output is always at ground

level. For RF output the VIDEO (-) signal is applied to the RF modulator instead of to the VIDEO OUT jack, J1.

For V7 to act as a phase inverter at the signal levels used here, its cathode must be maintained above ground. This is accomplished by the RC divider in its grid circuit which maintains the grid potential above ground.

RF Modulator

The RF carrier is generated by a crystal controlled oscillator stage, V28. The quartz crystal, CR17, is a third mode type similar to the crystals used in the General Electric Marker Generator, Type ST-5-A, and operates in the 20 mc region. The remaining section of V28 is a third harmonic amplifier which serves to select the RF channel frequency from the oscillator output. The plate impedance transformer, T2, of the harmonic amplifier is tuned to the third harmonic of the crystal by C100. The MAINTENANCE section outlines the procedure for tuning the harmonic amplifier output circuit to resonance. The peak voltmeter reading described in the procedure is furnished by the diode rectifier, CR18, and its associated circuitry, C101 and R225. The RF is also fed to the diode modulator circuit* which includes the diode, CR19, and its associated circuitry. A diode modulator of this type is very linear in operation when the percentage of modulation is kept below approximately 40 per cent.

When the selector switch is in the PIX or PIX & SOUND position, video from the output circuit of V7 is applied to V27B which serves to invert the signal and also transform the impedance to the correct value for working into the modulator circuit. From the plate circuit of V27B, the video is fed to the modulator circuit and from there to the RF output jack, J4.

It is important that the output cable connected to J4 be terminated in a 91-ohm load. The cable, furnished with the Color Alignment Generator, serves to terminate the J4 output properly. Note that the single ended cable which is furnished with the General Electric Sweep Generator, Type ST-4-A, may also be used, as can the Balanced Output Adaptor, Type ST-8-A. The INSTALLATION section contains cable instructions.

Sound Carrier

The sound carrier oscillator circuit is similar in configuration to the RF carrier oscillator. V27A and a 4.5 mc crystal, CR16, develop the RF signal, which is applied to the plate circuit of V27B where it is added to the video signal on its way to the modulator circuit. The crystal is of the type used in the General Electric Marker Generator, Type ST-5-A. When the sound carrier oscillator is energized, 4.5 mc sidebands are established on both sides of the RF frequency and are useful in determining the correct setting of the television receiver fine tuning control. Note that the sound carrier oscillator is energized only when the selector switch, S1, is in the PIX & SOUND POSITION and S5 is in the RF position. Fig. 10 (f) shows the waveform at the plate of V27B with sound carrier added.

*Truman S. Gray, "Applied Electronics", John Wiley & Sons, Inc., New York, 1954.

MAINTENANCE

General

To assure continuous satifactory operation of the Color Alignment Generator, precautions must be observed. The most important thing to remember is that the unit must be kept dry and clean. Therefore, never operate the unit for extended periods without the dust cover. Periodically, depending upon the duty cycle of the equipment, remove the dust cover and carefully clean the unit, using an air hose or soft brush, and taking care not to disturb the position of components and wiring.

Tube Replacement

When a tube replacement is required, note that the Type 6U8 tubes require a 4 hour aging period. Whenever a Type 6U8 tube is replaced, therefore, leave the unit running for four hours before using it in applications where the output signal must be optimum. One 6U8 tube, V17, does not require aging; therefore, if one of the other 6U8 tubes requires replacement, replace it with V17 and plug the new tube into the V17 socket. In this way, a ready-aged tube is maintained for the more critical circuits.

Parts Replacement

If a component requires replacement, obtain its description from the Parts List. Do not replace a faulty component without first determining the cause of the failure. Order special parts from the General Electric Company, and purchase standard components from an electronic parts wholesaler. It is important to note that the Delay Line assembly, DL1, is to be considered as a component. Do not adjust or alter the Delay Line in any way.

Changing the RF Oscillator Crystals

The RF output may be on any one channel, 2 through 5. Extra crystals (for obtaining output on more than one channel) may be purchased separately from the General Electric Company, or the crystals from a General Electric Marker Generator, Type ST-5-A, may be used.

The tuning procedure, when inserting a new crystal, is as follows:

1. Plug the new crystal into the CR17 socket.

2. Connect a VTVM with a 3.0 volt d-c scale between J3 and chassis ground.

3. Adjust the trimmer capacitor, C100, for a maximum meter reading. If two peaks are found, choose the peak which occurs near the minimum capacitance of C100*. The voltage peak may be between approximately 0.3 volt and 2.0 volts, depending upon the channel frequency of the crystal.

*The minimum capacitance position of C100 may be determined by noting the position of the silvered half of the rotor. It is away from the mounting screws at minimum capacitance.

Trouble Shooting

If a fault develops in the unit, consult the following service aids which are included in this manual.

1. The Elementary Diagram, Fig. 11.

2. The THEORY AND CIRCUIT ANALYSIS section.

3. The waveform pictures, Figs. 9 and 10.

4. The tube socket d-c voltage chart on page 24.

Tube Socket Voltage Chart

Note: All voltages were taken with a 20,000 ohm/volt d-c meter.

Tube	1	2	3	4	5	6	7	8	9	Selector Switch Position
V1							0.35	2.0		1, 2, or 3
V2			150				X	X		any
V3			150				X	X		any
V4			150				X	X		any
V5			150				X	X		any
V6			150				X	1.5		any
V7						15				any
V8								13		any
V9								13		any
V10								13		any
V11								13		any
V12			1.0					0.5		any
V13			7.5					6		any
V14								13		any
V15								2.75		any
V16								3.6		any
V17			150				0.05	3.4		any
V18								4.0		any
V19								3.0		any
V20								3.0		any
V21								5.0		any
V22			1.0					0.025		any
V23*								300		any
V24							150			any
V25			70					45		any
V26	150			150						
V27A**			0.2							2
V27B								5		any
V28**			1.0					1.0		any

*AC line voltage 117 volts rms.
**Output switch in the RF position.
X = voltages are present, but vary with potentiometer settings.
B+ is 150 volts.
Pin 9 of V12, V27, and V28 is grounded.

PARTS LIST

Symbol	Description	G-E Drawing
	MOTOR	
B1	Inductance type, 117 v, 50/60 cycles, 2400/3000 rpm, 1/250 hp. Alliance Mfg. Co. Type JSO600.	B-7488961-P1
	CAPACITORS (Silver mica, ± 5%, 500 v d-c w, unless otherwise specified.)	
C1	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
C2	Ceramic disk, 22 mmfd ± 10%, 500 v d-c w, 0 temp coef.	C-7774846-P13
C3	Variable, air, 2.97 to 17.64 mmfd, 125 v peak. Johnson Cat. #160-110-43.	M-7481115-P4
C4	Ceramic disk, 18 mmfd ± 5%, 500 v d-c w, 0 temp coef.	C-7774846-P45
C5	Ceramic disk, 5.0 mmfd ± 0.5% mmfd, 500 v d-c w, 0 temp coef.	C-7774846-P5
C6	150 mmfd.	P-3R122-P51
C7	10 mmfd.	P-3R122-P132
C8	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
C9	47 mmfd.	P-3R122-P39
C10	100 mmfd.	P-3R122-P47
C11	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C12	100 mmfd.	P-3R122-P47
C13	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13

Symbol	Description	G-E Drawing
	CAPACITORS (CONT'D.) (Silver mica, ± 5%, 500 v d-c w, unless otherwise specified.)	
C14	100 mmfd.	P-3R122-P47
C15	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C16	33 mmfd ± ½ mmfd. Type CM15 case.	A-7144139-P1
C17	100 mmfd.	P-3R122-P47
C18	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C19	33 mmfd ± ½ mmfd. Type CM15 case.	A-7144139-P1
C20	Electrolytic, 25 mfd +250% -10%, 50 v d-c w. Mallory Cat. #TC36.	C-7774786-P8
C21	33 mmfd ± ½ mmfd. Type CM15 case.	A-7144139-P1
C22	Electrolytic, 25 mfd +250% -10%, 50 v d-c w. Mallory Cat. #TC36.	C-7774786-P8
C23	33 mmfd ± ½ mmfd. Type CM15 case.	A-7144139-P1
C24	Electrolytic, 25 mfd +250% -10%, 50 v d-c w. Mallory Cat. #TC36.	C-7774786-P8
C25	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
C26	Variable, ceramic, 7 to 45 mmfd, 500 v d-c w. Erie Type TS2A-N500.	M-7484389-P6
C27	22 mmfd.	P-3R122-P31
C28	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
C29	Electrolytic, 10 mfd +100% -10%, 250 v d-c w. Mallory Cat. #TC52.	C-7774786-P22
C30	47 mmfd.	P-3R122-P39
C31 and C32	Electrolytic, 80 mfd +100% -10%, 350 v d-c w. Mallory Cat. #FP138 with insulating sleeve.	P-7772471-P17

Symbol	Description	G-E Drawing
	CAPACITORS (CONT'D.) (Silver mica, ± 5%, 500 v d-c w, unless otherwise specified.)	
C33	Ceramic high K disk, 0.001 mfd +100% -0%, 500 v d-c w.	C-7774750-P4
C34	Variable, ceramic, 7 to 45 mmfd, 500 v d-c w. Erie Type TS2A-N500.	M-7484389-P6
C35	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C36	15 mmfd.	P-3R122-P134
C37	27 mmfd.	P-3R122-P33
C38	100 mmfd.	P-3R122-P47
C39	15 mmfd.	P-3R122-P134
C40	27 mmfd.	P-3R122-P33
C41	100 mmfd.	P-3R122-P47
C42	15 mmfd.	P-3R122-P134
C43	27 mmfd.	P-3R122-P33
C44	100 mmfd.	P-3R122-P47
C45	10 mmfd.	P-3R122-P132
C46	Mica, Class B; 2200 mmfd ± 5%, 500 v d-c w. RETMA Type RCM30B222J.	P-3R139-P65
C47	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
C48	Paper, molded plastic; 0.01 mfd ± 20%, 400 v d-c w. Sprague Cat. #67P10304.	B-7481651-P27
C49	Paper, molded plastic; 0.47 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P47402.	B-7481651-P17
C50	Electrolytic, 10 mfd +100% -10%, 250 v d-c w. Mallory Cat. #TC52.	C-7774786-P22
C51	Variable, ceramic, 5 to 20 mmfd, 500 v d-c w. Erie Type TS2A-N300.	M-7484389-P4

Symbol	Description	G-E Drawing
	CAPACITORS (CONT'D.) (Silver mica, ± 5%, 500 v d-c w, unless otherwise specified.)	
C52	Electrolytic, 10 mfd +100% -10%, 250 v d-c w. Mallory Cat. #TC52.	C-7774786-P22
C53	5.0 mmfd ± 20%.	P-3R122-P1
C54	100 mmfd.	P-3R122-P47
C55	10 mmfd.	P-3R122-P132
C56	56 mmfd.	P-3R122-P41
C57	Variable, ceramic, 7 to 45 mmfd, 500 v d-c w. Erie Type TS2A-N500.	M-7484389-P6
C58 and C59	10 mmfd.	P-3R122-P132
C60	100 mmfd.	P-3R122-P47
C61	Variable, ceramic, 7 to 45 mmfd, 500 v d-c w. Erie Type TS2A-N500.	M-7484389-P6
C62	100 mmfd.	P-3R122-P47
C63	5.0 mmfd ± 20%.	P-3R122-P1
C64	100 mmfd.	P-3R122-P47
C65	Electrolytic, 10 mfd +100% -10%, 250 v d-c w. Mallory Cat. #TC52.	C-7774786-P22
C66	27 mmfd.	P-3R122-P33
C67 and C68	Mica, Class B; 1000 mmfd ± 5%, 500 v d-c w. RETMA Type RCM30B102J.	C-3R139-P57
C69	5.0 mmfd ± 20%.	P-3R122-P1
C70 and C71	Mica, Class B; 1000 mmfd ± 5%, 500 v d-c w. RETMA Type RCM30B102J.	C-3R139-P57
C72	22 mmfd.	P-3R122-P31

Symbol	Description	G-E Drawing
	CAPACITORS (CONT'D.) (Silver mica, ± 5%, 500 v d-c w, unless otherwise specified.)	
C73 and C74	Mica, Class B; 3300 mmfd ± 5%, 500 v d-c w. RETMA Type RCM35B332J.	P-3R139-P69
C75	Variable, ceramic, 5 to 20 mmfd, 500 v d-c w. Erie Type TS2A-N300.	M-7484389-P4
C76 and C77	Mica, Class B; 10,000 mmfd ± 5%, 300 v d-c w. RETMA Type RCM35B103J.	C-3R139-P81
C78	Electrolytic, 10 mfd +100% -10%, 250 v d-c w. Mallory Cat. #TC52.	C-7774786-P22
C79	180 mmfd.	P-3R122-P53
C80	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C81	Ceramic high K disk, 0.001 mfd +100% -10%, 500 v d-c w.	C-7774750-P4
C82	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C83	Ceramic high K disk, 0.001 mfd +100% -0%, 500 v d-c w.	C-7774750-P4
C84	220 mmfd.	P-3R122-P55
C85	100 mmfd.	P-3R122-P47
C86	Electrolytic, polarized twist prong base, 20-20-20 mfd +100% -10%, 350-350-350 v d-c w. Mallory Type FP.	P-7772415-P31
C87 and C88	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C89 and C90	56 mmfd.	P-3R122-P41
C91	39 mmfd.	P-3R122-P37

Symbol	Description	G-E Drawing
	CAPACITORS (CONT'D.) (Silver mica, ± 5%, 500 v d-c w, unless otherwise specified.)	
C92	Ceramic, feed-thru type, 1000 mmfd ± 20%, 500 v d-c w. Erie Style 327.	B-7485975-P19
C93	Paper, molded plastic; 0.10 mfd ± 20%, 200 v d-c w. Sprague Cat. #67P10402.	B-7481651-P13
C94	Electrolytic, 20 mfd +100% -10%, 250 v d-c w. Mallory Cat. #TC55.	C-7774786-P24
C95	Ceramic, feed-thru type, 1000 mmfd ± 20%, 500 v d-c w. Erie Style 327.	B-7485975-P19
C96 thru C98	22 mmfd.	P-3R122-P31
C99	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
C100	Variable, ceramic, 7 to 45 mmfd, 500 v d-c w. Erie Type TS2A-N500.	M-7484389-P6
C101 and C102	47 mmfd.	P-3R122-P39
C103	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13
C104 and C105	Ceramic, feed-thru type, 1000 mmfd ± 20%, 500 v d-c w. Erie Style 327.	B-7485975-P19
C106	Electrolytic, 25 mfd +250% -10%, 50 v d-c w. Mallory Cat. #TC36.	C-7774786-P8
C107	10 mmfd.	P-3R122-P132
C108 and C109	Ceramic high K disk, 0.01 mfd +100% -0%, 500 v d-c w.	C-7774750-P13

Symbol	Description	G-E Drawing
	RECTIFIERS AND OSCILLATORS	
CR1	Crystal oscillator: 3579.545 kc.	A-7147326-P1
CR2 thru CR11	Germanium diodes. Hughes Cat. #HD2120 or Type 1N90.	
CR12	Germanium diode. Hughes Type 1N67A.	
CR13	Crystal oscillator: 157.340 kc.	A-7147325-P1
CR14	Germanium diode. Hughes Type HD2120 or 1N90.	
CR15	Germanium diode. Hughes Type 1N67A.	
CR16	Crystal: 4500 kc.	K-112J716-P1
CR17	Channel crystal. Drawing number part determines the frequency. When reordering give channel frequency, G-E Dwg. No. and Part No. exactly as stamped on case.	K-113J771
CR18 and CR19	Germanium diodes. Hughes Type 1N90 or HD2120.	
	DELAY LINE	
DL1	Delay line.	PL-7489318-G1
	FUSE	
F1	2.8 amp, 125 v, slow blow. Bussman Cat. #MDL2.8.	B-7487942-P29
	LAMPS	
I1	6.3 v, 0.15 amp, miniature bayonet base. G-E Cat. #47.	
	JACKS AND RECEPTACLES	
J1 and J2	Receptacles. Amphenol Cat. #83-1R. Signal Corps #SO-239.	M-2R22-P3
J3	Tip jack: orange head. EF Johnson Cat. #105-526-25.	A-7142648-P6

Symbol	Description	G-E Drawing
	JACKS & RECEPTACLES (CONT'D.)	
J4	Receptacle: Series BNC, Type UG-262/U.	M-7478772-P1
	INDUCTORS	
L1	Variable inductance coil: 9 to 18 uh tunable inductance range. North Hills Elec. Type 120-D.	A-7140206-P24
L2 and L3	Variable inductance coils: 18 to 36 uh tunable inductance range. North Hills Elec. Type 120-E.	A-7140206-P25
L4	Reactor: inductance 8.5 h min at 0.225 amp d-c, 125 ohms max d-c resistance.	B-7489377-P1
L5	RF choke: 100.0 uh ± 10%. Jeffers Cat #10404-34.	B-7488079-P72
L6	RF choke: 5.60 uh ± 10%. Jeffers Cat. #10102-26.	B-7488079-P13
L7	RF choke: 2.70 uh ± 10%. Jeffers Cat. #10100-36.	B-7488079-P9
	PLUG	
P1	2 piece straight plug. Amphenol Cat. #83-1SP, Signal Corps #PL-259.	M-2R22-P1
	RESISTORS (Composition, ± 10%, ½ w, unless otherwise specified.)	
R1	0.27 megohm.	C-3R77-P274K
R2	15,000 ohms.	C-3R77-P153K
R3	0.10 megohm.	C-3R77-P104K
R4	220 ohms.	C-3R77-P221K
R5	Potentiometer, composition: 100 ohms ± 20%, 2 w, linear taper. Allen Bradley Type J.	M-2R73-P2
R6	1000 ohms.	C-3R77-P102K
R7	100 ohms.	C-3R77-P101K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition ± 10%, ½ w, unless otherwise specified.)	
R8	15,000 ohms.	C-3R77-P153K
R9	220 ohms.	C-3R77-P221K
R11	220 ohms.	C-3R77-P221K
R12 and R13	68,000 ohms.	C-3R77-P683K
R14	330 ohms.	C-3R77-P331K
R15	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R16	0.10 megohm.	C-3R77-P104K
R17	330 ohms.	C-3R77-P331K
R18	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R19	0.10 megohm.	C-3R77-P104K
R20	10,000 ohms.	C-3R77-P103K
R21	47,000 ohms.	C-3R77-P473K
R22	2000 ohms ± 5%.	C-3R77-P202J
R23	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R24	0.10 megohm.	C-3R77-P104K
R25	330 ohms.	C-3R77-P331K
R26	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R27	0.10 megohm.	C-3R77-P104K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R28	330 ohms.	C-3R77-P331K
R29	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R30	0.10 megohm.	C-3R77-P104K
R31	10,000 ohms.	C-3R77-P103K
R32	47,000 ohms.	C-3R77-P473K
R33	330 ohms.	C-3R77-P331K
R34	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R35	0.10 megohm.	C-3R77-P104K
R36	330 ohms.	C-3R77 P331K
R37	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5. Chicago Telephone Supply Type 70.	B-7487391-P115
R38	0.10 megohm.	C-3R77-P104K
R39	330 ohms.	C-3R77-P331K
R40	0.10 megohm.	C-3R77-P104K
R41	10,000 ohms.	C-3R77-P103K
R42	47,000 ohms.	C-3R77-P473K
R43	330 ohms.	C-3R77-P331K
R44	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R45	0.10 megohm.	C-3R77-P104K
R46	330 ohms.	C-3R77 P331K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R47	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R48	0.10 megohm.	C-3R77-P104K
R49	6800 ohms ± 10%.	C-3R77-P682J
R50	47,000 ohms.	C-3R77-P473K
R51	2.2 megohm.	C-3R77-P225K
R52	2700 ohms.	C-3R77-P272K
R53	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R54	0.10 megohm.	C-3R77-P104K
R55	3300 ohms.	C-3R77-P332K
R56	Potentiometer, composition: 10,000 ohms ± 20%, 2 w, linear taper. Allen Bradley Type J.	M-2R73-P14
R57	0.10 megohm.	C-3R77-P104K
R58	10,000 ohms ± 5%.	C-3R77-P103J
R59	330 ohms.	C-3R77-P331K
R60	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w, Chicago Telephone Supply Type 70.	B-7487391-P115
R61	0.10 megohm.	C-3R77-P104K
R62	330 ohms.	C-3R77-P331K
R63	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R64	0.10 megohm.	C-3R77-P104K
R65	10,000 ohms ± 5%.	C-3R77-P103J

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R66	330 ohms.	C-3R77-P331K
R67	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R68	0.10 megohm.	C-3R77-P104K
R69	330 ohms.	C-3R77-P331K
R70	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R71	0.10 megohm.	C-3R77-P104K
R72	10,000 ohms ± 5%.	C-3R77-P103J
R73	330 ohms.	C-3R77-P331K
R74	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R75	0.10 megohm.	C-3R77-P104K
R76	330 ohms.	C-3R77-P331K
R77	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R78	0.10 megohm.	C-3R77-P104K
R79	100 ohms.	C-3R77-P101K
R80	220 ohms.	C-3R77-P221K
R81	3900 ohms, 1 w.	C-3R78-P392K
R82	47,000 ohms, 1 w.	C-3R78-P473K
R83	1500 ohms.	C-3R77-P152K
R84	1000 ohms.	C-3R77-P102K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R85	120 ohms.	C-3R77-P121K
R86	5100 ohms.	C-3R77-P512J
R87	100 ohms.	C-3R77-P101K
R88	330 ohms, 2 w.	C-3R79-P331K
R89	100 ohms.	C-3R77-P101K
R90	330 ohms, 2 w.	C-3R79-P331K
R91	91 ohms ± 5%.	C-3R77-P910J
R92	10,000 ohms.	C-3R77-P103K
R93	1.0 megohm.	C-3R77-P105K
R94	0.22 megohm.	C-3R77-P224K
R95	68,000 ohms.	C-3R77-P683K
R96	47,000 ohms.	C-3R77-P473K
R97	10,000 ohms.	C-3R78-P103K
R98	1800 ohms.	C-3R77-P182K
R99	10,000 ohms, 1 w.	C-3R78-P103K
R100	2.2 megohm.	C-3R77-P225K
R101	68,000 ohms.	C-3R77-P683K
R102	10,000 ohms, 1 w.	C-3R78-P103K
R103	1800 ohms.	C-3R77-P182K
R104	10,000 ohms, 1 w.	C-3R78-P103K
R105	2.2 megohm.	C-3R77-P225K
R106	68,000 ohms.	C-3R77-P683K
R107	10,000 ohms, 1 w.	C-3R78-P103K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R108	1800 ohms.	C-3R77-P182K
R109	10,000 ohms, 1 w.	C-3R78-P103K
R110	2.2 megohm.	C-3R77-P225K
R111	68,000 ohms.	C-3R77-P683K
R112	10,000 ohms, 1 w.	C-3R78-P103K
R113	1800 ohms.	C-3R77-P182K
R114	10,000 ohms, 1 w.	C-3R78-P103K
R115	2.2 megohm.	C-3R77-P225K
R116	2200 ohms.	C-3R77-P222K
R117	220 ohms.	C-3R77-P221K
R118	15,000 ohms, 1 w.	C-3R78-P153K
R119	15,000 ohms.	C-3R77-P153K
R120	330 ohms.	C-3R77-P331K
R121	1000 ohms.	C-3R77-P102K
R122	1.0 megohm.	C-3R77-P105K
R123	47,000 ohms.	C-3R77-P473K
R124	33,000 ohms.	C-3R77-P333K
R125	10,000 ohms.	C-3R77-P103K
R126	0.10 megohm.	C-3R77-P104K
R127	4700 ohms.	C-3R77-P472K
R128 and R129	0.10 megohm.	C-3R77-P104K
R130	0.22 megohm.	C-3R77-P224K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R131	2.2 megohm.	C-3R77-P225K
R132	2700 ohms.	C-3R77-P272K
R133	2200 ohms.	C-3R77-P222K
R134	1.0 megohm.	C-3R77-P105K
R135	0.10 megohm.	C-3R77-P104K
R136	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
R137	330 ohms.	C-3R77-P331K
R138 and R139	100 ohms.	C-3R77-P101K
R140	0.12 megohm.	C-3R77-P124K
R141	10,000 ohms, 1 w.	C-3R78-P103K
R142	1800 ohms.	C-3R77-P182K
R143	10,000 ohms, 1 w.	C-3R78-P103K
R144	0.12 megohm.	C-3R77-P124K
R145	0.33 megohm.	C-3R77-P334K
R146	10,000 ohms, 1 w.	C-3R78-P103K
R147	390 ohms.	C-3R77-P391K
R148	10,000 ohms, 1 w.	C-3R78-P103K
R149	0.33 megohm.	C-3R77-P334K
R150	6800 ohms.	C-3R77-P682K
R151	39,000 ohms.	C-3R77-P393K
R152	10,000 ohms, 1 w.	C-3R78-P103K
R153	820 ohms.	C-3R77-P821K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ±10%, ½ w, unless otherwise specified.)	
R154	10,000 ohms, 1 w.	C-3R78-P103K
R155	1.0 megohm.	C-3R77-P105K
R156	220 ohms.	C-3R77-P221K
R157	0.15 megohm.	C-3R77-P154K
R158	8200 ohms.	C-3R77-P822K
R159	1200 ohms.	C-3R77-P122K
R160	39,000 ohms.	C-3R77-P393K
R161	33,000 ohms, 1 w.	C-3R78-P333K
R162	820 ohms.	C-3R77-P821K
R163	33,000 ohms, 1 w.	C-3R78-P333K
R164	0.12 megohm.	C-3R77-P124K
R165	Potentiometer, carbon film: 100,000 ohms ±20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P101
R166	0.33 megohm.	C-3R77-P334K
R167	33,000 ohms, 1 w.	C-3R78-P333K
R168	820 ohms.	C-3R77-P821K
R169	33,000 ohms, 1 w.	C-3R78-P333K
R170	0.33 megohm.	C-3R77-P334K
R171	Potentiometer, carbon film: 250,000 ohms ±20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P111
R172	0.33 megohm.	C-3R77-P334K
R173	33,000 ohms, 1 w.	C-3R78-P333K
R174	820 ohms.	C-3R77-P821K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R175	33,000 ohms, 1 w.	C-3R78-P333K
R176	0.33 megohm.	C-3R77-P334K
R177	Potentiometer, carbon film: 250,000 ohms ± 20%, 1/5 w, linear taper. Chicago Telephone Supply Type 70.	B-7487391-P111
R178	1000 ohms.	C-3R77-P102K
R179	0.82 megohm.	C-3R77-P824K
R180	10,000 ohms, 1 w.	C-3R78-P103K
R181	820 ohms.	C-3R77-P821K
R182	10,000 ohms, 1 w.	C-3R78-P103K
R183	2.2 megohm.	C-3R77-P225K
R184 and R185	1.0 megohm.	C-3R77-P105K
R186	220 ohms.	C-3R77-P221K
R187	15,000 ohms.	C-3R77-P153K
R188	15,000 ohms.	C-3R77-P153K
R189	0.10 megohm.	C-3R77-P104K
R190	100 ohms.	C-3R77-P101K
R192	0.10 megohm.	C-3R77-P104K
R193	33,000 ohms.	C-3R77-P333K
R194 thru R196	100 ohms.	C-3R77-P101K
R197	Wirewound, 2500 ohms ± 5%, 10 w. Ward Leonard Cat. #10F2500.	M-2R12-P35
R198	0.24 megohm ± 5%.	C-3R77-P244J

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R199	24,000 ohms ± 5%.	C-3R77-P243J
R200	20,000 ohms ± 5%.	C-3R77-P203J
R201	0.47 megohm.	C-3R77-P474K
R202	5600 ohms, 1 w.	C-3R78-P562K
R203	0.10 megohm.	C-3R77-P104K
R204	51,000 ohms ± 5%.	C-3R77-P513J
R205	Potentiometer, composition: 100,000 ohms ± 20%, ½ w, linear taper.	M-2R75-P60
R206	0.22 megohm.	C-3R77-P224K
R207	10,000 ohms.	C-3R77-P103K
R208	56 ohms.	C-3R77-P560K
R209	91 ohms ± 5%.	C-3R77-P910J
R210	10,000 ohms.	C-3R77-P103K
R211	100 ohms.	C-3R77-P101K
R212	0.10 megohm.	C-3R77-P104K
R213	1000 ohms.	C-3R77-P102K
R214	56 ohms.	C-3R77-P560K
R215	220 ohms.	C-3R77-P221K
R216	510 ohms ± 5%.	C-3R77-P511J
R217	180 ohms.	C-3R77-P181K
R218	0.33 megohm.	C-3R77-P334K
R219	330 ohms.	C-3R77-P331K
R220	0.15 megohm.	C-3R77-P154K

Symbol	Description	G-E Drawing
	RESISTORS (CONT'D.) (Composition, ± 10%, ½ w, unless otherwise specified.)	
R221	56 ohms.	C-3R77-P560K
R222	100 ohms.	C-3R77-P101K
R223	0.22 megohm.	C-3R77-P224K
R224	56 ohms.	C-3R77-P560K
R225	0.10 megohm.	C-3R77-P104K
R226	560 ohms.	C-3R77-P561K
R227	180 ohms.	C-3R77-P181K
R228	Potentiometer, composition: 200 ohms ± 20%, ¼ w, linear taper. Similar to Centralab Model E or 2 except with special plating.	K-102J978-P1
R229	Potentiometer, carbon film: 2500 ohms ± 20%, linear taper, 1/5 w. Chicago Telephone Supply Type 70.	B-7487391-P115
	SWITCHES	
S1	Rotary type, 3 bakelite sections, 5 position, 5 pole, nonshorting. Oak Type N.	C-7775906-P2
S2	Rotary type, #1 section ceramic, #2 section bakelite, 5 position, 3 pole, nonshorting. Oak Type N.	C-7775906-P1
S4	Rotary type, 1 ceramic section, 3 position, 3 pole, nonshorting. Oak Type NC.	C-7775906-P3
S5	Rotary type, 2 bakelite sections, 3 position, 4 pole, nonshorting. Oak Type N.	C-7775906-P4
S6	Rotary type, dpdt, shorting, phenolic part tropicalized. Oak Type 22.	M-7482940-P1
S7	Toggle type, spst, 3 amp at 250 v. Carling Cat. #110-73.	C-7775772-P1

Symbol	Description	G-E Drawing
	TRANSFORMERS	
T1	Filament and rectifier, single phase. Pri: 117/234 v, 50/60 cycles; sec #1: 570/285 v, 0.295 amp; sec #2: 5.0 v, 3.0 amp; sec #3: 6.3 v, 12.5 amp. Voltages given are for a primary voltage of 117 if primaries are parallel, and 234 if windings are in series.	B-7489378-P1
T2	Transformer assembly.	A-7146771-G1
	RECTIFIER SOCKETS	
XCR1 and XCR13	2 pin steatite. Type CR-7, HH Eby Cat. #9006.	K-7128948-P1
XCR16 and XCR17	2 pin steatite. Type CR-7, HH Eby Cat. #9006.	K-7128948-P1
	FUSE HOLDER	
XF1	Bussman Type HKP.	K-7115179-P1
	PILOT LIGHT	
XI1	Red faceted jewel. Drake Type 5B.	A-7140189-P1
	TUBE SOCKETS (Mica filled phenolic, 4 ground lugs.)	
XV1 thru XV13	9 pin miniature, 4 ground lugs.	M-7480532-P8
XV14 thru XV16	Turret type: 9 pin miniature, bottom mount saddle type.	B-7484399-P2
XV17 thru XV22	9 pin miniature.	M-7480532-P8

Symbol	Description	G-E Drawing
	TUBE SOCKETS (CONT'D.) (Mica filled phenolic, 4 ground lugs.)	
XV23 and XV24	Octal. Cinch Type 9886.	K-7103053-P1
XV25	9 pin miniature.	M-7480532-P8
XV26	7 pin miniature, bottom mount flat top.	P-7768887-P14
XV27 and XV28	9 pin miniature.	M-7480532-P8

COLOR ALIGNMENT GENERATOR

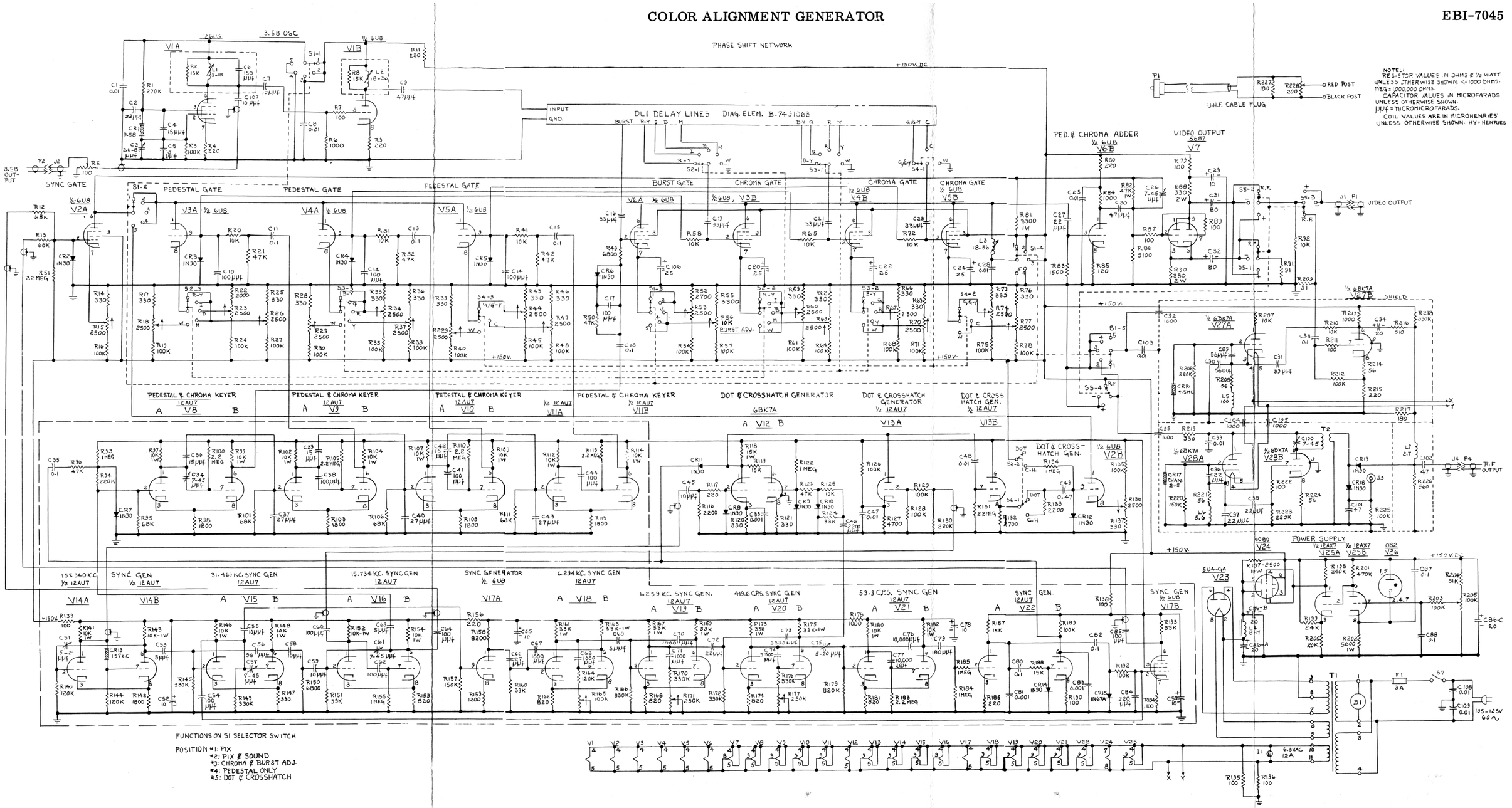


Fig. 11 Elementary Diagram, Color Alignment Generator, Type ST-16-A (EE-7352393)

End.