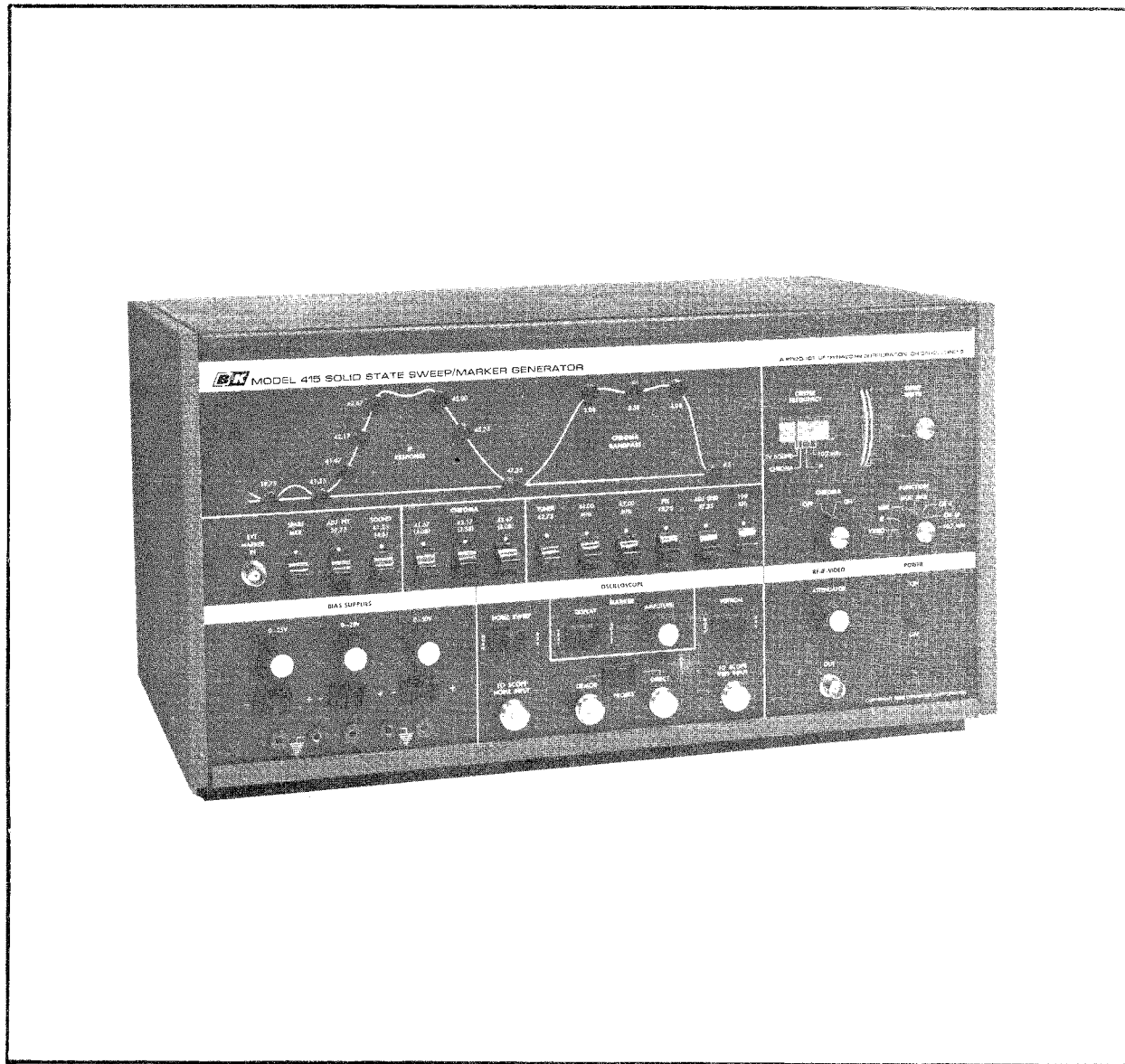


# INSTRUCTION MANUAL

**B&K** Model **415**

# Sweep/Marker Generator



A Product of DYNASCAN CORPORATION 1801 West Belle Plaine • Chicago, Illinois 60613

PRICE \$5.00





**INSTRUCTION MANUAL**  
**FOR**  
**MODEL 415**  
**SWEEP / MARKER GENERATOR**

**B & K** DIVISION OF DYNASCAN CORPORATION

1801 W. Belle Plaine Avenue

Chicago, Illinois 60613

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## INTRODUCTION

The objectives of the Model 415 Sweep Marker Generator and this manual are as follows:

- A. To simplify the sweep alignment of all television receivers, particularly color sets. Simplification is accomplished by an instrument design which concentrates all the required alignment tools (exclusive of oscilloscope and VTVM) into a single versatile package. Functional grouping of all controls and features adds to efficiency and ease of operation.
- B. To enable you to proceed confidently through complete alignment procedures in minimum time. The importance of confidence in the test equipment and alignment procedures cannot be overemphasized.
- C. To provide speed of alignment and alignment verification which are essential in attaining efficient and profitable operations. The 415 is designed to put sweep alignment and alignment verification into the proper perspective with regard to overall television servicing by eliminating complexity and drastically reducing the time required for these functions.
- D. To provide an instrument which will not be obsoleted by future television receiver designs. The Model 415 is the result of an extensive survey of older receivers and those currently on the market as well as a projection of future television receiver designs.

Without the Model 415 numerous separate pieces of equipment have to be grouped together in order to begin sweep alignment. These include a sweep generator capable of furnishing video sweep, i-f sweep and r-f sweep. Usually more than one generator is required. A second requirement is a marker generator capable of furnishing reference markers in the video, i-f and r-f ranges. Without the 415, this again usually requires more than one generator. If this generator is tunable, it can furnish only one reference marker at a time. Also, the fact that the generator is tunable raises questions of calibration accuracy. A marker adder is also used, particularly in chroma circuit alignment. Separate bias supplies are also required. Some alignment procedures call for simultaneous application of up to three bias voltages. In many procedures a demodulator is required to view r-f, i-f, or chroma envelopes. An oscilloscope and voltmeter complete the equipment requirements.

After the set-up is complete and alignment is under way the technician usually finds that the amplitude and tilt of the observed waveforms

are affected by the position of the interconnecting wires and cables in his set-up and that they can also be varied by touching the leads, cables and equipment. Upon completion of the alignment procedure the technician cannot help but wonder if the response curves which he has finally obtained are actually those of the receiver itself or are partly affected by his alignment set-up.

The Model 415 has been designed to eliminate the problems normally encountered in sweep alignment. This totally solid-state unit is capable of providing i-f sweep, r-f sweep on television Channels 4 and 10, video sweep, 10.7 MHz i-f sweep for f-m receivers and crystal-controlled post injection markers for accurate frequency identification on all sweep ranges. In addition, crystal-controlled output frequencies are available for spot alignment of trap circuits and bandpass circuits.

Three self-contained adjustable bias supplies of reversible polarity are more than adequate for all alignment tasks. The signal cable is properly terminated to minimize alignment errors and "hot" leads caused by standing waves. All accessories are provided: r-f demodulator probe, a direct cable with built-in isolating resistor, an r-f cable with built-in terminations which can be selected by a switch, i-f load blocks, and bias leads. Only an oscilloscope and a VTVM are required to complete the alignment set-up.

Additional features include unity gain through the signal-processing circuits of the 415 so that peak-to-peak amplitudes can be monitored continuously during alignments; a 15,750 Hz filter which enables the user to perform sweep alignment without disabling the horizontal output circuits; built-in low-frequency compensation to eliminate pattern tilt errors resulting from use of an oscilloscope with poor low-frequency response; marker tilt capability: the markers can be switched from vertical to horizontal positions. Alignment procedures are streamlined by the versatility and functional design of this instrument.

This manual will familiarize you with the applications and features of the 415, as well as the internal circuit functions of the instrument itself. In addition the signal processing circuits of color and black and white television receivers will be reviewed and the importance of proper alignment emphasized. In this way you can proceed rapidly and confidently through alignment procedures with a complete understanding of how and why the 415 signals are generated and how the television receiver responds to them.

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## SPECIFICATIONS

### 1.0 415 SWEEP/MARKER GENERATOR SPECIFICATIONS

- 1.1 Outputs available (selected by FUNCTION switch at single output jack):
  - a. Video Sweep
  - b. IF Sweep
  - c. Markers, unmodulated
  - d. Modulated markers
  - e. Channel 4 RF Sweep
  - f. Channel 10 RF Sweep
  - g. 10.7 MHz Sweep
- 1.2 Sweep Width:
  - a. IF, CH 4, CH 10—less than 1 MHz to over 10 MHz
  - b. 10.7 MHz—less than 200 KHz to over 2 MHz
  - c. Video—less than 1 MHz to over 6 MHz
- 1.3 Sweep Frequency Coverage (Sweep plus center frequency adjustment):
  - a. Video—less than 1 MHz to over 6 MHz
  - b. IF—35 MHz to 50 MHz
  - c. CH 4—56.5 MHz to 71.5 MHz
  - d. CH 10—182.5 MHz to 196.5 MHz
  - e. 10.7 MHz—8 MHz to 12 MHz
- 1.4 Sweep Frequency Rate:  
60/Sec
- 1.5 Output levels across 75 Ohms (Nominal):
  - a. IF—0.3 Volt
  - b. RF—50,000 microvolts
  - c. Markers—0.15 Volt
  - d. Video—1.5 Volts peak-to-peak
  - e. 10.7—0.3 Volt
- 1.6 RF Attenuator Range:  
60 dB Variable  
20 dB Switched
- 1.7 Output Impedances:  
75 Ohms or 300 Ohms. Desired impedance is selected by switch on R-F cable terminating pad.
- 1.8 Crystal-Controlled Markers:  
(Post Injection System)  
**IF (10 Standard Frequencies)**
  - a. 39.75 MHz (ADJ PIX)
  - b. 41.25 MHz (SOUND)
  - c. 41.67 MHz (CHROMA)
  - d. 42.17 MHz (CHROMA CARRIER)
  - e. 42.67 MHz (CHROMA)
  - f. 42.75 MHz
  - g. 44.00 MHz
  - h. 45.00 MHz
  - i. 45.75 MHz (PIX)
  - j. 47.25 MHz (ADJ SND)

### VIDEO

Internally generated markers available.

### CHANNEL 4, CHANNEL 10

Because of the marker generation system, the r-f equivalents of all i-f markers are available on Channel 4 and Channel 10.

### CUSTOMER OPTION

A spare marker oscillator circuit is provided for the customer option. The circuit can be adjusted to accept any third overtone crystal in the 35 MHz to 50 MHz range or, with a minor circuit modification, it can be used as a variable frequency oscillator.

### 10.7 MHz

A 10.7 MHz crystal marker oscillator is automatically energized when 10.7 MHz sweep is selected.

- 1.9 Additional marker provisions:

### EXTERNAL MARKER INPUT

External markers can be used in combination with the internal i-f or 10.7 MHz markers.

### 100 KHz MARKERS

A continuous string of markers having 100 KHz separations can be superimposed on any of the i-f markers or the 10.7 MHz marker. This enables the operator to interpolate frequencies to either side of a crystal controlled marker in 100 KHz increments. This feature is valuable in 10.7 MHz f-m i-f and discriminator alignment as well as in alignment of automatic fine tuning discriminators in television receivers.

- 1.10 Bias Supplies:

2 each  $\pm 0$  to 25 VDC (750 Ohms Max Impedance)

1  $\pm 0$  to 50 VDC (2.5K Ohms Max Impedance)

- 1.11 Controls:

- a. 12 ON/OFF Marker Switches
- b. 3 Bias Voltage Adjustments
- c. 3 Bias Polarity Switches
- d. NORM/REV Horizontal Sweep Switch
- e. NORM/REV Vertical Display Switch
- f. MARKER AMPLITUDE Control
- g. Marker VERT/HORIZ Display — selects either vertical or horizontal orientation of markers.
- h. SWEEP WIDTH Control for IF, CH 4, CH 10, VIDEO and 10.7 MHz sweeps.
- i. CENTER FREQUENCY Control for all sweep circuits.
- j. CHROMA ON/OFF Switch
- k. FUNCTION Switch—Selects outputs available at RF-IF-VIDEO OUT jack and performs internal switching functions.

- l. RF-IF-VIDEO ATTENUATOR — Provides continuous output level adjustment of all outputs.
- m. PROBES Selector Switch — Selects either the Direct probe or the Demodulator probe.
- n. POWER ON/OFF Switch

## 1.12 ADDITIONAL FEATURES

- 1.12.1 Unity gain through instrument into oscilloscope to eliminate intermediate connecting steps for calibration purposes.
- 1.12.2 15,750 Hz Filter enables user to view I-F and chroma response curves without disabling the horizontal output stage of the receiver under test. The response curves can then be viewed with no objectionable "grass" from the television receiver superimposed on the oscilloscope patterns.
- 1.12.3 Built-in Low Frequency Compensation to eliminate pattern tilt errors resulting from use of an oscilloscope with poor low-frequency response (internal adjustment).
- 1.12.4 Marker lights are provided on the front panel to indicate when specific markers are being used. In addition, the lights are located on idealized response curves to indicate the desired position of the markers. This is a built-in reference for the operator.

1.12.5 The horizontal sweep is synchronized to the power line frequency (60 Hz).

1.12.6 100 per cent solid state circuitry for zero warm-up time and maximum stability and reliability.

1.12.7 All internal voltages are regulated for maximum stability and immunity to line voltage fluctuations.

1.12.8 All accessories required for connection of Model 415 to oscilloscope and receiver under test are furnished. These include:

R-F cable with built-in d-c blocking and terminations (75 or 300 ohms).

PR-151 Demodulator Probe for all video, chroma, i-f and r-f demodulation requirements.

Direct cable with built-in 10K ohm isolating resistor.

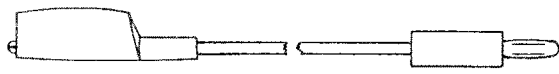
Two i-f load blocks for tuner link adjustment.

All shielded cables for connection to the oscilloscope.

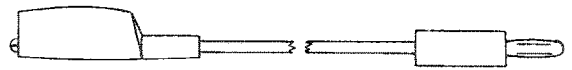
Three bias leads.

One ground cable.

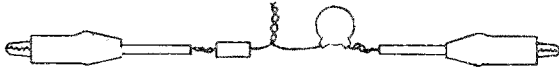
All accessories are illustrated in Figure 1.1.



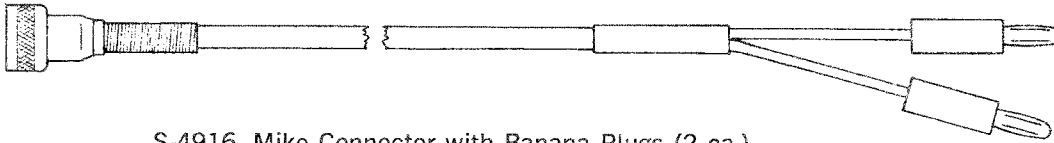
S-4911 Red Bias Lead (3 ea.)



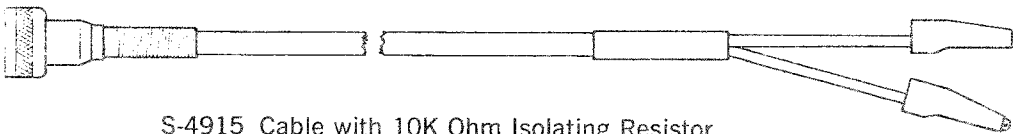
S-4912 Black Ground Lead



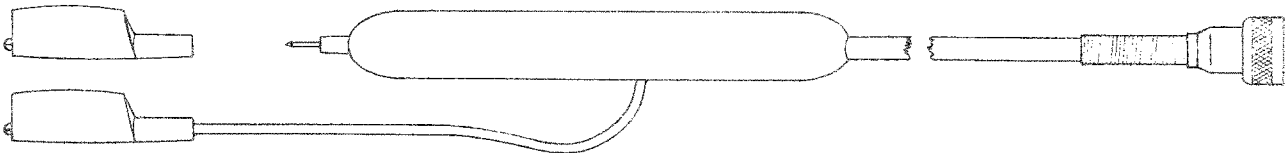
S-4918 I-F Load Block (2 ea.)



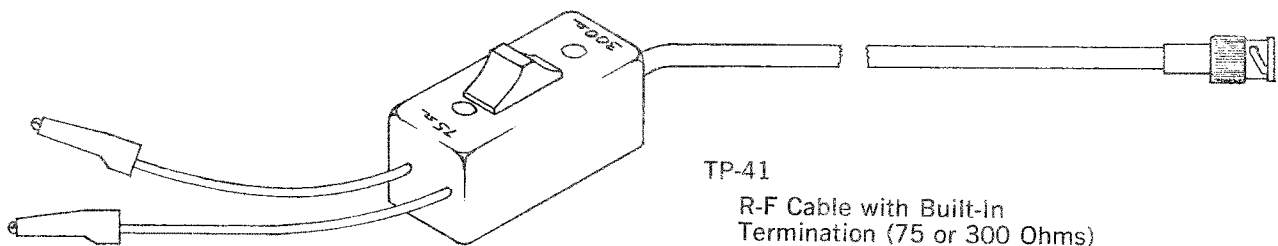
S-4916 Mike Connector with Banana Plugs (2 ea.)



S-4915 Cable with 10K Ohm Isolating Resistor  
(Black and Yellow Terminals)



PR-151 Demodulator Probe



TP-41  
R-F Cable with Built-In  
Termination (75 or 300 Ohms)

Figure 1.1 Accessories Furnished with the Model 415

# TELEVISION SIGNALS AND RECEIVER FUNCTIONS

## 2.0 TELEVISION SIGNAL PROCESSING

The following sections will first review the transmitted television signal. Then the television receiver will be reviewed with emphasis on the signal processing circuits. The Model 415 circuitry will then be described. Finally, the use of the 415 in receiver alignment will be described, first in general terms and later in detail as we proceed into the operating portion of the manual. Some background information may be repeated in several sections to maintain the continuity of those sections.

## 2.1 THE TRANSMITTED TELEVISION SIGNAL

Before proceeding into the television receiver description, a general review of the transmitted television signal and its individual components will be described.

The television channel spectrum is quite extensive. All existing television channels are listed in Table 2.1. Each channel occupies six megahertz of the spectrum. The Pix and Sound carrier frequencies for each channel are also listed.

Figure 2.1A. shows the simplified television frequency spectrum of Channel 10 as broadcast by the television transmitter. The Channel band width is 6 MHz. The picture carrier is 1.25 MHz above the lower limit of Channel 10. Within the channel, frequencies are referenced with respect to the picture carrier frequency.

Notice that the I and Q signals are centered on the Chroma center frequency of 196.83 MHz. The spectrum shows that the Q signal sidebands are symmetrical about the chroma center frequency with a distribution of  $\pm 0.5$  MHz. It is also indicated that the I signal sidebands are not symmetrical about the chroma center frequency, the upper sideband spread being 0.5 MHz and the lower sideband spread being 1.5 MHz. Early color television receivers had a bandpass in the chroma section which would pass the complete bandwidth of the I and Q signals. More modern color receivers have a bandpass of  $\pm 0.5$  MHz for both the I and Q frequency sidebands. This means that the portion of the I signal outside the  $\pm 0.5$  MHz bandpass is not utilized in the color television receiver. Experience and comparison has shown that picture quality is affected only very slightly by deleting this portion of the I signal spectrum. All modern color receivers use the narrow band chroma response ( $\pm 0.5$  MHz from the color subcarrier). The demodulator matrices of the color-signal processing circuits adjust the I and Q signal amplitudes of the chroma information and generate a phase shift of the chroma carrier (3.58 MHz) with respect to the I and Q components so

that the B-Y and R-Y signal equivalents are obtained. (The Y component is the monochrome or black and white portion of the television signal.) The B-Y and R-Y signals are then combined to produce the resultant G-Y signal. All three signals (R-Y, B-Y and G-Y) are then applied to their respective amplifiers and from there to the picture tube of the television receiver. The Y signal is also added at this point so that the original Blue, Red and Green signals are reproduced. Expressed as simple equations,

$$B-Y + Y = B,$$

$$R-Y + Y = R \text{ and}$$

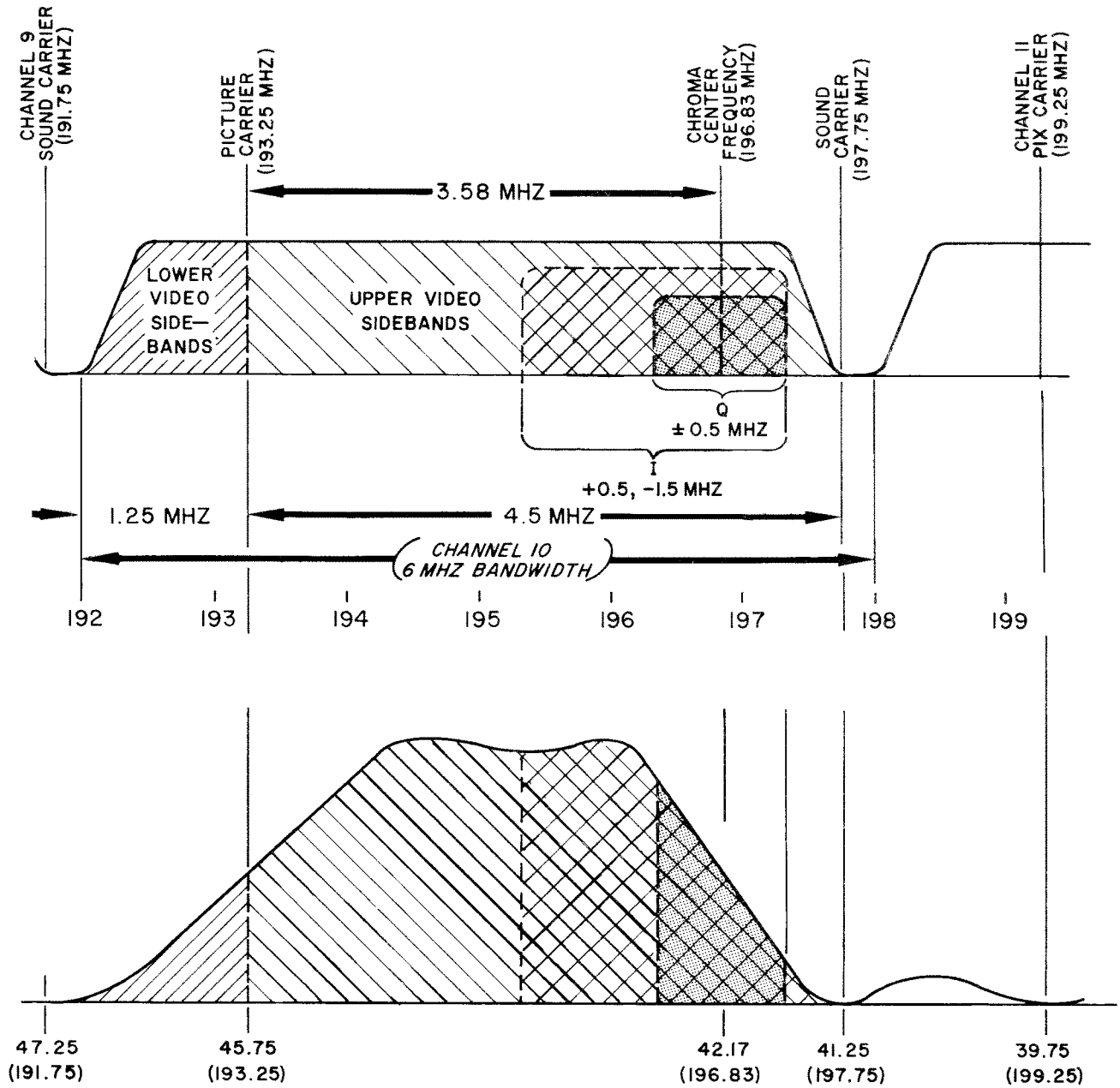
$$G-Y + Y = G$$

Figure 2.1B. shows how the relative response changes when the television signal is converted to the intermediate frequency by the tuner mixer and then passes through the i-f stages.

In Figure 2.1B the i-f frequencies are indicated with the corresponding Channel 10 r-f frequencies (because the local oscillator of the television receiver tuner operates above the incoming television signal the order of increasing frequency is reversed at the i-f frequencies). For example, the center frequency of the chroma information which is 196.83 MHz is 3.58 MHz above the picture carrier which is 193.25 MHz. Similarly, the sound carrier for Channel 10, which is 197.75 MHz, is 4.5 MHz above the picture carrier frequency.

Referring to Figure 2.1B again, notice that at the i-f frequencies the chroma center frequency is 3.58 MHz below the picture carrier frequency, which at the i-f frequencies is 45.75 MHz. Notice also that the sound carrier frequency is 4.5 MHz below the picture carrier frequency. Later in the manual the i-f frequency curve will be reversed so that increasing frequencies are read from left to right. In other words, the 39.75 MHz frequency will be at the extreme left of the frequency diagram and the 47.25 MHz signal will be shown at the extreme right of the frequency diagram. Throughout the manual it will be conventional that all frequency diagrams show increasing frequency from left to right.

Notice in Figure 2.1A that the sound carrier of Channel 9, which is 191.75 MHz, is just outside the lower end of the Channel 10 band. Also notice that the Channel 11 pix carrier (199.25 MHz) is 1.25 MHz above the upper band end of Channel 10. These two frequencies are called the adjacent channel sound carrier and the adjacent channel pix carrier, respectively, of Channel 10.



B. Television Signal Spectrum Showing Response Variations Produced by Processing the Signal Through the TV Receiver I-F Stages

Figure 2.1 Simplified Television Signal Spectrum (Channel 10)

	Channel No.	Freq. Limits		Channel No.	Freq. Limits		Channel No.	Freq. Limits
		54			542			716
P	55.25	<b>2</b>	P	543.25	<b>26</b>	P	717.25	<b>55</b>
S	59.75		S	547.75		S	721.75	
		60			548			722
P	61.25	<b>3</b>	P	549.25	<b>27</b>	P	723.25	<b>56</b>
S	65.75		S	553.75		S	727.75	
		66			554			728
P	67.25	<b>4</b>	P	555.25	<b>28</b>	P	729.25	<b>57</b>
S	71.75		S	559.75		S	733.75	
		72			560			734
		76			566			740
P	77.25	<b>5</b>	P	567.25	<b>30</b>	P	741.25	<b>59</b>
S	81.75		S	571.75		S	745.75	
		82			572			746
P	83.25	<b>6</b>	P	573.25	<b>31</b>	P	747.25	<b>60</b>
S	87.75		S	577.75		S	751.75	
		88			578			752
		174			584			758
P	175.25	<b>7</b>	P	579.25	<b>32</b>	P	753.25	<b>61</b>
S	179.75		S	583.75		S	757.75	
		180			584			758
P	181.25	<b>8</b>	P	585.25	<b>33</b>	P	759.25	<b>62</b>
S	185.75		S	589.75		S	763.75	
		186			590			764
P	187.25	<b>9</b>	P	591.25	<b>34</b>	P	765.25	<b>63</b>
S	191.75		S	595.75		S	769.75	
		192			596			770
P	193.25	<b>10</b>	P	597.25	<b>35</b>	P	771.25	<b>64</b>
S	197.75		S	601.75		S	775.75	
		198			602			776
P	199.25	<b>11</b>	P	603.25	<b>36</b>	P	777.25	<b>65</b>
S	203.75		S	607.75		S	781.75	
		204			608			782
P	205.25	<b>12</b>	P	609.25	<b>37</b>	P	783.25	<b>66</b>
S	209.75		S	613.75		S	787.75	
		210			614			788
P	211.25	<b>13</b>	P	615.25	<b>38</b>	P	789.25	<b>67</b>
S	215.75		S	619.75		S	793.75	
		216			620			794
		470			626			800
P	471.25	<b>14</b>	P	627.25	<b>40</b>	P	801.25	<b>69</b>
S	475.75		S	631.75		S	805.75	
		476			632			806
P	477.25	<b>15</b>	P	633.25	<b>41</b>	P	807.25	<b>70</b>
S	481.75		S	637.75		S	811.75	
		482			638			812
P	483.25	<b>16</b>	P	639.25	<b>42</b>	P	813.25	<b>71</b>
S	487.75		S	643.75		S	817.75	
		488			644			818
P	489.25	<b>17</b>	P	645.25	<b>43</b>	P	819.25	<b>72</b>
S	493.75		S	649.75		S	823.75	
		494			650			824
P	495.25	<b>18</b>	P	651.25	<b>44</b>	P	825.25	<b>73</b>
S	499.75		S	655.75		S	829.75	
		500			656			830
P	501.25	<b>19</b>	P	657.25	<b>45</b>	P	831.25	<b>74</b>
S	505.75		S	661.75		S	835.75	
		506			662			836
P	507.25	<b>20</b>	P	663.25	<b>46</b>	P	837.25	<b>75</b>
S	511.75		S	667.75		S	841.75	
		512			668			842
P	513.25	<b>21</b>	P	669.25	<b>47</b>	P	843.25	<b>76</b>
S	517.75		S	673.75		S	847.75	
		518			674			848
P	519.25	<b>22</b>	P	675.25	<b>48</b>	P	849.25	<b>77</b>
S	523.75		S	679.75		S	853.75	
		524			680			854
P	525.25	<b>23</b>	P	681.25	<b>49</b>	P	855.25	<b>78</b>
S	529.75		S	685.75		S	859.75	
		530			686			860
P	531.25	<b>24</b>	P	687.25	<b>50</b>	P	861.25	<b>79</b>
S	535.75		S	691.75		S	865.75	
		536			692			866
P	537.25	<b>25</b>	P	693.25	<b>51</b>	P	867.25	<b>80</b>
S	541.75		S	697.75		S	871.75	
		542			698			872
					704			878
					710			884
					716			890

P = Picture Carrier Freq. S = Sound Carrier Freq. All frequencies in MHz

TABLE 2.1 Television Channel Frequency Spectrum

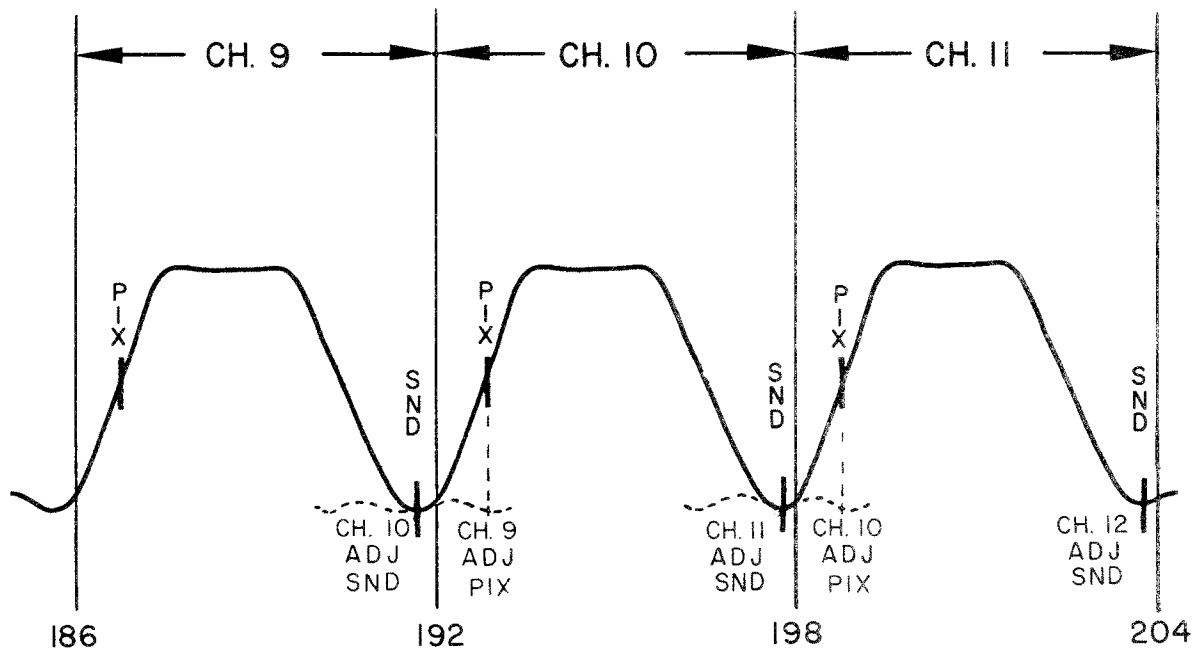


Figure 2.2 Frequency Spectrums of Channels 9, 10 and 11 Showing Relationships of Adjacent Channel Interfering Carriers.

In Figure 2.2, the frequency spectrums of Channels 9, 10 and 11 are shown adjacent to each other to show the potential interference problems of adjacent channel signals. The sound carrier of Channel 9 (191.75 MHz) is the sound carrier adjacent to Channel 10 as mentioned previously. The pix carrier of Channel 10 (193.25 MHz) is the pix carrier adjacent to Channel 9, as shown on the dotted portion of the Channel 9 curve which is extended into the Channel 10 spectrum.

The channel spectrum for each of the three channels shown is represented as it would appear after having passed through the selectivity of the television receiver IF stages. Further examination of Figure 2.2 shows that the sound carrier of Channel 10 is adjacent to the lower limit of Channel 11 and is referred to as the Channel 11 adjacent sound frequency. The Channel 11 pix carrier is also the Channel 10 adjacent pix carrier. These frequency relationships apply to all televi-

sion channels adjacent to each other. The purpose of Figure 2.2 is to show that the frequency spectrum of interest includes not only the particular channel band width, which is 6 MHz, but the portions on each side of the bandpass which include the adjacent channel sound carrier on one side and the adjacent channel pix carrier on the other side. This is why a sweep width of 10 MHz or more is desired for sweep alignment procedures, although the television channel bandwidth is only 6 MHz.

The sections following will describe how the transmitted television signal is processed through the television receiver and will also describe how various applications of tuned circuits are utilized to provide the desired gain and bandwidth characteristics required in the various sections of the television receiver to produce a good black and white picture or a good color picture.

## 2.2 THE TELEVISION RECEIVER

The basic functions of the television receiver are to select a specific television channel frequency spectrum, process the signals, shape the frequency spectrum as required by tuned circuits (either bandpass or trap), demodulate the frequency information and distribute the demodulated signals to all the sound and picture generating circuits. These circuits include vertical and horizontal sync, sound, agc, video, chroma circuits—all the circuits following the detectors.

### 2.2.1 TYPICAL TELEVISION RECEIVER BLOCK DIAGRAMS

Figure 2.3 depicts the block diagram of a representative black and white television set, whether solid-state, hybrid or tube-type. Figure 2.4 depicts a color set. Notice that a color receiver is essentially a black-and-white set with added circuitry for processing color picture information. Although the same color signal is received by color as well as black-and-white receivers, the black and white sets simply do not use the color information. Throughout this manual, emphasis is placed on color receiver alignment because color receiver alignment is more critical for proper picture quality than is alignment in black and white receivers. Black and white receivers

can, of course, be aligned by the methods outlined in this manual, the difference being that no chroma circuit alignment is required. This means that only the responses obtained at the video i-f detector and sound demodulator are required.

The color receiver block diagram of Figure 2.4 can be simplified as shown in Figure 2.5 which groups the stages by major functions. The circuit blocks which determine the gain and bandwidth properties of the television receiver are shown in Figure 2.6. These are the circuits involved in sweep alignment. The tuner selects the desired channel frequency band, amplifies it and converts it down to the i-f frequency. The tuner local oscillator operates above the incoming signal frequency. The mixer output of the tuner is coupled through the tuner link to the first i-f amplifier. Most of the response shaping and trapping of undesired frequencies is done in the i-f stages.

The i-f output is fed to the video detector and the demodulated output of this stage is fed to the video amplifier. From there it is fed into the delay line and to the color amplifier circuits. The color amplifiers have gain and bandwidth characteristics which shape the chroma information that is fed to the color demodulators.

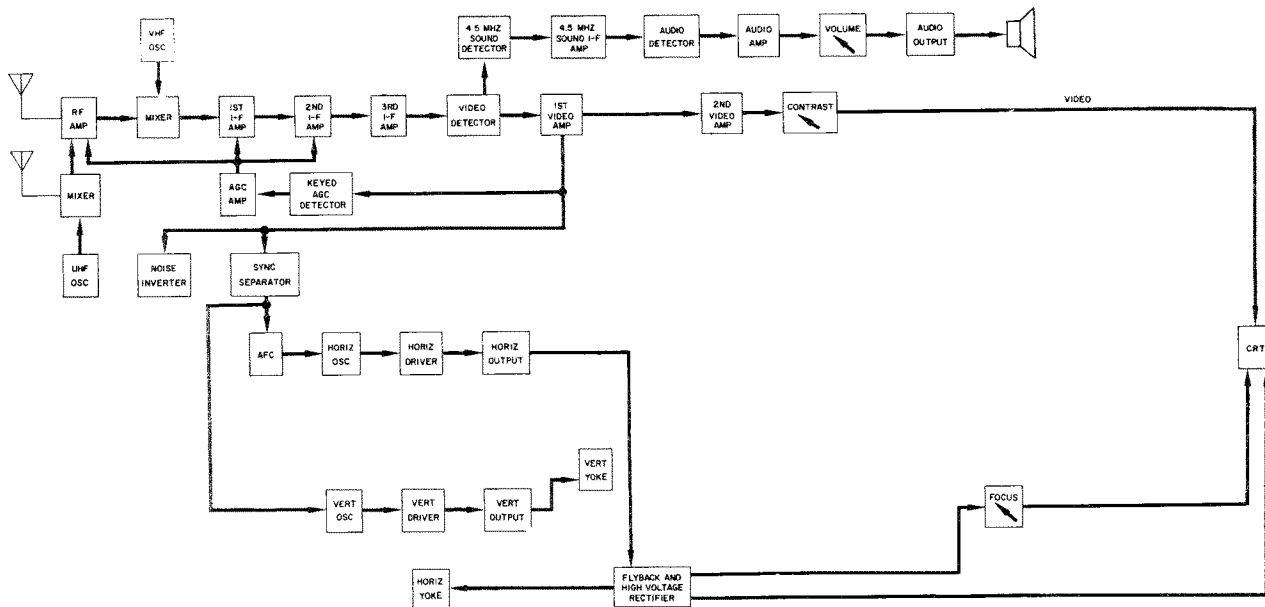


Figure 2.3 Block Diagram of Typical Black and White Television Receiver



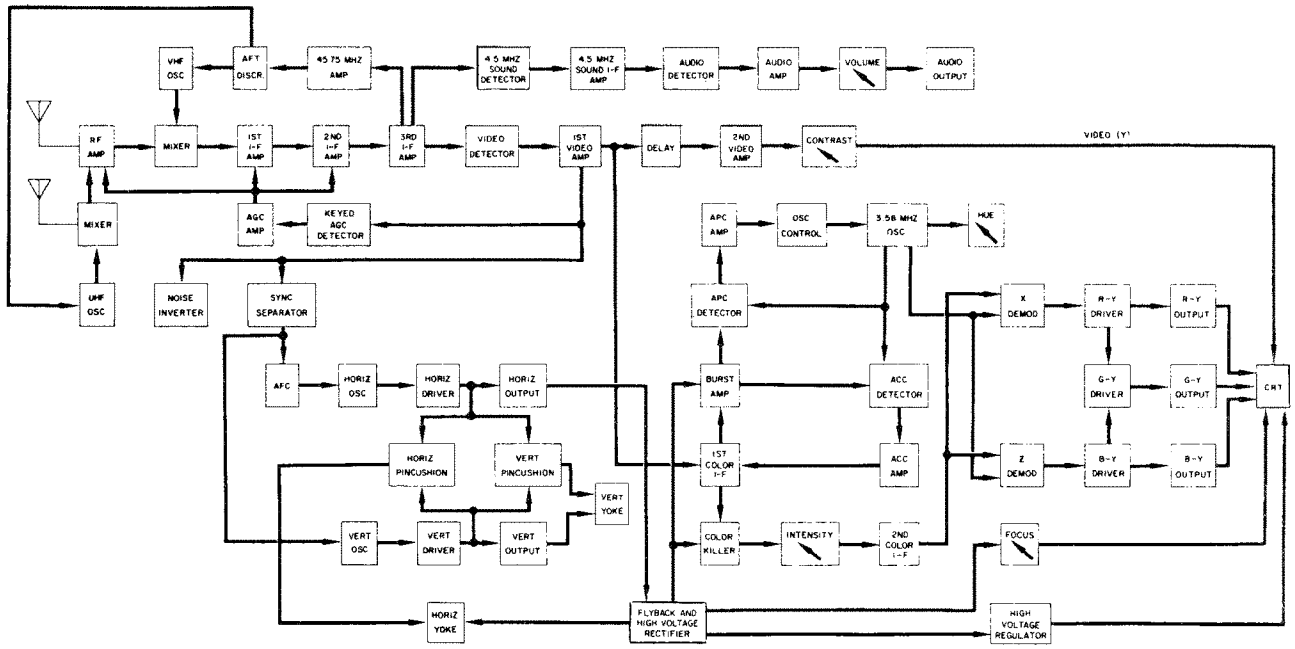


Figure 2.4 Block Diagram of Typical Color Television Receiver

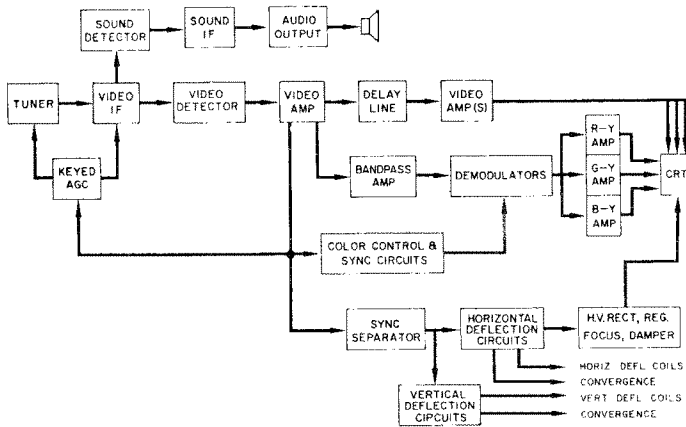


Figure 2.5 Simplified Television Receiver Block Diagram

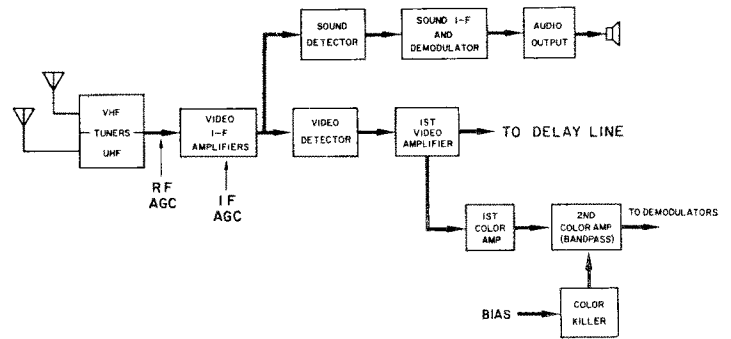


Figure 2.6 Signal Processing Circuits of Color Television Receiver

## 2.2.2 TELEVISION RECEIVER TUNED CIRCUITS

In order to process the signals properly the r-f section and i-f section of the receiver must possess certain gain and bandwidth characteristics. These are determined by the number of amplifiers and the associated tuned circuits.

The typical overall i-f bandpass curve is shown in Figure 2.7 with a typical tuner response curve superimposed. The i-f bandpass is obviously narrower than the tuner bandpass and therefore contributes most to the bandpass shaping.

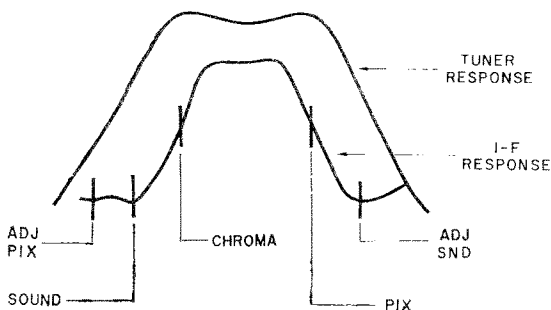


Figure 2.7 Typical Tuner and I-F Response Curves Showing Relative Bandwidths

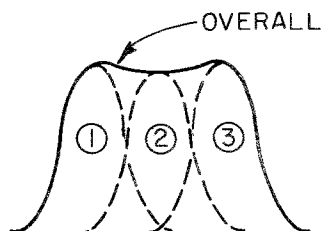


Figure 2.8 Overall Response of Stagger-Tuned Circuits

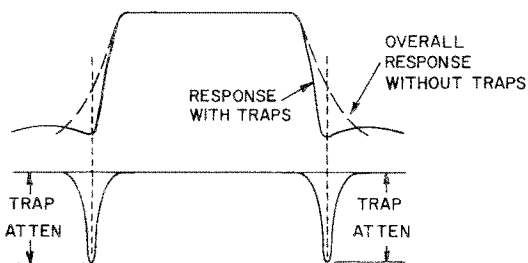


Figure 2.9 Effects of Trap Circuits on Overall Response Curves

### 2.2.2.1 STAGGER-TUNED CIRCUITS

To obtain the bandwidth required in television i-f amplifiers, stagger-tuned circuits must be employed. This means that the outputs of a series of stages tuned to different frequencies are combined to obtain a desired overall curve. This is demonstrated in Figure 2.8. Assume that each individual response curve (dotted lines) represents the output of a single stage in a three-stage amplifier. The overall response would be as indicated by the solid outline. This is the response curve obtained when a sweep-frequency generator is used.

### 2.2.2.2 TRAP FREQUENCY CIRCUITS

If it were desired to narrow the skirts of the curve, additional stagger-tuned circuits could be added, or specific trap frequency circuits could be added to sharpen the slope response. Because the trap is a highly selective circuit the frequency "suck-out" will be sharp and some flyback would occur outside the trap frequency response. Figure 2.9 demonstrates the overall effect. The dotted curve outline is the curve of Figure 2.8 without frequency traps. The solid curve is the result of trap frequency circuit responses superimposed on the original. Idealized trap responses are shown in a downward direction. Notice that outside the trap response region the resultant curve approaches the original. This flyback is evident in television i-f and chroma response curves where traps are used to reject undesired frequencies.

### 2.2.2.3 USE OF OVERCOUPLING IN TUNED CIRCUITS

Another method of obtaining a flat-top response with tuned circuits is to overcouple. If two tuned circuits are tuned to the same frequency the overall response of the coils is determined by the amount of coupling between them. Figure 2.10 shows typical curves obtained by undercoupled, critically coupled and overcoupled coils. In the overcoupled case, the center dip in response will increase as the coupling is increased to spread the peaks. The maximum amplitudes will also begin to decrease as overcoupling increases. This principle is used in chroma bandpass transformers. Usually, two tuning slugs are found in these transformers. One adjusts the coupling between windings and the other is a tuning adjustment. Sweep alignment of this type of transformer is practically a must. In this application as well as in i-f alignment, a compromise between gain and bandwidth is always made. The amplitude of the response curve can be greatly increased by tuning all adjustments for maximum amplitude, but this will be at a sacrifice in bandwidth which is equally important in proper circuit performance.

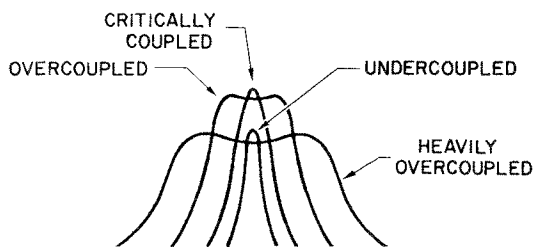


Figure 2.10 Effects of Coupling on Overall Response of Two Tuned Circuits

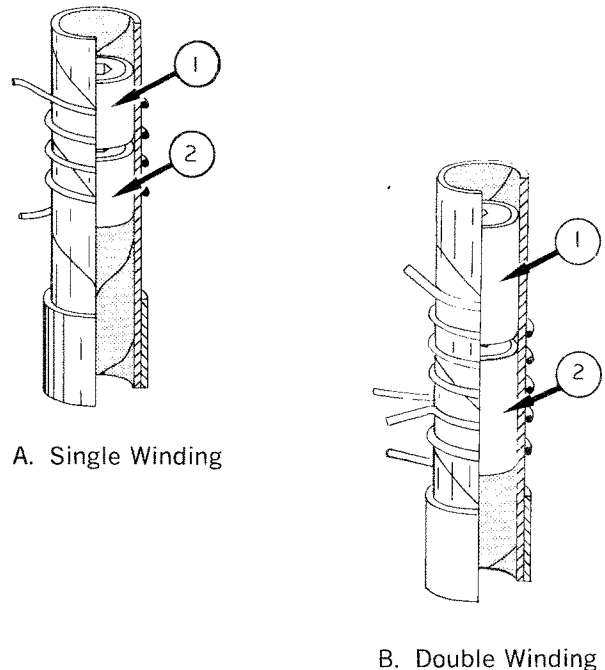


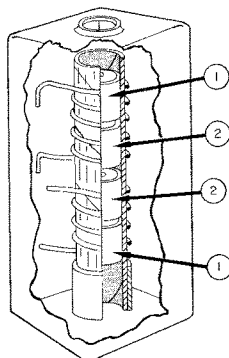
Figure 2.11 Core Positions at Resonance in Tunable Coil Assemblies

### 2.2.2.4 IMPORTANCE OF TUNING SLUG LOCATION IN TUNED CIRCUITS

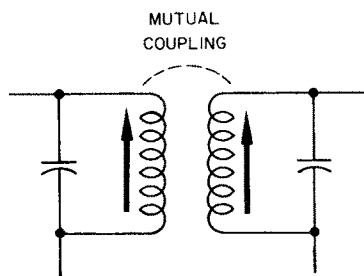
Regarding tuned circuits in general, it will be noted that the alignment procedures specify the locations of the tuning slugs with respect to the mounting board or chassis. In designing the coil, the parameters are selected so that the proper inductance value is obtained when the tuning slug is between the minimum and maximum inductance range of the coil, rather than being at the maximum or minimum point. This means that circuit resonance is obtained at two physical locations of the coil (See Figure 2.11A) because at position 1 the slug is surrounded by as many turns of the coil as it is at position 2. Suppose, however, that a secondary winding is added at the bottom of the coil form as shown in Figure 2.11B. As in Figure 2.11A, resonance is obtained at either position 1 or 2 of the tuning slug; however, at position 2 the presence of the slug in a portion of the primary and secondary of the assembly increases the coupling between the two windings as compared to the coupling obtained with the slug at position 1. The amount of coupling affects gain and bandwidth; therefore, to obtain the desired coil or transformer characteristics the slug must be properly

located at resonance. The effect of slug locations is also important in double-tuned coil assemblies for similar reasons. Figure 2.12A shows a double-tuned transformer with the equivalent electrical circuit in Figure 2.12B. Either tuned circuit of Figure 2.12A can be resonated with the slugs at position 1 or 2. The coil spacing is designed to give the desired response when the tuned circuits are resonated with the slugs in only one position, usually position 1. If the circuits are tuned with either slug in position 2, the coupling will be greater (possibly overcoupled). If the circuits are tuned with both slugs in position 2, greater overcoupling will occur. The range of response curves shown in Figure 2.10 can be obtained from the double-tuned coil assembly of Figure 2.12A by varying the slug positions.

A special application of controlled overcoupling in transformers is the chroma bandpass transformer of Figure 2.13. In this application a double-tuned coil assembly is used. Primary tuning and the amount of coupling to the secondary is controlled by the location of a tuning slug which couples the L1 and L2 windings. Tuning of the secondary is performed by a slug which varies the inductance of the L3 portion of the secondary. As previously mentioned the core locations are important for proper bandpass characteristics.



A. Double Tuned Transformer



B. Electrical Equivalent Circuit

Figure 2.12 Effects of Slug Locations in Double-Tuned Circuits

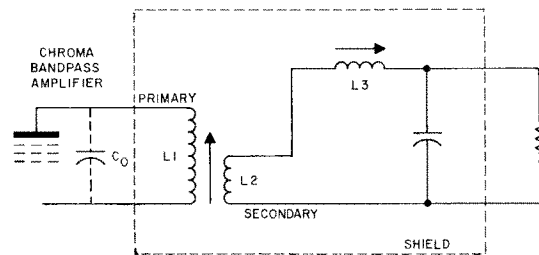


Figure 2.13  
Typical Chroma Bandpass Transformer

The preceding paragraphs show that the picture, sound and sync information of a television signal is fed through a rather long series of tuned circuits which affect the amplitude of one with respect to the other. If the circuits drift or are misaligned or if the gain of one or more stages changes, the signal properties are affected in several ways. Signal levels may be too low, the bandwidth may become too narrow, the signals may begin to interfere with each other or, if traps are misaligned, the receiver performance may be degraded by interference from undesired signals, such as adjacent channel sound or picture carrier frequencies.

## 2.3 SWEEP ALIGNMENT

### 2.3.1 IMPORTANCE OF SWEEP ALIGNMENT

The most rapid way to determine the overall condition of the tuner, i-f and chroma portions of the television receiver is to provide a constant-amplitude signal which sweeps through the entire bandwidth of a given television channel at a controlled, repetitive rate. As this signal is processed through the tuned portions of the receiver, it is shaped by the gain and bandpass properties of the various sections. Because the signal is channeled from one series of tuned circuits to another it is important that each section has the proper characteristics. If the signal is demodulated at certain points and the envelope observed, the gain and bandwidth properties up to that point can be determined.

Figure 2.14 shows the sweep signal with basic response curves of the tuner, i-f amplifiers and chroma bandpass circuits below it. The bandwidths shown are approximately to scale. These outlines are similar to the curves that would be obtained if the outputs of the various sections of the TV receiver were demodulated and the curve observed on an oscilloscope. Because of the relative bandwidths the tuner response is least critical.

Some reference frequencies are identified to show the importance of proper alignment. Notice that the chroma frequencies are on the slope of the i-f response curve. This area is the most critical because improper i-f alignment in this area will affect the amplitude and shape of the chroma response curve and this in turn affects color picture quality.

The development of the overall chroma response curve will be briefly described. Referring to Figure 2.1A (Transmitted Television Signal) notice that the chroma information is located on a constant-amplitude portion of the transmitted television spectrum. Referring to Figure 2.1B and to Figure 2.14, notice that the relative amplitudes of the chroma information are modified by passing through the tuned circuits of the television receiver tuner and i-f amplifiers. This is shown by reference to the overall i-f response curve of Figure 2.14. Notice that the signal information at the upper end of the chroma frequency range (4.08 MHz) is reduced in amplitude with respect to the signal level at the lower end of the chroma frequency range (3.08 MHz). To compensate for this frequency-versus-amplitude characteristic of the overall i-f response curve, a chroma takeoff coil is used between the i-f output and the bandpass amplifier of

the chroma portion of the receiver. The chroma takeoff coil is tuned to the upper end of the chroma frequency range, usually 4.08 MHz and provides a response as shown in Figure 2.14. This compensates for the amplitude-versus-frequency characteristic of the chroma portion of the overall i-f response curve. The result of combining the response of the i-f curve and the response of the chroma takeoff coil is to produce a flat overall response in the chroma frequency range (3.08 MHz to 4.08 MHz). The resultant signal is then applied to the bandpass amplifier which has the response indicated by the overall chroma response curve of Figure 2.14. Alignment of the chroma takeoff coil is sometimes specified as a separate step in manufacturer's test procedures. In other procedures, adjustment of the chroma takeoff coil is performed together with the adjustment of the bandpass transformer.

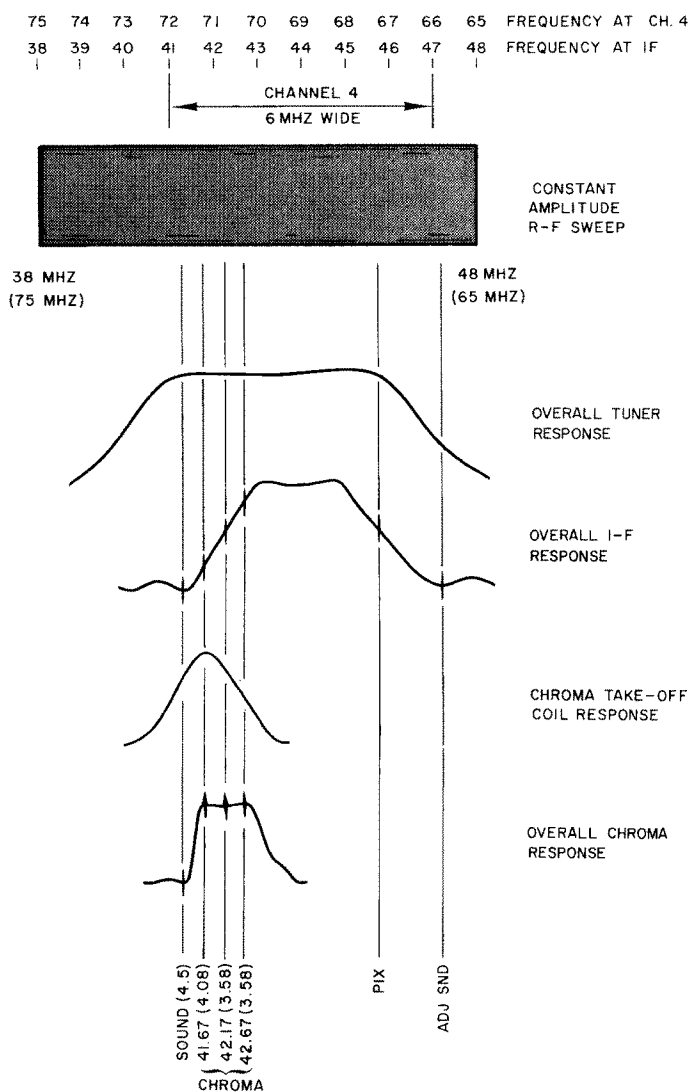


Figure 2.14 Television Response Curves Obtained Using Sweep-Frequency Techniques

### 2.3.2 SWEEP ALIGNMENT METHODS

The best method of checking alignment and determining which stages require alignment is to inject an r-f sweep frequency signal at the tuner antenna terminals. The agc bias line must be clamped by application of bias or grounding the agc line. The outputs of the i-f and chroma circuits are then observed on an oscilloscope and compared to the manufacturer's recommended response curves.

The technician can then decide which portions of the receiver require alignment. For example, if the i-f response is satisfactory but the chroma response is not, then the problem is between the video detector output of the i-f strip and the output of the bandpass amplifier. If the i-f response and the chroma response are poor then it is most likely that the i-f requires touch-up, particularly if the response is poor on the slope affecting chroma response.

The r-f portion of the tuner seldom creates an alignment problem because the passband is so much greater than that of the i-f section; however, the mixer output circuit, which is located on the tuner, may require attention. This is part of the tuned matching network between the tuner and the first i-f stage. A separate prealignment procedure is given for the link circuits by some manufacturers.

Once the deficient portion of the receiver is determined, an alignment check of that section can be performed. The alignment procedures vary with manufacturers. Some suggest signal combinations at the tuner antenna terminals which can generate i-f and video sweep frequencies in the receiver so that overall alignment can be done by selecting the right combination of input signals. One way of doing this is to first connect an r-f sweep generator for i-f alignment. After this is complete, the picture carrier frequency for the channel being used is selected and this is modulated by a video sweep signal (This is the VSM, or video sweep modulation, method). This video sweep modulation is demodulated at the video detector of the TV receiver and applied to the chroma bandpass circuits for the alignment of these stages.

Other manufacturers recommend an i-f sweep frequency injected at the mixer grid (or base, if transistorized) for i-f alignment. The i-f pix carrier frequency (45.75 MHz) is then modulated with a video sweep voltage (VSM

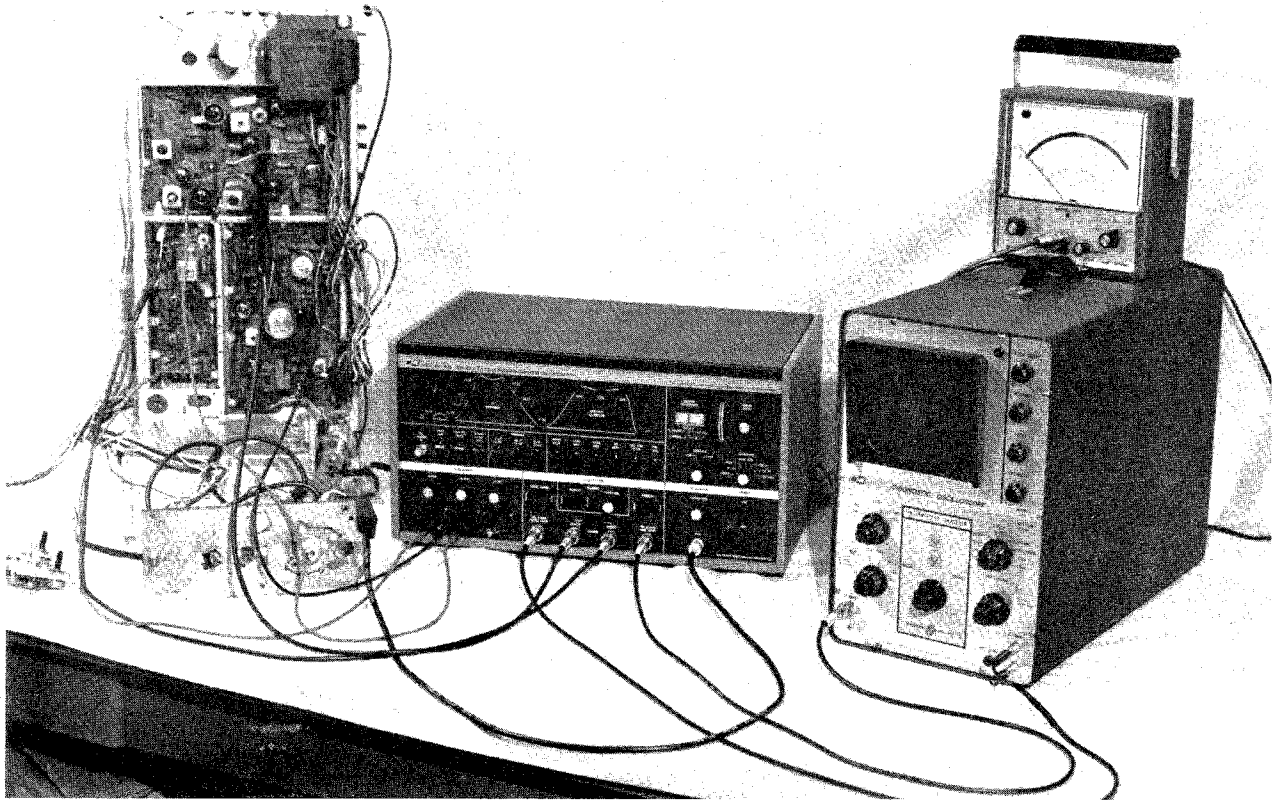
again). As before this is detected at the video detector of the TV receiver and the recovered sweep voltage is used for the chroma circuit alignment.

Another method is to first video-sweep align the chroma circuits directly. The i-f is then aligned and then video sweep modulation of the i-f pix frequency (45.75 MHz) is used to check the combined effect on the chroma response of i-f alignment and chroma alignment. Usually a touch-up of the chroma circuits is done to obtain the desired final overall chroma response.

In conjunction with i-f alignment practically all manufacturers recommend pretuning i-f traps by injecting spot frequencies into the i-f (usually at a specified tuner test point). Other procedures outline a prealignment of all tuned circuits in the i-f before sweep alignment procedures.

In all cases the manufacturer's method is the best for his particular receiver and the manufacturer's service manual is preferred for alignment. SAMS Photofact procedures are also reliable and in most cases repeat the manufacturer's procedure. If complete realignment of an apparently deficient receiver does not restore the required response, the technician must then consider that a component failure has occurred and must employ standard trouble shooting procedures.

The quantity of test equipment required to align any set by any method as well as the work involved for setting up a series of alignment tasks on a given receiver are a serious consideration for the serviceman and the technician who must perform efficiently. With this in mind we have developed the Model 415 SWEEP/MARKER GENERATOR which enables you to do any set with no additional equipment other than an oscilloscope and a VTVM. All "intercabling changes and generator selections" are done internally for you by a master function switch and front panel controls. Because a single output jack is used, several different outputs can be switched to the same injection point on the receiver without disconnecting or changing leads. This is done by selecting the desired output with the function switch. All outputs are properly terminated and stray radiation from the unit is negligible so that there are no confusing "hot" leads in the test set-ups. This instrument is unequalled in flexibility and functional design.



Typical Test Set-Up

Your technical introduction to the Model 415 is presented in the following section and is intended to show you how the various outputs are generated within the instrument. We believe that a good grasp of the operating principles of this instrument together with

the preceding description of television receivers will enable you to proceed confidently through alignment procedures with the ability to evaluate response curves and to pinpoint the sections which require alignment.

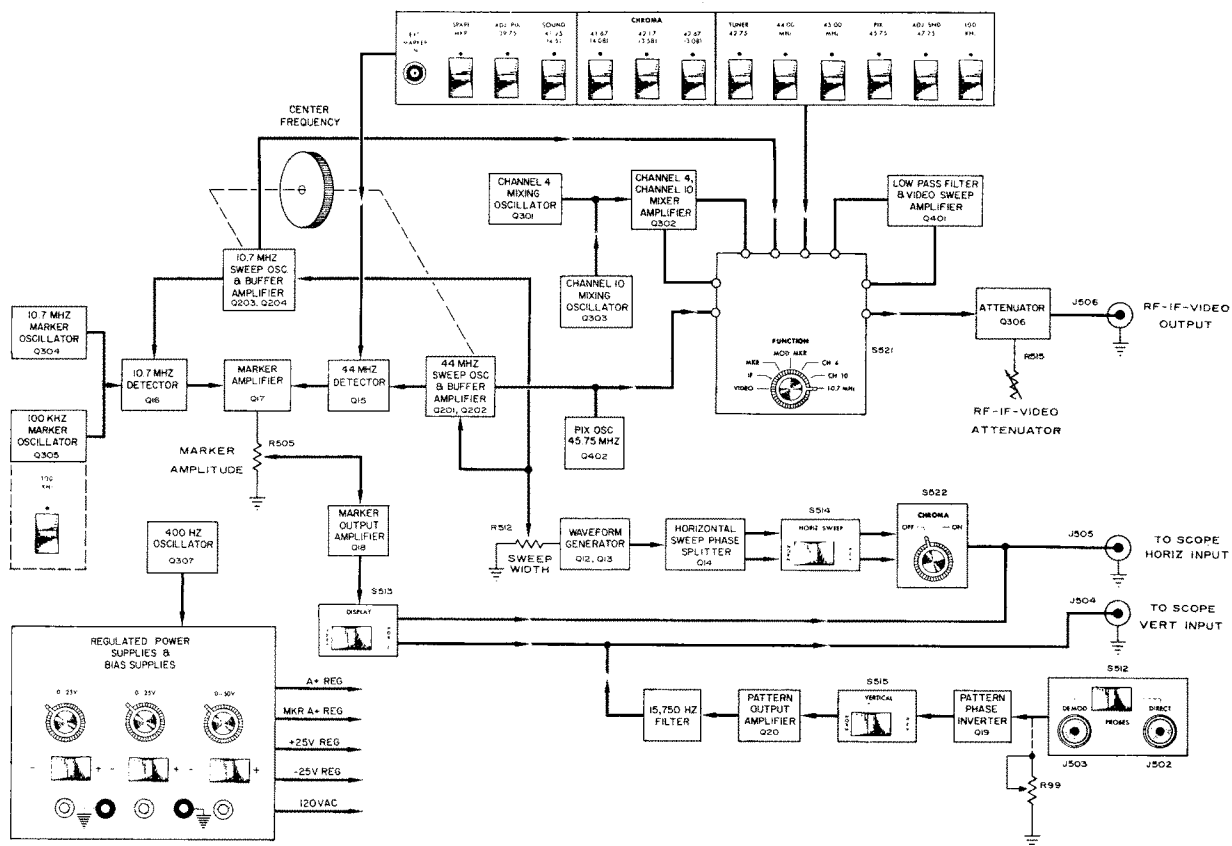
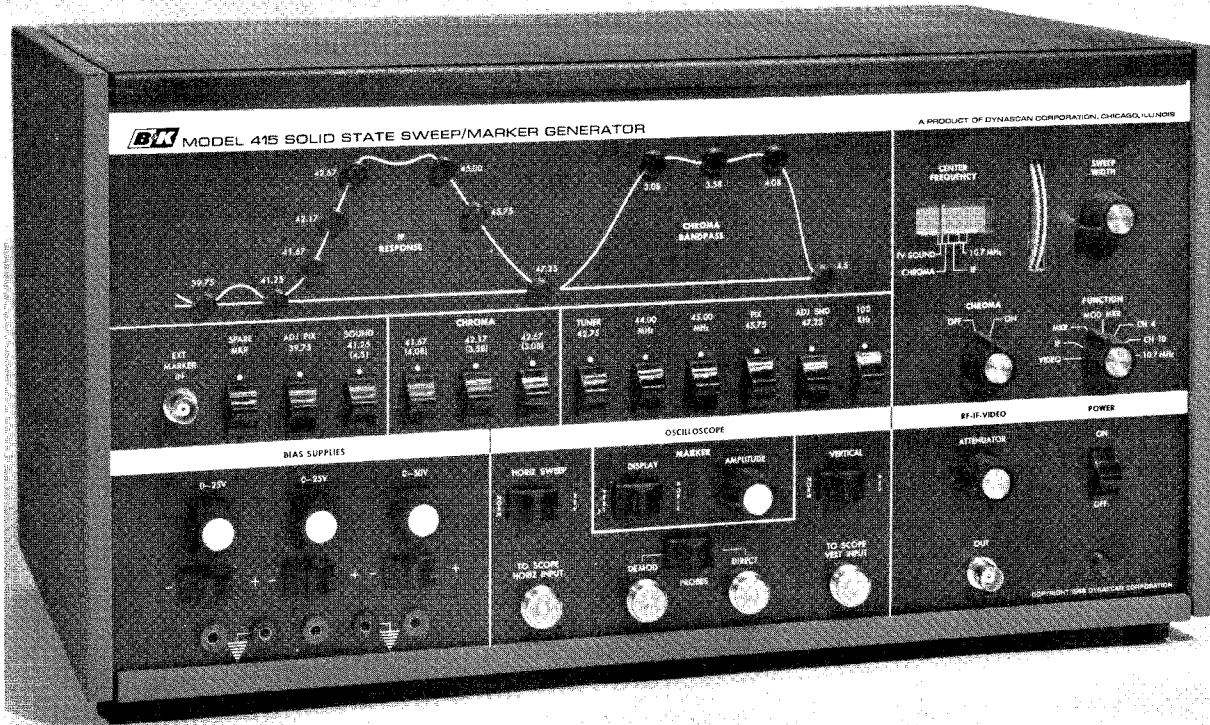


Figure 3.1 Model 415 Block Diagram



## FUNCTIONAL DESCRIPTION OF THE MODEL 415 CIRCUITS

### 3.0 MODEL 415 SWEEP/MARKER GENERATOR BLOCK DIAGRAM

A circuit introduction and functional description of the Model 415 will be outlined with reference to the block diagram of Figure 3.1. In the block diagram the stage numbers of the various blocks are included if you wish to refer to the schematic. Also, all control references on the block diagram and in the text are in capital letters and are written as they appear on the Model 415 front panel. To simplify the diagram, only the signal paths are indicated. All required d-c switching functions as well as the required signal switching are performed by FUNCTION switch S521. All output signals are routed through attenuator stage Q306 to the RF-IF-VIDEO OUT jack. Q306 is an electronic attenuator using a dual-gate field effect transistor. Gain and output level of the attenuator are controlled by adjustment of RF-IF-VIDEO ATTENUATOR control R515.

### 3.1 SWEEP CIRCUITS

The required internal and external sweep voltages are developed by the waveform generator (Q12 & Q13). A sawtooth output is fed through HORIZ SWEEP switch S514 and CHROMA switch S522 to the SCOPE HORIZ INPUT jack J505. The HORIZ SWEEP switch enables the operator to reverse the sweep direction of the oscilloscope as desired. Another output of the waveform generator is coupled through SWEEP WIDTH control R512 and shaping circuits to the 44 MHz and 10.7 MHz sweep oscillators. The sweep voltage is available at J505 for all positions of the FUNCTION switch.

### 3.2 44 MHz SWEEP OSCILLATOR AND I-F MARKER SYSTEM

#### 3.2.1 44 MHz SWEEP OSCILLATOR

The 44 MHz sweep oscillator employs a voltage variable capacitor (varactor diode) D201 in an otherwise conventional oscillator. The sweep voltage from the waveform generator is applied across the varactor and causes the capacitance of the varactor to vary. This in turn causes the oscillator frequency to vary at the sweep rate. The shaping circuits previously mentioned modify the applied sweep voltages so that the oscillator frequency change is linear. Maximum sweep width is greater than 10 MHz. The center frequency of the sweep oscillator can be adjusted over a range of  $\pm 5$  MHz by use of the CENTER FREQUENCY control. The waveform generator sweep rate is 60 times per second and is synchronized to the power-line frequency. Sweep duration is approximately 90 per cent of each cycle with retrace occurring during the remaining 10 per cent of the sweep interval.

A portion of the sweep oscillator output is coupled to 44 MHz Detector Q15. The output is also fed through Buffer Amplifier Q202 to the FUNCTION switch.

### 3.2.2 I-F MARKER OSCILLATORS

Marker oscillators Q1 through Q11 furnish marker frequencies in the television i-f frequency range. They can be turned on or off individually with the associated switches. Any number of markers can be used as desired. As seen by the frequency identifications, these frequencies include bandpass as well as trap frequencies. Each oscillator is crystal controlled. Standard trap and reference frequencies are furnished. Spare marker oscillator Q1 is provided in the event that an additional fixed marker frequency is required by the user. The circuit can be tuned to accept any third-overtone crystal in the 35 MHz to 50 MHz range. Operation of the spare marker oscillator and the required adjustments are covered in the OPERATING PROCEDURES section of this manual.

One output of the marker oscillator section is coupled to the FUNCTION switch. A second output is fed to 44 MHz Detector Q15. Notice also that the lights on the representative curve, shown on the front panel, correspond to certain marker frequencies. When one of the marker frequencies is selected by placing the marker switch in the on position the corresponding light is illuminated on the curve. Any or all of the markers and the corresponding lights can be selected as desired. These lights serve two purposes. First, they are a reminder to the operator that certain marker frequencies are being used. Secondly, they serve as a reference to indicate the approximate i-f response desired at certain frequencies in the response curve.

#### 3.2.3 EXTERNAL MARKER INPUT

EXT MARKER jack J501 is also provided for use of external fixed or variable marker frequencies. This input can be used simultaneously with the internal markers. The internal markers, being crystal controlled, can be used as calibration points for an external variable frequency generator.

#### 3.2.4 100 KHz MARKERS

The 100 KHz marker switch is used to provide a string of markers having 100 KHz frequency separation. This string of markers can be superimposed on any of the desired crystal controlled markers. 100 KHz Marker Oscillator Q305 is energized by the 100 KHz switch. The output of this oscillator is coupled to the 10.7 MHz detector and is used to provide the 100 KHz markers on the output of either the 10.7 or i-f marker detector circuits.

### 3.3 MARKER DETECTOR AND AMPLIFIERS

The 44 MHz sweep oscillator output is mixed with the marker oscillator outputs at 44 MHz Detector Q15. When the sweep frequency equals the crystal marker frequency, a pip is produced which is amplified and shaped by Marker Amplifier Q17 and Marker Output Amplifier Q18 to produce a narrow, well defined pip.

MARKER AMPLITUDE control R505 enables the operator to set the marker amplitude as desired. The marker signal from Q18 is fed through MARKER DISPLAY switch S513 to either the SCOPE VERT INPUT jack J504 (S513 in VERT position) or to the SCOPE HORIZ INPUT jack J505 (S513 in HORIZ position). The MARKER DISPLAY switch enables the operator to select markers having either vertical or horizontal orientation.

### 3.4 PATTERN AMPLIFIERS

The input to the pattern amplifier is selected by PROBES switch S512. Both the PR-151 Demodulator Probe and the direct probe can be connected to the proper monitoring points in the receiver under test and the output of either selected by the operator with the PROBES switch. This obviously reduces testing time by eliminating intermediate connect-disconnect procedures. Pattern Phase Inverter Q19 is a phase splitter using a field-effect transistor for high input impedance to minimize external circuit loading.

The VERTICAL switch enables the operator to select either the direct (NORM) or inverted (REV) output of Q19. This feature permits the operator to view the response curves with the desired polarity. The selected output of Q19 is then fed through Pattern Output Amp Q20 and the 15,750 Hz filter to SCOPE VERT INPUT jack J504. Note that the output of Q20 is mixed with the marker output of Q18 when the MARKER DISPLAY switch is in the VERT position. The observed markers

will be vertical. When the MARKER DISPLAY switch is in the HORIZ position the marker output of Q18 is superimposed on the horizontal sweep voltage and the observed markers will be horizontal (tilted). This marker tilt feature is valuable in determining the location of particular frequency points on response curves. The heights of all marker reference frequencies on response curves are expressed as a percentage of the total curve amplitude. The marker locations can be determined more precisely when horizontal markers are used.

The addition of markers to the response curve as described here is true post injection because the frequency identifying marker is superimposed on the response curve obtained from the receiver *after* the signal has been processed through the receiver circuits. Post injection has several pronounced advantages over other methods of marker display. First of all, the actual marker energy is not introduced into the r-f or i-f stages of the receiver. This eliminates pattern amplitude changes which would occur as the markers are turned on and off. Also, pattern distortion caused by excessive marker energy is eliminated. In addition, the marker amplitude remains independent of any tuning adjustments performed. This is particularly useful in trap alignment. By comparison, when using pre-injection (mixing marker signal with sweep frequency signal), the marker amplitude decreases as a particular trap is tuned for maximum rejection of the trap marker signal. This forces the operator to increase the marker signal level to

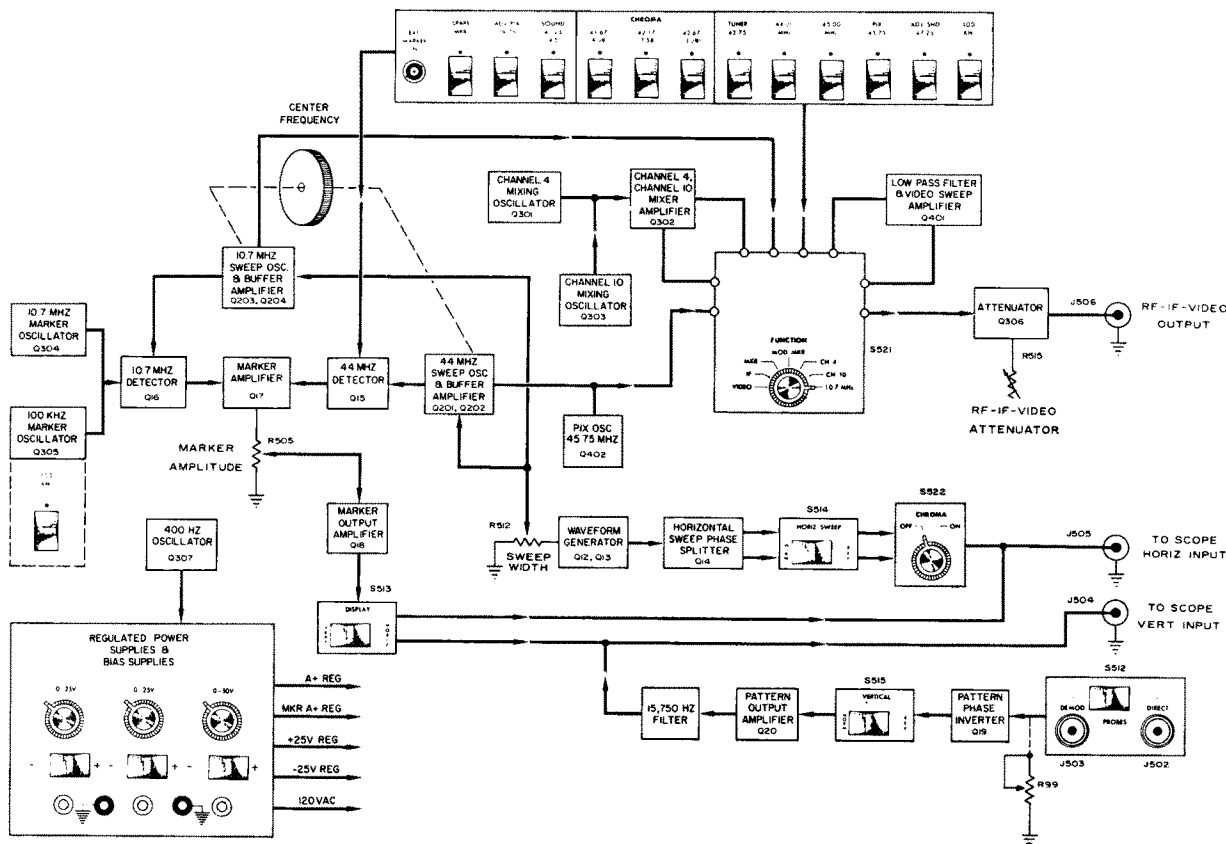


Figure 3.1 Model 415 Block Diagram

obtain a marker indication when the trap is properly aligned. This increase in marker signal amplitude can cause errors in i-f alignment by causing overload of the i-f stages in the receiver.

This basic coverage of the operation of the sweep, marker and pattern circuits should be well understood because these are the basic building blocks for the VIDEO, IF, CH 4 and CH 10 functions of the Model 415.

### 3.5 PIX OSCILLATOR AND CHROMA FUNCTION

The primary purpose of Pix Oscillator Q402 is to furnish a pix carrier signal at the television i-f frequency. This is added to the output of the 44 MHz sweep oscillator. The use of this frequency will be outlined in the later sections on MODEL 415 functions.

### 3.6 CHANNEL 4 AND CHANNEL 10 MIXING OSCILLATORS Q301 AND Q303

Channel 4 Mixing Oscillator Q301 produces a crystal-controlled signal frequency at 113 MHz. The difference between this frequency and the i-f pix carrier frequency (45.75 MHz) is 67.25 MHz, which is the r-f pix carrier frequency for Channel 4. The difference between 113 MHz and the i-f sound carrier (41.25 MHz) is 71.75 MHz, which is the r-f sound carrier frequency for Channel 4. This procedure can be used to find the Channel 4 r-f equivalent of each i-f marker reference frequency. This is further explained in Section 3.8. Also, by subtracting the i-f frequency spectrum (38 MHz to 48 MHz) from 113 MHz the Channel 4 frequency spectrum (75 MHz to 65 MHz) is obtained. Note that in the subtraction process the low end of the i-f sweep range corresponds to the high end of the Channel 4 frequency range and vice versa.

In television receiver tuners, the local oscillator operates above the incoming signal by an amount equal to the i-f frequency. When exactly adjusted by the fine tuning adjustment, the oscillator is running at 113 MHz. Therefore, when the 75 MHz to 65 MHz sweep range of Channel 4 is fed into the tuner, it is converted down to the original 38 MHz to 48 MHz sweep range.

These principles are used in the Model 415 to generate a Channel 4 signal. When the FUNCTION Switch of the Model 415 is in the CH4 position, the output of Channel 4 Oscillator Q301 is mixed with the output of the 44 MHz sweep oscillator at Mixer Amplifier Q302. This frequency combination is coupled through the FUNCTION switch and the attenuator to the RF-IF-VIDEO OUT jack and into the antenna terminals of the receiver under test. Because the Channel 4 mixing frequency is crystal controlled, all the i-f markers described in Par. 3.2 have the same frequency relationship to the television receiver i-f response as if the i-f sweep signal had been injected at the mixer grid (or base, if transistorized).

The same description of Channel 4 signal generation applies to the Channel 10 function. In this case, Channel 10 Oscillator Q303 generates a 239 MHz signal which mixes with the 38 MHz to 48 MHz i-f sweep from the 44 MHz sweep oscillator to produce the 201 MHz to 191 MHz Channel 10 sweep signal. This is converted in the television receiver tuner to the 38 MHz to 48 MHz sweep. Again because of crystal control of the Channel 10 oscillator, the internal i-f post-injection markers have the same relationship to the i-f response curve as if the 38 MHz to 48 MHz sweep had been injected at the mixer.

### 3.7 VIDEO SWEEP AMPLIFIER Q401

When video sweep output is desired, the 45.75 MHz output of Pix Oscillator Q402 is added to the output of the 44 MHz sweep oscillator and the difference frequencies are detected at the video amplifier stage Q401. The detector performs the same function as the video detector in a television set. The difference between the pix carrier and the sweep frequencies is passed through a low-pass filter and the pix carrier and i-f sweep frequencies are rejected. This can be explained by reference to Fig. 3.2. In Figure 3.2A the pix carrier (45.75 MHz) is superimposed on the 38 MHz to 48 MHz i-f sweep. In Figure 3.2B the detector output is shown in idealized form. Notice that the pix carrier is now the zero frequency reference and the end points of the sweep are the differences between 45.75 MHz and 38 MHz (7.75 MHz) at one end and 45.75 MHz and 48 MHz (2.25 MHz) on the other end. If the center frequency of the i-f sweep is lowered so that it sweeps from 45.75 MHz and below, the video sweep envelope of Figure 3.2C is obtained. This video sweep width can be reduced by use of the SWEEP WIDTH control so that any portion may be used as desired.

Once again some frequency relationships should be noted with reference to the i-f marker frequencies. Note that the difference between the pix carrier (45.75 MHz) and the chroma carrier frequency (42.17 MHz) is 3.58 MHz.

Also note that the differences between the chroma side markers 42.67 MHz and 41.67 MHz and the pix carrier are 3.08 MHz and 4.08 MHz, respectively. Finally, by subtracting the 41.25 MHz sound carrier from the 45.75 MHz pix carrier, 4.5 MHz is obtained which is the sound i-f of television receivers.

Once again the i-f marker system does double duty because the markers can be superimposed on a video sweep response curve and can be interpreted as chroma (3.08, 3.58 and 4.08 MHz) and sound (4.5 MHz) frequency markers. This is the reason for the double frequency identification of these four markers on the front panel of the Model 415.

### 3.8 MARKER FREQUENCY RELATIONSHIPS

Figure 3.3 shows the frequency relationships of all the sweep ranges used in the Model 415 and how the single set of post-injection markers can be used on all ranges. Only the markers corresponding to the lights on the front panel curve are shown, but the comparison applies to the other markers as well. The VIDEO/CHROMA segment of Figure 3.3 gives the absolute differences between the pix marker frequency and all others. Again, this is why the markers are valid for video and chroma frequency identification. Because the Channel 4 and Channel 10 oscillators are crystal controlled, the frequency identifications shown are also true. This system effectively provides the equivalent of four complete sets of crystal controlled markers as shown in Figure 3.3.

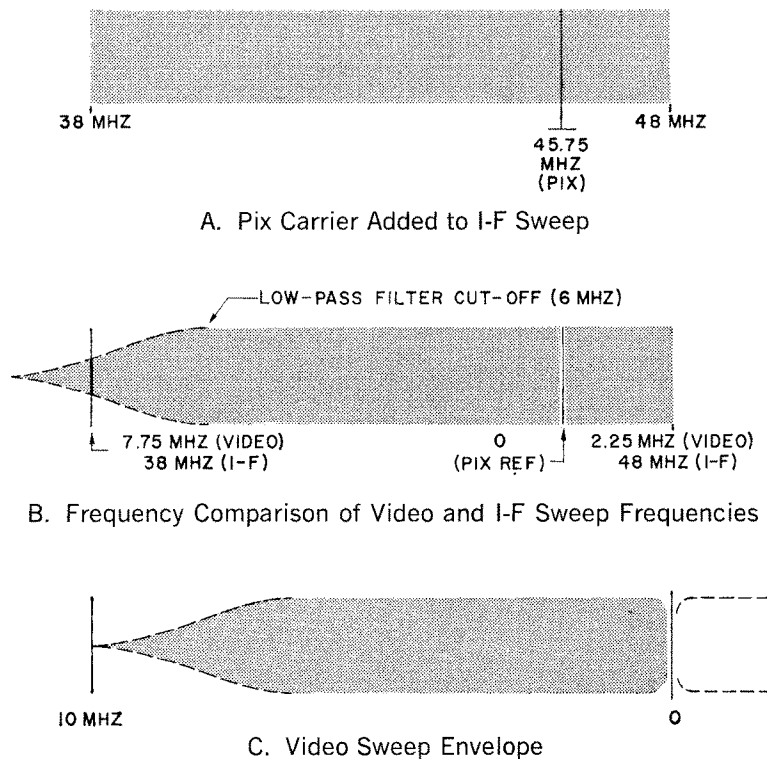


Figure 3.2 Video Sweep Generation

### 3.9 10.7 MHz CIRCUITRY

10.7 MHz Sweep Oscillator Q203 furnishes output to the FUNCTION switch and to 10.7 MHz Detector Q16. A 10.70 MHz crystal-controlled marker is automatically switched on when the 10.7 MHz function is selected.

The 100 KHz Marker Oscillator Q305 can be turned on by the 100 KHz marker switch. This generates a train of markers having 100 KHz separations. These markers appear on both sides of the 10.7 MHz marker and provide frequency reference points for 10.7 MHz i-f and discriminator alignment. A post-injection marker system is employed for the 10.7 MHz

system as in the TV alignment system. The same marker and pattern amplifiers are used and either the demodulator or direct probe outputs can be selected by the PROBES switch.

### 3.10 POWER SUPPLIES AND BIAS SUPPLIES

All internal supply voltages are furnished from zener-referenced regulators for optimum circuit stability. The voltages applied to the bias output-controls are also regulated. The bias voltage outputs are referenced to chassis ground. Either plus or minus polarity can be selected and the outputs are continually adjustable over the ranges indicated.

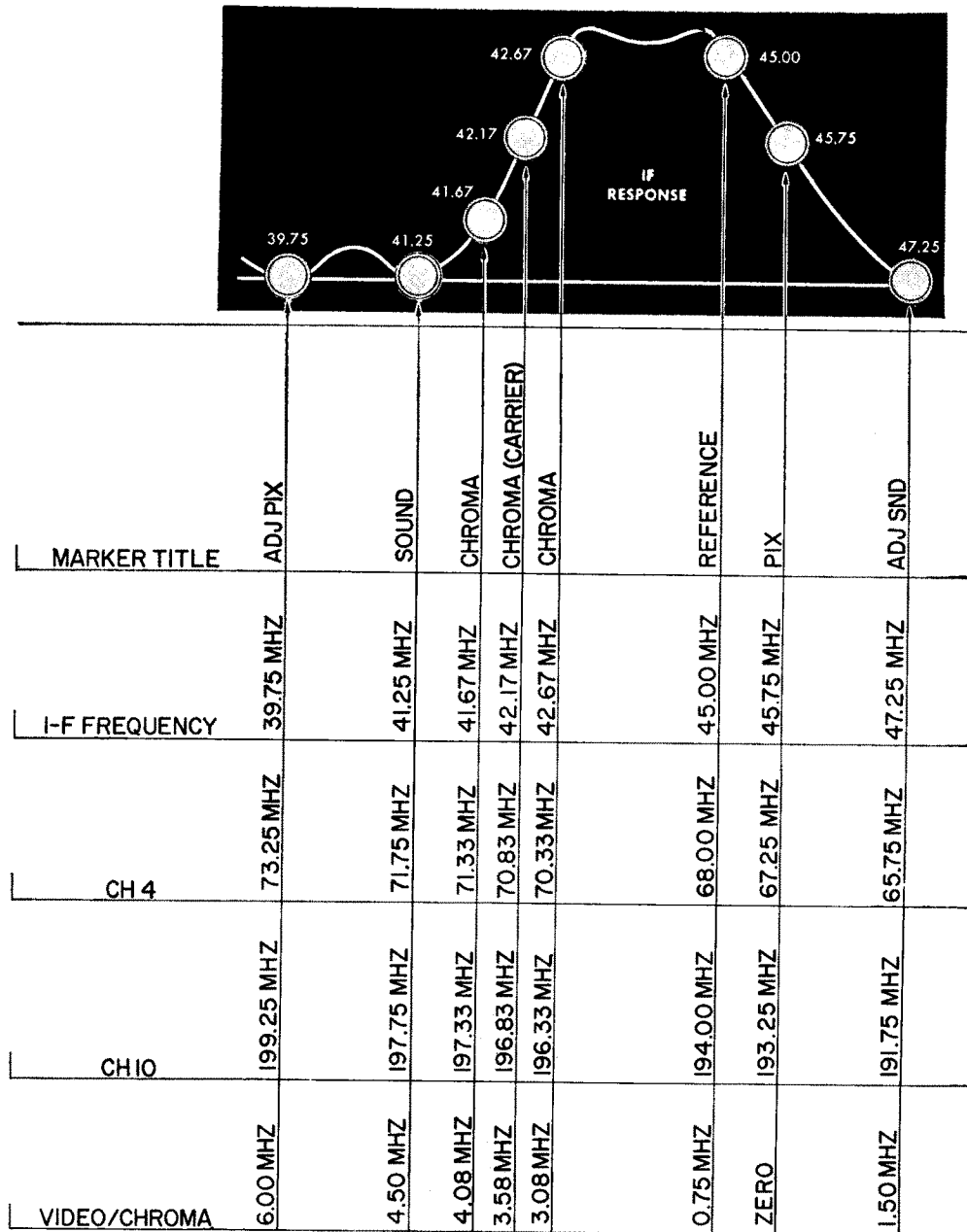


Figure 3.3 Marker Frequency Relationships in the Model 415

# INTRODUCTION TO TELEVISION RECEIVER ALIGNMENT USING THE MODEL 415

## 4.0 MATCHING THE MODEL 415 TO THE RECEIVER

Using the simplified receiver block diagram of Figure 2.6 and the Model 415 block diagram of Figure 3.1, we will proceed through the positions of the Model 415 FUNCTION switch.

In each position we will show the stages of the Model 415 which are involved in generating the desired signals and also show the related signal injection points and monitoring points of the television receiver.

## 4.1 GENERAL ALIGNMENT INFORMATION

The following paragraphs give general alignment information as an introduction to the operating descriptions of the 415 as used in television receiver alignment.

### 4.1.1 VIDEO SWEEP ALIGNMENT OF CHROMA CIRCUITS

In some sets, a prealignment of the chroma circuits of the receiver using video sweep is specified. In this application the video sweep output of the 415 is connected to the set as specified by the manufacturer, the injection point usually being the input of the bandpass amplifiers. The circuit response is monitored using the demodulator probe.

### 4.1.2 I-F AND CHROMA ALIGNMENT CHECKS

If it is desired to check i-f and chroma response by injecting the sweep signal at the mixer grid, the i-f sweep output of the 415 is applied to the mixer test point which is usually the grid (tube-type) or base (transistorized) of the mixer. The connection locations of the direct and demodulator cables are the same as for the overall alignment. The r-f agc bias is raised for this procedure to cut off the r-f amplifier stage of the tuner. This eliminates possible interference from strong local stations.

### 4.1.3 PREALIGNMENT OF TRAPS AND TUNED CIRCUITS USING MARKER FREQUENCIES

The Model 415 output is connected to the mixer test point of the receiver. When using modulated markers, the effects of tuning the coils is observed by connecting the direct cable of the Model 415 to the video detector test point and tuning for either minimum recovered 400 Hz or maximum recovered 400 Hz

depending on whether traps or bandpass coils, respectively, are being aligned.

### 4.1.4 OVERALL RECEIVER ALIGNMENT CHECK

To check overall receiver alignment (tuner and i-f) the Channel 4 or Channel 10 output of the Model 415 is connected to the antenna terminals of the receiver. The direct accessory cable of the 415 is connected at the video detector output and the PR-151 Demodulator Probe is connected at the bandpass amplifier output.

The locations of the monitoring points are specified by the manufacturer and should be observed in response checks or alignment procedures. Apply bias to the r-f and i-f agc lines as specified by the manufacturer. This "clamps" or locks the agc line at a constant voltage to maintain constant r-f and i-f gain during sweep alignment.

Separate bias voltages are usually specified. In addition, if chroma alignment is to be checked or performed, an additional bias is required for this section. The three internal bias supplies of the Model 415 are more than adequate for these requirements.

## 4.2 VIDEO

(See Figures 4.1 and 4.2)

In this position of the FUNCTION switch the outputs of the 44 MHz sweep oscillator and the pix oscillator are combined and coupled to the video sweep amplifier. The difference frequency (video sweep) is diode-detected and amplified by Q401. This amplified sweep output is fed to the attenuator through the FUNCTION Switch. The attenuator output is connected directly to the RF-IF-VIDEO OUT jack. The 415 r-f cable is used with the impedance switch in the 75  $\Omega$  position. Referring to the TV block diagram, only the chroma section is involved. The 415 r-f cable is connected as specified by the manufacturer, usually at the input to the bandpass amplifier. The PR-151 Demodulator Probe is connected at the output of the bandpass amplifier, usually at the demodulator input point. A typical demodulated chroma response curve with the related markers is shown in Figure 4.3. The sweep width is adjusted as required to provide a satisfactory response curve.

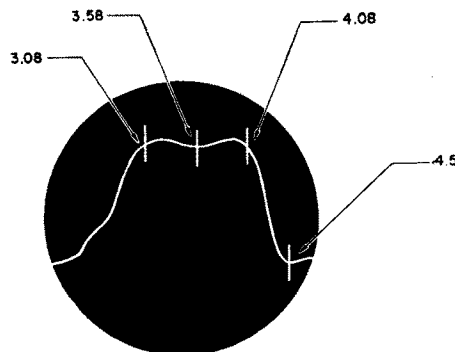


Figure 4.3 Chroma Response Curve with Markers Added



4.2.2 **IF POSITION** (See Figures 4.4 and 4.5)

The 44 MHz sweep oscillator output is fed through the FUNCTION switch to the attenuator. Also, part of the sweep output is coupled to the 44 MHz detector. The i-f marker oscillators can be activated as desired to generate markers. The markers appear as selected on the oscilloscope trace.

With the CHROMA switch in the OFF position, notice that in selecting the sound and chroma markers that the corresponding lights on the i-f response curve of the Model 415 front panel are lighted to indicate that these markers are energized.

The IF function is used for i-f alignment. Injection into the set is at the specified mixer test point. Again the SWEEP WIDTH is adjusted as desired to view the desired part of the trace and the RF-IF-VIDEO ATTENUATOR is adjusted to give the desired response amplitude. Figure 4.6 shows a representative response curve of a properly aligned i-f strip with reference markers. Where applicable, the corresponding light on the Model 415 panel is turned on when the marker is selected.

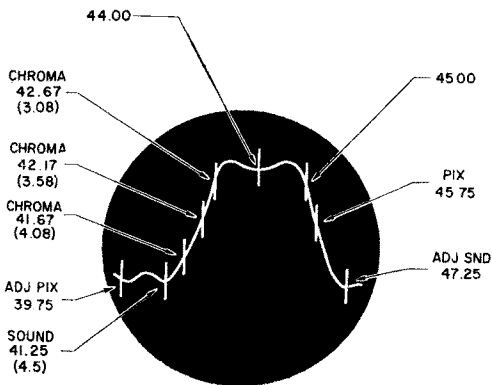


Figure 4.6 Typical I-F Response Curve with Reference Markers Added

4.2.2.1 Another function of Pix Oscillator Q402 will be described. As mentioned in the VIDEO function description (Par. 4.2.1), detection of the 44 MHz sweep and pix oscillator output gives a video sweep difference output, the difference frequencies being taken with respect to the 45.75 MHz pix oscillator frequency. In the video-sweep generating system of the Model 415 detection is accomplished by a diode in Video Sweep Amplifier stage Q-401.

To generate a video sweep in the television receiver using the Model 415, the pix oscillator output is added to the 44 MHz sweep and these combined signals are injected into

the receiver at the mixer. Detection of these signals to produce a video sweep is performed by the video detector of the television receiver. Once again the marker frequency relationships of Figure 3.3 apply. The pix oscillator is turned on by the CHROMA switch for this function.

To demonstrate the use of the CHROMA function, assume that the i-f response curve of Figure 4.6 has been obtained at the video detector with frequency increasing from left to right. Now it is desired to check the response of the chroma circuitry of the receiver. Use only the sound and the three chroma

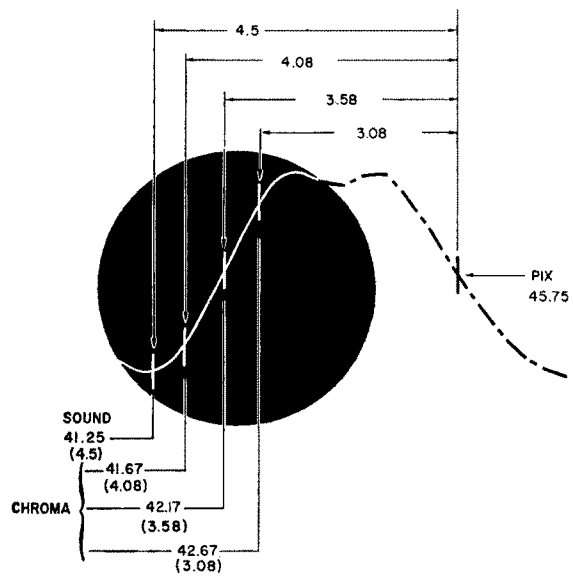
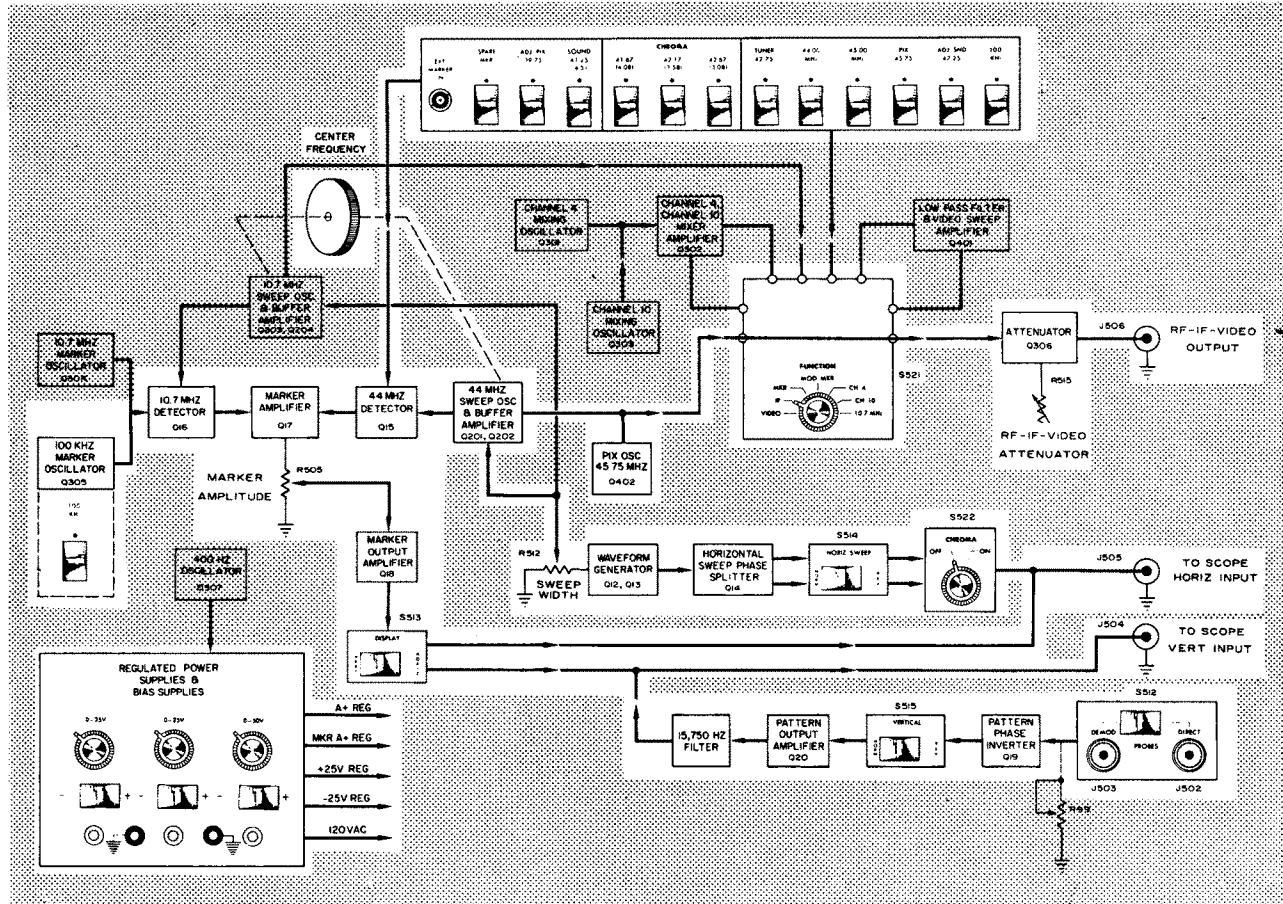


Figure 4.7 Enlarged Portion of I-F Response Curve Showing Sound and Chroma Region

markers. Slowly adjust the SWEEP WIDTH control and CENTER FREQUENCY control as required to keep the sound and chroma markers on the oscilloscope screen (Figure 4.7). The i-f response curve is shown extended beyond the scope screen to show the frequency relationship of the markers to the pix frequency (45.75 MHz). The signal injection is still at the mixer test point. With the PR-151 Demodulator Probe connected to the specified chroma monitoring point, place the CHROMA switch in the ON position. This turns on the pix oscillator and at the same time reverses the direction of sweep so that the extended response curve of Figure 4.7 is





shown in reverse (Figure 4.8). The sound and chroma marker lights on the I-F RESPONSE curve of the Model 415 front panel will be turned off and the three chroma lights and the sound light of the CHROMA BANDPASS curve of the Model 415 front panel will be turned on. This is a built-in reminder to the operator that chroma response information is to be obtained. In addition, the curve serves as a guide to the operator to indicate the typical chroma response desired as well as the relative placement of the indicated markers on the chroma response curve. Place the PROBES switch in the DEMOD position and the chroma response curve will now be obtained (Figure 4.9). The ATTENUATOR may have to be adjusted to establish the desired peak-to-peak response amplitude, as outlined in detail in the operating section of the manual.

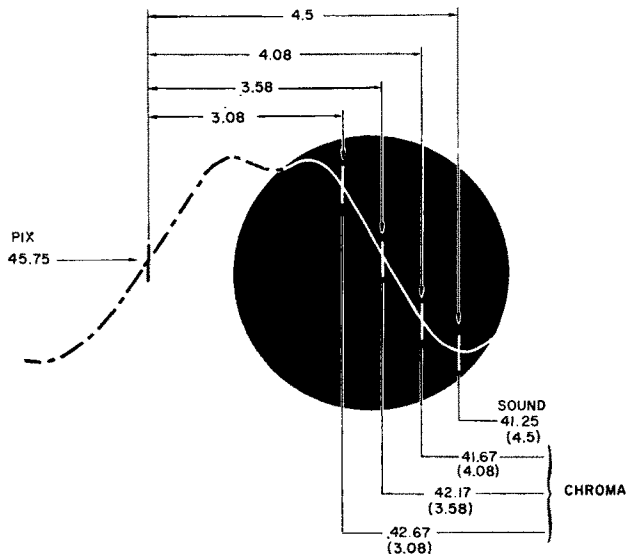


Figure 4.8 Reversal of Sweep of Figure 4.7 By Use of Chroma Switch

What has happened is that the combined 44 MHz sweep and pix oscillator frequencies have been detected by the video detector of the television receiver and a video sweep voltage is generated which is fed through the video amplifier to the chroma amplifiers. The marker relationships of Figure 3.3 still apply so that the 42.67, 42.17, 41.67 and 41.25 marker frequencies on the i-f curve of Figure 4.8 correspond to the 3.08, 3.58, 4.08 and 4.5 marker frequencies, respectively, of the chroma response curve of Figure 4.9. The sweep direction is automatically reversed by the CHROMA switch so that chroma frequency increases from left to right as indicated in Figure 4.9.

The preceding shows how the i-f and chroma response can be evaluated by a single input connection to the receiver. With the PROBES switch the operator can switch from the i-f response to the chroma response test point without any interconnection changes.

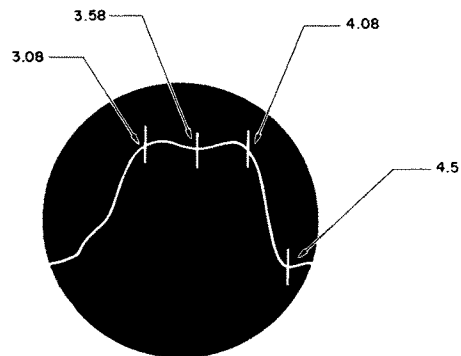


Figure 4.9 Chroma Bandpass Response Curve

#### 4.2.3 MKR

(See Figures 4.10 and 4.11)

In this position of the FUNCTION switch the marker oscillator outputs are coupled through the FUNCTION switch to the ATTENUATOR and to the RF - IF - VIDEO OUT jack. In this way spot frequencies are made available which are crystal controlled and can be adjusted in amplitude by the RF - IF - VIDEO ATTENUATOR as required.

All i-f marker frequencies are available for this function. Usually, the frequencies are selected one at a time for spot alignment of individual circuits. The signal can be injected at the recommended mixer test point. The effect of tuning a circuit using spot alignment can be monitored using a VTVM at a specified receiver metering point, usually at the video detector output.

Although the spot alignment frequencies are normally used singly, certain frequency combinations can also be used as follows: As previously explained, the video detector of the receiver will detect the difference between two frequencies in the i-f range. If the PIX (45.75 MHz) marker is turned on with the CHROMA (42.67 MHz) marker, the difference frequency, 3.08 MHz, is generated at the video detector and could be used for spot alignment in the chroma section of a TV receiver. All three chroma reference frequencies as well as the sound intermediate frequency (4.5 MHz) can be generated in this way. Once again, with a single input connection at the mixer, both i-f and chroma frequencies can be generated for spot alignment.

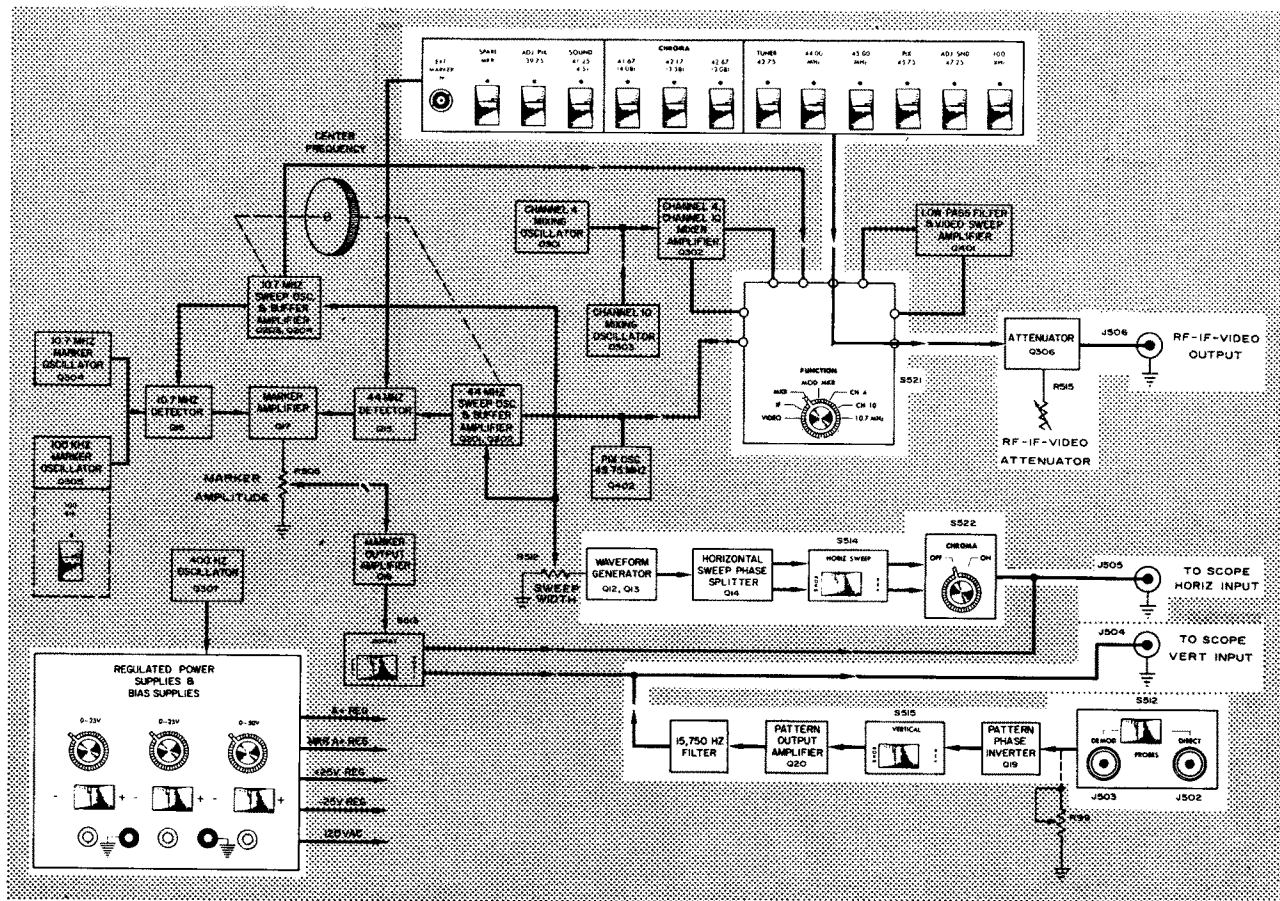


Figure 4.10 Model 415 Block Diagram for MKR Function

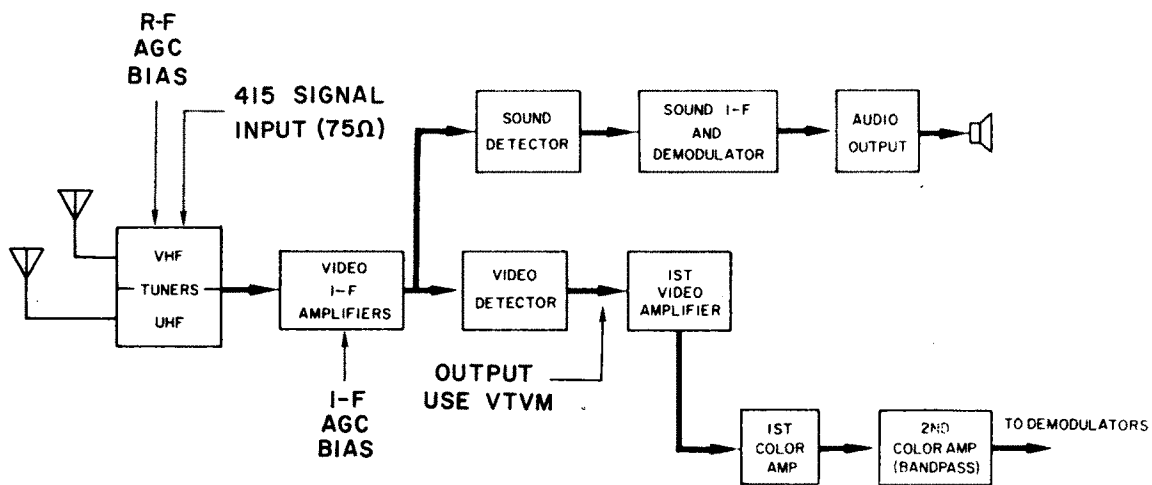


Figure 4.11 Color TV Receiver Block Diagram for MKR Function

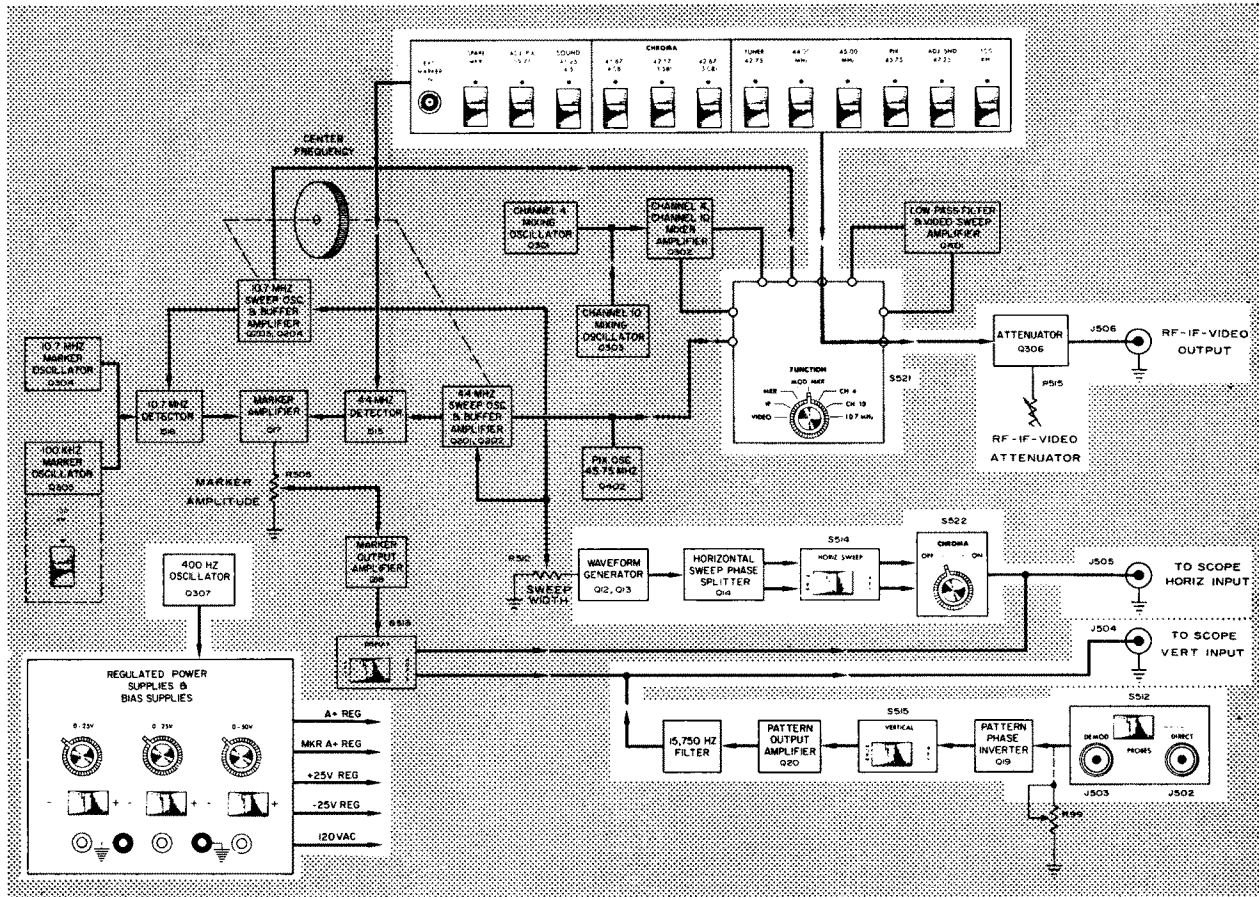


Figure 4.12 Model 415 Block Diagram for MOD MKR Function

#### 4.2.4 MOD MKR

(Figures 4.12 and 4.13)

In this position of the FUNCTION switch all circuit functions are the same as for the MKR position except that 400 Hz Oscillator Q307 is used to modulate the i-f marker A + line. The advantage of the modulated markers is that the VTVM is not required for monitoring spot alignment. If a complete alignment set-

up is used, the recovered 400 Hz modulation viewed on the oscilloscope can be used as an indication. Also, without altering connections, the operator can spot align traps or transformers with the FUNCTION switch in the MOD MKR position and switch to the IF position to see the effect on overall i-f response. In addition, by use of the CHROMA and PROBES switches he can also check overall chroma response.

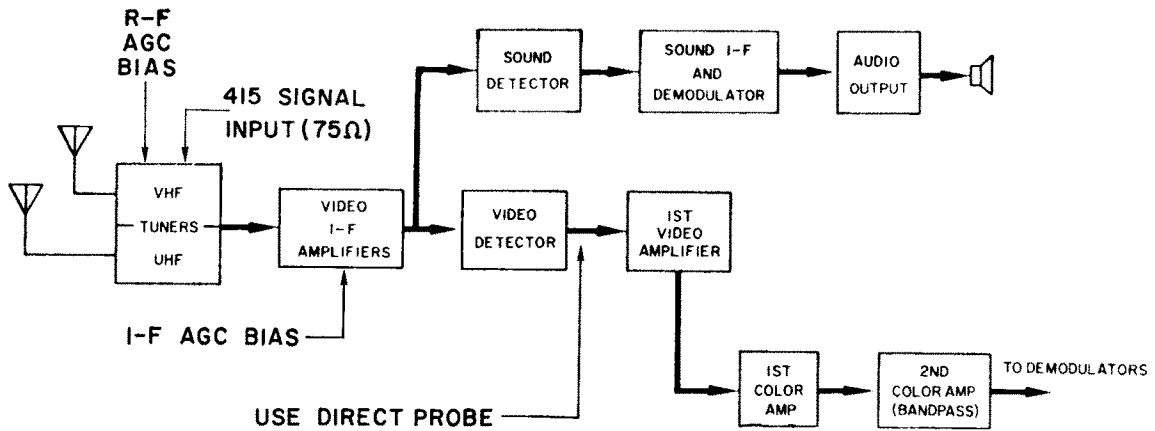


Figure 4.13 Color TV Receiver Block Diagram for MOD MKR Function

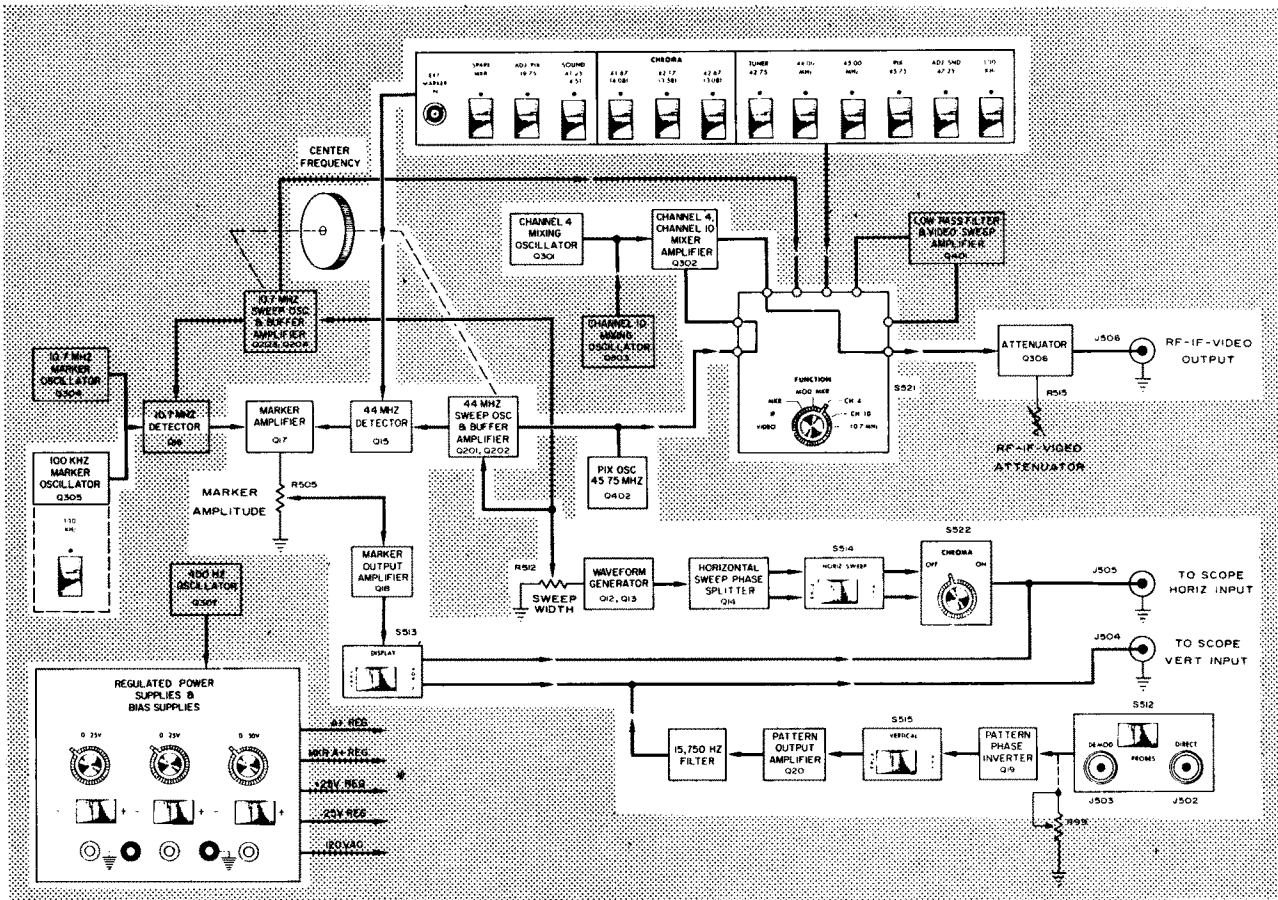


Figure 4.14 415 Block Diagram for CH 4 Function

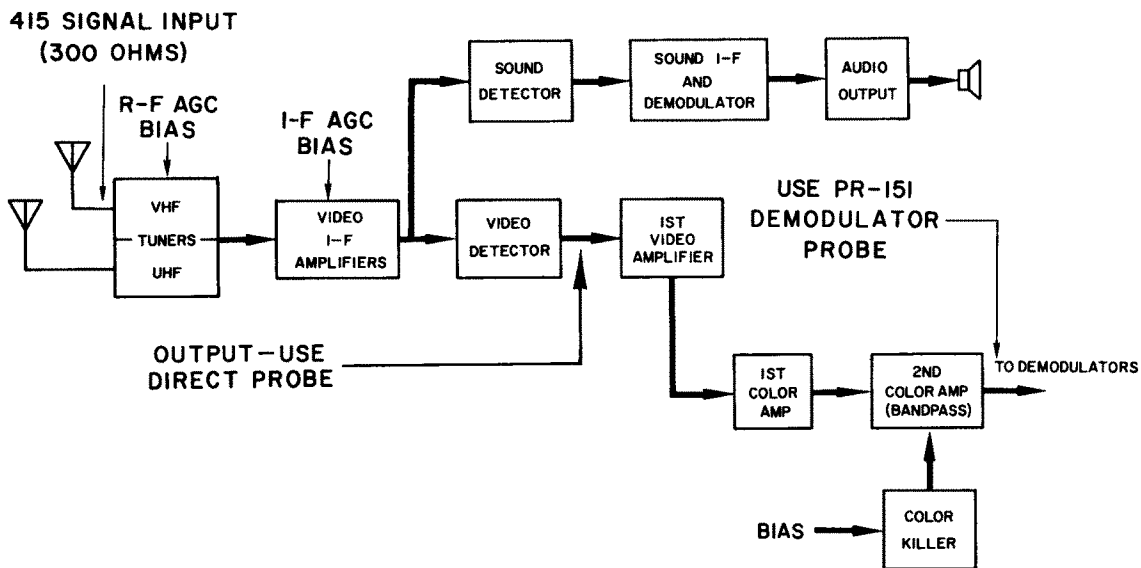


Figure 4.15 Color TV Receiver Block Diagram for CH 4 Function

4.2.5 **CHANNEL 4**

(Figures 4.14 and 4.15)

In this position the 44 MHz sweep is mixed with the crystal-controlled output of the Channel 4 mixing oscillator at Mixer Amplifier Q302. The output of this stage is fed through the attenuator to the RF-IF-VIDEO OUT jack. As explained in Par. 3.6, this generates an r-f sweep for Channel 4. With the termination switch of the 415 r-f cable in the 300 Ω position, the signal is connected to the antenna terminals of the receiver, so that the signal is processed through the tuner and i-f stages. The desired sweep range is selected as before by turning on the ADJ PIX (39.75) marker and the ADJ SND (47.25) marker and centering the sweep on the oscilloscope.

When going through the tuner, however, the setting of the fine tuning adjustment of the television receiver will affect the location of the response curve with respect to the markers. This is shown in Figure 4.16A. The i-f frequency nomenclature of the markers is used with the Channel 4 r-f equivalent in parenthesis. With the fine tuning improperly adjusted, the markers will not appear at the proper points on the response curve. One of the best ways to adjust the fine tuning is to locate the SOUND (41.25 MHz) marker in the sound notch on the response curve as shown in Figure 4.16B.

Additional resolution can be obtained by increasing the output of the Model 415 and at the same time increasing the oscilloscope sensitivity so that an enlarged portion of the sound trap region is visible on the oscilloscope as shown in Figure 4.17A.

Another effective method of obtaining accurate adjustment of the receiver fine tuning control is to use the horizontal marker display and adjust the fine tuning of the receiver until the sound marker is reduced to minimum width at the bottom of the sound frequency notch as shown in Figure 4.17B. When this is done and if the response curve is satisfactory, the pix marker and the chroma marker will be at approximately the same level on each side of the response curve.

The CHROMA switch can be turned on to generate video sweep voltage at the video detector of the receiver for checking alignment of the chroma circuits. Once the response curve is located properly by use of the receiver fine tuning, all chroma alignment procedures are identical to those described in the IF function.

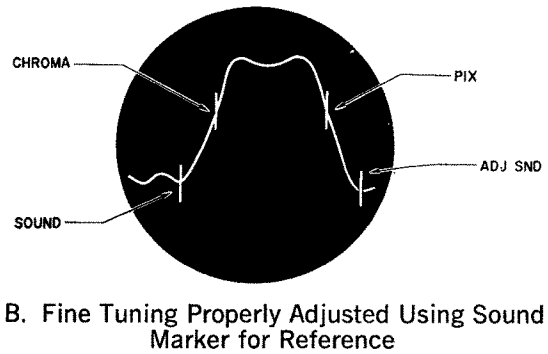
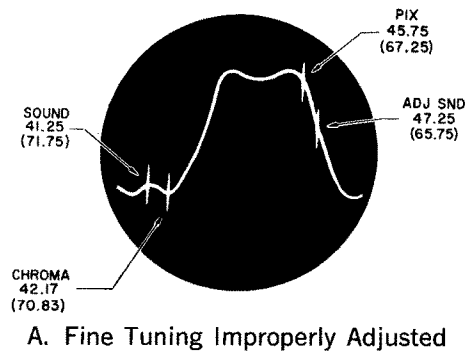


Figure 4.16 Setting Fine Tuning Using Sound Notch of Response Curve. (Channel 4 Marker Frequencies Shown)

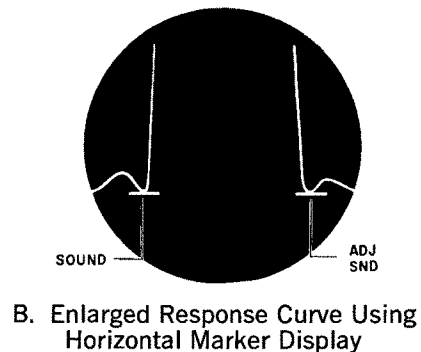
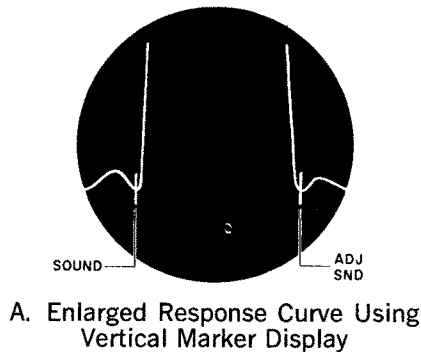


Figure 4.17 Increasing Sound Notch Resolution to Adjust Receiver Fine Tuning Control

**4.2.6 CHANNEL 10**  
(Figures 4.18 and 4.19)

The circuit operation for this function is identical to that described for CHANNEL 4, except that the Channel 10 mixing oscillator is combined with the 44 MHz sweep. This develops an r-f sweep frequency for Channel 10 and is applied to the receiver antenna terminals. The frequency relationships between the Channel 10 markers and i-f markers are shown in Figure 3.3. Chroma alignment can be performed as in the Channel 4 position by use of the CHROMA switch.

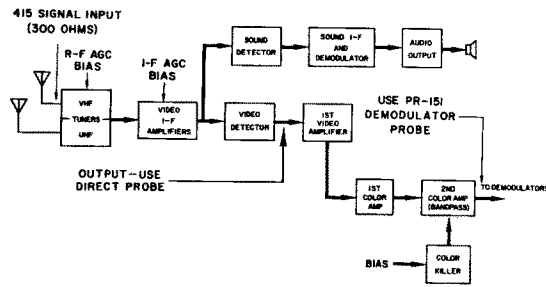
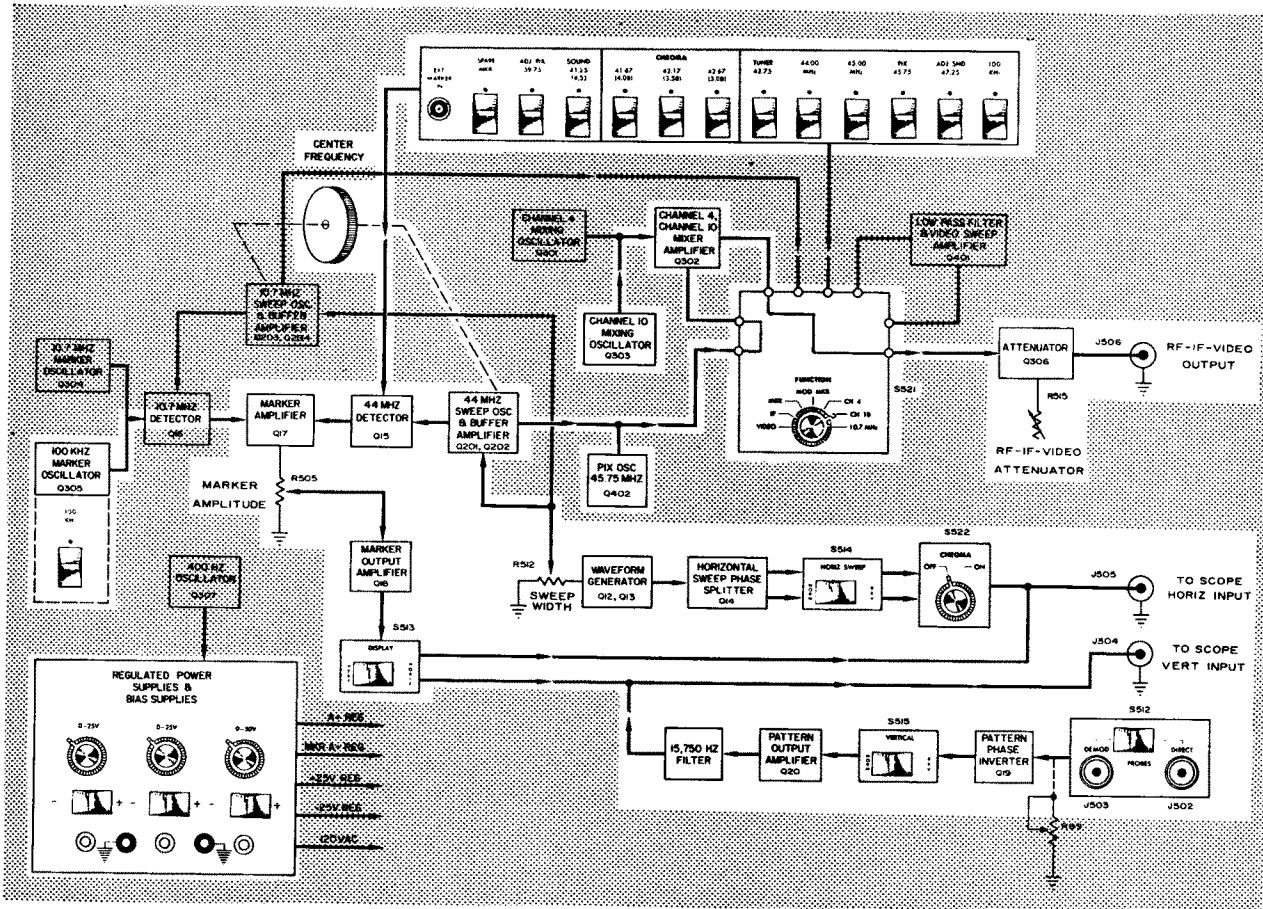


Figure 4.19 Color TV Receiver Block Diagram for CH 10 Function





4.2.7 10.7 MHz  
(Figures 4.20 and 4.21)

The output of the 10.7 MHz sweep oscillator is applied to attenuator Q306 through the FUNCTION switch. The 10.7 MHz crystal marker is automatically energized. The 10.7 MHz sweep signal is applied at the mixer grid (or base). Bias is applied to the i-f agc line if specified. The i-f response and the demodulator "S" - curve can then be viewed by use of the direct probe. The 100 KHz switch can be used to add 100 KHz markers to the response curve to determine bandwidth.

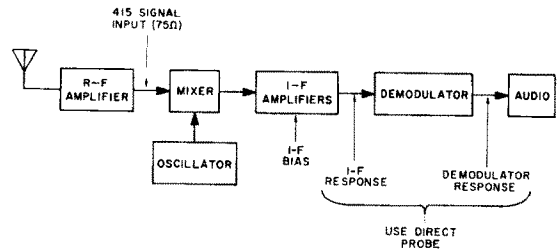


Figure 4.21 Typical F-M Receiver Block Diagram

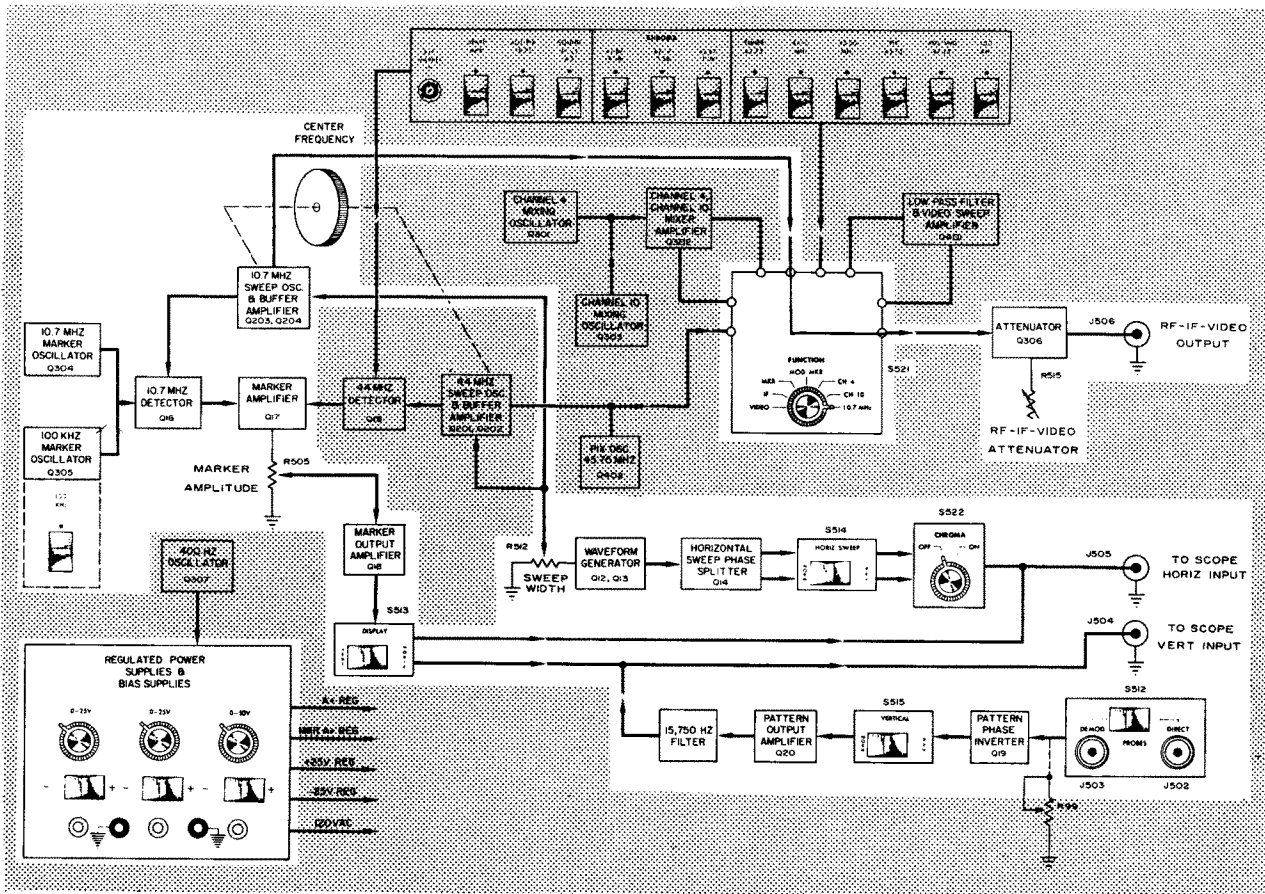


Figure 4.20 Model 415 Block Diagram for 10.7 MHz Function

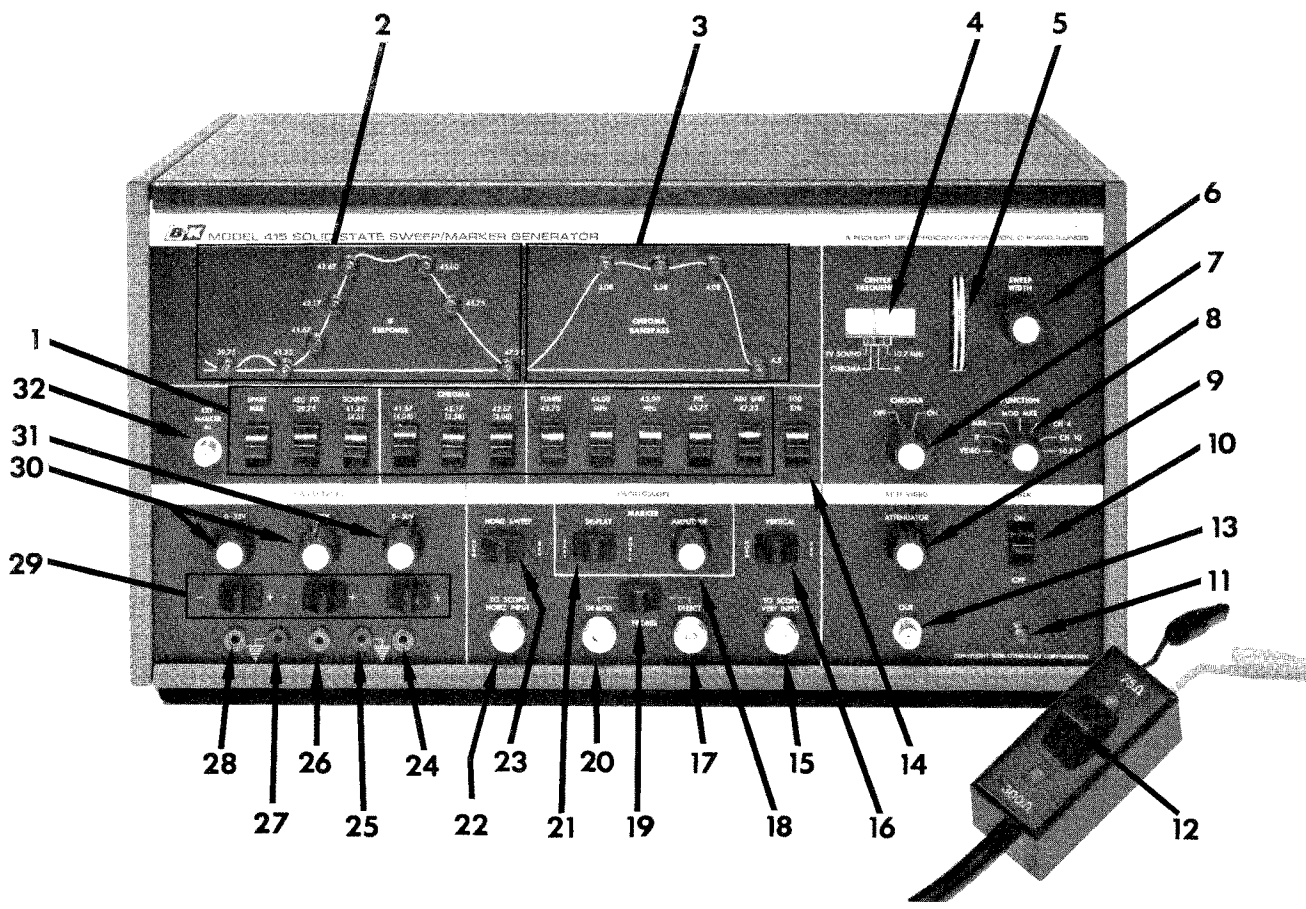


Figure 5.1 Front Panel Controls and Outputs of Model 415

## OPERATING PROCEDURES

### 5.0 USING THE MODEL 415 SWEEP/MARKER GENERATOR

#### 5.1 CONTROLS AND OUTPUTS

Figure 5.1 shows the front panel controls and outputs of the Model 415. All the control functions and outputs of the Model 415 have been described or referred to in the preceding sections of the manual. They will be listed here with a brief description of each. Complete operating instructions are given following the description and controls.

#### 1. MARKER SWITCHES

<u>TITLE</u>	<u>FREQ.</u>	<u>LIGHTS</u>
SPARE MKR	Optional	No
ADJ PIX	39.75	Yes
SOUND	41.25 (4.5)	Yes
CHROMA	41.67 (4.08)	Yes
CHROMA	42.17 (3.58)	Yes
CHROMA	42.67 (3.08)	Yes
TUNER	42.75	No
44.00 MHz	44.00	No
45.00 MHz	45.00	Yes
PIX	45.75	Yes
ADJ SND	47.25	Yes
100 KHz	100 KHz	No

2. I-F RESPONSE curve marker lights.
3. CHROMA BANDPASS curve marker lights.
4. CENTER FREQUENCY scale — Indicates center frequency of sweep oscillator.
5. CENTER FREQUENCY control — Adjusts the center frequency of the sweep oscillator.
6. SWEEP WIDTH—Adjusts the sweep range of the sweep oscillator.
7. CHROMA ON/OFF — Used to energize pix carrier oscillator for chroma circuit alignment.
8. FUNCTION switch—Selects desired output signal.
9. RF - IF - VIDEO ATTENUATOR—Controls the level of all signals appearing at the RF - IF - VIDEO OUT jack.
10. POWER ON/OFF—Turns the unit on and off. Because the 415 is completely solid-state, no warm-up time is required.
11. POWER ON/OFF PILOT—Indicates that unit is on.
12. 75/300-ohm switch (On r-f cable terminating pad) — Selects proper cable termination for alignment task being performed.
13. RF - IF - VIDEO OUT jack—All signal outputs made available at this jack.

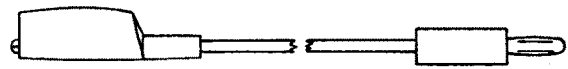
14. 100 KHz MKR switch—This switch is used to add a train of markers having 100 KHz frequency separations to any of the i-f markers as well as the 10.7 KHz crystal-controlled marker. The 100 KHz feature should be used with only one marker at a time.
15. TO SCOPE VERT INPUT jack—The oscilloscope vertical input signal is taken from this jack.
16. VERTICAL (NORM/REV) switch—Selects the polarity of patterns viewed on the oscilloscope.
17. DIRECT jack—Connect direct cable (accessory) to this jack.
18. MARKER AMPLITUDE control — Adjusts marker height as desired.
19. PROBES (DEMODO/DIRECT) switch — Switches either the demodulator probe or the direct probe to the internal pattern amplifiers.
20. DEMOD jack — Connect Demodulator Probe PR-151 to this jack.
21. MARKER DISPLAY (VERT/HORIZ) switch. Selects vertical or horizontal markers.
22. TO SCOPE HORIZ INPUT jack—Provides sawtooth horizontal sweep voltage for oscilloscope.
23. HORIZ SWEEP (NORM/REV) switch. Selects direction of horizontal sweep.
- 24, 26, 28. BIAS jacks — Connection points for bias take-offs.
- 25, 27. Ground jacks — Provide chassis ground connection to Model 415.
29. +, — Switches—Select polarity of bias voltages (with respect to chassis).
30. BIAS SUPPLIES — 0-25 (2) output voltage adjustments.
31. BIAS SUPPLY — 0-50 V output voltage adjustment.
32. EXT MARKER IN jack—Provision for injecting external marker. Can be used with internal markers.

**INTERNAL ADJUSTMENT**—R99, low frequency compensation (See Figure 5.8). Used if necessary to correct tilt errors caused by poor low frequency response of the oscilloscope.

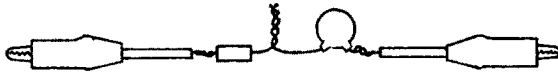
**ACCESSORIES**—The accessories used in the set-up of Figure 5.2 and in the alignment instructions to follow are shown in Figure 1.1 (Repeated). The cable numbers are shown in Figure 5.2.



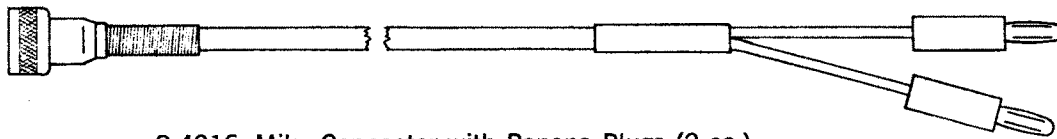
S-4911 Red Bias Lead (3 ea.)



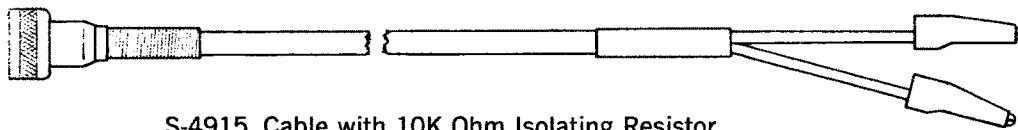
S-4912 Black Ground Lead



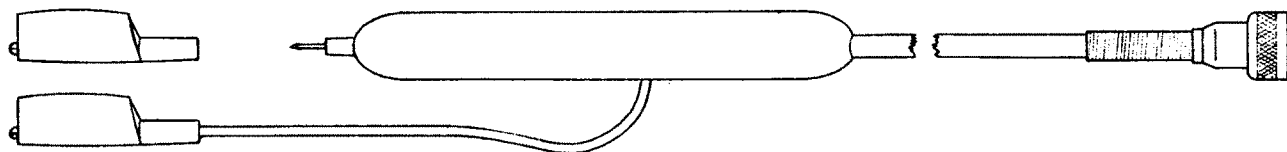
S-4918 I-F Load Block (2 ea.)



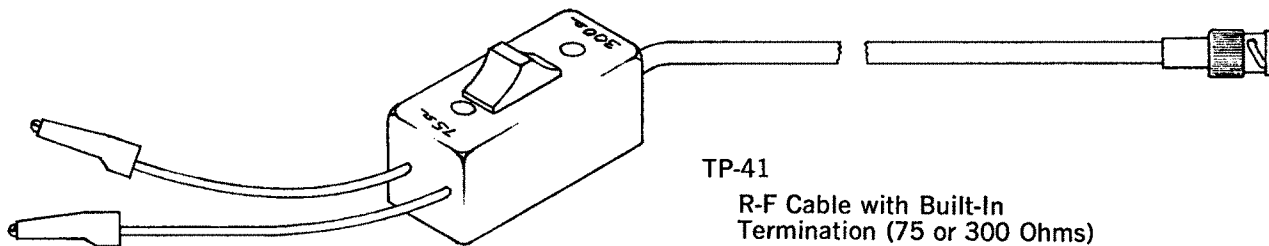
S-4916 Mike Connector with Banana Plugs (2 ea.)



S-4915 Cable with 10K Ohm Isolating Resistor  
(Black and Yellow Terminals)



PR-151 Demodulator Probe



TP-41  
R-F Cable with Built-In  
Termination (75 or 300 Ohms)

Figure 1.1 (Repeated) Accessories Furnished with the Model 415

## 5.2 EQUIPMENT INTERCONNECTION AND SET-UP PROCEDURE

The interconnection set-up of Figure 5.2 is typical of that required in alignment work and applies for all procedures outlined later in the manual. Because numerous references are made to this section and to Figure 5.2, the information is repeated at the end of the manual in fold-out form as a convenience to the user. Pertinent information from Section 5.3 will also be included. Proceed as follows:

- 5.2.1 Arrange TV chassis, Model 415, oscilloscope and VTVM so that all are readily accessible for adjustment as required during the alignment procedure. Refer to Figure 1.1 (repeated) for interconnecting cables furnished with the Model 415.
- 5.2.2 Turn the Model 415 POWER ON/OFF switch to ON. Connect an S-4916 cable between TO SCOPE HORIZ INPUT jack of the Model 415 and the horizontal input terminals of the oscilloscope. Set horizontal sweep selector switch on scope to the external position. Adjust scope horizontal gain for desired trace width.
- 5.2.3 Connect the other S-4916 cable between TO SCOPE VERT INPUT jack and the vertical input terminals of the oscilloscope.
- 5.2.4 Connect the black ground lead (S4912) between the TV receiver chassis and one of the ground jacks in the Model 415 bias section.
- 5.2.5 Connect the S-4915 cable between the DIRECT jack of the 415 and the video detector test point of the receiver; the lead with the yellow insulator is connected directly to the video detector test point and the lead with the black insulator to ground. A 10 K ohm resistor is built into this cable for isolation. The isolating resistor specified by the manufacturer is not required.
- 5.2.6 Connect the PR-151 Demodulator Probe to the DEMOD jack of the 415. The connection of the demodulator probe to the TV receiver depends on the alignment task being performed.
- 5.2.7 Connect the TP-41 r-f cable to the RF-IF-VIDEO jack. Connection of this cable to the receiver is also determined by the alignment task being performed. It will be specified for each alignment function.
- 5.2.8 Before connecting the bias leads to the television receiver, preset the bias voltages at the Model 415 using the VTVM, and be certain that the polarities of the bias voltages are as specified. With the television receiver functioning, connect the required bias leads (S-4911) to the television receiver and set the voltages to the specified values using the VTVM.

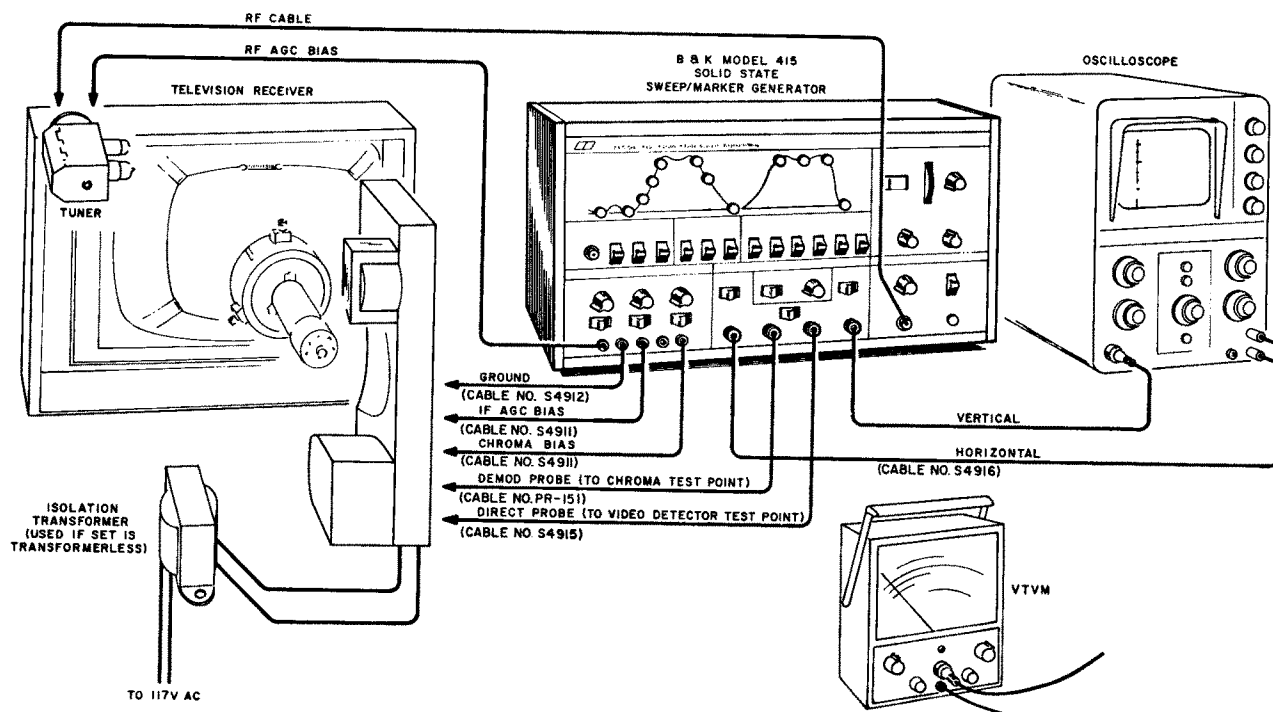


Figure 5.2 Equipment Interconnection

5.2.9 Most preliminary alignment procedures suggest that the horizontal output circuits of the TV receiver be disabled to eliminate horizontal frequency interference during alignment. This is not necessary when using the Model 415 because a 15,750 Hz filter has been inserted in the signal path to the SCOPE VERT INPUT jack which reduces any horizontal frequency "grass" to negligible level. Other alignment set-ups require removal of the horizontal output tube (or transistor), or opening the cathode lead of the horizontal output tube if a series heater string is used. The B+ line must then be loaded with external resistors to compensate for the decrease in drain. (DO NOT DISABLE THE HORIZONTAL OUTPUT CIRCUIT BY REMOVING THE PLATE CAP OF THE HORIZONTAL OUTPUT TUBE. This will cause excessive screen dissipation and may permanently damage the tube.)

**NOTE**

The user must keep in mind the fact that, with the horizontal circuits operating, the boosted B+ voltages are present as well as the high voltage which is 25,000 volts for color receivers.

**5.3 USE OF MODEL 415 CONTROLS**

As outlined in Par 3.8 all markers are available on all sweep ranges, except in the 10.7 MHz position in which only the 10.7 MHz marker and the 100 KHz markers are available. Because post injection is used, the markers are visible on the oscilloscope trace regardless of whether or not a receiver response curve is being viewed. Some general rules follow.

- 5.3.1 Always set SWEEP WIDTH control at maximum clockwise when setting up.
- 5.3.2 Turn on the ADJ PIX (39.75 MHz) marker and the ADJ SND (47.25 MHz) marker. Use the CENTER FREQUENCY control to center the sweep pattern as shown in Figure 5.3. With this setting the entire i-f response will be included in this range (Figure 5.4).

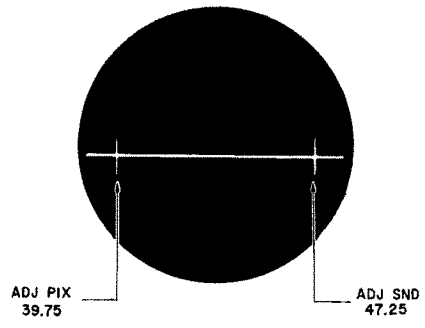


Figure 5.3 Centering Sweep Range by Use of ADJ PIX and ADJ SND Markers

5.3.3 The HORIZ SWEEP switch of the 415 can be used so that the direction of increasing frequencies can be selected as desired. Usually, increasing frequency from left to right across the scope trace is preferred as shown in Figure 5.4.

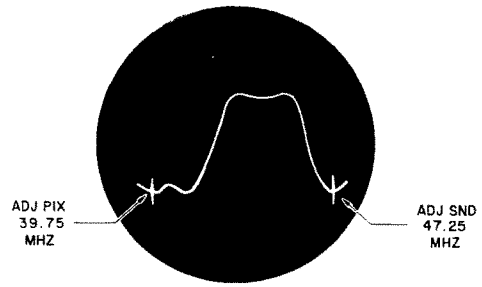


Figure 5.4 Receiver I-F Response Between ADJ PIX and ADJ SND Markers

- 5.3.4 The scope pattern polarity can be selected as desired or as shown in the manufacturer's instructions by use of the VERTICAL switch.
- 5.3.5 Depending on the alignment functions desired, the appropriate markers are selected for reference. For example Figure 5.5 is a typical marker display for i-f alignment.
- 5.3.6 The markers can be tilted to a horizontal position by use of the MARKER DISPLAY switch as shown in Figure 5.6. The MARKER AMPLITUDE control can be adjusted to give the best compromise between vertical and horizontal marker size.

**NOTE:**

If no response curve is being observed in conjunction with the markers when the MARKER DISPLAY switch is in the HORIZ position, the markers will disappear into the base line and will not be evident. Always check the position of this switch when there is an apparent loss of markers.

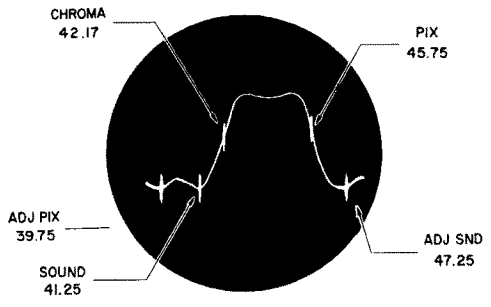


Figure 5.5 Typical I-F Response Curve with Markers Added

5.3.7 If a small portion of the overall response curve is to be viewed, turn on the markers in the area affected and slowly decrease the sweep width (SWEEP WIDTH control counterclockwise) and adjust the CENTER FREQUENCY control to keep the reference markers on the oscilloscope screen. For example if the chroma and sound regions of the i-f curve are to be examined, the i-f response would first appear as in Figure 5.7A. After decreasing the sweep width and recentering the sweep, the portion of interest would appear as in Figure 5.7B.

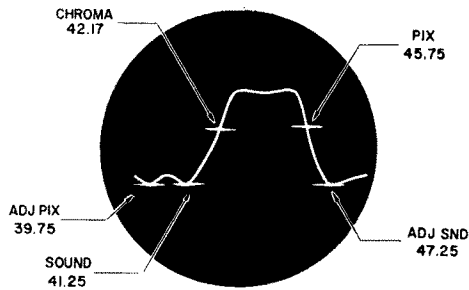


Figure 5.6 Response Curve of Figure 5.5 with Markers Tilted

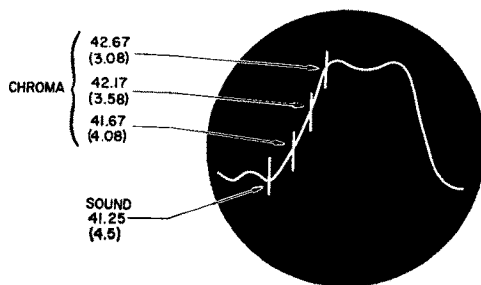
5.3.8 Although all markers can be used simultaneously, use only the markers required for a given alignment procedure to avoid any possible confusion.

5.3.9 When setting up use only the signal level required to obtain the peak-to-peak response amplitude given by the manufacturer. If the oscilloscope being used has a calibrated scale, the peak-to-peak pattern amplitude is read directly because there is unity gain through the signal processing circuits of the 415. If no amplitude limits are given, vary the ATTENUATOR control and observe the response pattern. Set the ATTENUATOR in the middle of the range over which the pattern amplitude varies without distorting.

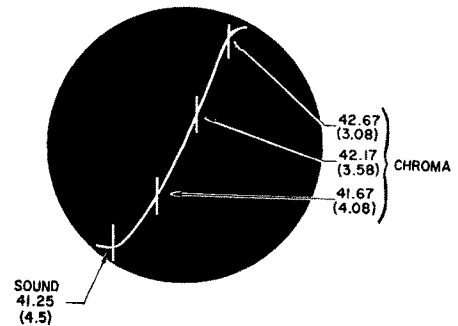
5.3.10 When performing trap and i-f transformer prealignment using the modulated markers always use the minimum signal required to give a satisfactory indication. Using excessive levels may desensitize the receiver and give extremely sluggish tuning indications, particularly on trap alignments. If additional sensitivity is required in trap alignment, the i-f bias voltage may be reduced to increase the i-f gain.

5.3.11 Unless chroma circuit alignment is being performed, keep the CHROMA switch in the OFF position.

5.3.12 The window calibration beside the CENTER FREQUENCY adjustment is a rough guide in presetting the center frequency of the sweep oscillator for a particular alignment procedure.



A. Full I-F Response with Chroma and Sound Markers Added



B. Sweep Width Reduced to Show Only Sound and Chroma Portion of I-F Response

Figure 5.7 Using Sweep Width Control to Enlarge Portion of I-F Response Curve

5.4 **COMPENSATION FOR POOR LOW FREQUENCY RESPONSE OF THE OSCILLOSCOPE**

- 5.4.1 If the operator is using an oscilloscope having poor low frequency response in conjunction with the Model 415, erroneous tilt will be introduced into the response patterns which is a function of the oscilloscope itself rather than being a function of the television receiver which is being aligned. The Model 415 has an internal adjustment which is used, when required, to compensate for poor low frequency response of the oscilloscope. The frequency compensation adjustment (R-99) is located on the printed circuit board inside the Model 415 and is accessible by opening the top cover of the unit. The location of this control is indicated in Figure 5.8. Normally, when no compensation is required this control is set to the extreme left position as viewed from the front of the unit. The Model 415 is shipped from the factory with the control in this position.
- 5.4.2 The most effective way to perform a compensation adjustment is to first obtain an i-f

response curve on the oscilloscope as outlined in the preceding paragraphs. Once the response curve has been obtained switch the horizontal sweep selector of the oscilloscope to an internally generated sweep position, and use a low sweep rate so that several IF response trace curves are repeated on the oscilloscope trace as shown in Figure 5.9A. Use line sync.

- 5.4.3 If the tilt observed at the base line is excessive, slowly adjust compensation control R-99, turning to the right as viewed from the front of the Model 415. until the tilt is corrected as indicated in Figure 5.9B.

**NOTE:**

If no compensation is required or if the Model 415 is to be used with several scopes, for example, in a large television repair shop, this control should be turned to the extreme left (no compensation) position when the test set-up is dismantled or if the 415 is used with another scope. If the Model 415 is to be used continuously with a particular oscilloscope the compensation control may be optimized and left in this position.

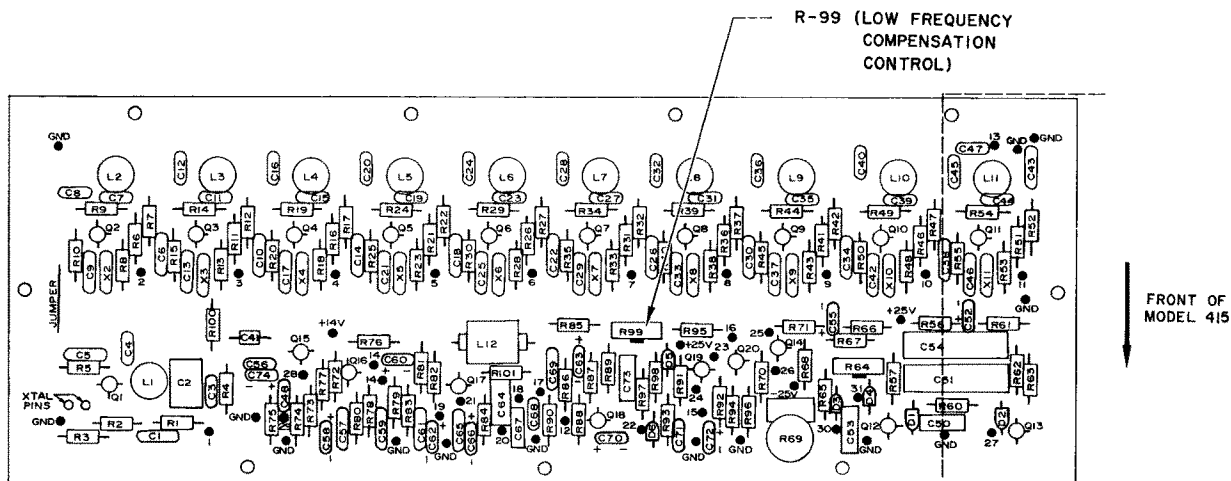


Figure 5.8 Location of Low Frequency Compensation Control (R-99)



A. Presentation of Oscilloscope Having Poor Low Frequency Response

B. Oscilloscope Presentation with Compensated Low Frequency Response

Figure 5.9 Correction of Pattern Tilt Using the Model 415 Low Frequency Compensation Control (R-99)



## 5.5 USE OF 100 KHZ MARKERS IN TELEVISION ALIGNMENT

When used in conjunction with the standard 415 marker frequencies, the 100 KHz marker function provides a useful method of determining frequencies other than the exact crystal-controlled marker frequencies provided in the Model 415. When the 100 KHz MKR switch is turned on, a string of markers with 100 KHz separations is superimposed on the standard marker as shown in Figure 5.10. A crystal reference marker must first be selected; in other words the 100 KHz markers cannot be generated unless used in conjunction with a reference marker in the i-f range. Because the 100 KHz modulation is added to every marker which is being displayed, it should be used with only one marker at a time. First, establish the direction of increasing sweep frequency by using several markers, if necessary, and then, to maintain convention, set the **HORIZ SWEEP** as required to select increasing frequency from left to right on the oscilloscope. Then, using only the reference marker in the frequency region of interest, turn on the 100 KHz markers and reduce sweep width as desired to display the desired sweep range as in Figure 5.10B. This feature is extremely useful in the alignment of Automatic Fine Tuning circuits as outlined in Section 9.2 of this manual.

## 5.6 USING THE SPARE MARKER OSCILLATOR

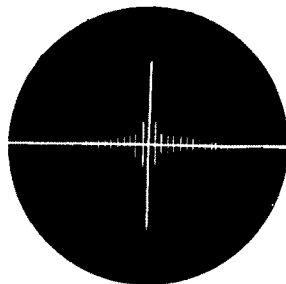
5.6.1 This oscillator stage is energized by the SPARE MKR switch. The primary purpose

of this oscillator stage is to provide an additional crystal-controlled marker oscillator in the event that a user does extensive alignment work in sets which require a special alignment frequency. This is true in trap frequency alignments; for example, some Motorola and Philco sets have trap frequencies of 35.25 MHz and 38.75 MHz respectively.

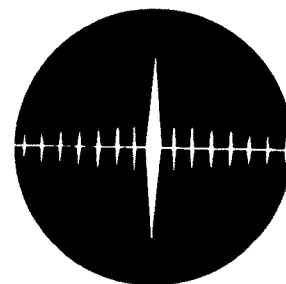
The oscillator circuit will accept a third overtone crystal in the 35 MHz to 50 MHz range. The crystal pin receptacles provided accept a crystal in the HC 25/U holder which has .040" diameter pins. Crystals in other holder configurations must be wired into the circuit. For best frequency correlation, the crystal frequency should be specified with 32 picofarad load capacitance.

## 5.6.2 USING THE SPARE MARKER OSCILLATOR AS A VARIABLE FREQUENCY SOURCE

Although the primary function of the SPARE MKR oscillator has been outlined in paragraph 5.6.1, the variable frequency feature can also be used effectively if a non-standard marker frequency is desired anywhere in the i-f sweep range of the Model 415. The spare marker oscillator can be converted to a variable frequency oscillator by performing minor circuit modifications. Adjustment of the SPARE MKR oscillator for crystal-controlled operation as well as the modifications for operation and calibration as a variable frequency oscillator are covered in the **ADJUSTMENTS AND MAINTENANCE** section of this manual.



A. I-F Marker with 100 KHz Markers Added



B. 100 KHz Marker Display at Reduced Sweep Width

Figure 5.10 Using 100 KHz Markers with I-F Reference Markers

## 6.0 TELEVISION RECEIVER ALIGNMENT USING THE MODEL 415

It is the purpose of this section to outline a standard approach for the various alignment functions. First, it is important that the technician develop confidence in his equipment and procedures. Next he must be able to interpret the response patterns obtained and decide which receiver sections require alignment and the extent of the required alignment. In some repair cases all that is required is that the technician satisfy himself that receiver alignment is not the basic problem (alignment verification) before he proceeds further in analyzing the set. Again, confidence in the procedure is a must.

The technician must also realize that alignment alone is not the universal cure for poor picture quality. Before he evaluates the effect of alignment on the picture quality he must be sure that the convergence, purity, focus and high voltage regulation are properly set, and that the set has been properly degaussed. He should also eliminate the possibility of interference from other test equipment.

The following outline will be used:

- 6.0.1 Connect the Channel 4 or Channel 10 signal from the 415 to the antenna terminals of the television receiver. Set the r-f cable terminating pad switch to the 300-ohm position. Apply bias as required to the tuner, i-f and chroma sections.
- 6.0.2 Observe the i-f alignment at the video detector and the chroma alignment at the output of the bandpass amplifier or at the demodulator input and compare them to the manufacturer's curves.
- 6.0.3 Based on the results obtained in 6.0.2 the technician will decide if touch-up alignment or complete realignment is required. In some cases, Step 6.0.2 will indicate that alignment is not required.
- 6.0.4 A touch-up alignment procedure will be outlined.
- 6.0.5 A detailed alignment procedure will be outlined.
- 6.0.6 Actual alignment procedures of various television receiver manufacturers will be included. These will be accompanied by detailed instructions on how to use the Model 415 to perform the indicated alignment steps.
- 6.0.7 A condensed work guide will be outlined for reference. This guide will include reference to instruction paragraphs in the manual for a particular task as well as a standard operating procedure for setting up and performing the task.

## 6.1 SIMPLIFIED PROCEDURE FOR DIAGNOSING NEED FOR ALIGNMENT

(The test set-up of Figure 5.2 and the set-up instructions of Par. 5.2 apply for the following procedures.)

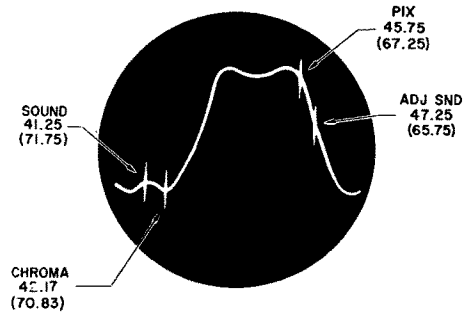
- 6.1.1 Refer to the manufacturer's service manual or the SAMS instructions. Read the complete alignment section. Note the location of all signal injections, bias and signal output points, particularly for the specific alignments to be performed. Note the requirements, if any, for special load blocks or detector circuits. Two i-f load blocks are included with the Model 415 accessories and the PR-151 Demodulator Probe is adequate for all r-f, i-f and video/chroma demodulator requirements. The 75/300  $\Omega$  switch on the r-f cable terminating pad eliminates the need for generator-to-antenna matching networks. A 10 K ohm isolating resistor is included in the direct cable furnished with the 415, so that no isolating resistor is required when connecting to the video detector test point.
- 6.1.2 Check the bias requirements for overall alignment (input at antenna). Preset the 415 bias supplies to the approximate voltage requirements using the VTVM. Connect the bias voltages at the indicated points. An r-f agc and i-f agc bias are usually specified. Use the 0-25 Volt supplies for these applications. If a color set is being evaluated, locate the color killer bias point and apply the specified bias. (This is usually specified in the chroma alignment section.)
- 6.1.3 Connect the direct cable to the specified video detector test point.
- 6.1.4 Connect the PR-151 Demodulator Probe to the chroma bandpass test point. This is usually at the output of the bandpass amplifier. Note the specified position of the color level and brightness controls of the television receiver and set them accordingly.
- 6.1.5 Set the IF - RF - VIDEO ATTENUATOR control to minimum (maximum counterclockwise).
- 6.1.6 With the impedance selector switch of the r-f cable termination in the 300-ohm position, connect to the antenna terminals of the receiver.
- 6.1.7 Set SWEEP WIDTH at maximum. Turn on ADJ PIX (39.75) and ADJ SND (47.25) markers and use MARKER AMPLITUDE control to set marker amplitude as desired. Using the CENTER FREQUENCY adjustment, center the sweep on the oscilloscope screen as in Figure 5.3.
- 6.1.8 Set the channel selector of the television receiver to Channel 4 and set the FUNCTION switch of the 415 to the CH 4 position. (Channel 10 may be used if Channel 4 is not convenient.)

- 6.1.9 Place PROBES switch in DIRECT position and make sure CHROMA switch is in OFF position.
- 6.1.10 Slowly increase the output of the Model 415 by turning the ATTENUATOR control in a clockwise direction until a response pattern of the specified peak-to-peak amplitude is obtained.
- 6.1.11 Turn on the SOUND (41.25), CHROMA (42.17) and PIX (45.75) Markers. Use the fine tuning as required to center the sound marker in the sound notch of the response curve. Refer to Figure 4.16A and 4.16B (Repeated) for incorrect and correct adjustment of the receiver fine tuning.

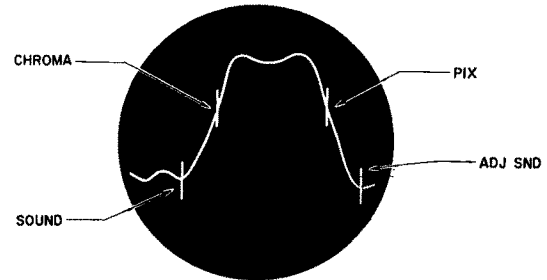
Additional resolution can be obtained by increasing the output of the Model 415 and at the same time increasing the oscilloscope sensitivity so that an enlarged portion of the sound trap region is visible on the oscilloscope as shown in Figure 4.17A (Repeated).

Another effective method of obtaining accurate adjustment of the receiver fine tuning control is to use the horizontal marker display and adjust the fine tuning of the receiver until the sound marker is reduced to minimum width at the bottom of the sound frequency notch as shown in Figure 4.17B (Repeated). Turn on the remaining CHROMA markers (41.67 MHz and 42.67 MHz), the ADJ PIX (39.75 MHz) marker and the 44.00 MHz and 45.00 MHz reference markers. The markers should appear approximately as shown in Figure 4.6. Compare the curve obtained at this point against the manufacturer's.

Slowly reduce the sweep width while using the CENTER FREQUENCY control to keep the sound and chroma markers on the oscilloscope trace as shown in Figure 5.7B (Repeated).

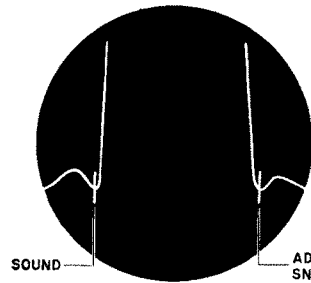


A. Fine Tuning Improperly Adjusted

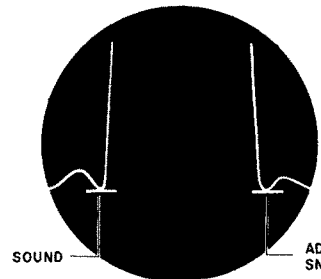


B. Fine Tuning Properly Adjusted Using Sound Marker for Reference

Figure 4.16 (Repeated) Setting Fine Tuning Using Sound Notch of Response Curve. (Channel 4 Marker Frequencies Shown)



A. Enlarged Response Curve Using Vertical Marker Display



B. Enlarged Response Curve Using Horizontal Marker Display

Figure 4.17 (Repeated) Increasing Sound Notch Resolution to Adjust Receiver Fine Tuning Control

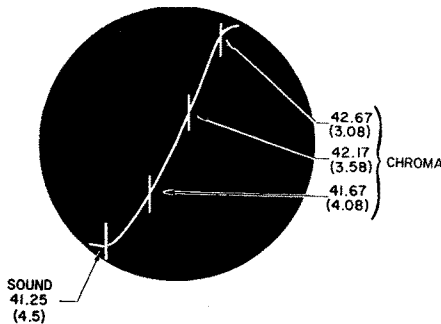


Figure 5.7B (Repeated) Sweep Width Reduced to Show Only Sound and Chroma Portion of I-F Response

6.1.12 Turn the CHROMA switch to the ON position. Notice that the curve is the same as in Figure 5.7B except the direction of sweep is reversed as shown in Figure 6.1.

Many test procedures specify a signal level adjustment at this point prior to checking the overall chroma response. Usually the d-c level at the video detector test point is specified when performing chroma alignment. This is done by connecting the VTVM to the video detector test point through an isolating resistor (10 K) and adjusting the attenuator of the generator to obtain the required d-c level at this test point.

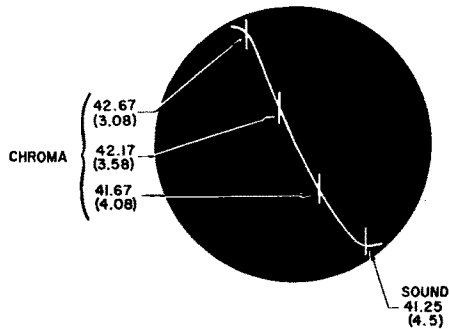


Figure 6.1 Reversal of Sweep when CHROMA Switch is Turned On

6.1.13 Switch the PROBES switch to the DEMOD position. The chroma bandpass response curve should now be observed on the screen with the markers as shown in Figure 4.9 (Repeated). Depending on the output polarity of the video detector diode, the polarity of the chroma response obtained may be inverted with respect to the i-f response curve. If it is wished to view the curve with opposite polarity, place the VERTICAL switch in its alternate position.

6.1.14 Adjust the Model 415 output so that the peak-to-peak value of the chroma response curve is as specified by the manufacturer, if the d-c level adjustment of the video detector is not

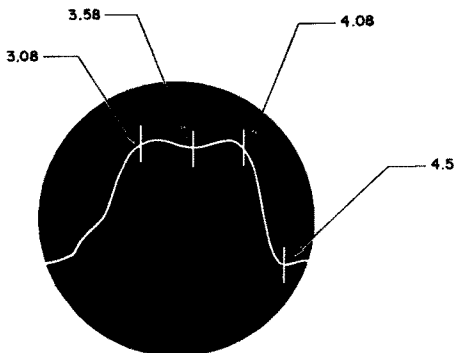


Figure 4.9 (Repeated) Chroma Bandpass Response Curve

specified. If no peak-to-peak value is given, observe the curve as the 415 ATTENUATOR control is varied. Set the 415 output in the center of the range over which the response curve amplitude changes without distorting. Compare the curve obtained with the manufacturer's.

## 6.2 ANALYZING THE RESPONSE CURVES

6.2.1 In the cases above, the technician must now determine if the curves obtained are satisfactory or if the set must be realigned. If it must be realigned, to what extent? Is a touch-up required or a complete realignment?

Figure 6.2A shows a typical manufacturer's i-f response curve and Figure 6.2B shows a typical chroma response curve. Notice that the reference marker locations are shown with given tolerances. This means that the response curves obtained may vary within these limits and still give satisfactory performance.

Figure 6.3A and 6.3B show some allowable variations based on the limits of Figure 6.2. The technician must therefore evaluate the response curves obtained with the allowable tolerances in mind. If the curves fall within the limits indicated, no alignment is required. If it is decided that the set should be aligned, then the extent of alignment must be determined. If the response curves are marginal at several or all points, but are still recognizable, a touch-up alignment can be performed to correct excessive tilts and to restore response levels at various points on the response curves.

The areas to examine aside from tilt across the top of the curve are the areas of the trap frequencies such as sound and adjacent sound, and the pix and chroma markers at the 50 per cent reference points on the curve. If a trap has been detuned toward the center of the response curve, it will pull the overall response downward. For example, if the sound trap were tuned near the chroma frequency, the curve response at the chroma frequency would be as shown in Figure 6.4 below.

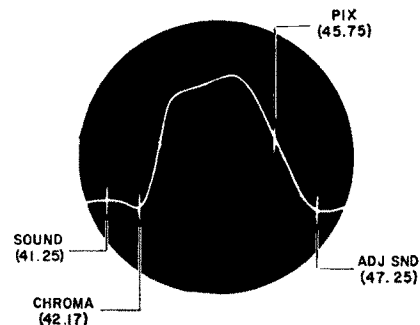
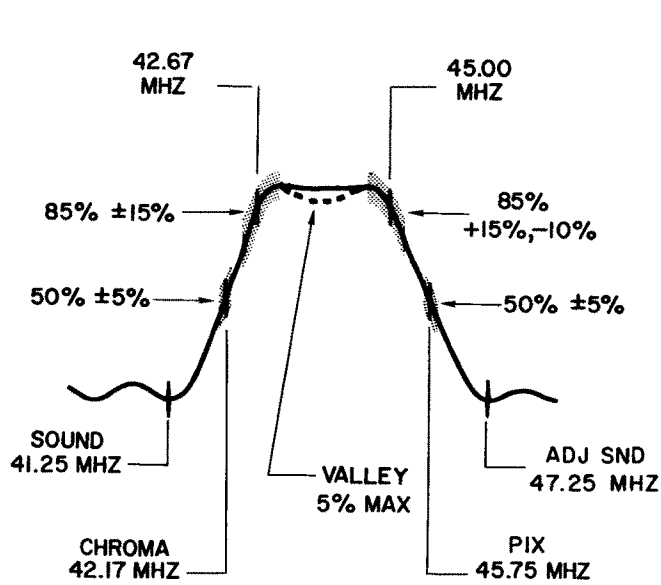
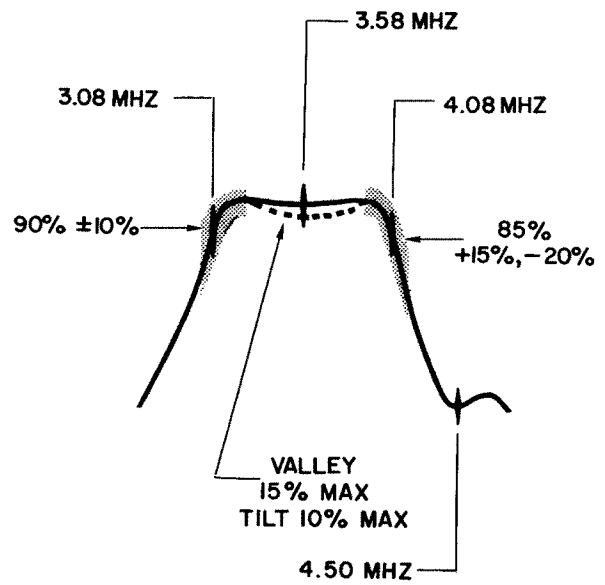


Figure 6.4 I-F Response with Sound Trap Tuned to Chroma Frequency

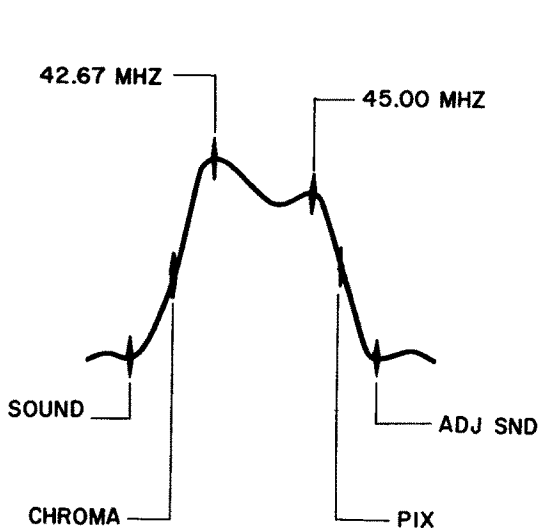


A. Typical I-F Response Curve Showing Tolerance Ranges of Response Levels

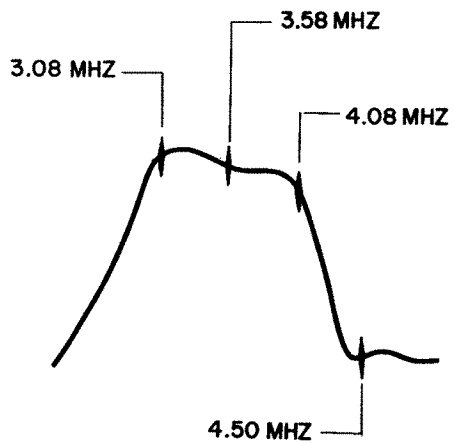


B. Typical Chroma Response Curve Showing Tolerance Ranges of Response Levels

Figure 6.2 Typical Manufacturer's Response Curves with Allowable Variations Indicated



A. I-F Response



B. Chroma Response

Figure 6.3 Response Curves within Limits of Figure 6.2

Reviewing the general description of stagger-tuned circuits in Paragraph 2.2.2.1 and Figure 2.8, the curve will be tilted to one side or the other if the coil which is tuned to the approximate center of the response curve is misaligned. This is demonstrated in Figure 6.5B and 6.5C. Also, if one of the outside tuned circuits were tuned toward the center of the response curve, the curve would peak toward the center with reduced bandwidth and excessive gain as shown in Figure 6.5D.

By realizing the effects of mistuning of traps and other tuned circuits, the technician can usually localize the mistuned circuit if the approximate alignment frequency of each circuit is given by the manufacturer. One method of obtaining this information is to check the alignment procedure thoroughly for prealignment instructions and cross-reference between marker frequencies and the tuned circuits to be adjusted. If a prealignment of traps and transformers is specified by the manufacturer, most or all the information relating to tuned circuits is included in that section. General background information for use in alignment is given in the following paragraphs.

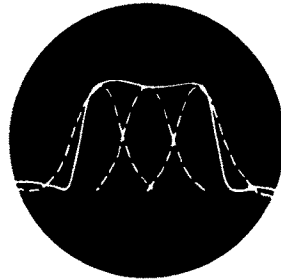
### 6.3 GENERAL ALIGNMENT INFORMATION

Before proceeding with the alignment procedures, some general background information is reviewed to acquaint the technician with existing methods and to point out certain specific points which are important in alignment but are not always emphasized in alignment procedures.

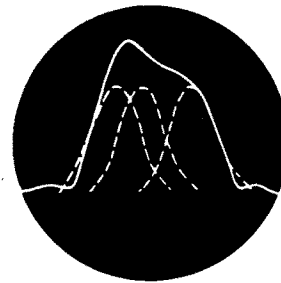
#### 6.3.1 LOCALIZING ALIGNMENT PROBLEMS

By examining the output of the video detector as well as the output of the chroma bandpass amplifier determine which of the circuits is misaligned. For example, if the i-f response curve is satisfactory as compared to the manufacturer's waveforms and if the chroma response curve at the same time is seriously misaligned then it is reasonable to assume that the misalignment is confined to the chroma circuits only.

If, however, the i-f response curve as viewed at the video detector shows signs of severe misalignment and if the chroma response curve is also misaligned, then the problem lies with the i-f alignment portion of the receiver and could also possibly include the chroma portions. If a separate sweep alignment of the chroma circuits is outlined in the test procedure this will immediately give the condition of chroma alignment. If a separate video sweep alignment of the chroma circuits is not provided, the most effective way to localize the problem is first to restore the i-f portion of the television receiver to proper alignment condition and then recheck the chroma section of the receiver. If only the i-f portion of the receiver has been misaligned or is in need of alignment then the realignment of the i-f section will correct both the i-f response and the chroma response or, at most, the chroma section will require only a touch-up alignment.



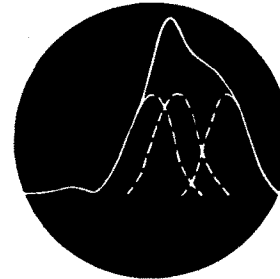
A. Coils Properly Tuned



B. Center Frequency (Tilt) Coil Tuned to Low End of I-F Response

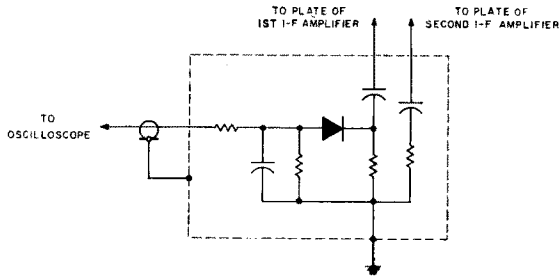


C. Center Frequency Coil Tuned to High End of I-F Response

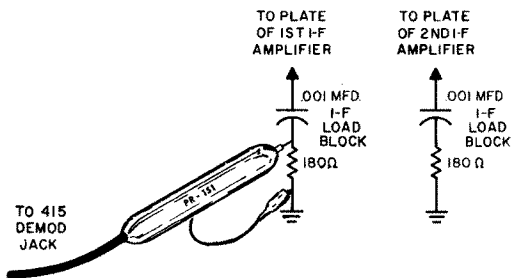


D. Low Side Coil Tuned to Center of I-F Response Curve

Figure 6.5 Typical Response Curves Showing Effects of Misalignment of Tuned Circuits



A. Typical I-F Load Block and Demodulator Assembly Used for Tuner Link Adjustment



B. Using the PR-151 and I-F Load Blocks for Tuner Link Adjustment

Figure 6.6 Detector Load Blocks Required for Tuner Link Adjustment

If, after completing alignment of the i-f section of the television receiver the chroma response still indicates misalignment, then this portion should subsequently be aligned. Finally, if the alignment procedures do not correct the response, the possibility of a defective circuit must be considered.

### 6.3.2 ALIGNMENT METHODS

It is unfortunate that in the television industry at the present time there are many methods of performing complete alignment of i-f and chroma circuits in television receivers. Manufacturers specify methods which sometimes are unique to their particular sets. As mentioned in the introductory portion of the manual the best alignment method for a given receiver is the manufacturer's method. Some of the various methods of alignment will be briefly discussed before describing in detail the use of the Model 415 in performing alignment.

#### 6.3.2.1 TUNER LINK

A complete overall i-f alignment usually involves a pre-alignment of the tuner link. The tuner link is actually the length of cable con-

necting the output of the tuner with the first i-f stage on the television chassis. A tuning adjustment is provided at each end of the tuner link to obtain a desired overall response. One adjustment of the tuner link is located at the tuner proper and is the tuning adjustment of the mixer output circuit. The other tuning adjustment is located at the input to the first i-f amplifier. In television receivers employing vacuum tube i-f amplifiers, the following procedure is generally specified.

The output circuits of the first and second i-f amplifiers are shunted by a capacitor and resistor in series to ground. The capacitor (usually a .001 MFD or .0015 MFD value) is selected to have a low reactance at the i-f frequency of the receiver and the resistor is of a low value to swamp out the selectivity of the output circuit of the first i-f amplifier. Many alignment procedures indicate the use of a single assembly which includes both loading blocks and a detector circuit as shown in Figure 6.6A. The Model 415 accessories include two i-f load block assemblies consisting of a capacitor and a resistor in series. In addition, the PR-151 Demodulator Probe is used for all demodulator functions. Therefore, the diagram of Figure 6.6B indicates a circuit equivalent to that shown in Figure 6.6A. Because the output circuit of the first i-f amplifier has been swamped by the addition of the load block, the demodulated response observed across the load resistor (in this case being 180 ohms) is essentially the overall response from the mixer output circuit to the input of the first i-f amplifier or, actually the overall response of the tuner link. Figure 6.7 indicates a typical tuner link response curve with the significant markers added. In most cases the link adjustment on the tuner affects the high frequency side of the response curve and the adjustment at the i-f input affects the low frequency (42.17 MHz) side.

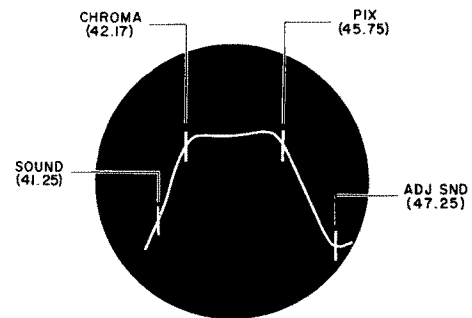


Figure 6.7 Tuner Link Response Curve with Markers Added

### 6.3.2.2 I-F ALIGNMENT

Following completion of the trap and tuner link adjustments there are essentially two methods of completing the balance of the i-f alignment. The first of these methods is to use modulated marker frequencies, taken one at a time, to prealign all tuned circuits in the i-f strip (This procedure is sometimes called AM alignment.). In other words, each tuned circuit is preset to a frequency specified by the manufacturer. Conventional sweep alignment is then used for final adjustment of the i-f circuits using reference markers (post injection). This method of pre-alignment of all tuned circuits in the i-f strip is superior because once all the coils have been pre-aligned to specific frequencies the final alignment using sweep frequencies is greatly simplified because all that is required is a slight touch-up of all coils which have been previously spot-aligned. Another advantage of the pre-alignment method is that the operator is given the tuned frequency of each circuit in the i-f strip and there is no possibility of confusion on the part of the operator in deciding which portion of the i-f response curve is affected by a particular tuning adjustment. The alternate method is that once having aligned the traps and the tuner link, the balance of the i-f is aligned using conventional sweep alignment and adjusting the balance of the tuned circuits as required to obtain the desired overall response curve.

An extensive review of the alignment procedures of many older television sets as well as procedures for new sets currently appearing on the market indicate that the following frequency and gain distributions apply. First the output tuned circuit of the first i-f amplifier stage is tuned toward the upper end of the i-f passband, and is used in sweep alignment to locate the 45.75 (pix carrier) marker on the i-f response curve. The output tuned circuit of the second i-f amplifier is tuned to the lower end of the i-f bandpass and adjustment of this transformer affects this end of the i-f response curve with respect to the 42.17 MHz (chroma carrier) marker.

The output section of the third i-f amplifier usually consists of a double tuned coil assembly. One of these coils, usually the top coil, is used for trapping the sound carrier (41.25 MHz) and the lower coil or bottom slug, as the adjustment is usually called, is tuned to the center of the i-f bandpass or to approximately 44 MHz. Tuning of this coil affects the amount of tilt obtained in the i-f response curve.

### 6.3.2.3 CHROMA ALIGNMENT

In alignment of the chroma portions of the receiver several methods are used. One meth-

od is to pre-align the bandpass amplifier output using direct video sweep applied at the grid (or base, if solid state) of the bandpass amplifier. The output of the bandpass amplifier is observed using a demodulator circuit. Some manuals show a schematic diagram of a chroma demodulator which is to be constructed and used in observing the chroma response curve. The PR-151 Demodulator Probe which is supplied with the Model 415 is capable of performing this function and should be used.

Once a bandpass amplifier circuit has been aligned, video sweep modulation or an equivalent sweep signal is applied at the mixer or at the antenna and the overall response of the chroma circuit is observed at the output of the bandpass amplifier.

Also included in most alignment procedures for the chroma circuitry is the adjustment of the chroma takeoff coil. This coil is located at the input to the first chroma amplifier or, if only one chroma amplifier stage is used, it is located at the input to the bandpass amplifier. Alignment of this takeoff coil is done either in conjunction with alignment of the chroma bandpass transformer or as a separate alignment step.

### 6.3.2.4 RECORDING ALIGNMENT REFERENCE INFORMATION

The preceding comments on i-f alignment are intended as a guide to the user in analyzing new or unfamiliar alignment procedures. As the user accumulates alignment experience on the television receivers of various manufacturers he will recognize that many similarities exist among the various procedures. Certain marker and reference frequencies are continually repeated through alignment procedures. In addition, the user should analyze each alignment procedure with reference to the circuit schematic. He should also make brief notes on new sets which he encounters. These notes at the minimum should identify the various tuned circuits in the i-f strip and also note which markers are observed while adjusting the various tuned circuits. Bias points and injection and monitoring test points should also be noted. Pitfalls should be logged to be avoided in the future. If this procedure is maintained over a period of time the user will soon begin to recognize the similarities in i-f design with respect to frequency and gain distribution. In addition, he will observe that all current models of a particular manufacturer have the same alignment procedure, or, if they vary, it is only with minor differences. Faithful adherence to the type of note taking outlined here will produce a surprising acceleration in the alignment process.



## 7.0 ALIGNMENT TOUCH-UP PROCEDURES

### 7.1 PRELIMINARY

When the evaluation of curves obtained in section 6.1 indicate that the curves are recognizable but marginal on response limits and possible trap alignment, the following must first be done.

- 7.1.1 Determine from the manufacturer's or SAMS procedure whether alignment of the i-f section is performed by injecting the sweep signal at the antenna (r-f sweep) or at the mixer (i-f sweep). The advantage of alignment by injecting at the mixer test point is that the fine tuning control of the tuner is no longer a consideration. Tuner bias is then set at a cut-off value to prevent interference from local television channels.
- 7.1.2 Determine the injection point for introducing spot frequency markers for prealignment of the i-f traps and other tuned circuits. This is usually a mixer test point and is also the sweep frequency injection point when alignment of the i-f stages is performed by injecting at the mixer.
- 7.1.3 When the mixer test point is specified for spot frequency injection for prealignment purposes only, do not use it for i-f sweep injection. The test procedure will indicate all injection points for various alignment tasks.
- 7.1.4 In reviewing the location and adjustment of various tuned circuits, note that the location of the tuning slug with respect to the chassis or circuit board is specified. Always observe the instructions in this regard (the importance of tuning slug locations in tuned circuits is reviewed in Paragraph 2.2.2). Another precaution regarding tuned circuits, particularly in older sets, is to beware of broken coil forms or excessively loose tuning slugs. This is indicated by sudden changes in observed response curves when the tuning tool is inserted or withdrawn from the tuning slug. This defect must be corrected before completing alignment because any vibration or shock can produce a change in the alignment curves.

### 7.2 TRAP ADJUSTMENTS

If trap alignment is indicated or is suspected, proceed as follows. (Use test set-up procedure of Par. 5.2 and set-up of Figure 5.2):

- 7.2.1 Locate spot frequency (marker) injection point. This is usually a test point in the mixer area of the tuner.
- 7.2.2 Connect direct probe of Model 415 to the video detector test point.
- 7.2.3 Place PROBES switch in DIRECT position.

- 7.2.4 Apply i-f and r-f agc bias voltages as specified for sweep alignment. This will enable you to switch between the MOD MKR and IF positions of the FUNCTION switch as required to see the effect on the i-f response of adjusting the traps.

- 7.2.5 Place FUNCTION switch of 415 in MOD MKR position.

- 7.2.6 Connect 415 r-f cable to the signal injection point of the mixer. Use the 75-ohm termination.

#### NOTE:

In selection of marker frequencies for trap alignment select only one marker at a time. Always use minimum signal level required to give satisfactory tuning indication.

- 7.2.7 Select the SOUND (41.25) marker frequency. Use maximum oscilloscope gain. Adjust the 415 ATTENUATOR and observe the oscilloscope for a sine-wave pattern (400 Hz). Set the 415 output in the middle of the range over which the detected 400 Hz signal varies with the setting of the ATTENUATOR. A typical waveform is shown in Figure 7.1. The 400 Hz is not synchronized to the sweep; therefore it may not be stationary on the oscilloscope trace.

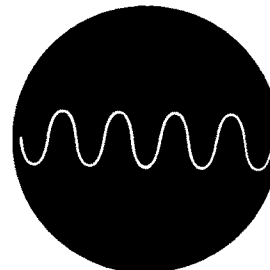


Figure 7.1 400 Hz Video Detector Output When Using Modulated Markers

- 7.2.8 Locate the sound (41.25 MHz) trap adjustments using the manufacturer's or SAMS instructions and adjust the trap for minimum indicated 400 Hz on the oscilloscope. This adjustment is usually in the last i-f transformer and is one of two coils in the same can. Sometimes a potentiometer adjustment is specified in addition to the coil adjustment to minimize the response at 41.25 MHz. Once again, verify that the proper slug is being adjusted and that the desired indication is obtained with the slug in the proper final position. Turn off SOUND (41.25 MHz) marker.

#### NOTE:

In the adjustment of traps in which a coil and potentiometer are involved, the potentiometer should never be set at either extreme of its adjustment range.

7.2.9 Turn on ADJ SND (47.25 MHz) marker. Use the level adjusting procedures of the preceding paragraph to obtain a satisfactory indication on the oscilloscope.

7.2.10 Tune the indicated adjacent sound (47.25 MHz) trap coil on the receiver chassis. This adjustment is usually located at the input circuit of the first i-f stage. Sometimes a potentiometer adjustment is specified together with the coil adjustment, or a double tuned trap is used. Alternately adjust for minimum indicated 400 Hz on the oscilloscope, using the minimum 415 output required to give a usable scope indication. Turn off ADJ SND (47.25 MHz) marker.

7.2.11 If an adjacent pix (39.75 MHz) trap adjustment is included in the alignment instructions, perform the adjustment as in the preceding paragraphs. The adjacent pix trap is usually located at the first i-f stage input circuit. Turn off the ADJ PIX (39.75 MHz) marker upon completion of the adjustment.

7.2.12 Place the FUNCTION switch of the 415 in the IF position. Turn on the ADJ PIX (39.75 MHz) and ADJ SND (47.25 MHz) markers. Set the SWEEP WIDTH control to max. and center the trace on the oscilloscope using the CENTER FREQUENCY control. Adjust the ATTENUATOR until the specified receiver i-f response curve amplitude is obtained.

### 7.3. I-F RESPONSE TILT ADJUSTMENT, MIXER INJECTION

With the traps properly adjusted the remaining touch-up should be in correcting excessive tilt in the i-f response. If the i-f sweep injection point is at the mixer, the set-up connections of the TRAP ADJUSTMENTS section can be used. Proceed as follows:

7.3.1 In the manufacturer's alignment procedure, note which i-f coil is tuned to the center of the i-f range (around 44 MHz). One of these is usually specified as a tilt adjustment. Usually the last i-f coil assembly combines the sound (41.25 MHz) trap adjustment and the tilt coil adjustment. (Refer to Figure 6.5 of Section 6.2 for the effect of a center-tuned coil on overall response of stagger-tuned circuits).

7.3.2 Observing the response pattern on the oscilloscope, adjust the coil which affects the tilt so that the top of the i-f curve is horizontal.

7.3.3 Turn on the CHROMA (42.17) marker and the PIX (45.75) marker. They should fall within the tolerance limits specified in the alignment procedure. If they do not, proceed to the next step.

7.3.4 Additional tilt correction can be obtained by minor adjustment of the i-f coils which affect the height of the high-frequency and low-frequency ends of the i-f response curve. These are specified in either the spot frequency alignment section or the overall sweep alignment section.

### 7.4. CHROMA CIRCUIT ADJUSTMENT

The touch-up in this section is limited to tilt correction of the chroma response.

7.4.1 With the i-f response obtained in Sec. 7.3 above, turn on the SOUND (41.25) and CHROMA (41.67, 42.17, 42.67) markers and decrease the sweep width, at the same time using the CENTER FREQUENCY control to center the four markers on the oscilloscope.

7.4.2 Place the CHROMA switch in the ON position and recenter the oscilloscope trace if required.

#### NOTE:

In performing adjustments in the chroma circuits, particularly the bandpass amplifier transformer, the signal level at the video detector is usually specified by the manufacturer. Alignment procedures usually specify that the level of signal injected at the mixer test point be adjusted so that a certain d-c voltage is obtained at the video detector test point. This level is set by using the VTVM to monitor the d-c level at the video detector test point while adjusting the signal level applied to the mixer input. With proper bias levels set in the i-f and chroma circuits as specified by the manufacturer no further adjustment of signal levels should be required to produce the proper chroma level in the chroma portions of the television receiver. Some procedures require that the input level be adjusted to produce a specified peak-to-peak waveform at the chroma circuit test point, this usually being the output of the bandpass amplifier. If neither a signal level or a peak-to-peak chroma response amplitude is specified the following must be done:

Observe the chroma response curve and adjust the signal input from the Model 415 so that the amplitude of the chroma response curve is centered in a range over which the amplitude can be varied without distortion or indications of overload.

7.4.3 Place the PROBES switch in the DEMOD position and observe the chroma response curve.

7.4.4 Perform the indicated chroma circuit adjustments to correct the curve tilt or to bring it within tolerances. The tilt adjustment is usually one of the two slugs in the chroma bandpass transformer of the television receiver.

### 7.5. TILT ADJUSTMENTS, ANTENNA INJECTION

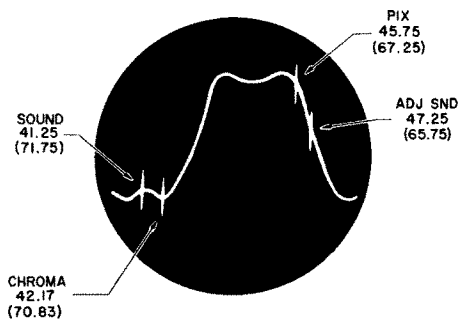
If the specified signal injection point for i-f alignment is not the mixer, the signal must be injected at the antenna terminals.

7.5.1 Place the 415 FUNCTION switch in the CH 4 position.

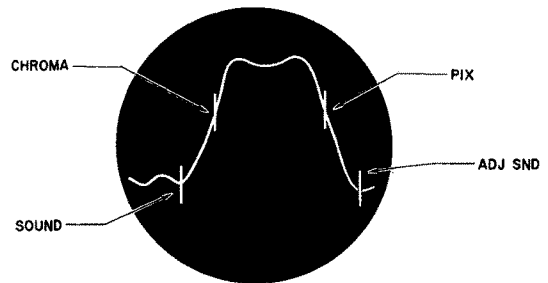
7.5.2 CHROMA switch in OFF position.

7.5.3 Place the impedance switch of the r-f cable terminating pad in the 300  $\Omega$  position and connect to the antenna terminals.

- 7.5.4 Apply proper r-f agc and i-f agc bias voltages, as well as the required bias in the chroma section.
- 7.5.5 With PROBES switch in the DIRECT position, turn on the ADJ PIX (39.75) and ADJ SND (47.25) markers and center the sweep on the oscilloscope using the CENTER FREQUENCY control and using maximum sweep width.
- 7.5.6 Increase the 415 output until a response curve of the proper amplitude is obtained.
- 7.5.7 Turn on the SOUND (41.25) marker and, using the fine tuning control of the television receiver, locate the response curve so that the sound marker falls in the sound notch of the response curve.  
(See Figure 4.16A and B, repeated)  
Increase scope gain and Model 415 output as required for additional resolution as shown in Figure 4.17. Restore scope and 415 levels.
- 7.5.8 When the above steps are performed the tilt adjustments for the i-f response can be performed.
- 7.5.9 With the SOUND (41.25) and the three CHROMA (41.67, 42.17, 42.67) markers on, reduce sweep width and center the chroma portion of the response curve.
- 7.5.10 Place CHROMA switch to ON position.
- 7.5.11 Place PROBES switch in DEMOD position. Perform the required signal level adjustments as outlined in Par. 7.4.2.
- 7.5.12 Adjust 415 output as required to obtain specified peak-to-peak chroma response amplitude.
- 7.5.13 Perform the required tilt correction adjustments.

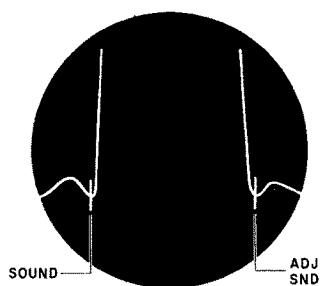


A. Fine Tuning Improperly Adjusted

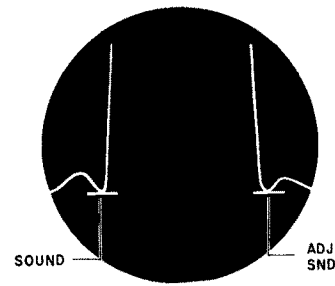


B. Fine Tuning Properly Adjusted Using Sound Marker for Reference

Figure 4.16 (Repeated) Setting Fine Tuning Using Sound Notch of Response Curve. (Channel 4 Marker Frequencies Shown)



A. Enlarged Response Curve Using Vertical Marker Display



B. Enlarged Response Curve Using Horizontal Marker Display

Figure 4.17 (Repeated) Increasing Sound Notch Resolution to Adjust Receiver Fine Tuning Control

## 8.0 COMPLETE I-F AND CHROMA ALIGNMENT PROCEDURE USING THE MODEL 415

The set-up instructions of Par. 5.2 and Figure 5.2 should also be used in this section.

Much of the alignment touch-up procedure information outlined in Section 7.3 and the trap adjustment information of Section 7.2 is also applicable in the complete i-f and chroma alignment procedures. Some of the information will be repeated in this section to maintain the continuity of the instructions. Read the general alignment information of Section 6.3 for additional background information, if you have not already done so.

### 8.1 TRAP ALIGNMENT USING MODULATED MARKERS

8.1.1 Determine the injection point for introducing spot frequency markers into the i-f. This injection point is usually a mixer test point and is indicated on the tuner drawing or photograph.

8.1.2 Determine from the alignment instructions the frequency and number of traps to be prealigned. The standard trap frequencies are the adjacent pix carrier (39.75 MHz), the sound carrier (41.25 MHz) and the adjacent sound carrier (47.25 MHz). Several manufacturers have an additional trap frequency over and above those listed here. For example, some Motorola receivers have a trap frequency at 35.25 MHz and some Philco receivers have a trap frequency at 38.75 MHz. Determine the location of the trap circuit, both physically on the television chassis as well as the location on the schematic diagram. All traps excepting the sound trap (41.25 MHz) are located at the input to the first i-f amplifier.

The sound trap circuit is usually located in the last i-f transformer or in the output circuit of the last i-f stage.

8.1.3 Locate the bias points and preset the bias supplies of the Model 415 to specified values making sure that the polarities are correct.

8.1.4 Connect the bias leads to the required bias points and recheck the bias values using the VTVM.

8.1.5 Turn off all markers of the Model 415 and place the FUNCTION switch in the MOD MKR position.

8.1.6 Connect the output cable of the Model 415 to the signal injection point of the tuner.

8.1.7 Connect the direct cable of the 415 to the video detector test point. A 10K-ohm resistor is provided in the "hot" lead of the direct cable. The 10K-ohm resistor specified in alignment procedures for isolation is not required.

8.1.8 Perform the trap alignment by selecting one marker frequency at a time and adjusting the 415 ATTENUATOR to obtain an indication at the video detector test point. A recovered 400 hz sine wave will be observed on the oscilloscope. The 400 hz modulation is not synchronized to the sweep voltage and, therefore, may not be stationary on the oscilloscope trace. Keep the ATTENUATOR level as low as possible while still maintaining a usable level on the oscilloscope. The oscilloscope may be used at maximum gain to increase the overall sensitivity of the measuring system. Trap circuits are always aligned for a minimum indication as observed on the oscilloscope.

8.1.9 Repeat the procedure of the preceding step for alignment of all specified trap frequency circuits. Usually one or two of the trap frequency adjustments involve the adjustment of a tuned circuit and a potentiometer.

Both the coil and potentiometer are alternately adjusted for minimum oscilloscope indication. Remember that the potentiometer must not be adjusted to either extreme of its adjustment range.

Upon completion of trap alignment turn off all markers.

### 8.2 PRE-ALIGNMENT OF I-F BANDPASS COILS AND TRANSFORMERS (When Specified)

Some alignment procedures specify a pre-tuning of all i-f bandpass coils and transformers as well as the traps as previously outlined. The procedure is identical to the trap adjustment except that in this case each circuit is tuned for a maximum output as indicated on the oscilloscope using modulated markers. Once again, remember that only one marker at a time may be used. Always turn off the marker when alignment of the particular coil or transformer is complete.

### 8.3 TUNER LINK ALIGNMENT (When Specified)

8.3.1 Turn off the television receiver.

8.3.2 Connect the load block provided with the Model 415 accessories between the plate of the first i-f amplifier and ground with the capacitor at the plate end and the resistor at the ground end. Connect the second load block between plate and ground of the second i-f amplifier in a similar manner.

8.3.3 Connect the PR-151 Demodulator Probe to the junction of the resistor and capacitor of the first load block and connect the black lead of the probe to ground. Connect the PR-151 cable to the DEMOD PROBE jack of the Model 415. Place the PROBES switch in the DEMOD position.

8.3.4 Set the FUNCTION switch of the 415 to the I-F position. Set the SWEEP WIDTH control to maximum (fully clockwise.)

- 8.3.5 Recheck instructions for bias requirements and apply accordingly. Turn on the ADJ PIX (39.75 MHz) marker and the ADJ SND (47.25 MHz) marker, and, using the CENTER FREQUENCY control, center the sweep on the oscilloscope pattern. Adjust marker amplitude as required using the MARKER AMPLITUDE control. Make sure that the MARKER DISPLAY switch is in the VERT position.
- 8.3.6 Turn on the receiver and allow several minutes warm-up time. Adjust the RF - IF - VIDEO ATTENUATOR for a specified signal level observed on the oscilloscope. Turn on the PIX (45.75) and the CHROMA (42.17) markers.
- 8.3.7 Adjust the mixer output tuning adjustment together with the i-f input adjustment of the tuner link to obtain the required bandwidth for the tuner link response. As previously mentioned the adjustment at the mixer affects the response at the high frequency end (45.75 MHz) of the curve and the adjustment at the i-f end of the link affects the low frequency (42.17 MHz) response. A typical tuner link response curve is shown in Figure 6.7 (repeated). As indicated, the significant marker positions are the pix (45.75 MHz) and the chroma center frequency (42.17 MHz). An aid in obtaining the required response is to insert a hex tuning tool into each adjustment (tuner output and i-f input) and alternately adjust these coils while observing the response on the oscilloscope.
- 8.3.8 Upon completion of the tuner link adjustment, turn off the television receiver and remove the load blocks and the PR-151 probe.
- 8.4.1 Read the complete alignment instructions. Note the location of the signal injection point, the bias requirements and the output monitoring point. The output will be the video detector test point which was used in the preceding sections. Review all bias requirements for i-f agc, r-f agc and for the chroma portion of the receiver.
- 8.4.2 Preset the bias values to the levels specified and make sure that polarities are correct before connecting to the receiver.
- 8.4.3 Connect the direct cable of the 415 to the video detector test point.
- 8.4.4 Connect the PR-151 Demodulator Probe to the Chroma bandpass test point. Note the recommended position of the color level and brightness controls of the television receiver and preset them accordingly.
- 8.4.5 Set the RF-IF-VIDEO ATTENUATOR control to minimum.
- 8.4.6 Set the SWEEP WIDTH control to maximum. Turn on the ADJ PIX (39.75) and ADJ SND (47.25) markers and use the MARKER AMPLITUDE control to set marker size. Using the CENTER FREQUENCY adjustment center the sweep on the oscilloscope screen.
- 8.4.7 If signal injection for i-f alignment is specified at the antenna terminals of the receiver, place the channel selector of the television receiver to Channel 4 and connect the r-f cable of the 415 to the antenna terminals of the receiver. If i-f sweep injection at the mixer test point is specified in the alignment procedure, connect the r-f cable of the Model 415 to the mixer test point. Set the channel selector of the television receiver to the channel specified when performing i-f alignment with signal injection at the mixer test point. The 75-ohm switch position of the r-f cable terminating pad is used for this procedure. The terminating pad of the r-f cable includes built-in d-c blocking capacitors for both the 75-ohm and 300-ohm switch positions. The terminating resistors and blocking capacitors usually shown in alignment procedures for terminating the signal generator cable are therefore not required.

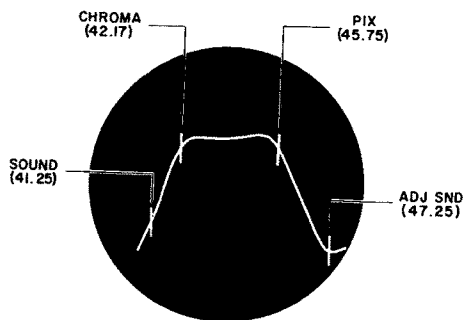


Figure 6.7 (Repeated) Tuner Link Response Curve with Markers Added

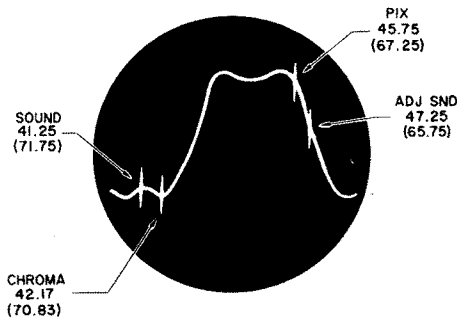
#### 8.4 SWEEP ALIGNMENT OF THE I-F STAGES USING THE MODEL 415

The test set-up of Figure 5.2 and the set-up instructions of Section 5.2 apply for the following procedures.

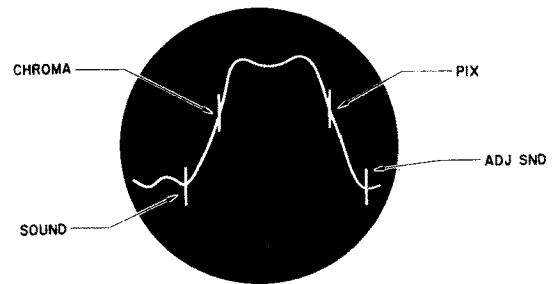
- 8.4.8 Place the PROBES switch in the DIRECT position and make sure the CHROMA switch is in the OFF position.
- 8.4.9 Turn on the television receiver and allow a suitable warm-up. Recheck the bias values using the VTVM and readjust, if required, to the specified values.
- 8.4.10 Slowly increase the output of the Model 415 by turning the ATTENUATOR control in a clockwise direction until a response pattern of the specified peak-to-peak amplitude is obtained.

8.4.11 Turn on the SOUND (41.25), CHROMA (42.17) and PIX (45.75) markers. If antenna signal injection is being used, use the fine tuning of the receiver as required to center the sound marker in the sound notch of the response curve. Refer to figures 4.16A and 4.16B (Repeated), for incorrect and correct adjustment of the receiver fine tuning. If all traps have been prealigned, the sound notch in the response curve will be evident regardless of the overall response of the i-f stages at this point. Additional resolution can be obtained by increasing the output of the 415 and at the same time increasing the oscilloscope sensitivity so that an enlarged portion of the sound trap is visible on the oscilloscope as shown

in Figure 4.17A (repeated). Another effective method of obtaining accurate adjustment of the receiver fine tuning control is to use the horizontal marker display and adjust the fine tuning until the sound marker is reduced to minimum width at the bottom of the sound frequency notch as shown in Figure 4.17B (repeated). If alignment of the i-f is being performed by signal injection at the mixer test point, the receiver fine tuning adjustment need not be considered. The i-f response curves obtained will be independent of the tuner. Restore all levels to obtain the required response display and peak-to-peak amplitudes.

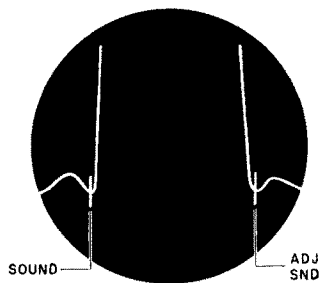


A. Fine Tuning Improperly Adjusted

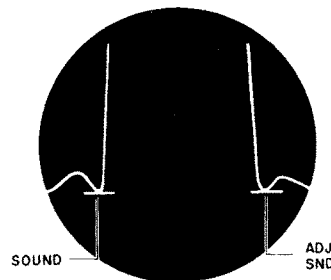


B. Fine Tuning Properly Adjusted Using Sound Marker for Reference

Figure 4.16 (Repeated) Setting Fine Tuning Using Sound Notch of Response Curve. (Channel 4 Marker Frequencies Shown)



A. Enlarged Response Curve Using Vertical Marker Display



B. Enlarged Response Curve Using Horizontal Marker Display

Figure 4.17 (Repeated) Increasing Sound Notch Resolution to Adjust Receiver Fine Tuning Control

- 8.4.12 Adjust the first, second and third i-f transformer circuits as outlined by the manufacturer. In some instances the procedure will give three reference markers, usually 42.17 MHz, 45.75 MHz and a 44 MHz sweep center frequency marker. If no order of adjustment is given, keep in mind that the output circuit of the first i-f amplifier adjusts the response of the i-f with respect to the 45.75 MHz marker and that the output coil of the second i-f amplifier adjusts the response of the i-f curve with respect to the 42.17 MHz marker. The output coil of the third i-f amplifier is tuned to the center of the passband and is adjusted for tilt correction. Be sure that the proper slug is adjusted in the third i-f transformer, because one coil performs the i-f tilt correction and the other coil is the sound trap adjustment (41.25 MHz).

#### NOTE

In many procedures the term or phrase "Set the marker height . . ." is used extensively when doing alignment work. This phrase may be misleading because, actually, the marker height on the response curve is not adjustable. The marker is simply a reference frequency which is independent of response amplitude or sweep width. In fact, without a response curve observed on the oscilloscope, the markers, being post injected, are still visible on the oscilloscope base line. When the term (Set the marker height) is used, actually what is being performed is that the response of the i-f stage is being adjusted so that at a particular marker frequency the response is at some percentage down from the maximum. For example, when the operator is instructed to set the height of the (42.17 MHz) marker at 50% amplitude on the i-f response curve by adjustment of the second i-f transformer, actually what is being done is this: The second i-f transformer is adjusted to alter the i-f response curve so that at 42.17 MHz the response is 50% of maximum.

- 8.4.13 After completion of the i-f alignment, recheck the position of the sound marker, especially if pronounced readjustment of the third i-f transformer or coil has been required to restore proper alignment.
- 8.4.14 After obtaining the desired i-f response so that the 42.17 MHz marker and the 45.75 MHz markers are located as specified, turn on the 41.67 MHz marker and the 42.67 MHz marker. These markers, together with the 42.17 MHz marker, define the response portion of the i-f curve on which the chroma information is carried. The marker should be positioned as indicated in the manufacturer's response curve drawings. The i-f alignment instructions outlined here apply whether the signal is injected at the mixer test point or at the antenna terminals.

## 8.5 CHROMA CIRCUIT ALIGNMENT

- 8.5.1 Upon completion of the i-f alignment, recheck the chroma alignment section of the manufacturer's procedure and verify that the biases are properly set and that the demodulator probe (PR-151) is properly connected.

### 8.5.2 BANDPASS AMPLIFIER ALIGNMENT USING DIRECT VIDEO SWEEP

- 8.5.2.1 Place the FUNCTION switch of the Model 415 to the VIDEO position. Set the ATTENUATOR control to minimum. Connect r-f cable to specified injection point.

- 8.5.2.2 Turn on the SOUND (41.25/4.5 MHz) marker and the three CHROMA markers (41.67/4.08, MHz, 42.17/3.58 MHz and 42.67/3.08 MHz).

- 8.5.2.3 Using the SWEEP WIDTH control and the CENTER FREQUENCY control reduce sweep width and center as required so that the sound and chroma markers occupy approximately 70 per cent of the total oscilloscope sweep.

- 8.5.2.4 Place the PROBES switch in the DEMOD position.

- 8.5.2.5 Adjust the ATTENUATOR control for the specified peak-to-peak amplitude as observed on the oscilloscope.

- 8.5.2.6 Adjust the bandpass transformer as required to obtain the desired overall response. Normally the bandpass transformer consists of two tuning adjustments. One of the tuning slugs adjusts the band width of the transformer and the other adjusts the center frequency of the transformer. The bandwidth adjustment is used to position the 3.08 MHz and 4.08 MHz markers on the curve and the tuning adjustment performs the tilt adjustment as required.

Direct video sweep alignment is done prior to performing final adjustment of the chroma tuned circuits using video sweep modulation or an equivalent method. Upon completion of the chroma prealignment overall chroma circuit alignment is performed by injecting either at the mixer test point or at the antenna terminals (Section 8.5.3).

- 8.5.2.7 Remove the r-f cable from the input to the chroma bandpass amplifier.

### 8.5.3 CHROMA ALIGNMENT USING SIGNAL INJECTION AT THE ANTENNA TERMINALS OF THE RECEIVER OR AT THE MIXER TEST POINTS

Chroma alignment is usually performed by either of these methods. The obvious advantage is that once all probes and biases have been connected to the television receiver the

operator may proceed directly from the i-f alignment into the chroma alignment without any additional connections or disconnections at the receiver. The following outline will demonstrate this procedure.

- 8.5.3.1 Connect the r-f cable of the 415 either to the mixer test point or the antenna terminals depending upon the signal injection point specified. Set the impedance switch of the r-f cable terminating pad as required, this being 75 ohms if the mixer injection point is used or 300 ohms if the antenna terminals are used.
- 8.5.3.2 Readjust sweep width to display the complete i-f response curve.
- 8.5.3.3 Turn on the SOUND (41.25) and the three CHROMA markers (41.67, 42.17 and 42.67). Set marker amplitude as required.
- 8.5.3.4 Using the SWEEP WIDTH control and the CENTER FREQUENCY control reduce the sweep and recenter as required so that the sound and chroma portion of the i-f response curve is centered on the oscilloscope as indicated in Figure 5.7B (Repeated).
- 8.5.3.5 Place the CHROMA switch in the ON position. The direction of sweep is now reversed as shown in Figure 6.1 (Repeated).

8.5.3.6 The signal level must now be adjusted prior to checking the overall chroma response. Usually the d-c level at the video detector test point is specified when performing chroma alignment. If this voltage is not specified, adjust signal input to obtain the recommended peak-to-peak response amplitude at the chroma test point.

8.5.3.7 Set the PROBES switch in the DEMOD position. The overall chroma response curve should now be present on the oscilloscope. Note the general response of the curve and the position of the markers. If the overall chroma response curve is seriously misaligned so that the general shape is not recognizable it may be necessary to identify the individual markers by turning each marker on and off. The 3.08 MHz marker should be at the left of the oscilloscope trace and the sound (4.5 MHz marker) should be at the right end of the oscilloscope trace.

**NOTE**

An internally generated 3.58 MHz marker or "birdie" may be visible on the response curve. This is caused by the 3.58 MHz oscillator of the television receiver. In some cases a low frequency beat may be produced between this birdie and the 3.58 MHz marker provided by the Model 415. This beat can be eliminated by turning off the 415 marker and using the internally generated birdie marker.

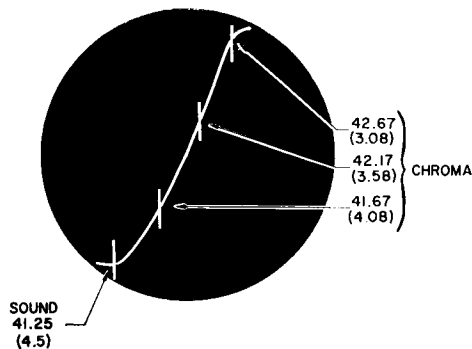


Figure 5.7B (Repeated) Sweep Width Reduced to Show Only Sound and Chroma Portion of I-F Response

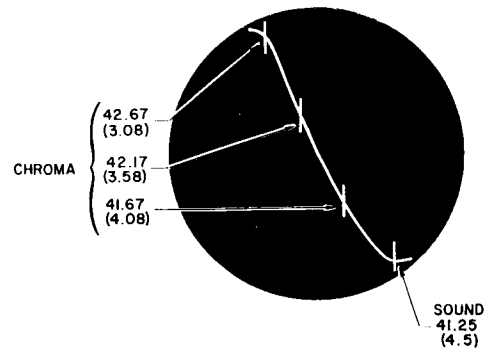


Figure 6.1 (Repeated) Reversal of Sweep when Chroma Switch is Turned On



## 9.0 ADDITIONAL TELEVISION ALIGNMENT PROCEDURES USING THE MODEL 415

### 9.1 TV SOUND ALIGNMENT

The preceding sections have outlined in considerable detail the two most important portions of television receiver alignment, these being alignment of the i-f section from the mixer output to the video detector and alignment of the chroma portion of the color television receiver. An additional section which must be reviewed is the sound portion of the television receiver which will be discussed briefly. An extensive survey of older and current television receivers reveals the following similarities among them. Following the sound detector is one and sometimes two 4.5 MHz sound i-f stages. Following this is the demodulator which in a high percentage of sets is of the quadrature type. In tube-type sets this type of demodulator is capable of high level audio output and is adequate to drive the audio output stage directly. Another result of experimentation with a variety of television receivers leads us to the conclusion that the most effective method of sound i-f alignment, particularly alignment of the quadrature demodulator, is by the method described by the manufacturer, this invariably being to use a signal from a television station for alignment. The alignment is sometimes performed by pre-peaking the 4.5 MHz amplifier stage or stages and then making a final adjustment of the quadrature demodulator coil and the tuned circuit preceding it by using the station signal. The two final adjustments are made by listening at the speaker of the receiver for maximum audio output and minimum distortion.

#### 9.1.1 USING THE MODEL 415 IN TELEVISION SOUND ALIGNMENT

There are several methods of using the Model 415 to generate alignment signals for the 4.5 MHz sound i-f.

- 9.1.1.1 Using the test set-up of Figure 5.2 and Section 5.2, connect the r-f cable of the 415 to the mixer test point of the receiver and use the 75-ohm switch position. Place the FUNCTION switch of the 415 to the MOD MKR position.
- 9.1.1.2 Turn on the PIX (45.75 MHz) marker and the SOUND (41.25 MHz) marker. The difference between these two markers, or 4.5 MHz, will

be detected by the sound detector at the last video i-f stage and will be applied to the sound i-f stages. In this way a crystal controlled 4.5 MHz signal is generated by using the Model 415 and the receiver, and this signal can be used for sound i-f amplifier alignment. The 400 Hz modulation can be heard at the receiver speaker, if it is connected.

- 9.1.1.3 Use the PR-151 wherever a demodulator assembly is called out for observing the effects of tuning the sound i-f stages. The PR-151 can be used two ways:

(a) Connect the PR-151 to the DEMOD jack of the Model 415 and, with the PROBES switch in the DEMOD position, adjust the indicated sound i-f coils as required for maximum observed 400 Hz on the oscilloscope.

(b) Connect the PR-151 to a VTVM as suggested for the demodulator assembly specified by the manufacturer and adjust the sound i-f coils for maximum d-c voltage. The recovered d-c output of the PR-151 is negative.

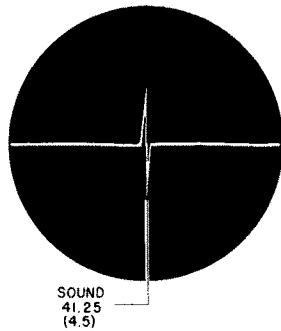
- 9.1.1.4 The most effective way of performing the alignment of the quadrature demodulator after the preceding sound i-f coils have been aligned is to select a weak television station and to tune the quadrature coil and the preceding i-f coil as directed in the alignment procedure for maximum sound and minimum distortion. This is determined by listening to the audio output of the receiver.

- 9.1.1.5 To observe the "S"-curve of the sound demodulator, connect the DIRECT cable of the 415 to the output of the sound demodulator and perform the following steps (In sets using high-output quadrature demodulators the output of the demodulator is applied across the volume control.):

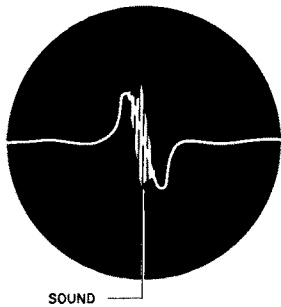
- 9.1.1.6 Retain the Model 415 test set-up of the preceding paragraphs. Use the same bias connections for r-f agc and i-f agc as are specified for the i-f alignment. Biasing of the chroma circuits is not required.

- 9.1.1.7 Place the PROBES switch in the DIRECT POSITION.

9.1.1.8 Turn on the SOUND (41.25) marker and reduce sweep as required, at the same time adjusting the CENTER FREQUENCY control to keep the sound marker centered. Because of the relatively narrow bandwidth of the sound i-f, as well as the sound demodulator, the "S"-curve of the sound demodulator will appear quite narrow at high sweep width as shown in Figure 9.1A. At very low (minimum) sweep width the "S"-curve will appear as shown in Figure 9.1B, with the sound marker added.



A. Demodulator Curve at High Sweep Width



B. Demodulator Curve at Reduced Sweep Width

Figure 9.1 Observing Sound Demodulator "S"-Curve

## 9.2 AUTOMATIC FINE TUNING (AFT)

The capability for alignment of AFT circuits is becoming increasingly important. All late model television receivers either include the AFT feature or offer it as an option. It is reasonable to assume that all future models will include AFT circuitry.

### 9.2.1 OPERATION OF AFT CIRCUITS

Because of the relatively recent introduction of automatic fine tuning circuitry and applications in television receivers, a brief description of the AFT circuitry is given here. Figure 9.2 shows a typical AFT amplifier and discriminator circuit. The basic AFT circuitry consists of a tuned amplifier such as VI which drives a discriminator as shown. The

input to the AFT amplifier is furnished from the last i-f stage. The AFT amplifier is tuned to the pix carrier frequency or 45.75 MHz. If an i-f sweep voltage is supplied to the AFT amplifier, the discriminator output will be an "S"-curve having a crossover at 45.75 MHz as indicated in Figure 9.3. The discriminator output is direct-coupled to a voltage-variable capacitor in the VHF and UHF tuners. This capacitance is usually a reverse-biased diode, a property of which is that the junction capacity will vary with the magnitude of the applied reverse voltage. As the voltage is increased the capacity of the diode decreases, and as the voltage is reduced the diode junction capacitance increases.

In some TV tuners the base-collector junction of a bipolar transistor is sometimes used as the voltage variable capacitor. It is characteristic of a semiconductor junction that it exhibits the voltage-capacitance characteristic described earlier. The voltage-sensitive capacitance device is connected across the resonant circuit of the tuner local oscillator. Usually the connection is made through rather small coupling capacitors to limit the frequency pulling effect of the voltage-variable capacitor, thereby limiting the range over which the tuner oscillator may be varied.

Because of the fact that the carrier frequencies transmitted by television stations are very accurately controlled, the only possible element which can affect the frequency of the converted pix (45.75 MHz) carrier is the setting of the oscillator fine tuning adjustment at the television receiver. A very small percentage of frequency drift in the local oscillator of the tuner, particularly at the upper end of the VHF range and in the UHF range will produce a rather large percentage change at the intermediate frequency range. This would cause a noticeable deterioration of picture quality, the effect being the same as if the fine tuning adjustment of the receiver were misadjusted. The purpose of the AFT circuitry, therefore, is to adjust the frequency of the local oscillator of the tuner as required to maintain the converted pix carrier (45.75 MHz) as close as possible to its nominal value.

The output of the AFT discriminator is applied to the voltage sensitive capacitance at the tuner local oscillator as previously mentioned. When properly aligned the AFT circuitry is adjusted so that the pix carrier frequency falls at the center of the discriminator "S"-curve. If, because of local oscillator drift the converted pix carrier frequency drifts, a correction voltage is generated at the output of the AFT discriminator and is applied to the voltage sensitive capacitor at the tuner local oscillator. The polarity of the correction voltage is such as to correct the frequency drift of the local oscillator so that the pix carrier frequency is returned to the discriminator crossover point, this being 45.75 MHz.

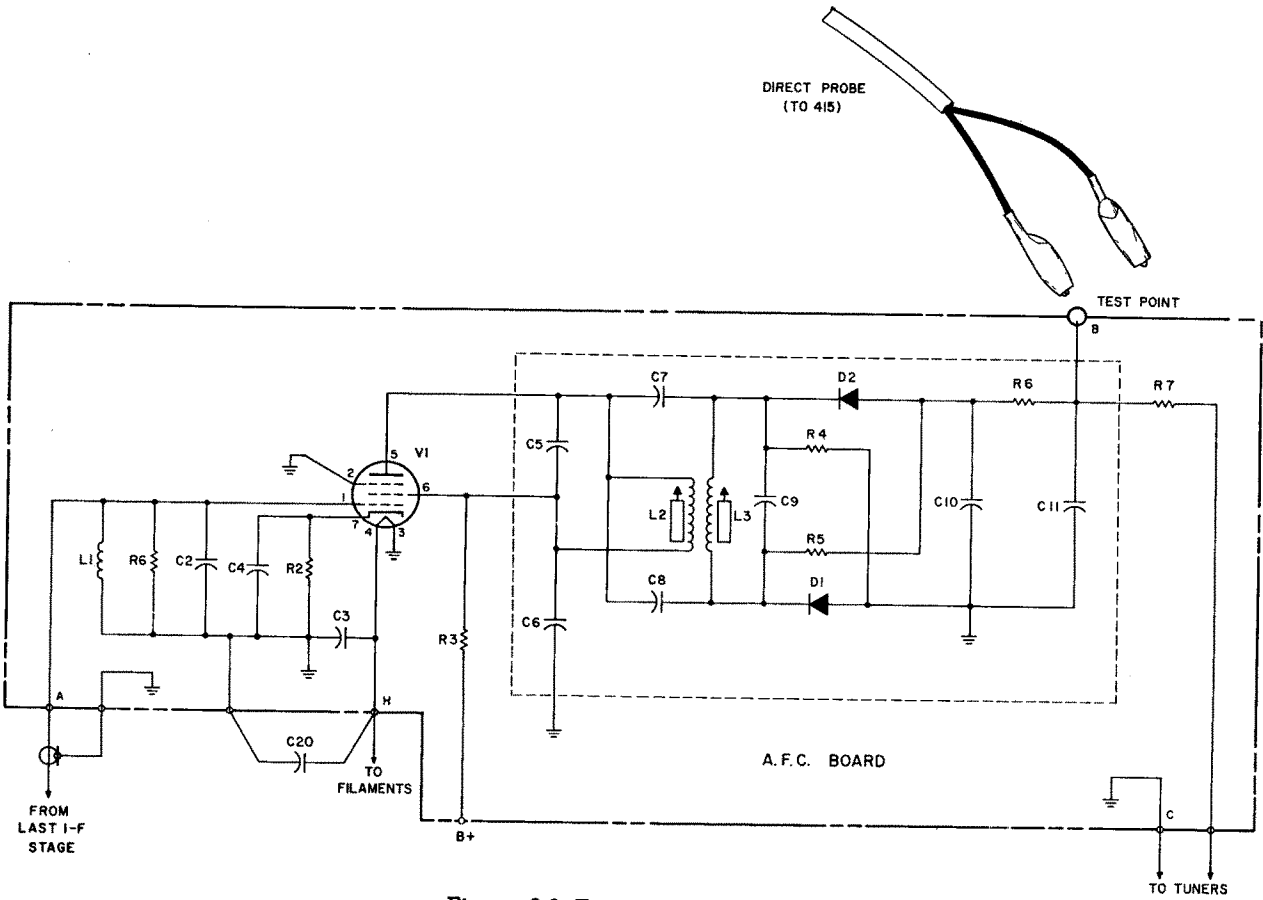
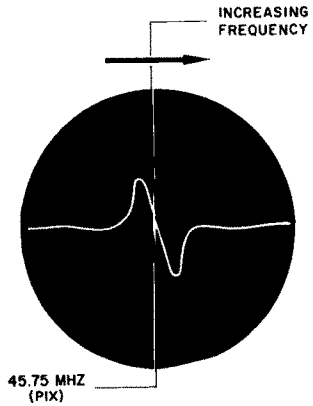


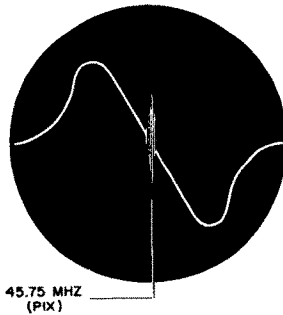
Figure 9.2 Typical AFT Circuit

## 9.2.2 ALIGNMENT OF AFT CIRCUITS

9.2.2.1 The interconnection diagram of Figure 5.2 and the set-up instructions of Paragraph 5.2 apply in the following. Actually, the automatic fine tuning alignment can be performed upon completion of the i-f alignment procedure with no changes in set-up connections other than connecting the direct cable of the Model 415 to the AFT test point and placing the PROBES switch in the DIRECT position.



A. "S"-Curve Presentation Using Wide I-F Sweep



B. "S"-Curve at Reduced I-F Sweep

Figure 9.3 AFT Discriminator "S"-Curve

9.2.2.2 The peak-to-peak spacing of the discriminator "S"-curve is usually about 1 MHz, so that at full i-f sweep the discriminator curve will appear compressed as shown in Figure 9.3A. Adjust the sweep width and center frequency as required to increase the size of the discriminator "S"-curve as shown in Figure 9.3B. Only the PIX (45.75 MHz) marker should be used for this section.

9.2.2.3 In the alignment of various AFT circuits marker frequencies of 45.25 MHz and 46.25 MHz are sometimes used as specified to locate the peaks of the AFT discriminator curve during the alignment process. Because these frequencies or any other frequencies required for AFT alignment are not standard, it is not likely that crystal controlled markers are readily available at these frequencies. Normally it would be necessary to use an external variable frequency marker generator to locate the peaks of the AFT "S"-curve.

When using the Model 415 for AFT alignment all that is required is that the 100 KHz marker switch be placed in the ON position. This generates a continuous string of markers having 100 KHz separations and extending over one megacycle in each direction from the pix carrier marker as shown in Figure 9.4. This enables the operator to set the discriminator adjustments as outlined in any procedure by counting in increments of 100 KHz in either direction from the pix carrier.

Figure 9.4 shows the method for determining the various frequency points of the AFT discriminator curve. The distance between each marker is 100 KHz as indicated and the method of counting in either direction from the pix (45.75) carrier is shown. For example, with a discriminator bandwidth of 1 MHz (45.75 MHz  $\pm$  0.5 MHz), the discriminator adjustment is performed so that the fifth 100 KHz marker on each side of the pix marker falls on each peak of the discriminator curve.

9.2.2.4 With the calibration provided by superimposing the 100 KHz markers on the AFT discriminator curve, perform the AFT circuit alignment as indicated by the manufacturer.

### NOTE:

Most manufacturers recommend disconnecting the AFT output to the tuner when performing AFT alignment.

9.2.2.5 After the discriminator has been aligned, the exact discriminator crossover is obtained by injecting a 45.75 MHz carrier at the signal injection point. The d-c output voltage of the AFT circuit is then checked at the AFT test point using a VTVM. This is performed when using the 415 by placing the FUNCTION switch in the MKR position and turning on the PIX (45.75) marker (all other markers off). The r-f cable of the Model 415 remains connected to the i-f sweep injection point. The required voltage is then obtained by performing the specified adjustments.

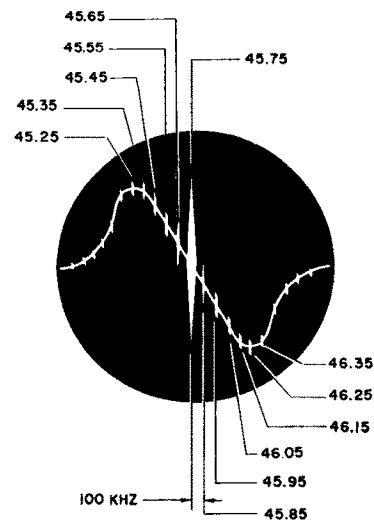


Figure 9.4 Using 100 KHz Markers to Determine Frequency Separation of Discriminator Peaks

9.2.2.6 Upon completion of the AFT alignment, perform the AFT check specified by the manufacturer. This involves connecting the television receiver to an external antenna and disabling the AFT and adjusting the fine tuning manually for best picture and sound with minimum sound interference in the picture. The AFT feature of the TV receiver is then activated and the "pull-in" effect is observed. The amount of pull-in should be unnoticeable. Another test of AFT effectiveness is to adjust the fine tuning of the receiver in either direction from the optimum picture setting with the AFT disabled. The AFT is then activated and the effect on the picture is observed. The picture should automatically be restored to the optimum setting obtained by manual adjustment of the receiver fine tuning when the AFT was disabled.

### 9.3 CONDENSED WORK GUIDE

The flow chart of Figure 9.5 is a simplified outline of the alignment portion of this manual. The procedures are shown in sequence for effective use of the Model 415 in performing alignment checks, touch-ups and complete realignment. The sections or para-

graphs containing the information required to perform each task are called out.

Keep in mind the importance of logging information on each receiver model aligned. This should include the model number, bias points, signal injection points for each alignment function, test points and special notes on the alignment process, when required. The special notes should list the frequency associated with each tuned circuit as well as notes on any difficulties encountered and how they were resolved. Alignment sequences should be planned in advance for minimum switching of signal leads. For example, with the initial set-up of Figure 5.2 and Paragraph 5.2, the following can be done with only one interconnection change, this being to connect the direct cable to the AFT test point.

- Trap alignment
- Coil pre-peaking
- I-F sweep alignment
- Chroma alignment
- AFT alignment

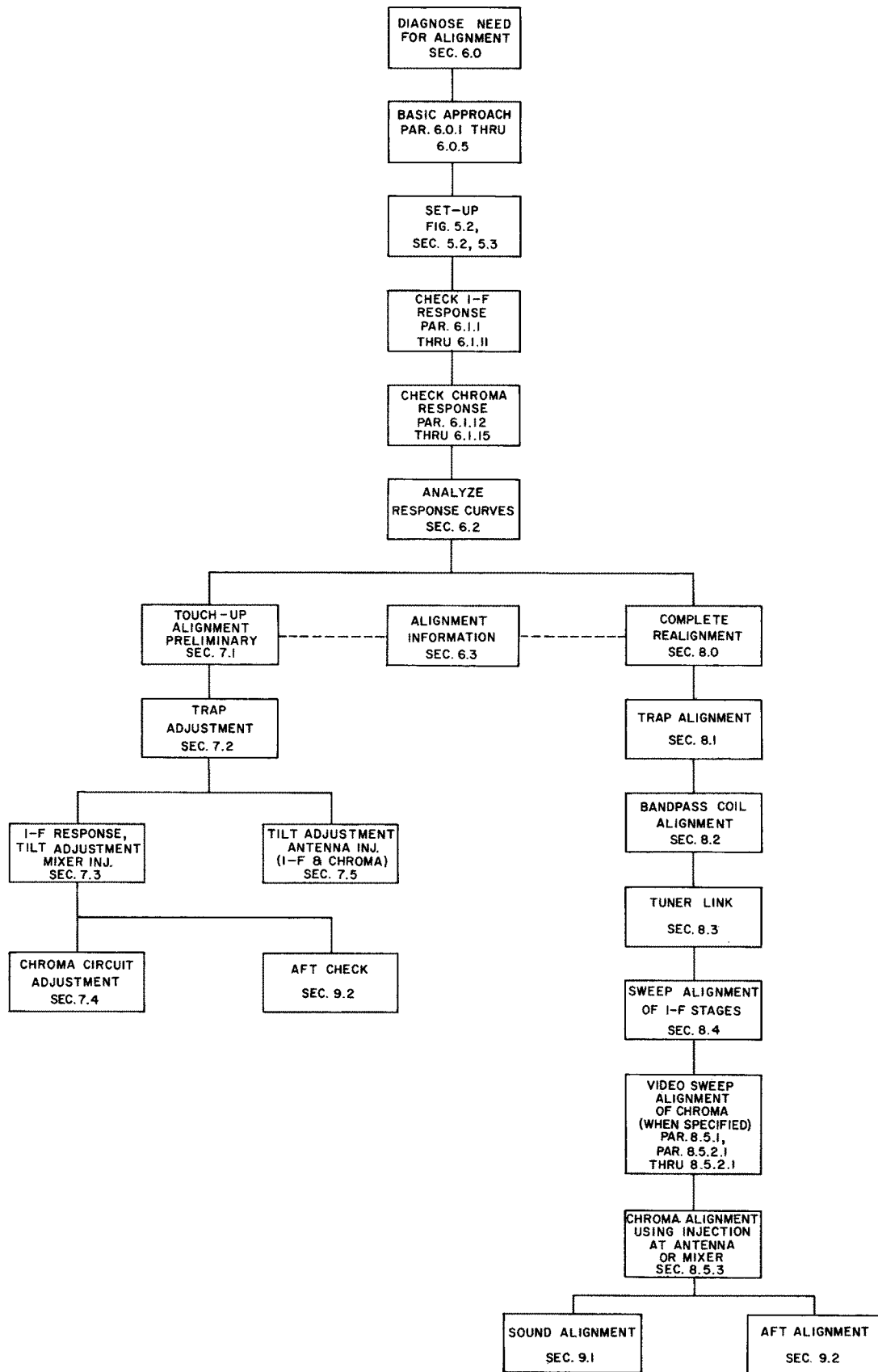


Figure 9.5. Condensed Work Guide for Television Alignment Using the Model 415

# MANUFACTURERS' ALIGNMENT PROCEDURES USING THE MODEL 415

## 10.0 INTRODUCTION

In this section the i-f and chroma alignment procedures of two television receivers are reproduced (Courtesy of Philco-Ford Corporation and The Magnavox Company). Opposite these procedures are shown the same alignment sequences using the Model 415. By comparing the Model 415 method to specific procedures the user can acquire additional familiarity with the use of the Model 415 in actual practice. The drawings of test set-ups, chassis layouts and waveforms are those of the manufacturers. The Model 415 interconnection and set-up information is shown in Figure 5.2 and

Paragraph 5.2 in the fold-out at the end of the manual. The user may also refer to the condensed work guide of Figure 9.5 in Section 9.3 to locate specific information regarding all Model 415 procedures.

## 10.1 ALIGNMENT OF MAGNAVOX MODEL T933

The first television chassis to be reviewed is the Magnavox Model T933. The adapters and response curves recommended by the manufacturer are shown below. In the alignment procedure using the Model 415, reference to only the response curves is required. The manufacturer's figure numbers are retained.

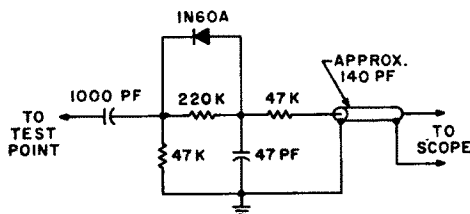


FIGURE 3  
VIDEO DETECTOR

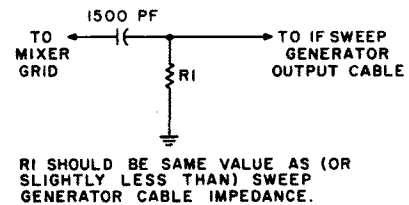


FIGURE 4  
MIXER GRID PAD

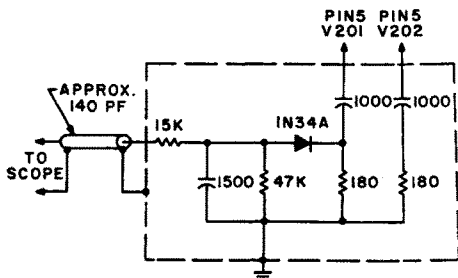


FIGURE 5  
I.F. DETECTOR AND LOAD

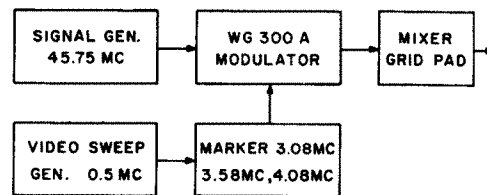
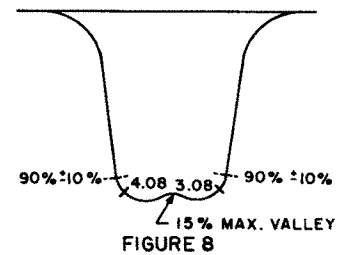
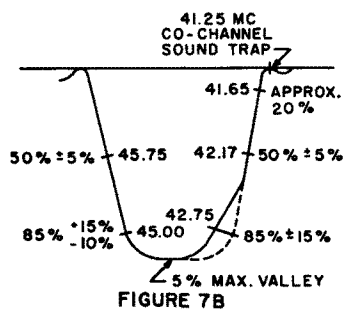
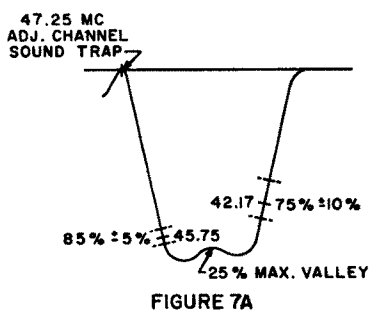


FIGURE 6  
I.F. OVERALL CHROMA ALIGNMENT HOOKUP



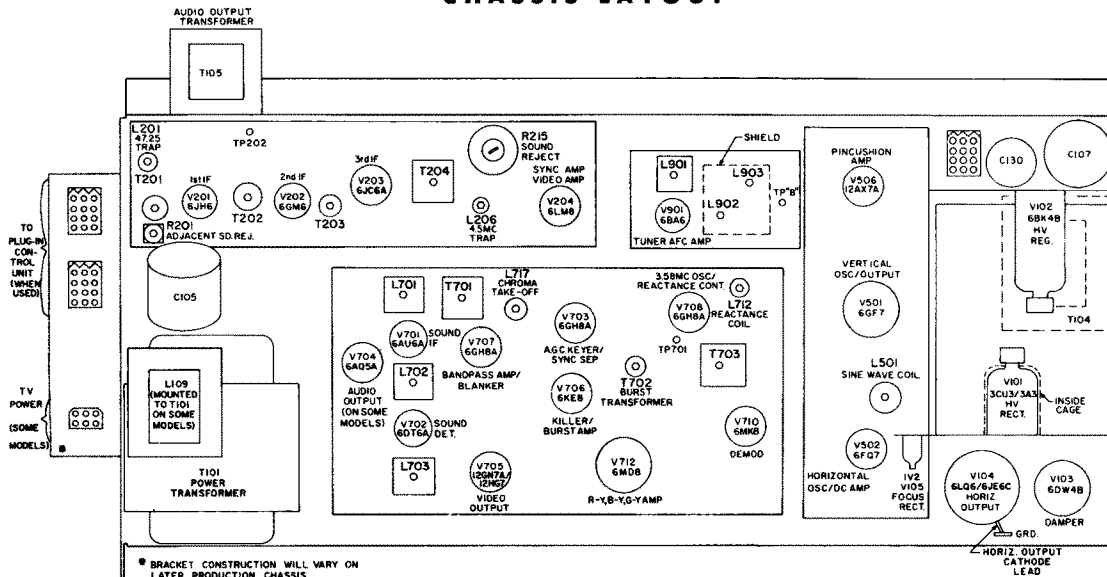
Courtesy of The Magnavox Company

# MAGNAVOX MODEL T933

## RF-IF & CHROMA ALIGNMENT

Preliminary Connections			
1. Adjust Contrast and Brightness controls fully counter-clockwise and the Sharpness control to its mid-range position. 2. Adjust the Color control to its center position. 3. Set the VHF tuner to the highest unused channel. 4. Connect a -40 volt bias to pin 9 of V707, -2 volt bias to the junction of R738 & R739 (Bandpass Amplifier),		and a -2.5 volt bias to RF AGC (Point E) on the Chroma Board. 5. Ground TP202 (Video IF Board) and IF AGC (Point D) on the Chroma Board. 6. Open the cathode circuit of the Horizontal Output tube. 7. Turn the receiver on and set the Volume control for minimum volume. Allow at least 10 minutes warmup time before proceeding with alignment.	
EQUIPMENT CONNECTIONS	SWEEP GEN. FREQUENCY	MARKER FREQUENCY	REMARKS
Connect AM Signal Generator through .01 Capacitor to Pin 7 of V203. Connect scope through Figure 3 to junction of C728 & L717.	4.5MC 400CPS Modulation	-----	Adjust L206 for minimum output. <u>Slug should be positioned at point nearest board.</u>
Connect IF Sweep Generator and Marker to Tuner Test Point through Figure 4. Connect scope through Figure 5 to TV chassis.	43MC 10MC Sweep	47.25MC	Adjust L201 to center marker pip in suckout. Adjust R201 for maximum attenuation. <u>L201 slug should be at a point near top of coil.</u>
Connect IF Sweep Generator and Marker through Figure 4 to Tuner Test Point. Connect scope through Figure 5 to TV chassis.	43MC 10MC Sweep	42.17MC 47.25MC 45.75MC	Adjust the Tuner Converter Plate Coil and T201 for maximum gain and response as shown in Figure 7A. T201 slug should be at point nearest top of can; Tuner Converter Plate Coil slug should be at point farthest into coil.
Apply a 41.25MC CW signal to Tuner Test Point. Connect a VTVM to TP201.	-----	-----	Adjust T204 (Top) and R215 for minimum reading on VTVM. <u>T204 slug should be at point nearest top of can.</u>
Connect IF Sweep Generator and Marker through Figure 4 to Tuner Test Point. Connect scope through a 10K resistor to TP201. Remove the jumper from TP202.	43MC 10MC Sweep	41.65MC 42.17MC 45.0MC 47.25MC	Adjust T204 (Bottom) for maximum gain and minimum tilt. Adjust T203 to position 42.17MC Marker and T202 to position 45.75MC Marker (see Figure 7B). <u>T204 slug should be positioned at point nearest board; T202 and T203 positioned at point nearest top of can. Recheck 47.25MC trap.</u>
Recheck 41.25MC Trap as Outlined Previously			
Apply video sweep modulated 45.75MC (1.5V at TP201 on VTVM) to Tuner Test Point. See Figure 6 for hook-up. Connect scope through Figure 3 to Pin 7 of V710.	0-5MC Sweep	3.08MC 3.58MC 4.08MC	Adjust L717 and T701 (Top & Bottom) for amplitude and response shown in Figure 8. <u>L717 top slug should be positioned at point nearest board. T701 top slug should be positioned at point nearest top of can; Bottom slug should be positioned nearest board.</u>

### CHASSIS LAYOUT





## MAGNAVOX MODEL T933 RF, IF & CHROMA ALIGNMENT USING THE MODEL 415

<b>PRELIMINARY CONNECTIONS</b>			
1. Perform Steps 1-7 of opposite page (Step 6 may be omitted if desired). 2. Use test set-up of Figure 5.2 and procedure of Par. 5.2 (Fold-out at end of Manual). 3. All bias voltages furnished from Model 415 supplies. <b>CHECK FOR PROPER POLARITIES.</b> 4. Use only markers indicated and observe instructions regarding final position of tuning slugs. 5. Unless otherwise specified under <b>REMARKS</b> column, perform adjustments of opposite page.			
<b>EQUIPMENT CONNECTIONS</b>	<b>MODEL 415 CONTROLS</b>	<b>MARKER FREQUENCIES*</b>	<b>REMARKS</b>
Connect 415 r-f cable to tuner test point; use 75 ohm impedance. PR-151 Demodulator probe to junction of C728 and L717.	FUNCTION switch to MOD MKR. CHROMA switch to OFF. PROBES switch to DEMOD position.	PIX (45.75) SOUND (41.25)	Adjust L206 for minimum indicated 400 Hz on oscilloscope. Turn off markers. Remove PR-151.
415 r-f cable as above. Direct cable to TP201.	FUNCTION switch to MOD MKR. PROBES switch in DIRECT position.	ADJ SND (47.25)	Adjust L201 and R201 for minimum indicated 400 Hz on oscilloscope. Observe slug location. Turn off marker.
415 r-f cable as above. Connect load blocks between pins 5 of V201 and V202 and ground. Connect PR-151 across 180-ohm resistor of first load block and ground.	FUNCTION switch to IF. PROBES switch to DEMOD position. SWEEP WIDTH at max, then adjust as required.	CHROMA (42.17) ADJ SND (47.25) PIX (45.75)	Perform adjustments indicated on opposite page, observing tuning slug locations.
415 r-f cable as above. Remove load blocks. Direct cable at TP201.	FUNCTION switch to MOD MKR.	SOUND (41.25)	Alternately adjust T204 (Top) and R215 for minimum indicated 400 Hz on oscilloscope. Turn off marker.
415 r-f cable as above. Direct cable to TP201. Remove jumper from TP202.	FUNCTION switch to IF.	CHROMA (42.67 and 42.17) PIX (45.75) 45.00 MHz ADJ SND (47.25)	Perform adjustments indicated on opposite page, observing tuning slug locations.
Recheck 41.25 MHz Trap as Outlined Previously.			
415 r-f cable as above. Connect PR-151 to pin 7 of V710.	FUNCTION switch to IF. Reduce sweep and center SOUND and CHROMA markers; then turn CHROMA switch to ON position.	SOUND (41.25/4.5) CHROMA (41.67/4.08) (42.17/3.58) (42.67/3.08)	Perform adjustments indicated on opposite page, observing tuning slug locations.

\*For marker frequency relationships at r-f, i-f and video/chroma frequencies, refer to Section 3.8 and Figure 3.3 of this manual.

MANUAL NO.	7304
SECTION	3.1
ISSUED	Aug., 1968

## T933 COLOR TV CHASSIS

### TUNER AFC ALIGNMENT

Before proceeding with the Tuner AFC Alignment, check the overall response to make sure the curve falls within the limits specified. If necessary repeat the Video IF and Chroma alignment and then proceed with the following instructions:

1. Connect the sweep generator, with markers at 45.75MC and 47.25MC, to the Tuner Test Point. Connect the oscilloscope through a 10K isolation resistor to Point "B" on the AFC Board. Open the "AFC Defeat" Switch i. e., set the "Auto Color" Switch to the "On" position.
2. Detune L903 by turning slug all the way out.
3. Adjust L901 for maximum response between the 45.75MC and 47.25MC markers. (Slug should be positioned at point nearest board).
4. Adjust L902 for maximum response at 45.75MC.
5. Adjust L903 for "S" curve with 45.75MC marker falling at zero voltage crossover (see Figure 1). (Slug should be positioned at point nearest board).
6. Repeat the adjustments of L901 and L902 for maximum gain with a symmetrical curve.
7. Recheck the IF overall response curve and if necessary adjust T204 (Bottom) to correct tilt (see RF-IF Alignment).
8. Recheck the adjustment of T204 (Top) and R215, 41.25MC Trap (see RF-IF Alignment). This adjustment must be precise.
9. Apply a 45.75MC CW signal to the Tuner Test Point and adjust the amplitude of this signal to obtain -1.5 volts at TP201.
10. Connect the VTVM to Point "B" on the AFC Board and adjust L903 for zero volts.

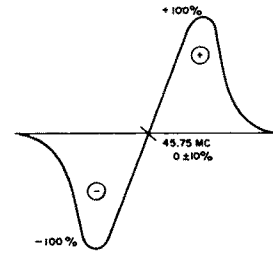
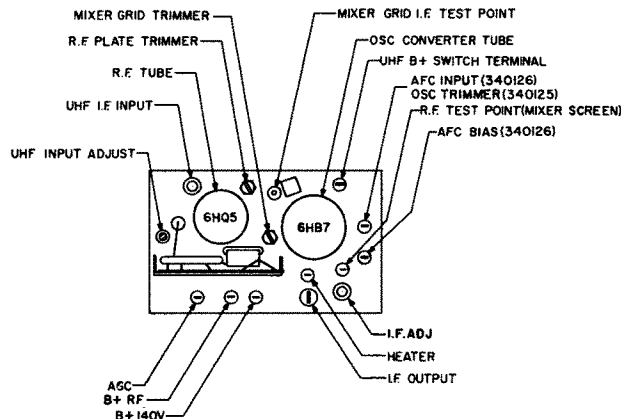
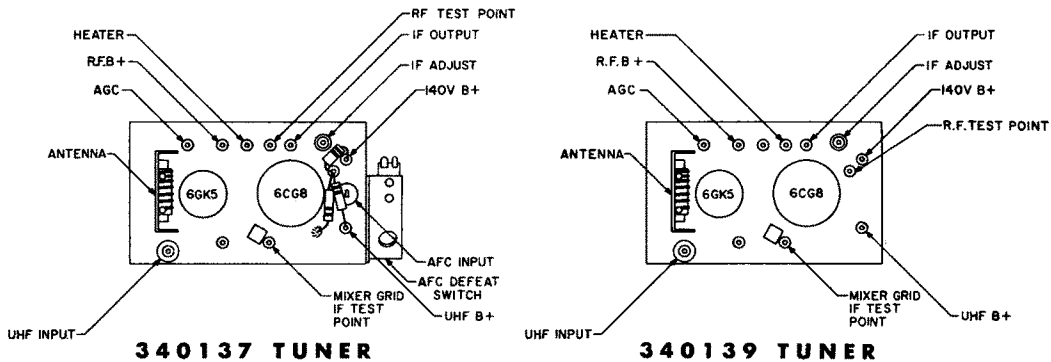


FIGURE 1

### VHF TUNER LAYOUTS



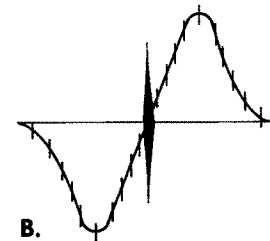
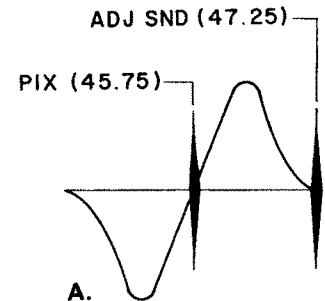
340125 & 340126 TUNERS

Courtesy of The Magnavox Company

## MAGNAVOX MODEL T933 TUNER AFC ALIGNMENT USING THE MODEL 415

Before proceeding with the Tuner AFC Alignment, check the overall response to make sure the curve falls within the limits specified. If necessary repeat the Video IF and Chroma alignment and then proceed with the following instructions:

1. Use test equipment set-up of Figure 5.2 and Section 5.2 of manual. Connect r-f cable of Model 415 to tuner test point using 75-ohm impedance. Connect Direct cable to Point "B" on the AFC Board. Open the "AFC Defeat" Switch, i.e., set the "Auto Color" Switch to the "On" position.  
Model 415 FUNCTION switch to IF position. Turn on PIX (45.75) and ADJ SND (47.25) markers. PROBES switch to DIRECT position. Adjust SWEEP WIDTH to center PIX (45.75) marker with ADJ SND (47.25) marker at right edge of oscilloscope (frequency increasing from left to right). A properly aligned curve would appear as in Figure A.
2. Detune L903 by turning slug all the way out.
3. Adjust L901 for maximum response between the 45.75 MHz and 47.25 MHz markers. (Slug should be positioned at point nearest board.)
4. Adjust L902 for maximum response at 45.75 MHz.
5. Adjust L903 for "S" curve with 45.75 MHz marker falling at zero voltage crossover, as in Figure A. (Slug should be positioned at point nearest board). Set the VERTICAL switch of the Model 415 as required for proper polarity (Figure 1, opposite page).
6. Turn off ADJ SND (47.25) marker and turn on 100 KHz markers. Adjust MARKER AMPLITUDE for suitable marker heights. Repeat adjustments of L901 and L902 for maximum gain with a symmetrical curve, using the 100 KHz markers. The peak-to-peak separation of the "S" curve is about one MHz, so that the fifth 100 KHz marker on each side of the PIX (45.75) marker should fall approximately at each peak of the "S" curve as shown in Figure B. Adjust Model 415 signal level as required to produce peak-to-peak curve amplitude of six to eight volts.
7. Recheck the IF overall response curve and if necessary adjust T204 (Bottom) to correct tilt (see RF-IF Alignment).
8. Recheck the adjustment of T204 (Top) and R215, 41.25 MHz Trap (see RF-IF Alignment). This adjustment must be precise.
9. Model 415 FUNCTION switch to MKR position. Turn off 100 MHz markers. Turn on only the PIX (45.75) marker and, using VTVM at TP201 (Video detector test point), adjust signal level for -1.5 volts.
10. Connect the VTVM to Point "B" on the AFC Board and adjust L903 for zero volts.



### 10.2 ALIGNMENT OF THE PHILCO-FORD "S" LINE COLOR TELEVISION RECEIVER

The second receiver chassis alignment is that of the Philco-Ford "S" Line color television receiver. The alignment procedures are on

the following pages of this section. All drawings and waveforms shown are those of the manufacturer.

# PHILCO-FORD "S" LINE TELEVISION RECEIVER

## VIDEO IF AM AND SWEEP ALIGNMENT PROCEDURE - ALL CHASSIS

- Preliminary: A. The following video IF alignment is based upon a tuner with proper bandpass alignment connected to the TV chassis.  
 B. Disable horizontal sweep section by opening jumper from cathode of horizontal output tube 6KD6 pin #2 to ground and place "Normal/Service" switch in "Service" position.  
 C. Preset VR1 sound rejection pot. and VR2 AGC distribution pot. to approx. 1/4 turn CW.
- Bias Supply: D. Apply approx. 10.5VDC to M4 (AGC) and adjust for 2.2VDC at M9 (Tuner AGC). Adjust VR2 (AGC) for 6.0VDC at IF AGC T.P. (Test Point).
- Oscilloscope: E. Connect in series with test jig to tuner UHF input (J2T). Set channel selector to UHF.
- Signal Gen.: F. Connect in series with test jig to tuner UHF input (J2T). Set channel selector to UHF.

SECTION

1

### AM ALIGNMENT CHART

STEP	SIGNAL GEN. 30% MOD.	ADJUST	REMARKS
1	44.0MHZ	L6 (BOTTOM) FOR MAX.	PEAK L6 (BOTTOM), L9, L10, & L13 AT THEIR RESPECTIVE FREQUENCIES FOR MAXIMUM DEFLECTION ON SCOPE. USE PEAK WITH CORE NEAREST TOP OF COIL. ADJUST SIGNAL GENERATOR INPUT AS NECESSARY TO MAINTAIN 1.0V P/P ON SCOPE.
2	44.0MHZ	L9 & L10 FOR MAX.	
3	42.75MHZ	L13 FOR MAX.	
4	45.5MHZ	L1T FOR MAX. (ON TUNER)	PEAK L1T AT 45.5MHZ. ADJUST SIGNAL GENERATOR INPUT AS NECESSARY FOR 1.0V P/P ON SCOPE. PEAK L1T WITH CORE AT TOP OF COIL.
5	41.25MHZ	L6 (TOP) FOR MIN.	ADJUST L6 (TOP) AND VR1 IN THAT ORDER FOR MINIMUM DEFLECTION ON SCOPE. INCREASE SCOPE GAIN IF NECESSARY FOR SUFFICIENT INDICATION. REPEAT STEPS 5 AND 6. ADJUST L12 FOR MINIMUM DEFLECTION. ADJUST L11 AND L14 IN THAT ORDER FOR MINIMUM DEFLECTION. INCREASE SCOPE GAIN IF NECESSARY FOR SUFFICIENT INDICATION. REPEAT STEP 8. KEEP ALL CORES AT COIL END AWAY FROM BOARD.
6	41.25MHZ	VR1 FOR MIN.	
7	38.75MHZ	L12 FOR MIN. (TRAP)	
8	47.25MHZ	L11 AND L14 FOR MIN. (TRAPS)	

CAUTION: REMOVE AM GENERATOR FROM J2T BEFORE PROCEEDING WITH SWEEP ALIGNMENT.

NOTE: TO PROPERLY POSITION FINE TUNING FOR SWEEP ALIGNMENT. SET TUNER TO CHANNEL 4 AND INJECT 65.75MHZ 30% MODULATED AT ANTENNA TERMINALS. ADJUST FINE TUNING CONTROL FOR MINIMUM SCOPE INDICATION. DO NOT TOUCH FINE TUNING OR CHANNEL SELECTOR FOR BALANCE OF ALIGNMENT.

SWEEP GEN.: G. CONNECT IN SERIES WITH MATCHING NETWORK TO VHF TUNER ANT. INPUT. (SEE FIGURE 9 FOR NETWORKS)

SIGNAL GEN.: H. LIGHTLY COUPLE TO LUG M16 (ON P2) OR SWEEP GEN. OUTPUT CABLE TO PROVIDE MARKERS.

### SWEEP ALIGNMENT CHART

STEP	SWEEP GEN.	SIGNAL GEN.	ADJUST	REMARKS
9	40-50MHZ (I-F)	42.17MHZ 45.75MHZ	L13 L1T (ON TUNER)	SET SWEEP FOR 1.0V P/P ON SCOPE. ADJUST FOR MAXIMUM GAIN AND RESPONSE FIG. 16A. ADJUST SWEEP INPUT TO MAINTAIN 1.0V P/P ON SCOPE. L13 ADJUSTS 42.17MHZ MARKER AND L1T ADJUSTS 45.75MHZ MARKER. ADJUST L9 TO TILT FOR FLAT RESPONSE.
10	40-50MHZ (I-F)	42.17MHZ 45.75MHZ	L9	IF L9 DOES NOT GIVE FLAT RESPONSE, L6 (BOTTOM) CORE MAY BE ADJUSTED FOR FLAT RESPONSE. IF L6 IS ADJUSTED REPEAT STEPS 5 AND 6 IN "AM ALIGNMENT" PROCEDURE. "DO NOT TOUCH L10."
11	OBTAIN FRINGE CURVE AS FOLLOWS A. REMOVE BIAS FROM M4; (APPLY SLIGHT BIAS IF NECESSARY TO REMOVE NOISE LEVEL INTERFERENCE). B. LOWER SWEEP INPUT TO MAINTAIN 1.0V P/P SCOPE DEFLECTION. RESPONSE FIG. 16B SHOULD BE OBTAINED. IF FIG. 16B IS NOT CORRECT REPEAT STEPS 1 THROUGH 10.			

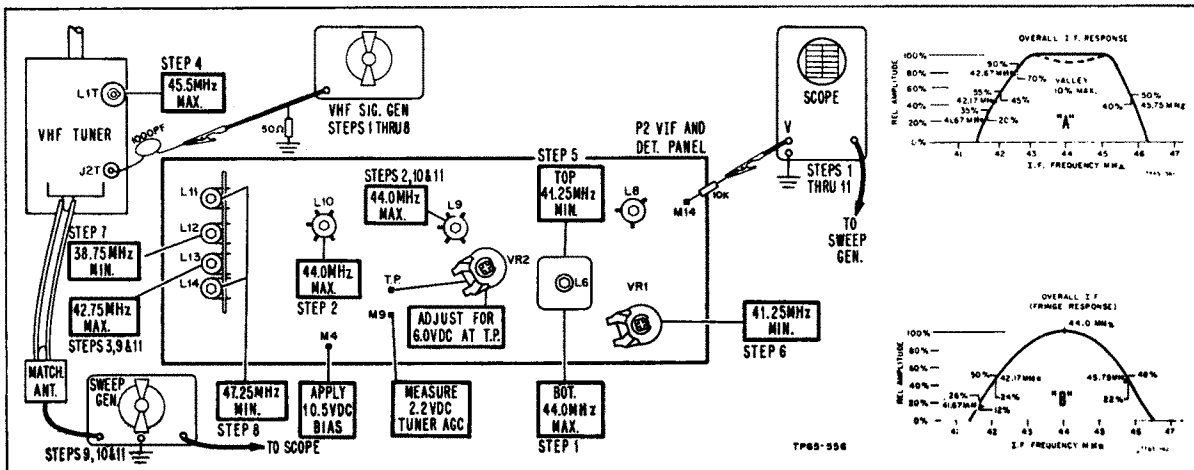


Figure 16. Video IF AM & Sweep Alignment and Response Curves

Courtesy of Philco-Ford Corporation

## PHILCO-FORD "S" LINE VIDEO IF AM AND SWEEP ALIGNMENT PROCEDURE USING THE MODEL 415

- Preliminary:** A. The following video IF alignment is based upon a tuner with proper bandpass alignment connected to the TV chassis.  
 B. Disable horizontal sweep section by opening jumper from cathode of horizontal output tube 6KD6 pin #2 to ground and place "Normal/Service" switch in "Service" position. (This step may be omitted if desired.)  
 C. Preset VR1 sound rejection pot. and VR2/AGC distribution pot. to approx. 1/4 turn CW.
- Bias Supply:** D. Apply approx. 10.5 VDC to M4 (AGC) and adjust for 2.2 VDC at M9 (Tuner AGC). Adjust VR2 (AGC) for 6.0 VDC at IF AGC T.P. (Test Point).  
 (Use Model 415)
- Oscilloscope:** E. Connect as in Figure 5.2 (Fold-out at end of 415 Manual). Connect Direct cable of Model 415 to lug M14 on VIF panel (P2).
- Signal Gen. (415):** F. Set FUNCTION Switch to MOD MKR position. Connect Model 415 to UHF input (J2T) using short length of stiff wire to contact center pin of connector. Select 75-ohm impedance. Set channel selector to UHF.

### AM ALIGNMENT CHART (Use one marker at a time)

STEP	MODEL 415 MARKER FREQUENCY	ADJUST	REMARKS
1	44.00 MHZ	L6 (BOTTOM) FOR MAX.	PEAK L6 (BOTTOM), L9, L10, & L13 AT THEIR RESPECTIVE FREQUENCIES FOR MAXIMUM DEFLECTION ON SCOPE. USE PEAK WITH CORE NEAREST TOP OF COIL. ADJUST SIGNAL GENERATOR INPUT AS NECESSARY TO MAINTAIN 1.0 V P/P ON SCOPE.
2	44.00 MHZ	L9 & L10 FOR MAX.	
3	42.75 MHZ	L13 FOR MAX.	
4	USE PIX (45.75) AND OPTIMIZE IN STEP 9 BELOW.	L1T FOR MAX. (ON TUNER)	PEAK L1T AT 45.5 MHZ. ADJUST SIGNAL GENERATOR INPUT AS NECESSARY FOR 1.0 V P/P ON SCOPE. PEAK L1T WITH CORE AT TOP OF COIL.
5	SOUND (41.25)	L6 (TOP) FOR MIN.	ADJUST L6 (TOP) AND VR1 IN THAT ORDER FOR MINIMUM DEFLECTION ON SCOPE. INCREASE SCOPE GAIN IF NECESSARY FOR SUFFICIENT INDICATION. REPEAT STEPS 5 AND 6. ADJUST L12 FOR MINIMUM DEFLECTION. ADJUST L11 AND L14 IN THAT ORDER FOR MINIMUM DEFLECTION. INCREASE SCOPE GAIN IF NECESSARY FOR SUFFICIENT INDICATION. REPEAT STEP 8. KEEP ALL CORES AT COIL END AWAY FROM BOARD. REMOVE MODEL 415 R-F CABLE FROM J2T.
6	SOUND (41.25)	VR1 FOR MIN.	
7	38.75 MHZ*	L12 FOR MIN. (TRAP)	
8	ADJ SND (47.25)	L11 AND L14 FOR MIN. (TRAPS)	

\*USE SPARE MKR OSCILLATOR CRYSTAL-CONTROLLED OR AS A VARIABLE-FREQUENCY OSCILLATOR (REFER TO SECTION 5.6 OF MODEL 415 INSTRUCTION MANUAL).

NOTE: TO POSITION FINE TUNING FOR SWEEP ALIGNMENT USING R-F SWEEP.

(1) SET TUNER TO CHANNEL 4.

(2) PLACE FUNCTION SWITCH OF MODEL 415 TO CH 4 POSITION AND CONNECT R-F CABLE TO ANTENNA TERMINALS. USE 300-OHM IMPEDANCE.

(3) DIRECT CABLE REMAINS AT LUG M14 OF VIF PANEL.

(4) REFER TO PAR. 6.1.11 OF MANUAL FOR METHOD OF SETTING FINE TUNING USING THE SOUND TRAP NOTCH.

**Sweep Gen. (Model 415):**

G. Connected to antenna terminals of receiver.

**Signal Gen. (Marker):**

H. Not required; use internal markers of Model 415.

### SWEEP ALIGNMENT CHART

STEP	MODEL 415 CONTROLS	MARKER FREQUENCIES*	ADJUST	REMARKS
9	FUNCTION SW. TO CH 4. CHROMA SW. OFF. SWEEP WIDTH MAX. THEN ADJUST AS REQUIRED.	SOUND (41.25) CHROMA (42.17) PIX (45.75)	L13 L1T (ON TUNER)	USE SOUND MARKER REFERENCE TO ADJUST FINE TUNING. SET SWEEP FOR 1.0 V P/P ON SCOPE. ADJUST FOR MAXIMUM GAIN AND RESPONSE FIG. 16A. ADJUST SWEEP INPUT TO MAINTAIN 1.0 V P/P ON SCOPE. L13 ADJUSTS 42.17 MHZ MARKER AND L1T ADJUSTS 45.75 MHZ MARKER. ADJUST L9 TO TILT FOR FLAT RESPONSE.
10	SAME AS ABOVE	SAME AS ABOVE	L9	IF L9 DOES NOT GIVE FLAT RESPONSE, L6 (BOTTOM) CORE MAY BE ADJUSTED FOR FLAT RESPONSE. IF L6 IS ADJUSTED REPEAT STEPS 5 AND 6 IN "AM ALIGNMENT" PROCEDURE. "DO NOT TOUCH L10."
11	OBTAIN FRINGE CURVE AS FOLLOWS: A. REMOVE BIAS FROM M4: (APPLY SLIGHT BIAS IF NECESSARY TO REMOVE NOISE LEVEL INTERFERENCE). B. LOWER SWEEP INPUT TO MAINTAIN 1.0 V P/P SCOPE DEFLECTION. RESPONSE FIG. 16B SHOULD BE OBTAINED. IF FIG. 16B IS NOT CORRECT REPEAT STEPS 1 THROUGH 10.			

\*41.25 MHZ IS EQUIVALENT TO 71.75 MHZ ON CHANNEL 4.  
 42.17 MHZ IS EQUIVALENT TO 70.83 MHZ ON CHANNEL 4.  
 45.75 MHZ IS EQUIVALENT TO 67.25 MHZ ON CHANNEL 4.

## PHILCO-FORD "S" LINE TELEVISION RECEIVER CHROMA BANDPASS ALIGNMENT - ALL CHASSIS

### Test Equipment Connections:

- Preliminary:** A. Disable horizontal sweep section, remove ground connection from cathode (pin #2) of horizontal output tube 6KD6 (V201).  
 B. Set "Normal/Service" switch (SW36) to "Service" position.  
 C. Set color control to maximum (fully C.W.)
- Bias Supply:** D. Apply approximately +12VDC to lug M4 and adjust for 2.2VDC at M9, apply -5VDC to lug M42.
- Oscilloscope:** E. Using direct probe connect to chroma detector block, connect chroma detector to lug M51 for step 1, to M50 for steps 2, 3 and 4. (See figure 8 for chroma detector circuit)
- Signal Gen.:** F. Connect as shown for steps 3 and 4.
- Sweep Gen.:** G. Connect in series with absorption marker box and 0.1mf capacitor to lug M43 for steps 1 and 2, set generator for video sweep to RF modulator for steps 3 and 4.
- RF Modulator:** H. Connect as shown for steps 3 and 4.
- VTVM:** J. Connect to M14, adjust sweep input for .5VDC for steps 3 and 4.

STEP	SWEEP GENERATOR	SIGNAL GENERATOR	ADJUST	REMARKS	
1	ALIGN CHROMA BANDPASS TRANS. L40	3.5MHZ SWEEP WIDTH AT 3.58MHZ CENTER FREQ.	. . .	L40 TOP AND BOTTOM CORES	ADJUST L40 TOP & BOTTOM FOR RESPONSE CURVE FIGURE "B". MAINTAIN EQUAL MARKER HEIGHT. CHROMA DETECTOR TO M51.
2	ALIGN CHROMA COUPLING COIL L41	SAME AS STEP 1	. . .	L41	ADJUST L41 FOR MAX. 3.08MHZ. CURVE WILL BE TILTED. CHROMA DETECTOR AT M50.
3	ALIGN CHROMA TAKEOFF COIL L38	0-5MHZ (I-F)	RF VIDEO CARRIER	L38	ADJUST L38 FOR MAX. 4.08MHZ.
4	CHECK OVERALL CHROMA RESPONSE	0-5MHZ (I-F)	RF VIDEO CARRIER	L40 (TOP CORE)	CHECK CURVE FOR RESPONSE FIG. 17"A". IF NECESSARY RETOUCH L40 TOP FOR CURVE FIG. 17"A".

NOTE: WHEN FEEDING IN AT R-F THE VIDEO CARRIER MUST BE AT CRYSTAL ACCURACY AND THE FINE TUNING SET FOR ZERO BEAT BETWEEN THE VIDEO CARRIER AND A CRYSTAL OSC. AT 45.75MHZ WITH CHANNEL SELECTOR AT THE PROPER CHANNEL FOR THE RF VIDEO CARRIER.

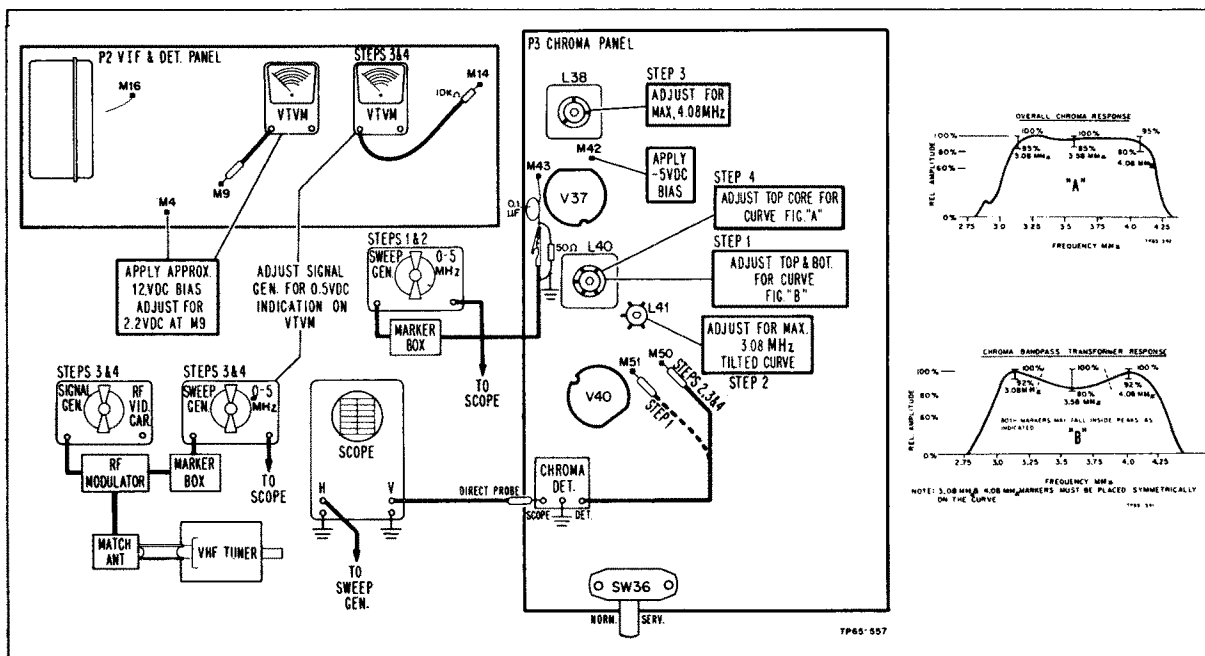


Figure 17. Chroma Bandpass Alignment and Bandpass Curves

Courtesy of Philco-Ford Corporation

## PHILCO-FORD "S" LINE TELEVISION RECEIVER CHROMA BANDPASS ALIGNMENT USING THE MODEL 415

### TEST EQUIPMENT CONNECTIONS:

- Preliminary:** A. Disable horizontal sweep section, remove ground connection from cathode (pin #2) of horizontal output tube 6KD6 (V201). (May be omitted if desired.)  
 B. Set "Normal/Service" switch (SW36) to "Service" position. (May be omitted if desired.)  
 C. Set color control to maximum (fully C.W.).
- Bias Supply:** D. Using Model 415 bias supplies, apply approximately +12 VDC to lug M4 and adjust for 2.2 VDC at M9; apply -5 VDC to lug M42.
- Oscilloscope:** E. Connect to Model 415 as indicated in Figure 5.2 (Fold-out at end of Manual). Connect PR-151 to M51 for Step 1, to M50 for Steps 2, 3 and 4. Connect Direct cable to video detector test point (Lug M14 on VIF panel P2).
- Signal Gen:** F. Not required; use internal markers of Model 415.
- Sweep Gen (Model 415):** G. Connect r-f cable of Model 415 directly to Lug M43 for Steps 1 and 2, using 75-ohm impedance (marker box not required).  
 Connect r-f cable of Model 415 directly to antenna terminals of receiver for Steps 3 and 4, using 300-ohm impedance (R-F modulator not required).
- R-F Modulator:** H. Not required.
- VTVM:** J. Connect to lug M14; adjust Model 415 output for 0.5 VDC for Steps 3 and 4.

**NOTE:** When performing alignment by injecting the r-f sweep at the antenna, first adjust the receiver fine tuning using the Sound trap for reference as outlined in the note following the AM ALIGNMENT CHART. Then proceed as indicated below.

STEP	MODEL 415 CONTROLS	MARKER FREQUENCIES*	ADJUST	REMARKS
1. ALIGN CHROMA BANDPASS TRANS. L40	FUNCTION SW. TO VIDEO. PROBES SW. TO DEMOD.	41.25 (4.5) 41.67 (4.08) 42.17 (3.58) 42.67 (3.08)	L40 TOP AND BOTTOM CORES	CONNECT PR-151 TO M51. ADJUST L40 TOP & BOTTOM FOR RESPONSE CURVE FIGURE "B". MAINTAIN EQUAL MARKER HEIGHT.
2. ALIGN CHROMA COUPLING COIL L41	SAME AS STEP 1	SAME AS STEP 1	L41	CONNECT PR-151 TO M50. ADJUST L41 FOR MAX 3.08 MHZ. CURVE WILL BE TILTED.
3. ALIGN CHROMA TAKEOFF COIL L38	FUNCTION SW. TO IF. PROBES SW. TO DEMOD. CHROMA SW. TO ON.	SAME AS STEP 1	L38	ADJUST L38 FOR MAX 4.08 MHZ.
4. CHECK OVERALL CHROMA RESPONSE	SAME AS STEP 3	SAME AS STEP 1	L40 (TOP CORE)	CHECK CURVE FOR RESPONSE FIG. 17 "A". IF NECESSARY RETOUCH L40 TOP FOR CURVE FIG. 17 "A".

\*FOR MARKER FREQUENCY RELATIONSHIPS AT R-F, I-F AND VIDEO/CHROMA SWEEP FREQUENCIES, REFER TO SECTION 3.8 & FIGURE 3.3 OF THIS MANUAL.

## 11.0 OTHER USES OF THE MODEL 415

Because of the inherent versatility and flexibility of the Model 415 there are many applications and uses of this instrument over and above basic alignment of television receivers. The capability for the alignment of f-m receiver i-f and discriminator circuits have been designed into the Model 415 and the use of this instrument in f-m receiver alignment will be outlined in detail. In addition, other applications of the Model 415 will be outlined briefly. As the user develops familiarity with the Model 415 and becomes progressively more experienced in its use and the various features, it is certain that he will develop other applications for use of this instrument over and above those outlined in this manual.

## 11.1 ALIGNMENT OF FM RECEIVERS USING THE MODEL 415

### 11.1.1 10.7 MHz I-F ALIGNMENT

In this type alignment as in the preceding sections on television receiver i-f alignment, it is important to first read the alignment procedure and locate all test points and signal injection points, both physically on the chassis as well as on the schematic diagram. In this way the operator will accumulate experience in performing the various i-f alignment tasks and once again recognize the similarity in the procedures regarding various manufacturers. Alignment of 10.7 MHz i-f sections of f-m receivers is considerably less involved than the alignment procedures outlined in the television section of this manual. Invariably the sweep voltage is injected in the region of the mixer, sometimes at the mixer grid (or base, if transistorized) of the receiver. The monitoring probe is connected at one test point for performing i-f alignments and is reconnected at a second test point when performing discriminator alignment. Proceed as follows (See Figure 4.21, Repeated.):

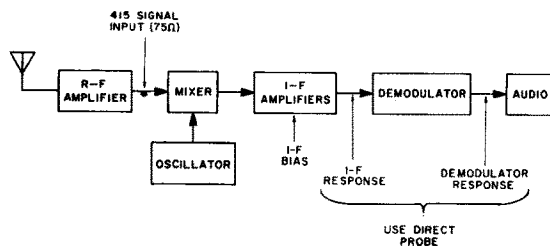


Figure 4.21 (Repeated) Typical F-M Receiver Block Diagram

- 11.1.1.1 Place FUNCTION switch of Model 415 to 10.7 MHz position.
- 11.1.1.2 Set the SWEEP WIDTH control to maximum and use the CENTER FREQUENCY control to set the dial indicator at the 10.7 MHz section of the dial calibration.
- 11.1.1.3 Set the ATTENUATOR control to minimum and connect the r-f output of the Model 415 to the 10.7 MHz injection point of the tuner. Use the 75-ohm termination.
- 11.1.1.4 Connect the direct cable of the Model 415 to the i-f alignment test point as determined from the alignment procedure.
- 11.1.1.5 Place the PROBES switch to the DIRECT position.
- 11.1.1.6 Increase the marker amplitude control as required to observe the 10.7 MHz marker which is automatically energized when the 10.7 MHz function is selected. Use the CENTER FREQUENCY control to center the 10.7 MHz marker on the oscilloscope trace.
- 11.1.1.7 Adjust the ATTENUATOR as required to produce the required peak-to-peak response amplitude on the oscilloscope.
- 11.1.1.8 Reduce the sweep width as required, at the same time using the CENTER FREQUENCY control to keep the 10.7 MHz marker centered on the oscilloscope trace.
- 11.1.1.9 To determine bandwidth at the various points on the response curve, place the 100 KHz marker switch in the on position. Adjust marker height as required to obtain suitable marker levels. A typical i-f response curve with the 10.7 MHz and 100 KHz markers added is shown in Fig. 11.1.
- 11.1.1.10 Perform the required alignment as outlined in the procedure.

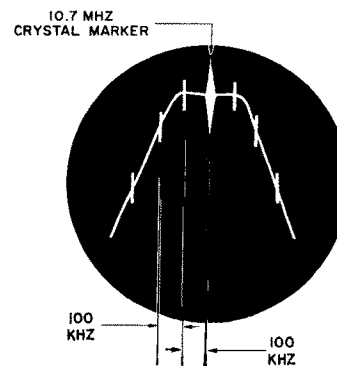


Figure 11.1 Typical 10.7 MHz I-F Response Curve with 100 KHz Markers Added



11.1.1.11 Remove the direct cable connection from the i-f alignment test point and reconnect it to the discriminator or detector test point as specified in the alignment instructions. A typical discriminator "S"-curve is shown in Fig. 11.2. The discriminator bandwidth requirements vary among manufacturers. The use of the 100 KHz markers enables the operator to identify any bandwidth required. In addition, it is possible to interpolate between the 100 KHz markers to obtain additional frequency resolutions when performing i-f and discriminator alignments.

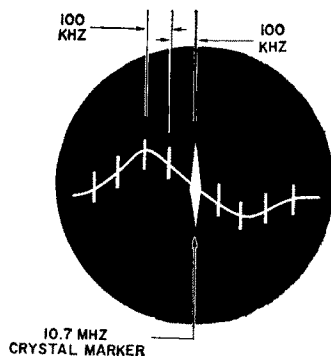


Figure 11.2 Typical 10.7 MHz Discriminator Response Curve with 100 KHz Markers Added

11.1.1.12 Perform the required discriminator alignment. This completes the i-f and discriminator alignment.

#### 11.1.2 CHECKING FM RECEIVER TRACKING

Tracking of f-m receivers at the low end and near the center of the f-m band can be performed by using the harmonics of the crystal markers as follows: Place the FUNCTION switch to the MOD MKR position. To check the low end (88 MHz) of the f-m band, turn on the 44 MHz marker and connect the r-f cable of the Model 415 to the antenna terminals (use 300 ohm switch position). Tune receiver towards 88 MHz and listen for 400 Hz tone at the speaker, if connected. If the receiver has an electronic tuning indicator tune the receiver for max-

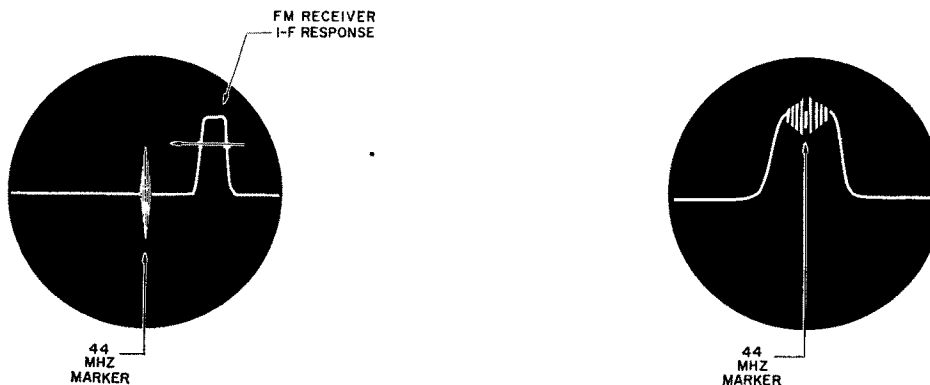
imum signal indication. Frequency setting of the dial should be 88 MHz. The same procedure can be used to check other points on the dial by using the second harmonic of other markers. This procedure can be used to check tracking up to 94.5 MHz ( $47.25 \times 2$ ). By using other features of the Model 415, tracking of the f-m receiver through the complete f-m band (88 MHz to 108 MHz) can be performed. Harmonics of the 44 MHz i-f sweep as well as harmonics of the 10.7 MHz sweep can be used to perform tracking checks and adjustment on f-m receivers.

11.1.2.1 Connect the direct cable of the Model 415 to the i-f alignment test point used in the preceding section for 10.7 MHz i-f alignment.

11.1.2.2 Connect the r-f cable of the Model 415 to the antenna terminals of the f-m receiver. Place the impedance switch in the 300 position.

11.1.2.3 Place the FUNCTION switch of the Model 415 in the IF position. Set the sweep width to maximum and turn on the 44 MHz marker only. Center the marker on the oscilloscope trace.

11.1.2.4 Tune the f-m receiver to the lower end of the f-m band, while watching the oscilloscope. The i-f response curve should become visible on the oscilloscope pattern as shown in Figure 11.3A. Use the ATTENUATOR control as required to produce a suitable pattern amplitude. Because of the wide sweep width the response curve will appear extremely narrow with full sweep width. Reduce the sweep width at the same time keeping the 44 MHz marker centered on the oscilloscope. Adjust the tuning of the f-m receiver to center the 44 MHz marker on the i-f response curve of the receiver as the sweep width is reduced. (Fig. 11.3B). In this application a second harmonic of the i-f sweep in the region of 44 MHz is being used to generate sweep signal at 88 MHz. The 44 MHz marker can be interpreted as an 88 MHz crystal controlled marker in this application.



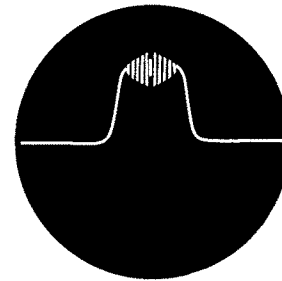
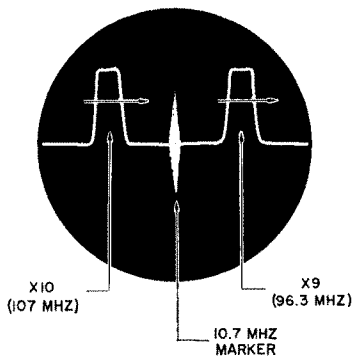
A. F-M Receiver I-F Response at Maximum Sweep

B. Receiver Response Using Reduced Sweep Width (44 MHz Marker Centered on Response Curve).

Figure 11.3 Checking F-M Receiver Tracking at the Low End of the F-M Band

- 11.1.2.5 Check the dial setting of the f-m receiver. It should read exactly 88 MHz. Make the required tracking adjustment for the low end of the f-m band.
- 11.1.2.6 A similar check of dial calibration can be performed at  $2 \times 47.25$  or 94.5 MHz, using the procedure outlined for 88 MHz.
- 11.1.2.7 To calibrate the upper end of the f-m band the 10th harmonic of the 10.7 MHz output of the Model 415 is used. Place the FUNCTION switch to the 10.7 MHz position, keeping the r-f output cable of the Model 415 connected to the antenna terminals of the f-m receiver. Because the tenth harmonic of the 10.7 MHz signal is used the sweep frequency observed on the oscilloscope will be ten times the sweep range observed at 10.7 MHz or approximately 20 megacycles. As a result the response curve obtained at the ninth harmonic of the 10.7 MHz ( $9 \times 10.7 = 96.3$ ) will be observed as well as the tenth harmonic (107.0 MHz). This is indicated in Fig. 11.4A.
- 11.1.2.8 With the 10.7 MHz marker centered on the oscilloscope trace, tune the f-m receiver while observing the movement of the ninth

and tenth harmonic markers on the trace. The markers may move either to the right or to the left depending upon whether the f-m receiver uses high-side injection or low-side injection. Because of the fact that the two response curves observed are 10.7 MHz apart there is no possibility of confusing one with the other, because reference to the tuner dial of the f-m receiver will indicate which response curve is being tuned in. Assume that the receiver is being tuned to 107 Megahertz. The tenth harmonic response curve will then move toward the center marker and the ninth harmonic response curve will move away from the marker as indicated by the arrows of Fig. 11.4A. When the response curve is centered under the marker, reduce the sweep width at the same time using the CENTER FREQUENCY control to keep the marker centered until a presentation such as Fig. 11.4B is obtained. With the marker located as shown, the dial setting of the f-m receiver can be checked. In this case it should be at 107 MHz. By tuning in the opposite direction the same procedure can be used to calibrate the f-m receiver dial to the ninth harmonic of 10.7 MHz, or 96.3 MHz.



A. Receiver Response Curves Generated by 9th and 10th Harmonics of 10.7 MHz Sweep Signal

B. Response Curve at Reduced Sweep Width (10.7 MHz Marker Centered on Response Curve)

Figure 11.4 Checking F-M Receiver Tracking Using the 9th and 10th Harmonics of the 10.7 MHz Sweep

## 11.2 VARIABLE FREQUENCY GENERATOR CALIBRATION

The large number of crystal controlled frequency markers available in the Model 415 make it an ideal instrument for calibration of tunable generators. Direct frequency calibration can be performed or harmonic relationships between the generator and the Model 415 can be used to calibrate an unusually extensive range of frequencies.

- 11.2.1 Connect the Model 415 to an oscilloscope as indicated in Figure 5.2.
- 11.2.2 Connect the signal generator to be calibrated at the EXT MARKER IN jack of the Model 415.
- 11.2.3 Place the FUNCTION switch of the Model 415 to the IF position. Make sure the CHROMA switch is in the OFF position.
- 11.2.4 Select the internal marker of the Model 415 against which it is desired to calibrate the tunable generator. Center this marker on the oscilloscope screen, using the MARKER AMPLITUDE control to set the desired height. Use one to two volts peak-to-peak marker amplitude.
- 11.2.5 Tune the generator to the marker frequency. Adjust the tunable generator output so that a marker is visible on the oscilloscope trace. Adjust the tunable generator until the two markers coincide. A beat frequency will be observed on the oscilloscope as the variable frequency marker approaches the crystal reference marker from one side and passes to the other side. Set the tunable generator marker in the center of the

double beat observed. At this point the tunable generator frequency is exactly equal to the crystal marker frequency.

- 11.2.6 If it is desired to calibrate the signal generator at a frequency other than the marker frequencies supplied in the Model 415, proceed as follows:
  - 11.2.6.1 Assume that it is desired to calibrate the signal generator at 44.5 MHz. Turn on the 44 MHz and 45 MHz markers to determine the direction of increasing frequency, which should be from left to right. Once this is determined turn off the 45 MHz marker and turn on the 100 KHz markers. Reduce sweep width so that 10 or 12 100 KHz markers are visible on the oscilloscope trace (Figure 11.5A). Using the CENTER FREQUENCY control set the 44 MHz marker at the left edge of the oscilloscope trace as shown in Figure 11.5B.
  - 11.2.6.2 Tune the generator which is to be calibrated to 44 MHz as determined by a beat between the internal crystal marker and the generator. Use as low a generator output as possible to provide an accurate variable marker from the tunable generator.
  - 11.2.6.3 Slowly increase the generator frequency and observe the generator marker on the oscilloscope. When the generator marker coincides with the fifth 100 KHz marker to the right of the 44 MHz marker, the signal generator frequency is exactly 44.5 MHz. Keep in mind that it is important to establish the direction of increasing frequency prior to performing this type of frequency calibration.

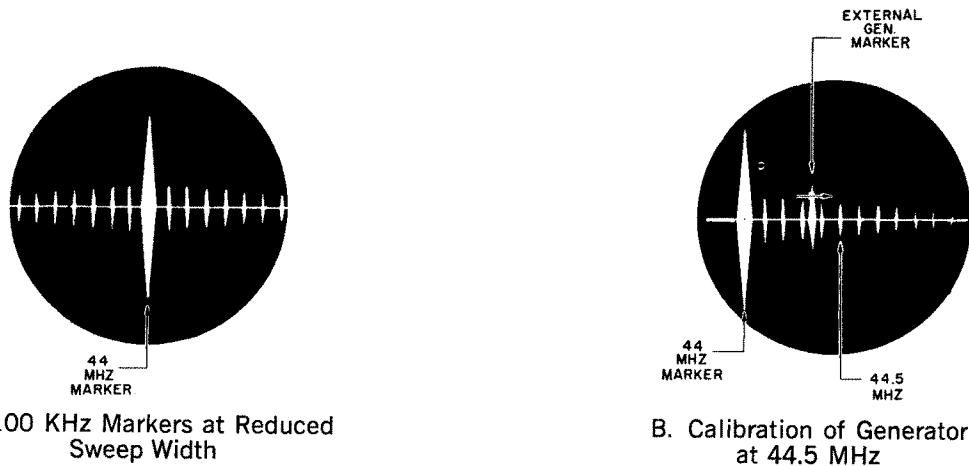


Figure 11.5 Use of 100 KHz Markers in the Calibration of Variable Frequency Generators

## 11.2.7 USING HARMONIC RELATIONSHIPS TO CALIBRATE VARIABLE FREQUENCY GENERATORS

11.2.7.1 To illustrate this procedure assume that it is desired to calibrate a generator at 22.5 MHz.

11.2.7.2 With the FUNCTION switch of the Model 415 in the IF position, select the 45 MHz marker. Tune the variable generator to an indicated 22.5 MHz point while observing the oscilloscope trace. As the 22.5 MHz frequency is approached a marker corresponding to the second harmonic of the generator frequency will appear on the oscilloscope trace.

Once again, the generator is adjusted until a zero beat occurs between the 45 MHz marker of the Model 415 and the second harmonic of the variable generator. This indicates that the variable generator is adjusted to exactly 22.5 MHz.

11.2.7.3 Using the same principles a variable frequency generator can be calibrated at 90 MHz by adjusting the variable generator output until the generator marker coincides with the 45 MHz marker of the Model 415. In this case what is happening is that the 2nd harmonic of the 45 MHz signal of the Model 415 is beating against the 90 MHz signal from the variable generator. This general procedure can be used with 3rd and 4th harmonics as well as the 2nd harmonic method illustrated here.

## 11.3 AM BROADCAST RECEIVER TUNING AND TRACKING CHECKS

Because the Model 415 has crystal controlled signals available at the output when used in the MKR or MOD MKR functions, the combinations of these marker frequencies can be used to generate difference frequencies which fall in the AM broadcast range. For example, by using the 41.67 MHz and 42.17 MHz markers, a difference frequency of 0.5 MHz is generated and is amplitude-modulated if the MOD MKR function position of the Model 415 is used. Using 41.67 and 42.67, a 1 MHz crystal controlled, amplitude-modulated signal can be generated. Repeating the procedure, combining 39.75 MHz and 41.25 MHz a difference frequency of 1.5 MHz is obtained. This procedure can be used in the broadcast band as well as in short wave bands using other frequency differences. In addition, multiples of the marker crystal frequencies can be used as outlined earlier to generate additional crystal controlled reference frequencies.

## 11.4 ADDITIONAL USES OF THE MODEL 415

11.4.1 As previously mentioned, multiples of the basic sweep frequency ranges can be used for sweep frequency checks in frequency

bands other than the basic 10.7 MHz and the television i-f frequency range. Any of the 10.7 MHz harmonics can be used for sweeping at frequency multiples of 10.7 MHz. Because harmonics are used, this means that the maximum sweep available at the fundamental 10.7 MHz sweep range is multiplied by the order of the harmonic being used. For example, if the 3rd harmonic of the 10.7 MHz sweep is being used for alignment in the 30 MHz region then the maximum sweep would be 3 times that available at 10.7 MHz or over 6 MHz. The 100 KHz markers, when used, would represent frequency intervals of 300 KHz in this case.

11.4.2 The swept video output of the Model 415 can be used for direct-sweep frequency evaluation in the 1 to 6 MHz range. The output is essentially flat over this frequency range. As with the other frequency outputs, harmonics of the video sweep can be used for sweeping at multiples of the basic 1 to 6 MHz range. Once again, the internally generated markers of the Model 415 can be used for frequency checks. For example, the 41.25, 41.67, 42.17, and 42.67 markers can be read directly as 4.5, 4.08, 3.58 and 3.08 respectively. Also, any other marker can be used for frequency identification in the video sweep range by subtracting the indicated frequency from the pix frequency which is 45.75 MHz. For example, if the 44 MHz marker is energized while using video sweep the marker can be interpreted as  $45.75 - 44.00 = 1.75$  MHz. This applies to all other marker frequencies as well.

When using multiples of the basic video frequency the indicated marker frequency must be multiplied by the harmonic of the video sweep being used. As an example, if the 2nd harmonic of the video sweep is being used for response checks in the 2 to 12 MHz region, the indicated marker at 4.08 MHz will actually be 8.16 MHz or twice the indicated frequency.

11.4.3 When using modulated marker outputs or unmodulated outputs of the Model 415 for performing receiver tracking checks for calibration purposes it is not always necessary to make a direct connection to the receiver under test. If a short lead is connected to the yellow lead of the RF cable terminating pad this acts as an antenna and can be used to radiate the test signal to the receiver under test by placing it near the receiver.

The above miscellaneous applications of the Model 415 are intended to demonstrate the versatility of the Model 415 in applications other than television receiver alignment. We are sure that the user will develop additional uses for the Model 415 as he becomes increasingly familiar with its features and its operation.

## MODEL 415 ADJUSTMENTS AND MAINTENANCE

12.0

### MAINTENANCE AND ADJUSTMENT PROCEDURES

The Model 415 Sweep/Marker Generator has been factory adjusted for optimum performance and, because of its all solid state construction and regulated power supplies, does not require periodic calibration or readjustment. Because the instrument has been designed to withstand severe mechanical shock as well as electrical overloads (All internal supplies are regulated and have built-in short circuit protection), maintenance and repair requirements should be minimal. If maintenance work is required then possible readjustments may be required if tuned circuits are involved or if the circuit repaired requires a calibration adjustment.

12.1

### TROUBLESHOOTING INFORMATION AND PROCEDURES

To aid in localizing possible problems the functional block diagrams of Section 3 and Section 4 of this manual are repeated. A thorough review of Sections 3 and 4 of this manual with reference to the accompanying block diagrams will aid considerably in circuit analysis. In addition to the block diagrams and complete schematics, the following troubleshooting information is included at the end of this section:

Figure 12.2. Parts layout for Marker, Waveform Generator and Pattern Amplifier Board (Viewed from Component Side).

Figure 12.3. Parts layout for Power Supply/R-F Board (Viewed from Component Side).

Figure 12.4. Parts Layout for Sweep Oscillator Board (Viewed from Component Side).

Figure 12.5. Parts Layout for Pix Oscillator Board (Viewed from Component Side).

Figure 12.6. Waveform Generator Waveforms.

TABLE 12.1 Troubleshooting Chart

TABLE 12.2 Model 415 Switching Chart

TABLE 12.3 Transistor Voltage Chart

Because of the multiple outputs available at the Model 415 front panel as well as the control and switching functions performed at the front panel, many problems, if not all trouble symptoms may be determined by operation of various front panel controls and observing that a required function should result. Absence of a particular signal or output can then be used to analyze the problem. Reference to the Troubleshooting Chart of Table 12.1 can be made to localize the problem. As outlined in Sections 3 and 4 of this manual the FUNCTION switch is used to activate certain stages as required in each position as well as to combine output signals in the desired sequence so that the required output is generated at the RF-IF-VIDEO jack. The Switching Chart

of Table 12.2 condenses this information into compact form. By reference to the Switching Chart as well as the functional block diagrams and schematics, the defective signal path can be readily determined, and from there the defective stage can be localized. Voltage checks may then be employed to investigate a suspected stage. There are certain basic circuits in the Model 415 which operate independently of the FUNCTION switch and as a result can be evaluated or analyzed without reference to the FUNCTION switch position.

#### 12.1.1 INTERCONNECTING CABLES, TEST LEADS AND SWITCHES

Whenever an apparent loss of input signal to the Model 415 or a signal from the Model 415 to external equipment (television receiver and oscilloscope) occurs the first items to be evaluated are all interconnecting cables. This is particularly true after the unit has been in service for a considerable period of time. Continued manipulation of all test leads furnished with the Model 415 can cause intermittent or open leads which may not be readily apparent, particularly in the shielded cables. Another check to be made before proceeding into the Model 415 circuitry proper is to check all connectors and switches for proper operation. This can be done by use of an ohmmeter with the unit off, or, in the case of signal tracing, this can be done by using an oscilloscope to trace the signal either through a connector or through a switch.

If horizontal sweep is available at the Model 415 and a scope is used for signal tracing, the sweep selector of the oscilloscope may be left in the external sweep position while signal tracing in the Model 415. In this way the observed wave forms are always synchronized on the oscilloscope. If it is desired to view the wave forms at slower sweep rates select line sync operation of the oscilloscope. Do not use line sweep because this will distort the observed waveforms.

#### 12.1.2 REGULATED POWER SUPPLIES AND BIAS SUPPLIES

The regulated 25 volt positive and negative internal supplies of the Model 415 may be checked indirectly at the bias jacks of the front panel. Both 0-25V bias adjustments are connected across the internal regulated supplies. Therefore, when each bias adjustment is at maximum clockwise position the voltage available at the bias jacks is equal to the internal regulated supply voltage. The positive and negative voltages available at the 0-50V supply are unregulated but may be checked in a similar manner at the corresponding bias jack.

To locate voltage reference points within the unit proper, several methods may be used. First, the bottom cover of the unit may be removed, exposing the under portion of the printed circuit boards. All voltage test points are indicated in the copper foil of the underside of the boards. Points which are called out on the schematic are identified accordingly on the underside of the P.C. boards. All reference points may also be located, but not as readily, from the top side of each printed circuit board. In this way, it is not necessary to remove the bottom cover of the unit for voltage checks. Reference to the parts location diagrams of Figures 12.2, 12.3, 12.4 and 12.5 identify various test points as they would appear from the top. The corresponding identification lettering is not visible from the top. Because the drawings are to scale, however, voltage points may be located by reference to the drawings and to the particular board under investigation. A similar approach may be used in locating signal points as well as voltage measurement points. All interconnecting cables and wires in the Model 415 are also terminated at tie points which are identified on the underside of the P.C. board. By referring again to the parts layout diagrams, the points can be located from the component side of the boards for signal tracing purposes. The parts layout drawings indicate the orientation of each board when viewed from the front of the unit.

The test point identification procedure will be outlined by taking each of the parts location diagrams in order. Referring to Figure 12.2 notice that test points have been called out, and that each refers to a specific point on the P.C. boards. These points are identified on the underside of the P.C. board but, because of the scaled layout of the parts drawing these points can be located from the component side of these P.C. boards. For example in Figure 12.2 TP-1 indicates a point where +14 volts is always present when the unit is turned on. TP-2 indicates that terminal where +25 volts should be present at all times. TP-3 indicates the point where -25 volts should be present at all times. TP-4 indicates the point where supply voltage to Q2 (ADJ PIX oscillator) would appear when the ADJ PIX marker switch is energized at the front panel. A similar procedure can be used to verify that A+ appears at each marker oscillator by turning on the appropriate switch and checking for the appearance of voltage at points 3, 4, 5, etc., across the marker board. The "TP" numbers do not appear on the P.C. board foil. They are used here for convenience in discussing troubleshooting and adjustment procedures.

Referring to Figure 12.3, a similar identification of certain voltage test points is made. As indicated, TP-301 indicates a point at

which +14 volts is present when the Model 415 is turned on. TP-302 indicates a -25 volt point. TP-303, TP-305, and TP-306 indicate points at which +14 volts, +25 volts DC and -25 volts, respectively, appear in the power supply portion of the Model 415 when the unit is turned on.

Referring to Figure 12.4, TP-202 indicates a point at which +14 volts should appear when the 10.7 MHz sweep oscillator is energized. TP-204 indicates the point at which +14 volts should appear when the 44 MHz sweep oscillator is energized. TP-206 indicates a point at which -25 volts is always present when the Model 415 is turned on.

To check for proper sweep voltage application to the sweep oscillators, connect the oscilloscope to TP-203 and adjust the SWEEP WIDTH control from min to max. The observed waveform should vary as indicated in Figure 12.6F, with maximum amplitude occurring at the maximum clockwise position of the SWEEP WIDTH control.

Referring to Figure 12.5, TP-401 indicates a point at which +14 volts appears when Video Sweep Amplifier Q401 is energized, and TP-402 indicates the point at which +14 volts appears when Pix Oscillator Q402 is energized.

#### 12.1.3

### HORIZONTAL SWEEP CIRCUITS

All internal sweep voltages are generated by the waveform generator consisting of Q12 and Q13. The horizontal sweep voltage is taken from the base circuit of Q13 and supplied to Q14 from which sweep voltages of opposite polarities may be selected. These outputs are supplied to the sweep reversing terminals of CHROMA switch S522 and then to the HORIZ SWEEP switch S514 and from there to SCOPE HORIZ INPUT jack J505. To aid in evaluating circuit performance the waveforms of Figure 12.6 are provided for reference. These circuits are operational in all positions of the FUNCTION switch; therefore, loss of oscilloscope sweep when the oscilloscope sweep selector is in the external sweep position indicates a defect in the signal path described. The synchronizing trigger for the waveform generator is developed by neon lamp P513, which is also the POWER ON/OFF indicator lamp (See Schematic 488-084-9-001). Failure of this lamp results in loss of sync, which causes the basic sweep rate to be slightly less than 60 Hz. The Model 415 can still be used satisfactorily; the only noticeable effect is that there will be a slight low-frequency "breathing" of response curves and waveforms observed on the oscilloscope.

#### 12.1.4

### PATTERN AMPLIFIER CIRCUITS (Q19 and Q20)

Input signals from receiver under test are connected to either the DIRECT jack (J502)

or the DEMOD jack (J503) and either is selected by the PROBES switch S512 and the signal is then processed through Q19, a phase splitter, VERTICAL switch S515, Pattern Output Amplifier Q20 and from there through a 15,750 Hz filter to SCOPE VERT INPUT jack J504. Connect an audio oscillator to either the DIRECT or the DEMOD jack and, with the PROBES switch in the corresponding position, observe the oscilloscope output. The condition of the pattern amplifiers can then be determined.

**12.1.5 MARKER DETECTORS AND AMPLIFIERS**  
The 44 MHz Detector Q15 and the 10.7 MHz Detector Q16 as well as marker amplifiers Q17 and Q18 are energized at all times. Outputs are generated by these circuits when the proper input signals are furnished from the FUNCTION switch or from stages activated by other front panel switches, such as the marker switches.

**12.1.6 VIDEO IF/RF ATTENUATOR Q306**  
All Model 415 outputs are supplied to the output jack through the attenuator stage. The gain of this stage is controlled by ATTENUATOR control R515.

**12.2 USE OF MAINTENANCE INFORMATION IN TROUBLESHOOTING**

An example of the use of the troubleshooting information furnished will be outlined. Assume that there is no video output with the FUNCTION switch in the VIDEO position, but outputs at all other FUNCTION switch positions are normal. Refer to Figure 4.1 (Repeated).

**12.2.1** Check that marker operation is normal. Because of the post injection marker system, markers will be available if Marker Amplifier Q17 and Q18, 44 MHz Detector Q15, 44 MHz Sweep Oscillator Q201 and Buffer Amplifier Q202 and the Marker Oscillators Q2 through Q11 are operating properly.

**12.2.2** If output is available in the IF position of the FUNCTION switch and if the CHROMA switch is effective in providing the proper signal for circuit alignment, Pix Oscillator Q402 is operating properly, but may not have dc applied in the VIDEO function. Check the d-c switching to the stages outlined here.

**12.2.3** Notice in Figure 4.1 that the combined outputs of the 44 MHz sweep oscillator and the pix oscillator are supplied through the FUNCTION switch to Low Pass Filter and Video Sweep Amplifier Q401, and that the output of Q401 is fed through Attenuator Q306 to the output jack. Because this stage is used only in the VIDEO function, it should be investigated. Access to this stage is obtained by removing the bottom cover of the Model 415. The parts layout diagram of Figure 12.5 and the voltage chart of Table 12.3 can be used for reference. The schematic can be used to check cabling and d-c

switching if required.

**12.2.4** The above troubleshooting information is condensed in the troubleshooting chart of Table 12.1. Under the TROUBLE column locate "No Video Sweep Output." Opposite this under POSSIBLE CAUSES are listed Q401 (Video Sweep Amp), Q402 (Pix Osc), X401 (Pix Osc Crystal), D403 (Mixer diode), Q201 (44 MHz Sweep Osc) and Q202 (44 MHz Buffer Amp). As explained previously, normal outputs in other FUNCTION Switch positions as well as evidence of Markers in the VIDEO position of the FUNCTION switch eliminate all suspected stages except Q401 and diode D403.

**12.2.5** The switching information of Table 12.2 summarizes in chart form the information of the functional block diagrams. Only the stages affected by the FUNCTION switch are indicated. The left hand column lists the FUNCTION switch positions in order, and the headings across the top list the stages affected by the FUNCTION switch. For each position of the FUNCTION switch the corresponding condition of each stage is given.

**12.3 REPLACEMENT OF DEFECTIVE COMPONENTS**

All components shown in the parts layout drawings of Figure 12.2 and Figure 12.3 are accessible from the component side of the P.C. boards by lifting the cover of the Model 415. For component replacement access to the underside of the P.C. boards is obtained by removing the bottom cover of the unit. This is done by removing the four corner screws which retain the rubber feet on the unit as well as the four remaining screws, two toward the front of the unit and two toward the rear of the unit. Removal of the bottom cover is also necessary to provide access to the Pix Oscillator board of Figure 12.5. Once the bottom cover is removed the component side of the Pix Oscillator board is accessible. For replacement of components the underside of the Pix Oscillator board is accessible by removing the three P.C. board mounting screws which hold the Pix Oscillator board in place. The board can then be turned to allow access to the underside.

Component replacement on the sweep oscillator board of Figure 12.4 is performed as follows. Inscribe or pencil a line on the tuner carriage to indicate the position of the pointer which is attached to the carriage by means of a sheet metal screw. Loosen the screw which retains the pointer and remove the pointer. Unsolder resistor R516 at point K as indicated in Figure 12.4. Unsolder the lead of C505 which connects to TP-203 on the sweep oscillator board as indicated in Figure 12.4. Remove the five mounting screws which hold the sweep oscillator board in place. Gently slide the oscillator board with the tuner attached straight back

from the front panel. Sufficient lead length is provided so that the board can now be turned over for access to the foil side. After replacing the board, align the pointer on the line previously scribed and tighten the retaining screw. Make sure the pointer is not binding against the mounting bracket or the front panel.

#### 12.4 INTERNAL ADJUSTMENT PROCEDURES

With only a few exceptions the internal adjustments of the Model 415 that may be required consist primarily of tuned circuit adjustments. For example, referring to the trouble shooting chart of Table 12.1, the absence of any one of the markers may be the result of a mistuned coil in each oscillator stage.

#### 12.4.1 MARKER OSCILLATOR ADJUSTMENTS

One of the most straightforward methods of performing marker oscillator tuning is to first connect the Model 415 to an oscilloscope as shown in Figure 5.2 (fold-out at end of manual). Place the FUNCTION switch in the IF position. Turn on several of the IF markers and adjust the MARKER AMPLITUDE control for suitable marker amplitude as observed on the oscilloscope. Adjust the SWEEP WIDTH control as required, together with the CENTER FREQUENCY control so that the frequency region which includes the missing marker is displayed on the oscilloscope. Now adjust the applicable coil in a counterclockwise direction until the marker appears on the oscilloscope.

The parts layout drawing of Figure 12.2 is useful in locating the applicable marker, when used in conjunction with the troubleshooting chart of Table 12.1. For example, if the CHROMA (42.67) marker is missing, then reference to the troubleshooting chart indicates that the possible defect is Q6, X6 or mistuning of L6. The parts location diagram makes it possible to locate the questionable stage immediately. With the 42.67 (3.08) CHROMA marker switch in the ON position, adjust L6 in a counterclockwise direction as required to restore the marker. If the marker is not restored, perform the voltage measurements on the oscillator stage.

Once the marker is restored this indicates that the oscillator as well as the post injection system of the Model 415 are functioning properly. Next, it must be verified that the marker output is available at the output jack. The PR-151 Demodulator Probe can be used effectively in conjunction with a vacuum tube volt meter to determine the presence of marker output at the output jack. The PR-151 can be connected to any VTVM having a microphone type connector such as that employed on the B&K Model 177 VTVM. Turn the ATTENUATOR control to max.

Using the lowest d-c voltage range avail-

able (0.5 volts on the B&K Model 177) with negative polarity, turn on only the marker which is to be tuned. A d-c voltage reading will be indicated on the VTVM if the marker oscillator is functioning. Adjust the marker coil tuning slug for a maximum indication on the VTVM. The slug is then adjusted one-half turn counterclockwise from the maximum output point. Return the FUNCTION switch to the IF position and observe that the marker is visible on the oscilloscope. The method outlined here can be used for peaking all marker oscillators.

#### 12.4.2 CH 4 OSCILLATOR ADJUSTMENT

The method of using the PR-151 for peaking oscillators can be used for the Channel 4 oscillator, Channel 10 oscillator and the pix oscillator as well. To perform alignment of the Channel 4 oscillator, place the FUNCTION switch in the Ch 4 position. Next, referring to Figure 12.4, ground the end of resistor R207 indicated as TP-205. This disables the IF sweep so that only the Channel 4 oscillator component is supplied to the output jack of the Model 415. With the PR-151 connected to the output jack of the Model 415 adjust coils L301 and L302 for maximum indicated output, using the lowest d-c voltage range of the VTVM.

#### 12.4.3 CHANNEL 10 OSCILLATOR ADJUSTMENT

The Channel 10 oscillator tuning adjustments can be performed in a manner similar to that outlined for Channel 4. Place the FUNCTION switch in the CH 10 position and ground TP-205 of Figure 12.4 as was done for Channel 4. With the PR-151 connected to the output jack of the Model 415 and the ATTENUATOR at maximum, adjust the coils L305 and L307 for maximum indicated dc on the VTVM.

#### 12.4.4 PIX OSCILLATOR ADJUSTMENT (BOTTOM COVER OF MODEL 415 REMOVED)

The pix oscillator peaking can be performed in a similar manner. Place the FUNCTION switch in the IF position. Ground TP-205 of Figure 12.4. Place the CHROMA switch in the ON position and connect the PR-151 to the output jack on the Model 415. Adjust the shielded coil L-404 of the pix oscillator (refer to Figure 12.4) for maximum output as indicated on the VTVM. REMOVE THE SHORTING LEAD UPON COMPLETION OF THE ABOVE OSCILLATOR ADJUSTMENTS.

#### 12.4.5 USING THE SPARE MKR OSCILLATOR

This oscillator stage is energized by the SPARE MKR switch. The primary purpose of this oscillator stage is to provide an additional crystal-controlled marker oscillator in the event that a user does extensive alignment work in sets which require a special alignment frequency. This is true in trap frequency alignments; for example, Motorola and Philco sets have trap frequencies of 35.25 MHz and 38.75 MHz respectively.



### 12.4.5.1 USING THE SPARE MKR OSCILLATOR AS A CRYSTAL-CONTROLLED MARKER OSCILLATOR

The oscillator circuit will accept a third overtone crystal in the 35 MHz to 50 MHz range. The crystal pin receptacles provided accept a crystal in the HC 25/U holder which has .040" diameter pins. Crystals in other holder configurations must be wired into the circuit. For best frequency correlation, the crystal frequency should be specified with 32 picofarad load capacitance. The frequency adjustments (C2 and L1) can be located in Figure 12.2. Trimmer capacitor C2 is a rough frequency adjustment and tunable inductor L1 is used for final oscillator peaking. When a crystal is to be used at the low-frequency end of the tuning range, C2 is set toward maximum capacitance and L1 is adjusted for maximum oscillator output. Minimum C2 capacitance is used at the high-frequency end of the tuning range.

To observe the effect of tuning the oscillator, connect the Model 415 to an oscilloscope as shown in Figure 5.2 and place the FUNCTION switch in the IF position. Set sweep width to maximum and adjust the sweep center frequency so that the sweep range includes the spare marker frequency. With the CENTER FREQUENCY control set at the low-frequency limit the sweep range is about 34 MHz to 45 MHz. With the CENTER FREQUENCY control at the high-frequency limit, the sweep range is about 42 MHz to 54 MHz. Set the MARKER AMPLITUDE control for suitable marker height as determined from observation of the standard internal

markers. Adjust L1 and C2 as required to produce a marker indication on the scope. Adjust L1 for final peaking (maximum marker height) and then readjust L1 one turn counterclockwise from the maximum indication. The marker frequency can then be used in the 415 post-injection marker system. The marker signal is also available at the RF-IF-VIDEO jack when the FUNCTION switch is in the MKR or MOD MKR positions.

### 12.4.5.2 USING THE SPARE MARKER OSCILLATOR AS A VARIABLE FREQUENCY SOURCE

Although the primary function of the spare marker oscillator has been outlined in paragraph 12.4.5, the variable frequency feature can also be used effectively if a non-standard marker frequency is desired anywhere in the i-f sweep range of the Model 415. The spare marker oscillator can be converted to a variable frequency oscillator by performing the circuit modifications shown in dotted lines in Figure 12.1.

A 6.8 pf capacitor is added to Q1 between the emitter and collector, and a .005 Mfd ceramic capacitor is connected to the crystal pin receptacles. The oscillator will then free-run at a frequency determined by the adjustment of L1 and C2.

As in the crystal-controlled application, this marker can be used in conjunction with the other reference markers and is available at the RF-IF-VIDEO jack of the Model 415 with the FUNCTION switch in the MKR or MOD MKR position. It is turned on and off by use of the SPARE MKR switch.

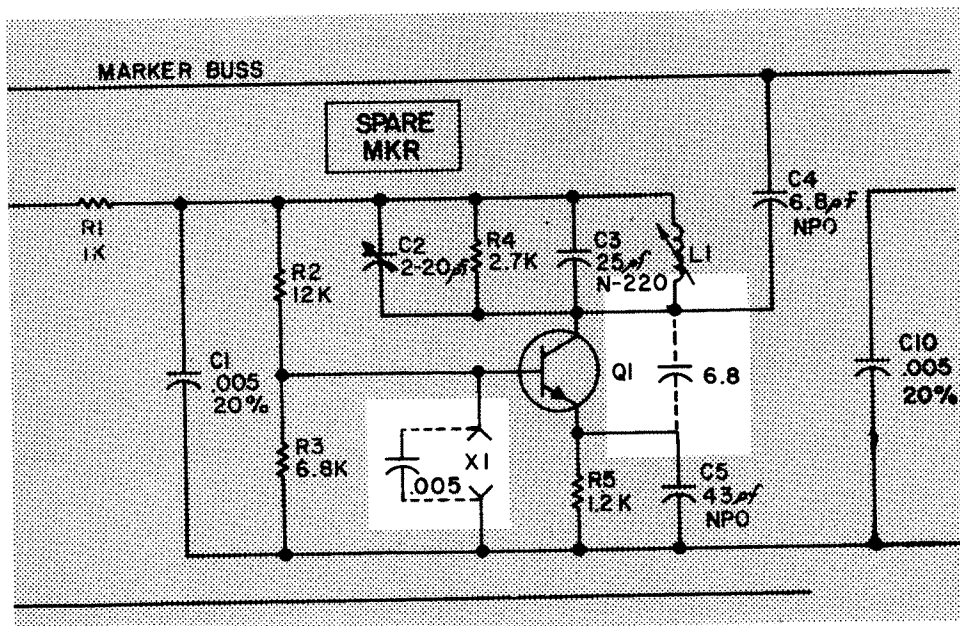


Figure 12.1. Modification of Spare Marker Oscillator for Variable Frequency Operation

### 12.4.5.3 CALIBRATION OF THE SPARE MKR OSCILLATOR FOR VARIABLE FREQUENCY OPERATION

The internal crystal markers of the Model 415 can be used to calibrate the spare marker oscillator when it is used as a variable marker generator. Because the 100 KHz markers will modulate every reference marker used, they cannot be used for intermediate frequency calibration of the variable oscillator. Calibration must therefore be performed by interpolating between the standard crystal-controlled markers of the Model 415. For example, if it is desired to calibrate the spare marker oscillator at 44.5 MHz, turn on the 44 MHz and 45 MHz markers and adjust L1 and C2 of the spare marker oscillator circuit as required to center the variable marker midway between the reference markers. Because the sweep is linear, the frequency is proportional to distance along the oscilloscope base line. To illustrate, if calibration at 44.3 MHz is desired, the variable oscillator is adjusted so that its marker falls at three-tenths the distance from the 44.00 MHz marker to 45.00 MHz. This method can be used between any pair of markers. Once calibrated, the spare marker can be used for spot alignment and is available at the RF-IF-VIDEO jack of the Model 415 when the FUNCTION switch is in the MKR or MOD MKR position.

### 12.4.6 BALANCING SWEEP OUTPUTS OF HORIZONTAL SWEEP AMPLIFIER Q14

If replacement of Q14 is required, the following balancing adjustment should be performed to insure that the oscilloscope trace length does not vary when the sweep direction is reversed by use of the HORIZ SWEEP NORM/REV switch. This can be done by use of a VTVM as follows:

- 12.4.6.1 Set the VTVM range switch to a peak-to-peak voltage range greater than 15 volts. If a B&K Model 177 is used, use the 40-volt P-P range with the VTVM probe switch in the AC position.
- 12.4.6.2 Turn on the Model 415 and place the CHROMA switch in the OFF position and place the HORIZ SWEEP switch to the REV position. Connect the VTVM to the center pin of the SCOPE HORIZ INPUT jack and note the peak-to-peak reading on the VTVM. Place the HORIZ SWEEP switch to the NORM position and adjust the trimpot R69 (refer to Figure 12.2) for an equal peak-to-peak reading.

### 12.4.7 ADJUSTMENT OF SWEEP OSCILLATOR VARACTOR BIAS

(Refer to Figure 12.4)

If any repair work has been performed on the sweep oscillator assembly board, the setting of the varactor bias adjustment should be rechecked. Set SWEEP WIDTH control to minimum.

- 12.4.7.1 With the Model 415 turned on, connect a VTVM (negative d-c voltage range) to TP-207 (center arm of potentiometer R202) as indicated in Figure 12.4. Adjust potentiometer R202 as required to obtain a reading of 11.0 volts dc.
- 12.4.7.2 To test for excessive varactor leakage, place the VTVM at TP-201. The voltage at this point should be greater than 9.8 volts dc (negative polarity). A d-c reading of a lower value indicates that either varactor D201 or D202 has excessive leakage and must be replaced.

### 12.4.8 SWEEP LINEARITY ADJUSTMENT

(R64, Figure 12.2)

This adjustment has been preset at the factory and should seldom if ever require readjustment. If however, any repair or replacement work has been performed in the waveform generator circuitry or in the sweep oscillator circuitry, particularly varactor replacement, it is possible that the linearity may have to be readjusted. Proceed as follows:

- 12.4.8.1 The most convenient method of performing this adjustment is to set the SWEEP WIDTH control to maximum, set the FUNCTION switch to the IF position, and turn on all IF markers. Set the MARKER AMPLITUDE control for suitable marker height as observed on an oscilloscope. Adjust the CENTER FREQUENCY control to move the marker display from one end of the oscilloscope trace to the other. Observe the marker spacing as this is done. If the markers suddenly compress or separate as they approach either end of the sweep, this indicates that some non-linearity exists. Adjust R64 slightly in either direction and repeat the CENTER FREQUENCY adjustment and observe the effect on relative marker position. Continue to adjust R64 in small increments until the marker separation appears to remain constant as the markers are moved from one end of the oscilloscope trace to the other.



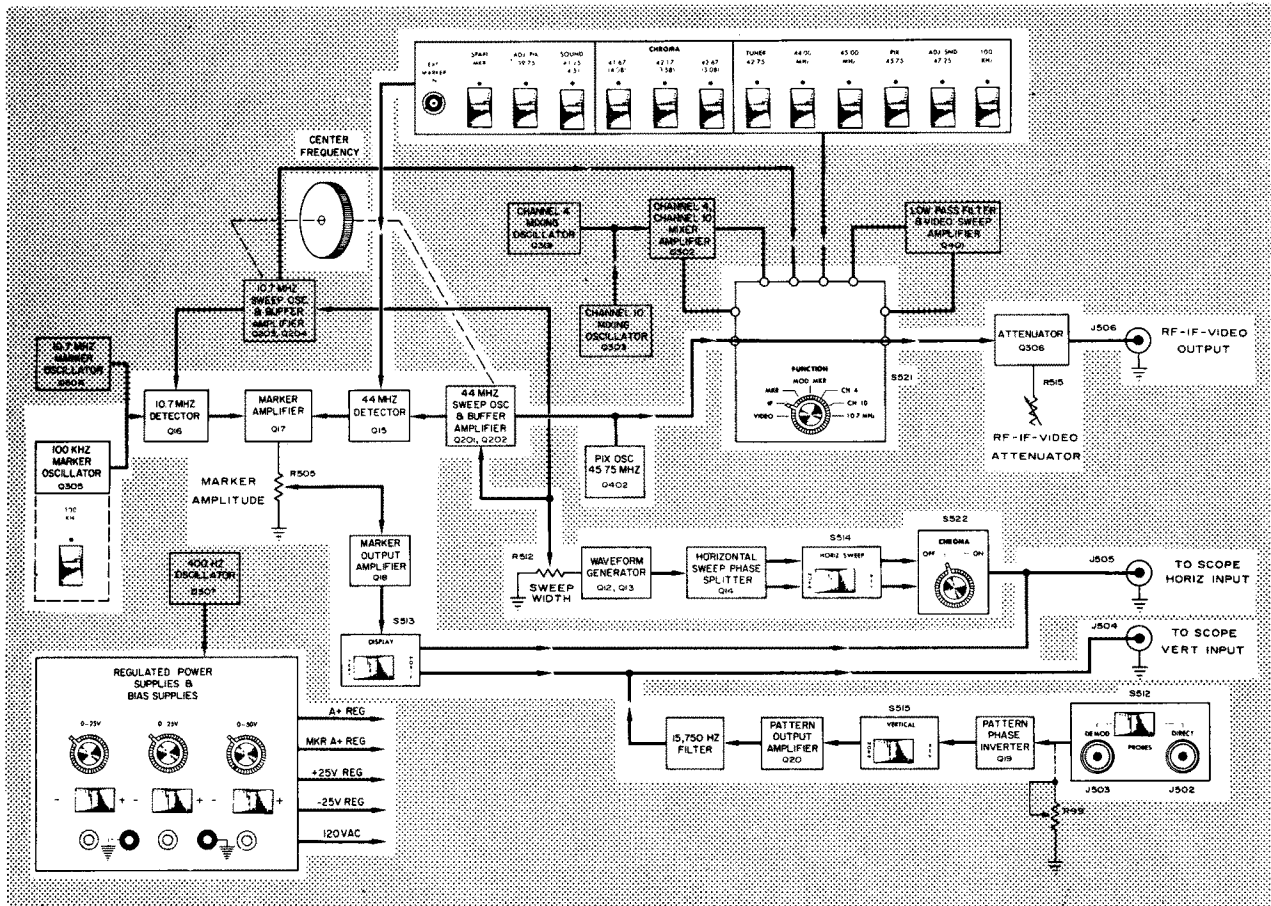


Figure 4.4 (Repeated) Model 415 Block Diagram for I-F Alignment and Overall Chroma Alignment

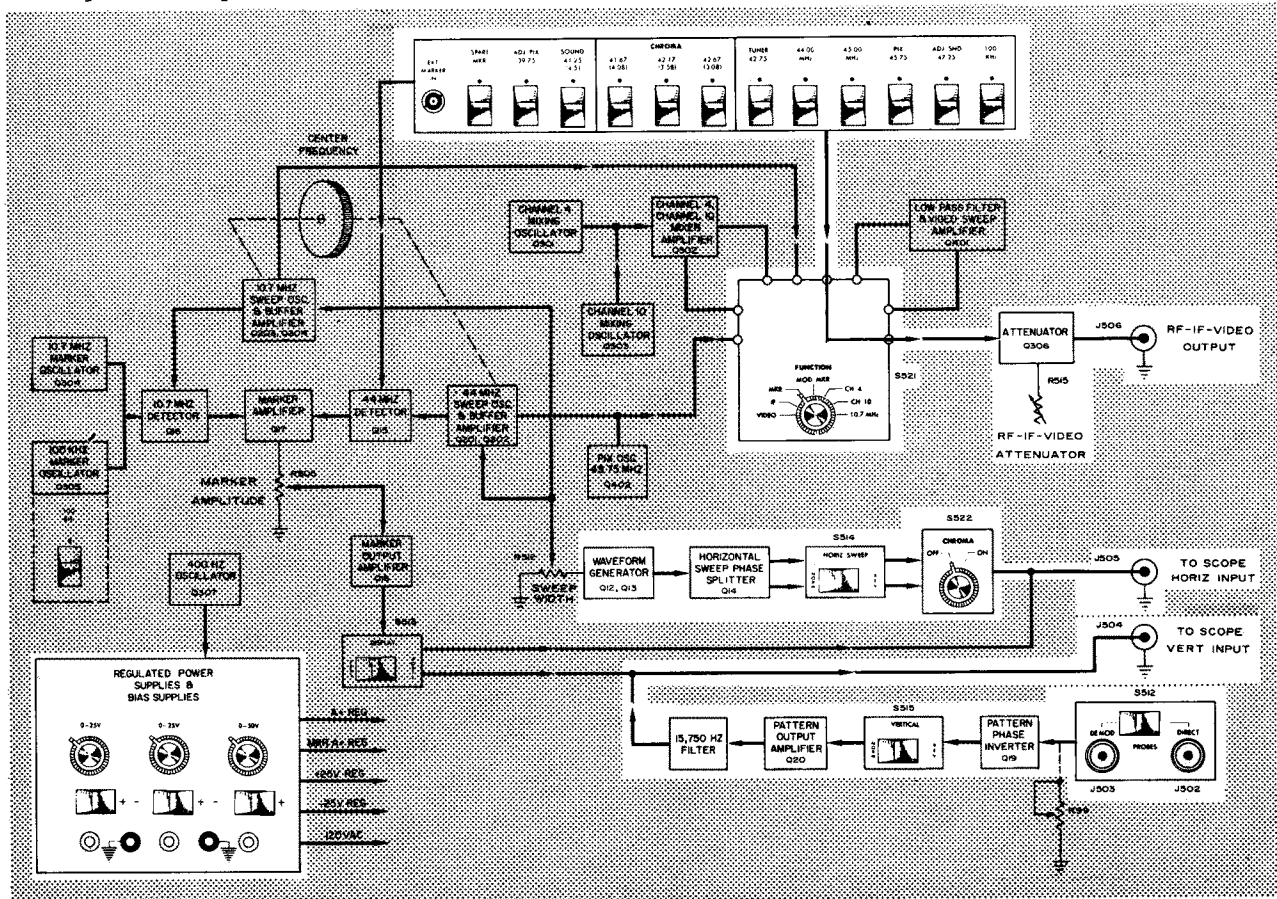


Figure 4.10 (Repeated) Model 415 Block Diagram for MKR Function

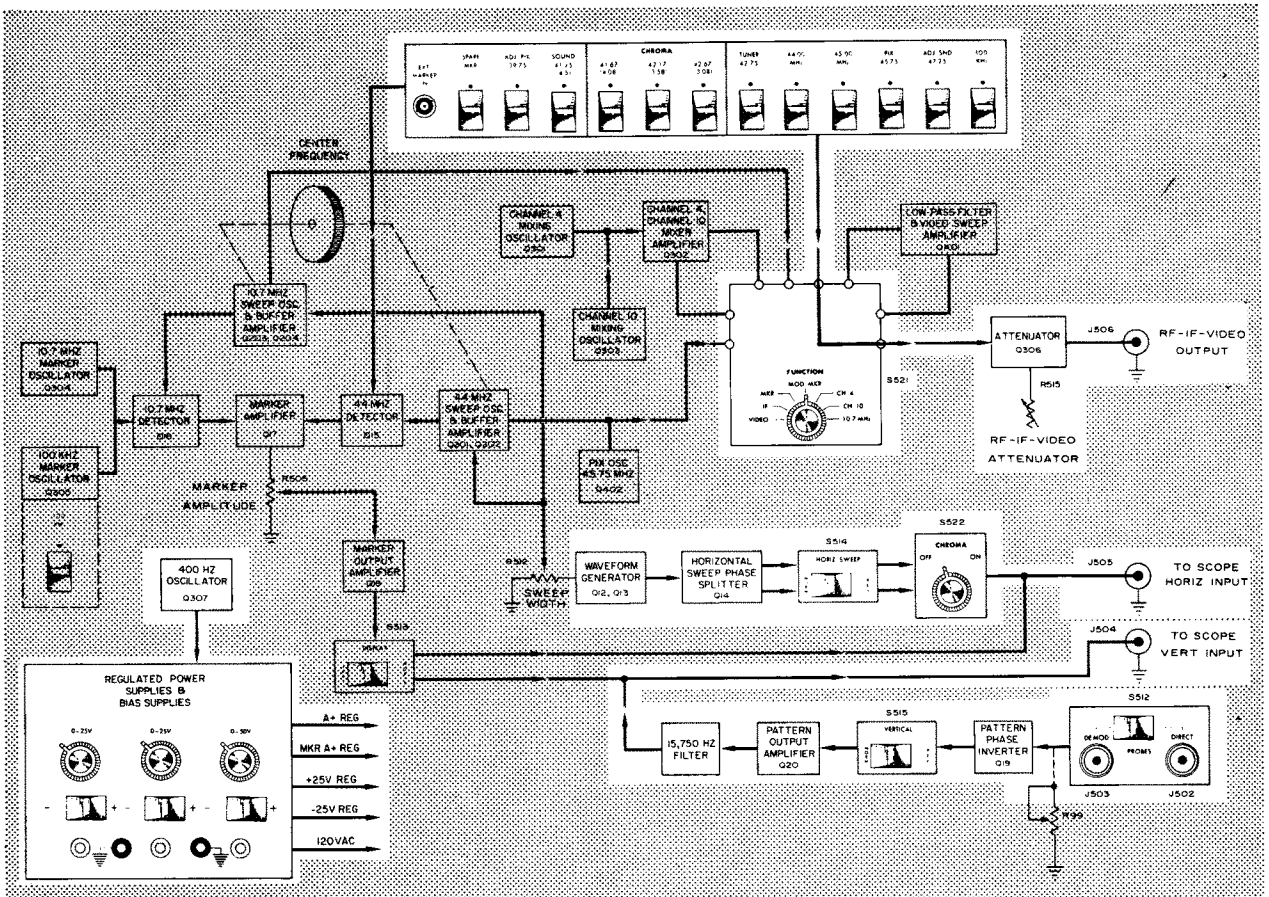


Figure 4.12 (Repeated) Model 415 Block Diagram for MOD MKR Function

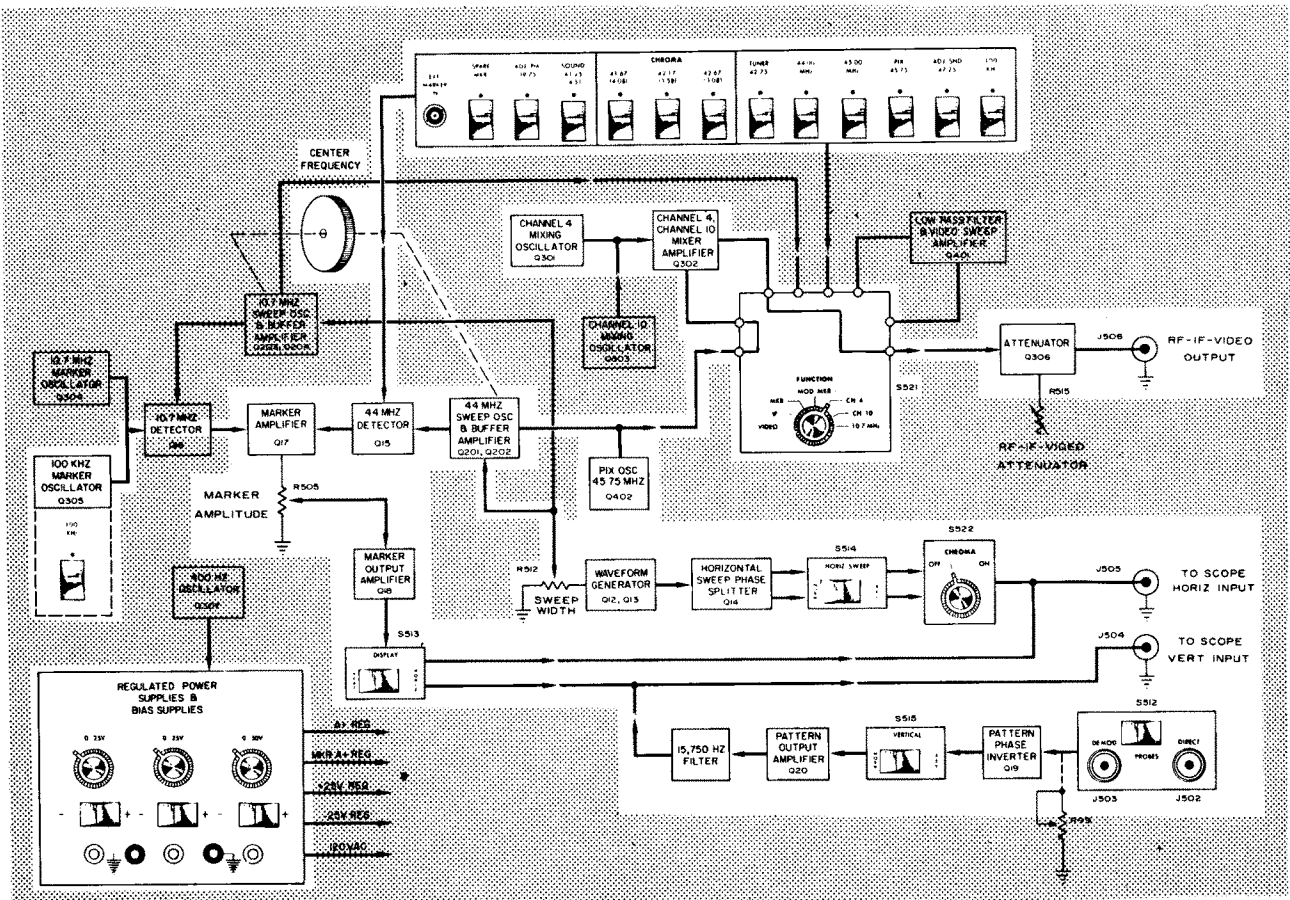


Figure 4.14 (Repeated) 415 Block Diagram for CH 4 Function

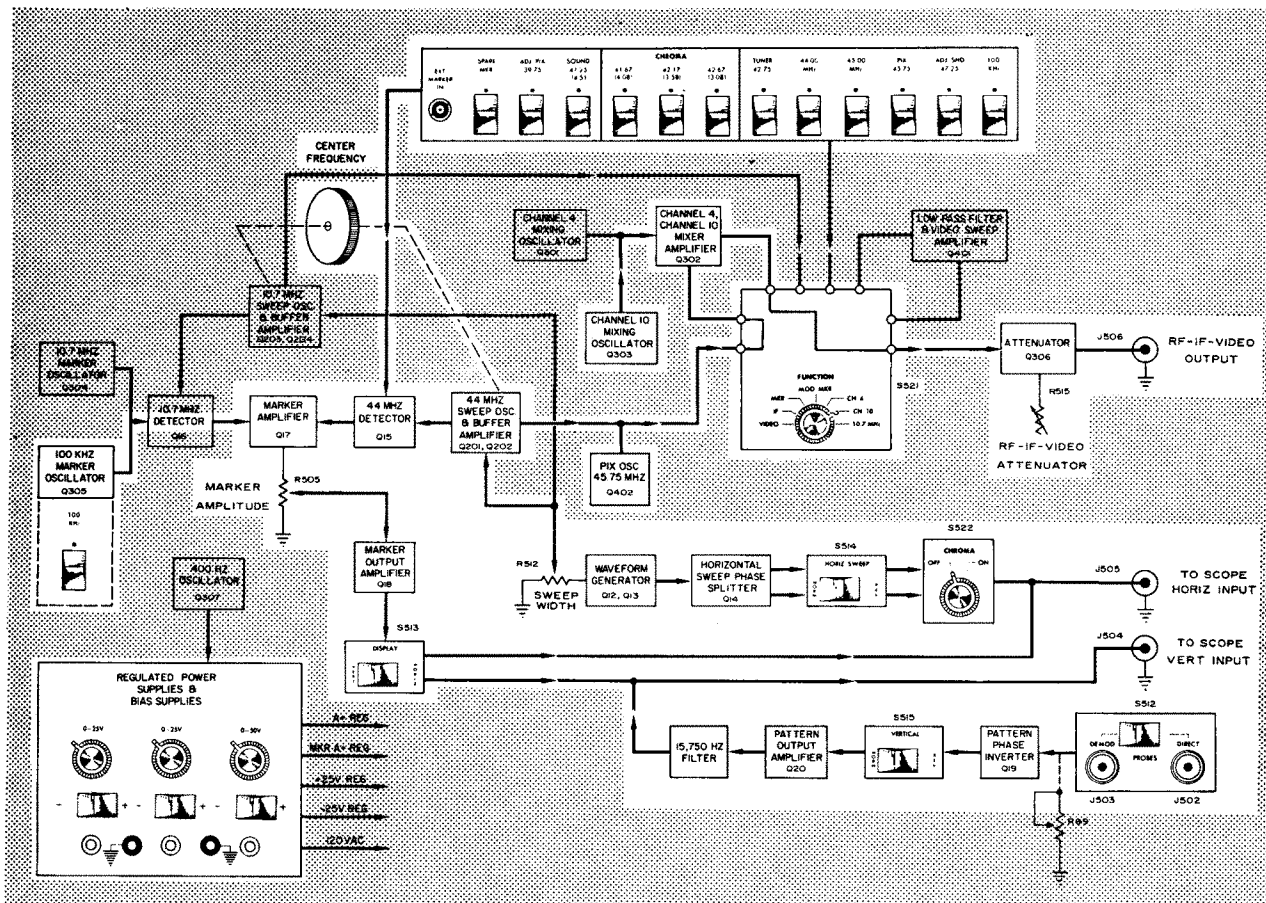


Figure 4.18 (Repeated) 415 Block Diagram for CH 10 Function

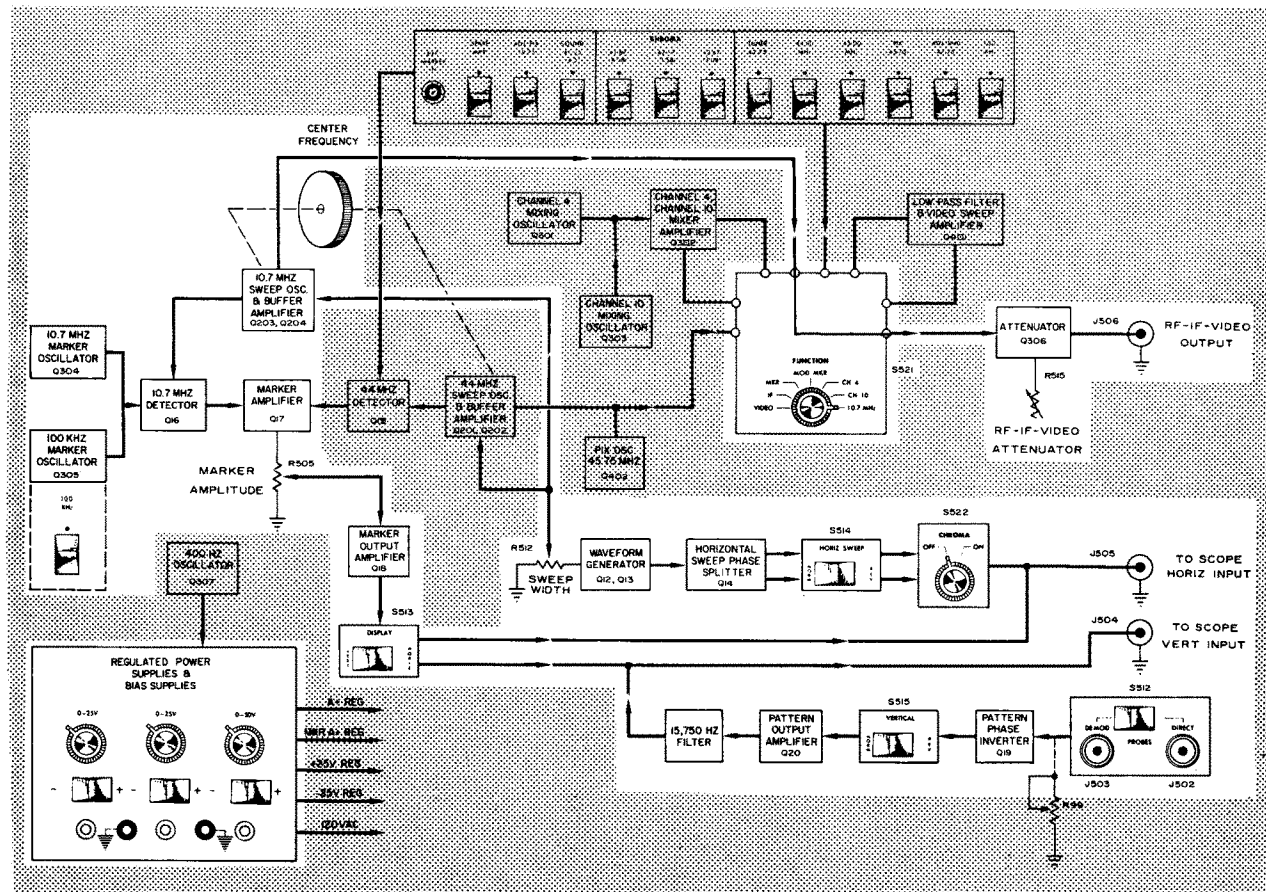


Figure 4.20 (Repeated) Model 415 Block Diagram for 10.7 MHz Function

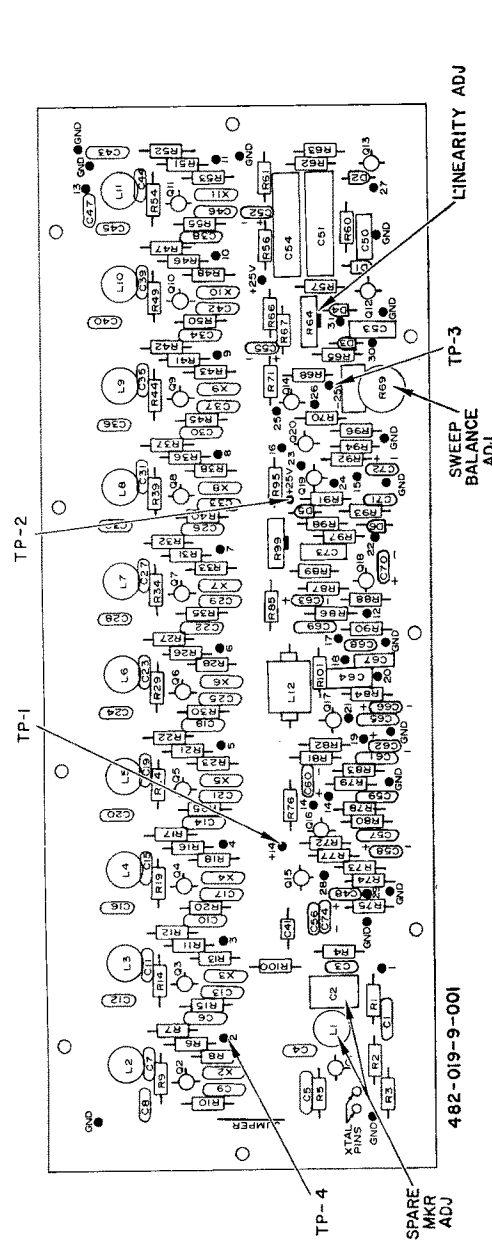


Figure 12.2 Parts Layout for Marker, Waveform Generator, and Pattern Amplifier Board (Viewed from Component Side)

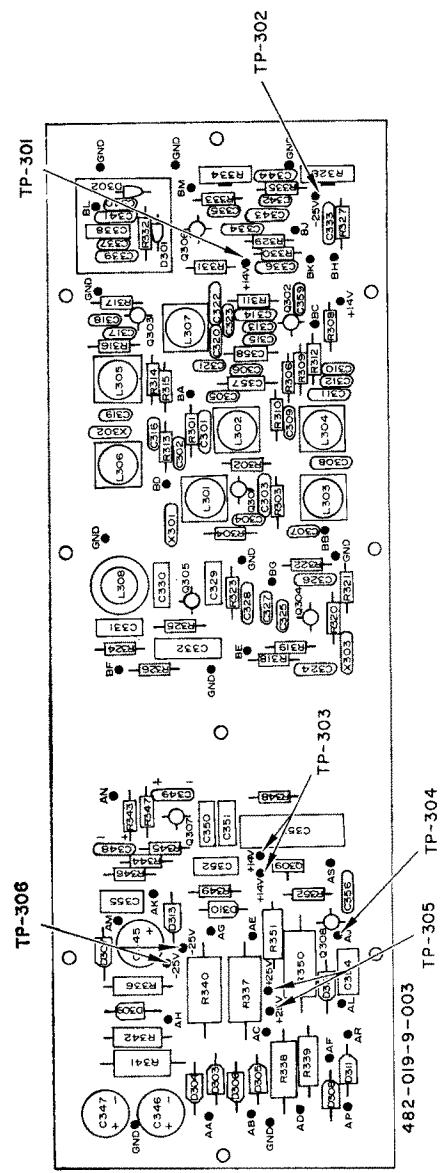


Figure 12.3 Parts Layout for Power Supply/RF Board (Viewed from Component Side)

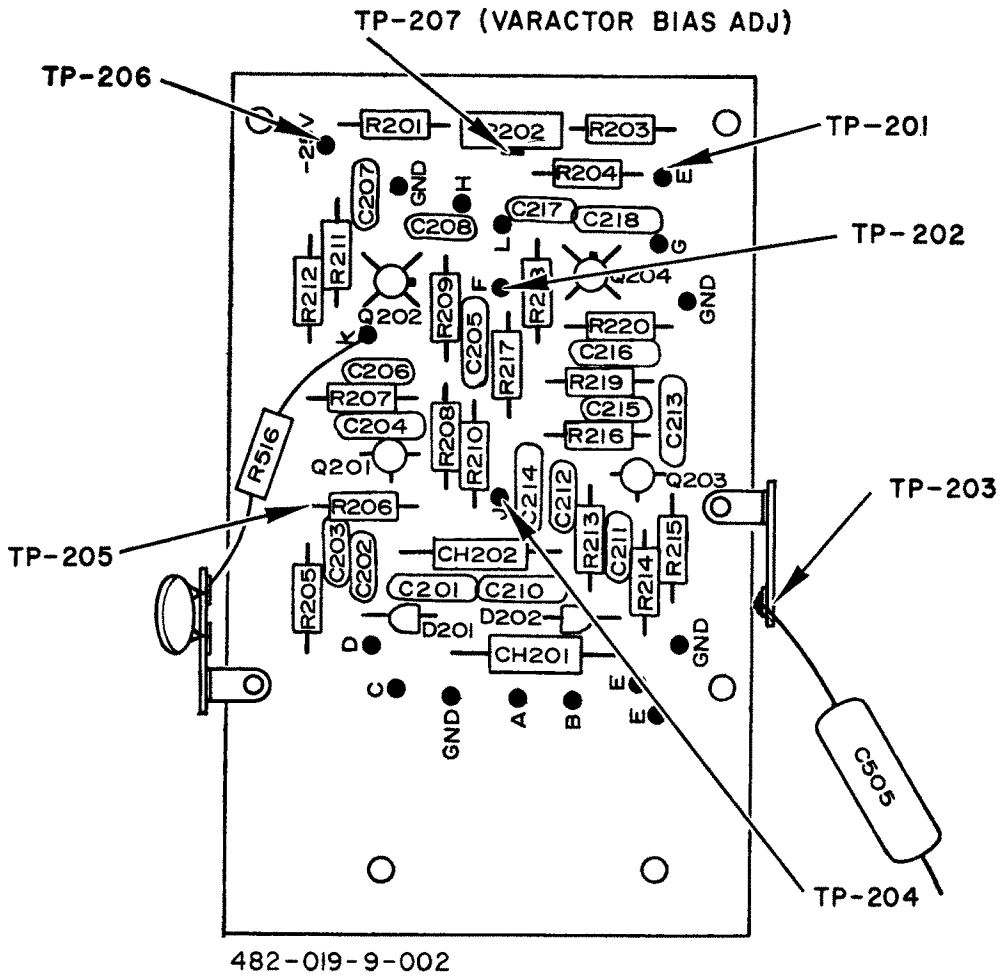


Figure 12.4. Parts Layout for Sweep Oscillator Board (Viewed from Component Side)

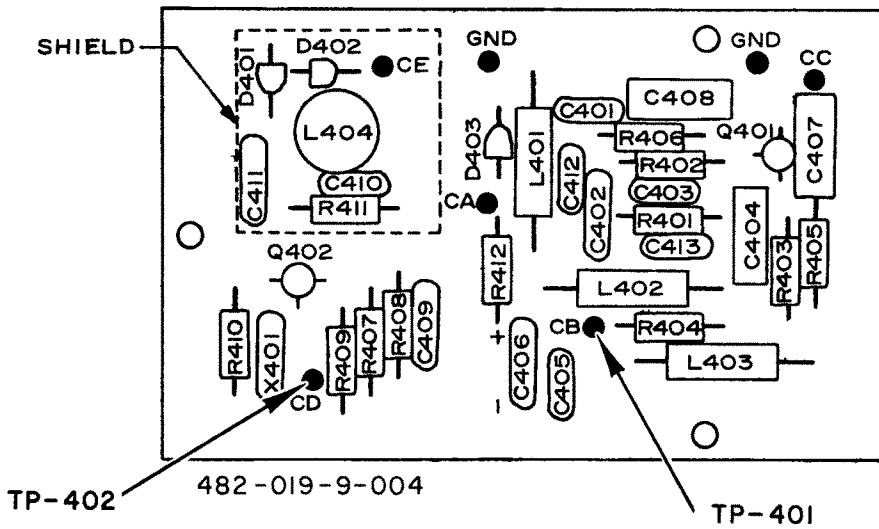
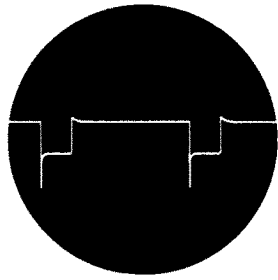
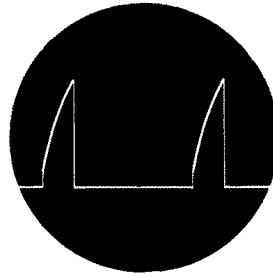


Figure 12.5. Parts Layout for Pix Oscillator Board (Viewed from Component Side)

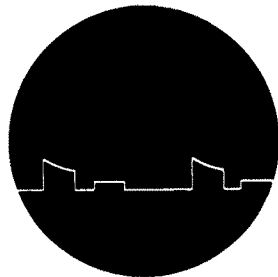




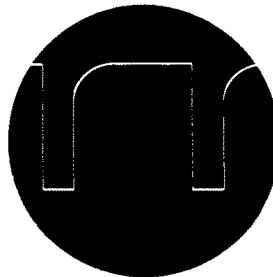
A. Q-12 Base (2 V. P-P)



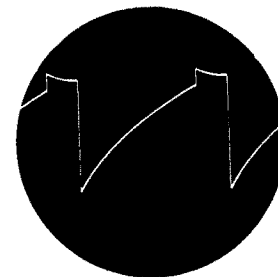
B. Q-12 Collector (12 V. P-P)



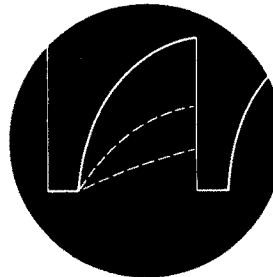
C. Q-13 Base (1 V. P-P)



D. Q-13 Collector (25 V. P-P)



E. Q-14 Base (13 V. P-P)



F. Sweep Oscillator Voltage at TP-203, Fig. 12.4 (22 V. P-P)

Figure 12.6. Waveform Generator Waveforms

TABLE 12.1

## TROUBLESHOOTING CHART

<u>Trouble</u>	<u>Possible Cause</u>
No +14 V Marker Supply at point marked AJ on underside of power supply board or TP-8, Figure 12.3 (FUNCTION Switch at MKR).	Q-308
No +14 V Internal Supply at point marked +14V on underside of power supply board or TP-7, Figure 12.3	Q-309
No Bias Supply Voltages: Pos 50 V Neg 50 V Pos 25 V Neg 25 V	D-304, D-306, D-307 D-303, D-305, D-311 D-308, D-312, Q-501 D-309, D-313, Q-502
No Attenuator Output (All FUNCTION Switch positions)	Q-306, R-515 Atten Control
No SCOPE HORIZ DRIVE Output	Q-12, Q-13, Q-14, CHROMA Switch, NORM-REV HORIZ SWEEP Switch
No SCOPE VERT Output	PROBES Switch S512, Q19, VERTICAL Switch S515, Q20
No IF Marker Pips on Scope (all markers dead)	Q-15, Q-17, Q-18, MARKER AMPLITUDE Control R-505, MARKER DISPLAY Switch S513.
No Specific Marker Pip (39.75) (41.25) (41.67) (42.17) (42.67) (42.75) (44.00) (45.00) (45.75) (47.25)	L-2 Mistuned, Q-2, X-2 L-3 Mistuned, Q-3, X-3 L-4 Mistuned, Q-4, X-4 L-5 Mistuned, Q-5, X-5 L-6 Mistuned, Q-6, X-6 L-7 Mistuned, Q-7, X-7 L-8 Mistuned, Q-8, X-8 L-9 Mistuned, Q-9, X-9 L-10 Mistuned, Q-10, X-10 (NOTE 1) L-11 Mistuned, Q-11, X-11
No Marker Output at Output Jack	See specific marker under "No Marker Pip." Also Q-308.
No Modulated Marker Output at Output Jack	Q-307, Q-308
No IF Sweep Output	Q-201, Q-202, D-201
No Video Sweep Output	Q-401, Q-402, X-401, D-403, Q-201, Q202
No Channel 4 Output	Q-301, Q-302
No Channel 10 Output	Q-303, Q-302
No 10.7 Marker Pip	Q-304, Q-16
No 100 KHz Markers (Available only in conjunction with other markers)	Q-305

## NOTES:

1. The 45.75 Marker Oscillator is "locked out" if CHROMA switch is ON or if FUNCTION switch is in VIDEO position.
2. Check all signal and d-c paths through FUNCTION switch S521 when individually checked stages appear normal.

TABLE 12.2 MODEL 415 SWITCHING CHART

Function Switch Position	44 MHz Sweep Q201 Q202	Pix Osc Q402	Low Pass Filter & Video Ampl Q401	IF Markers Except PIX (45.75) Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q11	45.75 Mkr Q10	10.7 MHz Sweep Q203, Q204	10.7 MHz Marker Osc. Q304	100 KHz Marker Osc. Q305	Ch 4 Osc. Q301	Ch 10 Osc. Q303	400 Hz Oscillator Q307
VIDEO	ON	ON	ON	OFF or ON (A+ = 6 V)	OFF	OFF	OFF	OFF or ON	OFF	OFF	OFF
IF	ON	OFF or ON*	OFF	OFF or ON (A+ = 6 V)	OFF or ON* (A+ = 6 V)	OFF	OFF	OFF or ON	OFF	OFF	OFF
MKR	OFF	OFF	OFF	OFF or ON (A+ = 14 V)	OFF or ON (A+ = 14 V)	OFF	OFF	OFF or ON	OFF	OFF	OFF
MOD MKR	OFF	OFF	OFF	OFF or ON (A+ = 14 V)	OFF or ON (A+ = 14 V)	OFF	OFF	OFF or ON	OFF	OFF	ON
CH 4	ON	OFF or ON*	OFF	OFF or ON (A+ = 6 V)	OFF or ON* (A+ = 6 V)	OFF	OFF	OFF or ON	ON	OFF	OFF
CH 10	ON	OFF or ON*	OFF	OFF or ON (A+ = 6 V)	OFF or ON* (A+ = 6 V)	OFF	OFF	OFF or ON	OFF	ON	OFF
10.7 MHz	OFF	OFF	OFF	OFF	OFF	ON	ON	OFF or ON	OFF	OFF	OFF

\*Pix oscillator (Q402) may be turned on by use of the CHROMA switch in the IF, CH 4 and CH 10 positions of the FUNCTION switch, in which cases the 45.75 marker oscillator (Q10) is locked out. Functions marked "OFF or ON" are controlled by front panel switches other than FUNCTION switch. Functions marked only "ON" or "OFF" are automatically turned on or off by the FUNCTION switch for each position.

The following circuits are always on when power is applied to unit: Attenuator (Q306), Waveform Generators (Q12 and Q13), Horiz Sweep Phase Splitter (Q14), 44 MHz Detector (Q15), 10.7 MHz Detector (Q16), Marker Amplifier (Q17), Marker Output Amplifier (Q18), Pattern Phase Inverter (Q19), Pattern Output Amplifier (Q20), 15.750 Hz Filter, Ch 4 - Ch 10 Mixer-Amplifier (Q302), Bias Supplies and Internal Power Supplies.

**TABLE 12.3 TRANSISTOR VOLTAGE CHART**

All transistor voltage readings are DC and are taken with the FUNCTION switch at the position indicated with CHROMA switch off. See schematics for transistor basing diagrams. Field Effect Transistors (FET's) are listed at the end of the chart. All voltage readings plus or minus 20%.

Schematic Symbol	Transistor Function	Parts Layout Figure No.	FUNCTION Sw Position	Emitter Voltage	Base Voltage	Collector Voltage
Q-1	Spare Mkr Osc.	12.2	IF	1.0 V	1.7 V	5.0 V
			MKR	3.0 V	3.6 V	10.6 V
Q-2	39.75 Mkr Osc.	12.2	IF	1.4 V	1.5 V	5.0 V
			MKR	3.7 V	3.2 V	10.5 V
Q-3	41.25 Mkr Osc.	12.2	IF	1.5 V	1.6 V	5.0 V
			MKR	3.7 V	3.3 V	10.4 V
Q-4	41.67 Mkr Osc.	12.2	IF	1.5 V	1.6 V	5.0 V
			MKR	4.0 V	3.2 V	10.3 V
Q-5	42.17 Mkr Osc.	12.2	IF	1.5 V	1.5 V	5.0 V
			MKR	3.7 V	3.1 V	10.3 V
Q-6	42.67 Mkr Osc.	12.2	IF	1.9 V	1.5 V	4.6 V
			MKR	4.3 V	3.1 V	10.0 V
Q-7	42.75 Mkr Osc.	12.2	IF	1.6 V	1.5 V	5.0 V
			MKR	4.0 V	3.1 V	10.4 V
Q-8	44.00 Mkr Osc.	12.2	IF	1.5 V	1.5 V	5.0 V
			MKR	4.2 V	3.0 V	10.3 V
Q-9	45.00 Mkr Osc.	12.2	IF	1.6 V	1.5 V	4.9 V
			MKR	4.0 V	3.2 V	10.2 V
Q-10	45.75 Mkr Osc.	12.2	IF	1.3 V	1.5 V	5.0 V
			MKR	3.6 V	3.3 V	10.4 V
Q-11	47.25 Mkr Osc.	12.2	IF	1.3 V	1.6 V	5.0 V
			MKR	3.6 V	3.3 V	10.5 V
Q-12*	Waveform Gen	12.2	VIDEO	See Waveforms of Figure 12.6		
Q-13*	Waveform Gen	12.2	VIDEO			
Q-14*	Horiz Sweep Phase Splitter	12.2	VIDEO			
Q-15*	44 MHz Detector	12.2	VIDEO			
Q-16*	10.7 MHz Detector	12.2	VIDEO	0.7 V	1.3 V	6.4 V
Q-17*	Marker Amplifier	12.2	VIDEO	3.5 V	4.0 V	11.6 V
Q-18*	Marker Output Amplifier	12.2	VIDEO	4.3 V	5.0 V	10.4 V
Q-201	44 MHz Sweep Osc.	12.4	VIDEO	3.8 V	3.4 V	7.5 V
Q-203	10.7 MHz Sweep Osc.	12.4	10.7 MHz	4.1 V	2.4 V	6.5 V
Q-301	Ch 4 Osc.	12.3	Ch 4	6.5 V	5.5 V	12.4 V
Q-302*	Ch 4 - Ch 10 Mixer-Amplifier	12.3	Ch 4 or Ch 10	.55 V	1.0 V	11.6 V
Q-303	Ch 10 Osc.	12.3	Ch 10	2.7 V	3.0 V	12.4 V
Q-304	10.7 MHz Mkr Osc.	12.3	10.7 MHz	5.7 V	3.2 V	7.6 V

**TABLE 12.3 TRANSISTOR VOLTAGE CHART (Cont'd.)**

Schematic Symbol	Transistor Function	Parts Layout Figure No.	FUNCTION Sw Position	Emitter Voltage	Base Voltage	Collector Voltage
Q-305	100 KHz Mkr Osc.	12.3	10.7 MHz (100 KHz Mkr Switch ON)	4.9 V	2.4 V	9.6 V
Q-307	400 Hz Osc.	12.3	MOD MKR	3.5 V	4.2 V	21.0 V
Q-308	+14 V Mkr Modulator	12.3	IF	6.4 V	6.8 V	18.0 V
			MKR	14.0 V	14.3 V	23.0 V
Q-309*	14 V Regulator	12.3	VIDEO	13.7 V	14.4 V	18.0 V
Q-401	Video Sweep Amp	12.5	VIDEO	3.0 V	3.6 V	8.3 V
Q-402	Pix Osc.	12.5	VIDEO	5.0 V	3.4 V	12.0 V
Q-501*	+25 V Regulator	Mounted on Chassis under PC boards	VIDEO	27.5 V	28.0 V	40.0 V
Q-502*	-25 V Regulator	Mounted on Chassis under PC boards	VIDEO	-28.0 V	-28.0 V	-64.0 V

**FIELD-EFFECT TRANSISTORS**

Schematic Symbol	Transistor Function	Parts Layout Figure No.	FUNCTION Sw Position	Drain	Source	Gate #1	Gate #2
Q-19*	Pattern Phase Inverter	12.2	VIDEO	24.0 V	3.5 V	0.0 V	....
Q-20*	Pattern Amplifier	12.2	VIDEO	20.0 V	1.3 V	0.0 V	....
Q-202	44 MHz Sweep Buffer Amplifier	12.4	IF	9.5 V	0.25V	0.0 V	....
Q-204	10.7 MHz Sweep Buffer Amplifier	12.4	10.7 MHz	10.0 V	0.3 V	0.0 V	....
Q-306* **	Attenuator	12.3	VIDEO	5.5 V	0.0 V	0.0 V	6.6 V

\*Energized in all positions of FUNCTION switch.

\*\*Q-306 voltage readings taken with front panel ATTENUATOR control fully clockwise (maximum).

Note: Marker oscillators Q-1 through Q-11 and Q-305 require that the corresponding front panel switch be ON to obtain voltage readings.

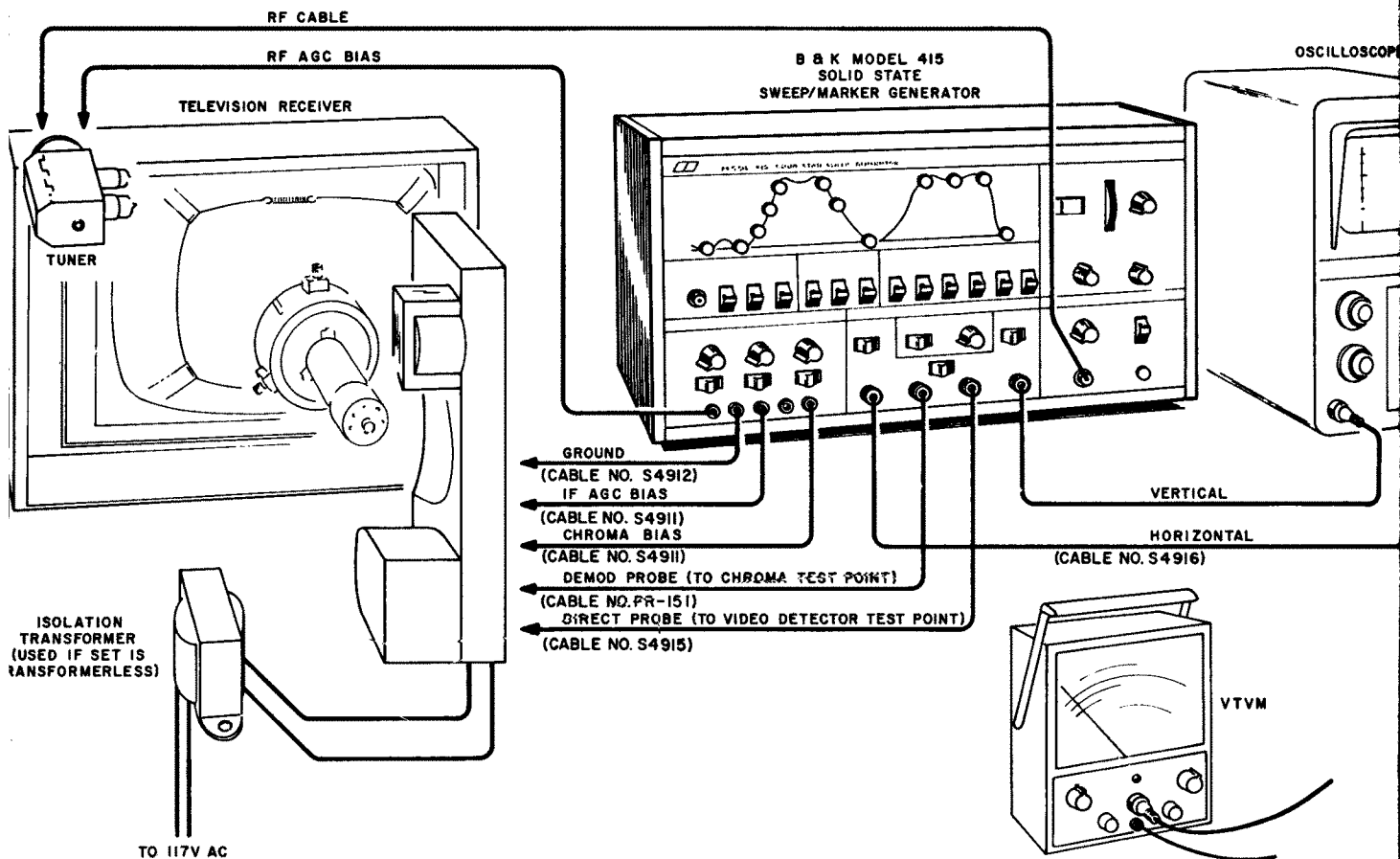


Figure 5.2 (Repeated) Equipment Interconnection

## 5.2 EQUIPMENT INTERCONNECTION AND SET-UP PROCEDURE

The interconnection set-up of Figure 5.2 is typical of that required in alignment work and applies for all procedures outlined in the manual. Proceed as follows:

- 1.1 Arrange TV chassis, Model 415, oscilloscope and VTVM so that all are readily accessible for adjustment as required during the alignment procedure.
- 1.2 Turn the Model 415 Power On/Off switch to ON. Connect an S-4916 cable between TO SCOPE HORIZ INPUT jack of the Model 415 and the horizontal input terminals of the oscilloscope. Set horizontal sweep selector switch on scope to the external position. Adjust scope horizontal gain for desired trace width.
- 1.3 Connect the other S-4916 cable between TO SCOPE VERT INPUT jack and the vertical input terminals of the oscilloscope.
- 1.4 Connect the black ground lead (S-4912) between the TV receiver chassis and one of the two ground jacks in the Model 415 bias section.
- 1.5 Connect the S-4915 cable between the DIRECT jack of the 415 and the video detector test point of the receiver; the lead with the yellow insulator is connected directly to the video detector test point and the lead with the black insulator to ground. A 10K ohm resistor is built into this cable for isolation. The isolating resistor specified by the manufacturer is not required.
- 1.6 Connect the PR-151 Demodulator probe to the DEMOD jack of the 415. The connection of the Demodulator probe to the TV receiver depends on the alignment task being performed.

- 5.2.7 Connect the TP-41 r-f cable to the RF-IF-VIDEO jack. Connection of this cable to the receiver is also determined by the alignment task being performed. It will be specified for each alignment function.
- 5.2.8 Before connecting the bias leads to the television receiver, preset the bias voltages at the Model 415 using the VTVM, and be certain that the polarities of the bias voltages are as specified. With the television receiver functioning, connect the required bias leads (S-4911) to the television receiver and set the voltages to the specified values using the VTVM.
- 5.2.9 Most preliminary alignment procedures suggest that the horizontal output circuits of the TV receiver be disabled to eliminate horizontal frequency interference during alignment. This is not necessary when using the Model 415 because a 15,750 Hz filter has been inserted in the signal path to the SCOPE VERT INPUT jack which reduces any horizontal frequency "grass" to negligible level. Other alignment set-ups require removal of the horizontal output tube (or transistor), or opening the cathode lead of the horizontal output tube if a series heater string is used. The B+ line must then be loaded with external resistors to compensate for the decrease in drain. (DO NOT DISABLE THE HORIZONTAL OUTPUT CIRCUIT BY REMOVING THE PLATE CAP OF THE HORIZONTAL OUTPUT TUBE. This will cause excessive screen dissipation and may permanently damage the tube.)

### NOTE:

The user must keep in mind the fact that, with the horizontal circuits operating, the boosted B+ voltages are present as well as the high voltage which is 25,000 volts for color receivers.

- 5.3.1 Always when set
- 5.3.2 Turn on SND (A control entire i
- 5.3.3 The HO the dire desired across t
- 5.3.4 The sca as show VERTIC
- 5.3.5 Depend priate r
- 5.3.6 The mo of the TUDE e mise be
- 5.3.7 If a sm viewed slowly

As outli sweep r only the available visible c not a eral rule

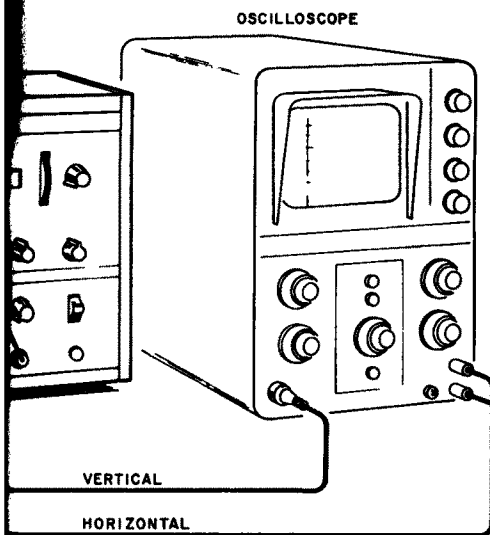


TABLE NO. S4916)

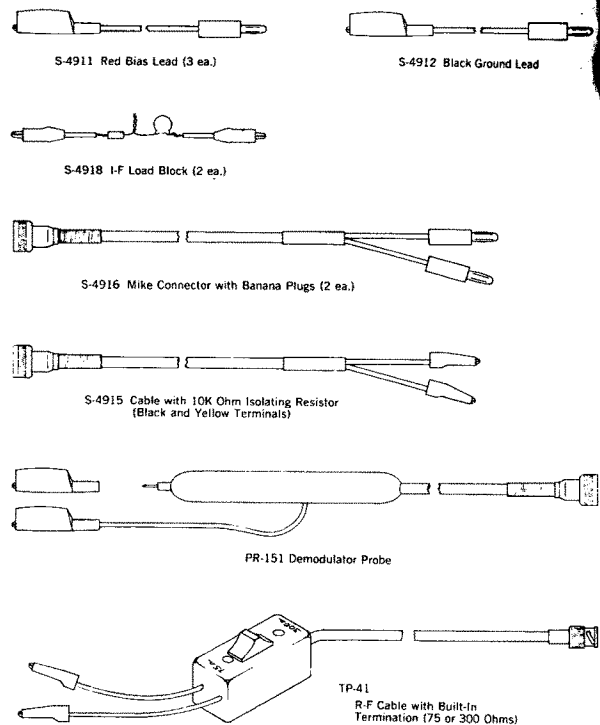
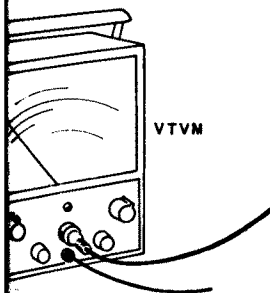


Figure 1.1 (Repeated) Accessories Furnished with the Model 415

### 5.3 USE OF MODEL 415 CONTROLS

VIDEO jack. As determined will be speci-

ision receiver, 15 using the the bias volt-receiver func-4911) to the the specified

gest that the be disabled ence during the Model orted in the hich reduces ble level. the hori-cathode ater string external ain. (DO CIRCUIT BY TAL OUT-ation and

the hori-ages are 000 volts

- As outlined in Par 3.8 all markers are available on all sweep ranges, except in the 10.7 MHz position in which only the 10.7 MHz marker and the 100 KHz markers are available. Because post injection is used, the markers are visible on the oscilloscope trace regardless of whether or not a receiver response curve is being viewed. Some general rules follow.
- 5.3.1 Always set SWEEP WIDTH control at maximum clockwise when setting up.
  - 5.3.2 Turn on the ADJ PIX (39.75 MHz) marker and the ADJ SND (47.25 MHz) marker. Use the CENTER FREQUENCY control to center the sweep pattern. With this setting the entire i-f response will be included in this range.
  - 5.3.3 The HORIZ SWEEP switch of the 415 can be used so that the direction of increasing frequencies can be selected as desired. Usually, increasing frequency from left to right across the scope trace is preferred.
  - 5.3.4 The scope pattern polarity can be selected as desired or as shown in the manufacturer's instructions by use of the VERTICAL switch.
  - 5.3.5 Depending on the alignment functions desired, the appropriate markers are selected for reference.
  - 5.3.6 The markers can be tilted to a horizontal position by use of the MARKER DISPLAY switch. The MARKER AMPLITUDE control can be adjusted to give the best compromise between vertical and horizontal marker size.

**NOTE:**

- If no response curve is being observed in conjunction with the markers when the MARKER DISPLAY switch is the HORIZ position, the markers will disappear into the base line and will not be evident. Always check the position of this switch when there is an apparent loss of markers.
- 5.3.7 If a small portion of the overall response curve is to be viewed, turn on the markers in the area affected and slowly decrease the sweep width (SWEEP WIDTH control

counterclockwise) and adjust the CENTER FREQUENCY control to keep the reference markers on the oscilloscope screen.

- 5.3.8 Although all markers can be used simultaneously, use only the markers required for a given alignment procedure to avoid any possible confusion.
- 5.3.9 When setting up use only the signal level required to obtain the peak-to-peak response amplitude given by the manufacturer. If the oscilloscope being used has a calibrated scale, the peak-to-peak pattern amplitude is read directly because there is unity gain through the signal processing circuits of the 415. If no amplitude limits are given, vary the ATTENUATOR control and observe the response pattern. Set the ATTENUATOR in the middle of the range over which the pattern amplitude varies without distorting.

To increase the output attenuator range of the Model 415, an additional 20dB of attenuation is available. The attenuator control is identified as:

**ATTENUATOR  
PULL FOR 20db**

- 5.3.10 When performing trap and i-f transformer prealignment using the modulated markers, always use the minimum signal required to give a satisfactory indication. Using excessive levels may desensitize the receiver and give extremely sluggish tuning indications, particularly on trap alignments. If additional sensitivity is required in trap alignment, the i-f bias voltage may be reduced to increase the i-f gain.
- 5.3.11 Unless chroma circuit alignment is being performed, keep the CHROMA switch in the OFF position.
- 5.3.12 The window calibrations beside the CENTER FREQUENCY adjustment are a rough guide in presetting the center frequency of the sweep oscillator for a particular alignment procedure.

SHEET 1 OF 1	
488-084-9-001	
REV	DESCRIPTION
1	ASSEMBLED
2	REVISION
3	REVISION
4	REVISION
5	REVISION
6	REVISION
7	REVISION
8	REVISION
9	REVISION
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18	REVISION
19	REVISION
20	REVISION

TO S-528 FUNCTION SWITCH SECTION / FRONT PIN NO. 12

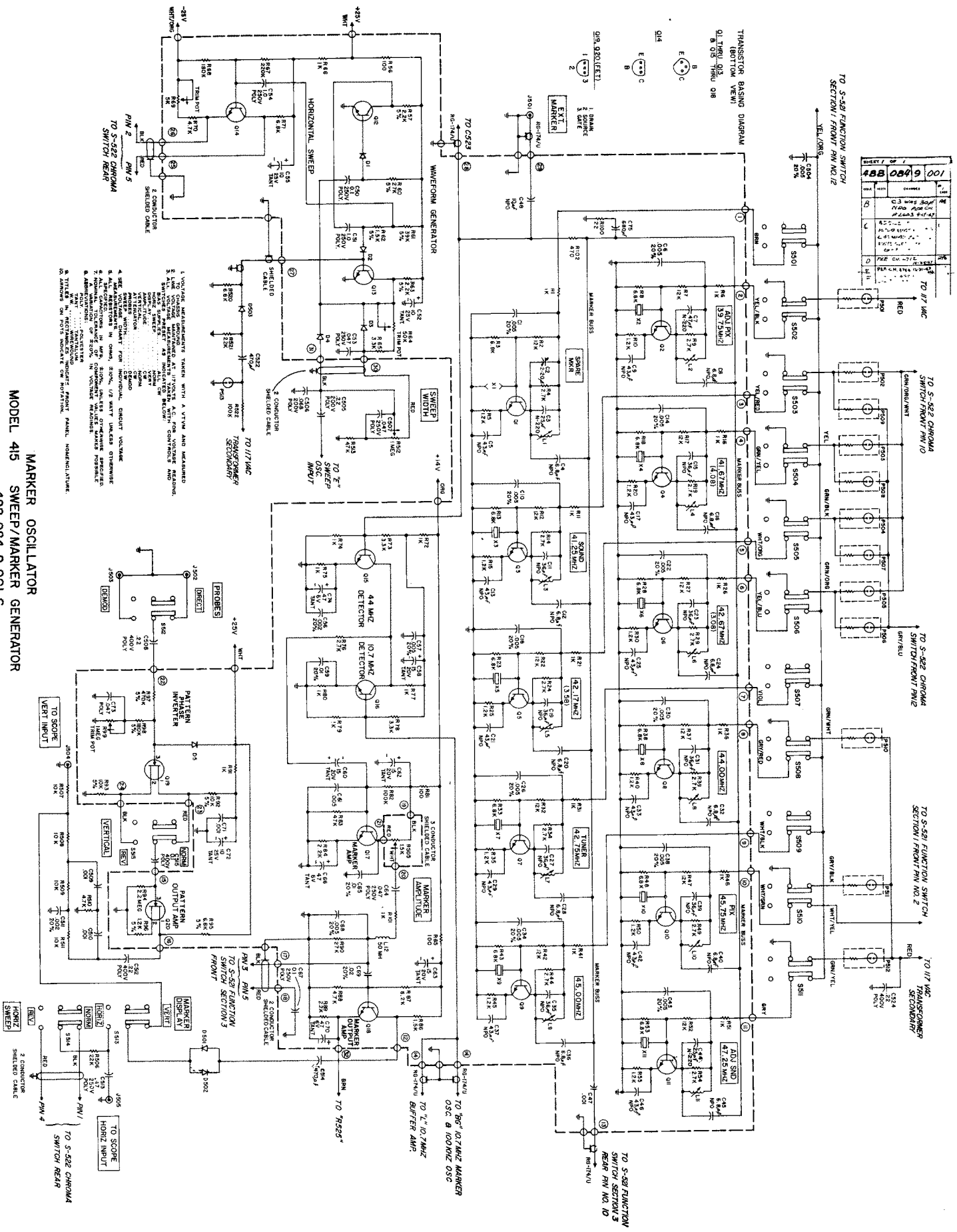
TO S-522 CHROMA SWITCH FRONT PIN 10

TO S-522 CHROMA SWITCH FRONT PIN 2

TO S-521 FUNCTION SWITCH SECTION / FRONT PIN NO. 2

TO 117 IAC TRANSFORMER SECONDARY

TO S-527 FUNCTION SWITCH SECTION 3 REAR PIN NO. 10

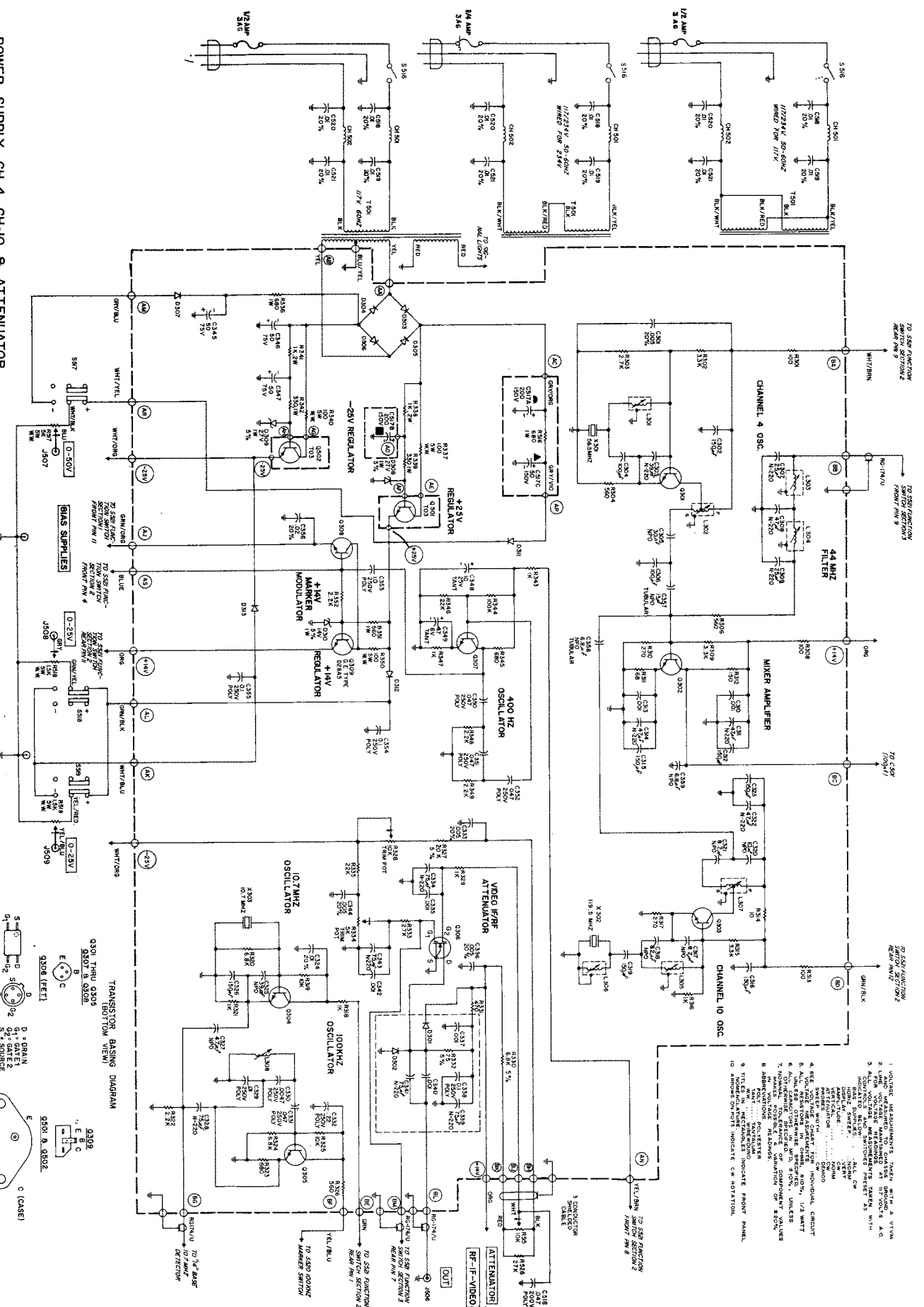


1. VOLTAGE MEASUREMENTS TAKEN WITH A VTVM AND MEASURED
2. ALL RESISTORS IN OHMS, 20%, 1/2 WATT UNLESS OTHERWISE SPECIFIED
3. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED
4. USE VOLTAGE WHICH FURNISHES INDIVIDUAL CIRCUIT VOLTAGE
5. ALL RESISTORS IN OHMS, 20%, 1/2 WATT UNLESS OTHERWISE SPECIFIED
6. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED
7. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED
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10. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED
11. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED
12. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED
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19. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED
20. ALL CAPACITORS IN PFD, 50V, UNLESS OTHERWISE SPECIFIED

MARKER OSCILLATOR GENERATOR  
 MODEL 415 SWEEP/MARKER GENERATOR  
 488-084-9-001 G

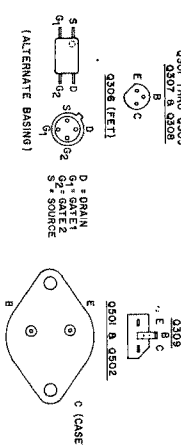


POWER SUPPLY, CH-4, CH-10 & ATTENUATOR  
 MODEL 415 SWEEP/MARKER GENERATOR  
 488-084-9-002 H



1. CHECK DISCONNECTS: TESTS, MODEL 4, VIEW
2. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
3. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
4. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
5. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
6. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
7. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
8. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
9. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10
10. CHECK DISCONNECTS TO CHANNELS: MODEL 4, 10

TRANSISTOR BIASING DIAGRAM  
 (BOTTOM VIEW)





# B & K Model 415 Parts List

488-084-9-004G

**SCHEMATIC SYMBOL**

**DESCRIPTION**

**B & K PART No.**

**SCHEMATIC SYMBOL**

**DESCRIPTION**

**B & K PART No.**

## RESISTORS & CONTROLS

R-64	50K $\Omega$ Trimpot	008-093-9-001
R-69	5K $\Omega$ Trimpot	008-087-9-001
R-99	1 meg $\Omega$ Trimpot	008-069-9-001
R-202	10K $\Omega$ Trimpot	008-058-9-001
R-328	5K $\Omega$ Trimpot	008-057-9-001
R-324		
R-337		
R-340	100 $\Omega$ , 5W, 10% W.W. Resistor	006-005-6-101
R-350		
R-505	1.5K $\Omega$ MARKER AMP. Control	008-092-9-001
R-512	1 meg $\Omega$ SWEEP WIDTH Control	008-086-9-001
R-515	10K $\Omega$ , IF-RF-VIDEO ATTENUATOR Control (Special Taper)	008-090-9-001
R-517	5K $\Omega$ W.W. 50V BIAS Control	009-023-9-001
R-518		
R-519	1.5K $\Omega$ W.W. 25V BIAS Control	009-022-9-001

## CAPACITORS & TRIMMERS

C-2	2-20 pfd Trimmer Capacitor	028-001-9-001
C-52		
C-55	10, $\mu$ fd, 25 Volt Tantalum Capacitor	027-001-9-005
C-58		
C-60		
C-62		
C-63	15 $\mu$ fd, 20 Volt Tantalum Capacitor	027-001-9-003
C-66		
C-70	47, $\mu$ fd, 6 Volt Tantalum Capacitor	027-001-9-004
C-72	10 $\mu$ fd, 25 Volt Tantalum Capacitor	027-001-9-005
C-74	47 $\mu$ fd, 6 Volt Tantalum Capacitor	027-001-9-004
C-345		
C-346	50 $\mu$ fd, 75 Volt P.C. Electrolytic Capacitor	022-038-9-001
C-347		
C-348	10 $\mu$ fd, 25 Volt Tantalum Capacitor	027-001-9-005
C-349	47 $\mu$ fd, 6 Volt Tantalum Capacitor	027-001-9-004
C-357	15 pfd, 200 Volt, 5% NPO Tubular Capacitor	032-002-9-001
C-358	6.8 pfd, 200 Volt, 5% NPO Tubular Capacitor	032-001-9-001
C-406	10 $\mu$ fd, 25 Volt, Tantalum Capacitor	027-001-9-005
C-517	3 Section Electrolytic Capacitor	021-032-9-001

## COILS-CHOKES-TRANSFORMERS

L-1 thru	Inductor, Variable (Green)	044-017-9-001
L-11		
L-12	50 millihenry Choke	041-033-9-001
L201A	44 MHz Coil (Uses Tuning Core 870-005-9-001)	041-041-9-001
L201B	10.7 MHz Coil (Uses Tuning Core 870-005-9-001)	041-043-9-001
L-301	Inductor, Variable (Violet)	044-016-9-001
L-302	Inductor, Variable (Red)	044-013-9-001
L-303		
L-304		
L-305	Inductor, Variable (Violet)	044-016-9-001
L-306		
L-307	Inductor, Variable (Red)	044-013-9-001
L-308	1 millihenry Coil, Variable	044-011-9-001
L-401		
L-402	3.9 microhenry Coil	041-036-9-001
L-403		
L-404	Inductor, Variable (Green)	044-017-9-001
L-501	33 microhenry Coil	041-001-9-016
CH-201	10 microhenry R.F. Choke	041-001-9-023
CH-202		
CH-501	R.F. Filter Choke	041-034-9-001
CH-502		
T-501	Power Transformer, 117 Volt Pri.	065-055-9-001
	Power Transformer, 234 Volt Pri.	065-055-9-002

## DIODES & TRANSISTORS

D-1 thru	Diode, Silicon	151-015-9-001
D-5		
D-201	Diode, Varactor	153-001-9-001
D-202		
D-301	Diode, Silicon	151-015-9-001
D-302		
D-303 thru	Diode, Silicon 1 amp 600 Volt	151-018-9-001
D-307		
D-308		
D-309	Zener Diode, 27 Volt, 1 Watt, 5%	152-011-9-001
D-310	Zener Diode, 14 Volt, 1 watt 5%	152-007-9-001
D-311		
D-312	Diode, Silicon, 1 amp, 600 Volt	151-018-9-001
D-313		
D-401	Diode, Silicon	151-014-9-001
D-402		
D-403	Diode, Germanium	150-003-9-001
D-501		
D-502	Diode, Silicon	151-015-9-001
D-503		
Q-1 thru	Transistor, NPN Silicon Signal (Yellow Dot)	176-005-9-001
Q-11		

Note: Standard value resistors and capacitors are not listed.

Q-12	Transistor, NPN Silicon Signal (Green Dot)	176-006-9-001
Q-13	Transistor, NPN Silicon Signal	176-010-9-001
Q-14		
Q-15	Transistor, NPN Silicon Signal (Yellow Dot)	176-005-9-001
Q-16		
Q-17	Transistor, NPN Silicon Signal (Blue Dot)	176-008-9-001
Q-18		
Q-19	Transistor, Field Effect (MPF-105/2N5459)	182-003-9-001
Q-20	Transistor, Field Effect (MPF-104/2N5458)	182-010-9-001
Q-201	Transistor, NPN Silicon Signal (2 yellow Dots)	176-019-9-001
Q-202	Transistor, Field Effect (RCA 40468)	182-004-9-001
Q-203	Transistor, NPN Silicon Signal (Yellow Dot)	176-005-9-001
Q-204	Transistor, Field Effect (RCA 40468)	182-004-9-001
Q-301		
Q-302	Transistor, NPN Silicon Signal (2N5127)	176-012-9-001
Q-303		
Q-304		
Q-305	Transistor, NPN Silicon Signal (Yellow Dot)	176-005-9-001
Q-306	Transistor, Field Effect (3N140/MPF122)	182-016-9-001
Q-307	Transistor, NPN Silicon Signal (Blue Dot)	176-008-9-001
Q-308		
Q-309	Transistor, NPN Silicon Power (GE-D28A5)	172-005-9-001
Q-401	Transistor, NPN Silicon Signal (Yellow Dot)	176-005-9-001
Q-402		
Q-501	Transistor, NPN Silicon Power	172-004-9-001
Q-502	Transistor, PNP Germanium Power	171-013-9-001

## SWITCHES

S-501 thru	Switch, Slide, D P.D.T.	084-014-9-001
S-520		
S-521	7 Pos. FUNCTION Switch	083-079-9-001
S-522	2 Pos. CHROMA Switch	083-080-9-001

## LAMPS

P-501 thru	Neon Lamp w/100K $\Omega$ Resistor	401-001-9-002
P-512		
P-513	Neon Lamp NE-2L	401-002-9-001

## CRYSTALS

X-2	Crystal, 39.75 MHz (2 Brown Dots)	132-002-9-001
X-3	Crystal, 41.25 MHz (2 Red Dots)	132-002-9-002
X-4	Crystal, 41.67 MHz (2 Orange Dots)	132-002-9-003
X-5	Crystal, 42.17 MHz (2 Yellow Dots)	132-002-9-004
X-6	Crystal, 42.67 MHz (2 Green Dots)	132-002-9-005
X-7	Crystal, 42.75 MHz (2 Blue Dots)	132-002-9-006
X-8	Crystal, 44.00 MHz (1 Brown, 1 Gray Dot)	132-002-9-018
X-9	Crystal, 45.00 MHz (2 Violet Dots)	132-002-9-007
X-10	Crystal, 45.75 MHz (2 White Dots)	132-002-9-009
X-11	Crystal, 47.25 MHz (2 Black Dots)	132-002-9-010
X-301	Crystal, 55.5 MHz (1 Brown, 1 Blue Dot)	132-002-9-016
X-302	Crystal, 119.5 MHz (1 Brown, 1 Violet Dot)	132-002-9-017
X-303	Crystal, 10.7 MHz (1 Brown, 1 Orange Dot)	132-002-9-013
X-401	Crystal, 45.75 MHz (2 White Dots)	132-002-9-009

## KNOBS & GLAMOR CAPS

Knobs	751-040-9-001
Caps, Molded	384-008-9-001

## PROBES-CABLES-TEST LEADS

Probe, Demodulator	PR-151
Cable, Terminated R.F. (75 $\Omega$ /300 $\Omega$ )	TP-41
Red Test Lead	522-036-9-001
Black Test Lead	522-036-9-001
Cable, Mike Connector Both Ends	522-042-9-001
Cable, Mike Connector on One End, 10K $\Omega$ Series Resistor w/Alligator Clips on Other End	522-043-9-001
Cable, Mike Connector on One End, Banana Plugs on Other End	522-044-9-001

## MISCELLANEOUS

Case, Back	272-057-9-903
Case, Top	272-058-9-903
Case, Bottom	272-059-9-903
Case, Left	272-060-9-903
Case, Right	272-061-9-903
Fuse Holder Complete	742-001-9-805
Fuse, 1/2 amp, 250 Volt, 3AG	191-251-3-102
Rubber Feet	381-002-9-001
Line Cord, 3 Wire w/ Molded Plug	420-011-9-001
Panel Connector	772-001-9-001
BNC Connector Complete	772-018-9-803
Instruction Manual	480-096-9-001
Carton	500-157-9-001
Filler, Top & Bottom (2 required)	503-033-9-001
Filler, Sides (2 required)	503-034-9-001

Values may be obtained from schematic diagram.

Minimum charge \$2.00 per invoice. Orders will be shipped C.O.D. unless previous open account arrangements have been made or remittance accompanies order. Advance remittance must cover postage or express charges.

**COMPOSITE**  
**499-005-9-001K**