CW Sensitivity (Signal level + noise = 2X noise)

The following characteristics are applicable with the input internally terminated or with a 600Ω or less source impedance:

| Display Mode | Resolution Bandwidth 3 kHz | 10 Hz |
|---|---|---|
| dBV | -123 dBV | -147 dBV |
| dBm 50 Ω | -110 dBm | -134 dBm |
| dBm 600 Ω | -121 dBm | -145 dBm |
| LIN | 680 nV | 45 nV |

With the input open, displayed noise is the thermal noise of the input 1 MΩ/50 pF impedance.

Intermodulation Distortion (with the input signal level equal to or less than the reference level):

Third order products are down 70 dB or more from two -10 dBm/dBV signals, within any frequency span and 75 dB or more down from two -20 dBm/dBV signals, within any frequency span.

Spurious Signals from Internal Sources (Residual Response) with TRKG GEN and 5 kHz FREQ COMB OFF and the input terminated in an impedance of 600 Ω or less are:

Equal to or less than -130 dBm/dBV referred to the input

Line related spurii are less than -120 dBm/dBV

With high input impedance and single-ended, the high voltage oscillator in some mainframes causes spurii at 30 kHz and harmonics $\leq$100 dBV.

The zero (start) spur is less than -80 dBV or four divisions (10 dB/DIV) with -10 dBV to -40 dBV reference level range.

Input Characteristics

The INPUT connector is a floating two-conductor BNC connector that provides either a differential or single-ended input. Input selection is provided by a switch that grounds the outer conductor of the connector when it is in the SINGLE ENDED position. An accessory adapter (floating BNC to dual BNC) provides full shielding of the input signal leads.

*NOTE*

*When operating in the DIFFerential mode, the INPUT connector is floating. The outer conductor therefore equals the voltage level of the external source. Since the external source voltage may be some high potential, the outer conductor voltage is clamped at ±10 V for safety.*

Selectable input impedance provides; either high Z of 1 MΩ/50 pF, or internally terminated impedances of 600 Ω or 50 Ω ±2%.

Differential Input Characteristics

Common-mode signal range: ±10 volt

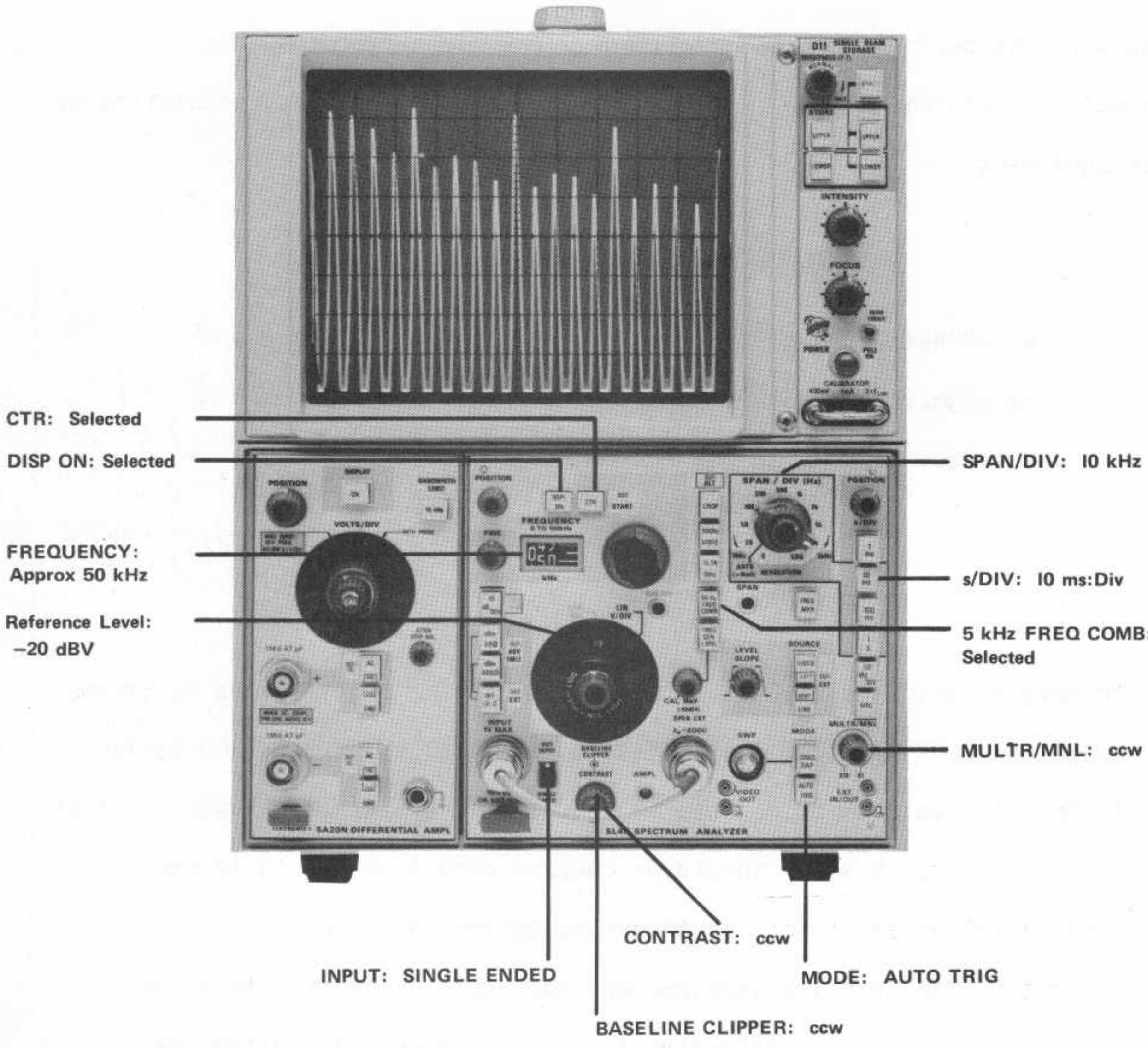
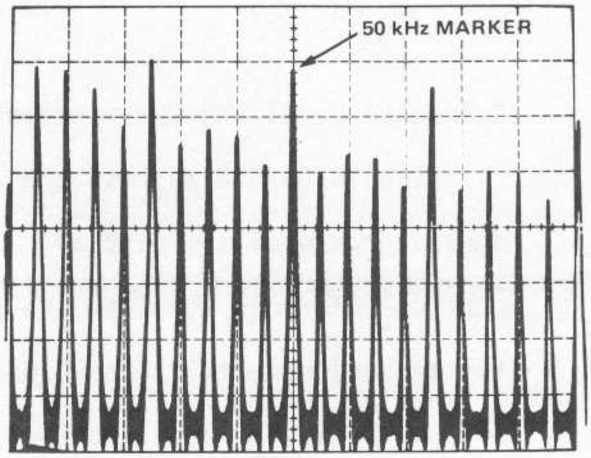


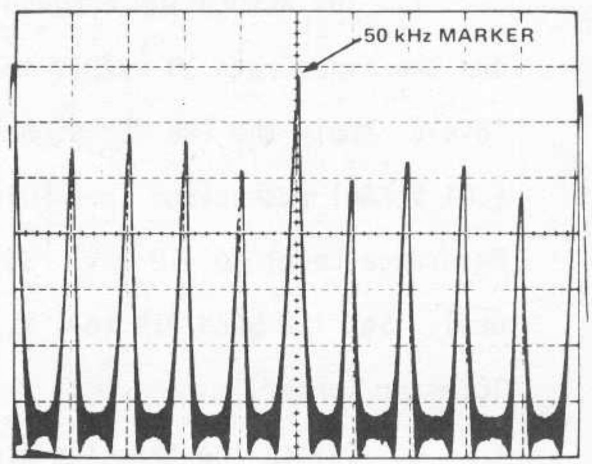

Fig. 3-1. Front panel control and selector positions for the initial operational check and front panel calibration.

With the display mode in 2 dB/Div (LOG), adjust the mainframe Intensity and Focus controls for the best display definition (it may be necessary to select a slower sweep rate to adjust Focus and Intensity); set the baseline of the display at the bottom graticule line and center the display with the horizontal POSITION control. Select the STORE mode if the mainframe has store capabilities.

Depress the 10 dB/DIV button. Adjust the RESOLUTION for the best marker definition. Display should now resemble the illustration shown in Fig. 3-2A.



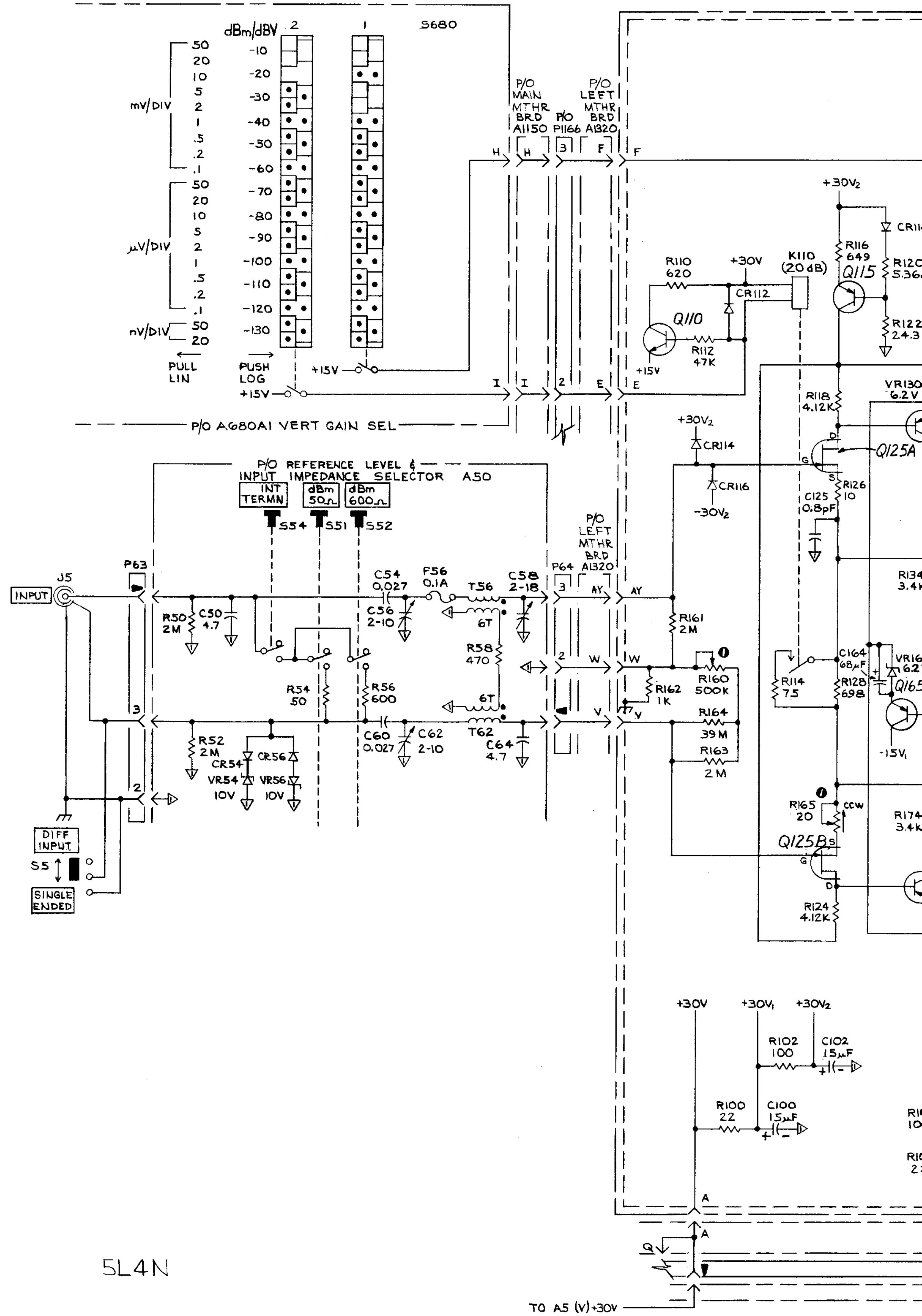

(A) 5 kHz FREQ COMB with SPAN/DIV set at 10 kHz.



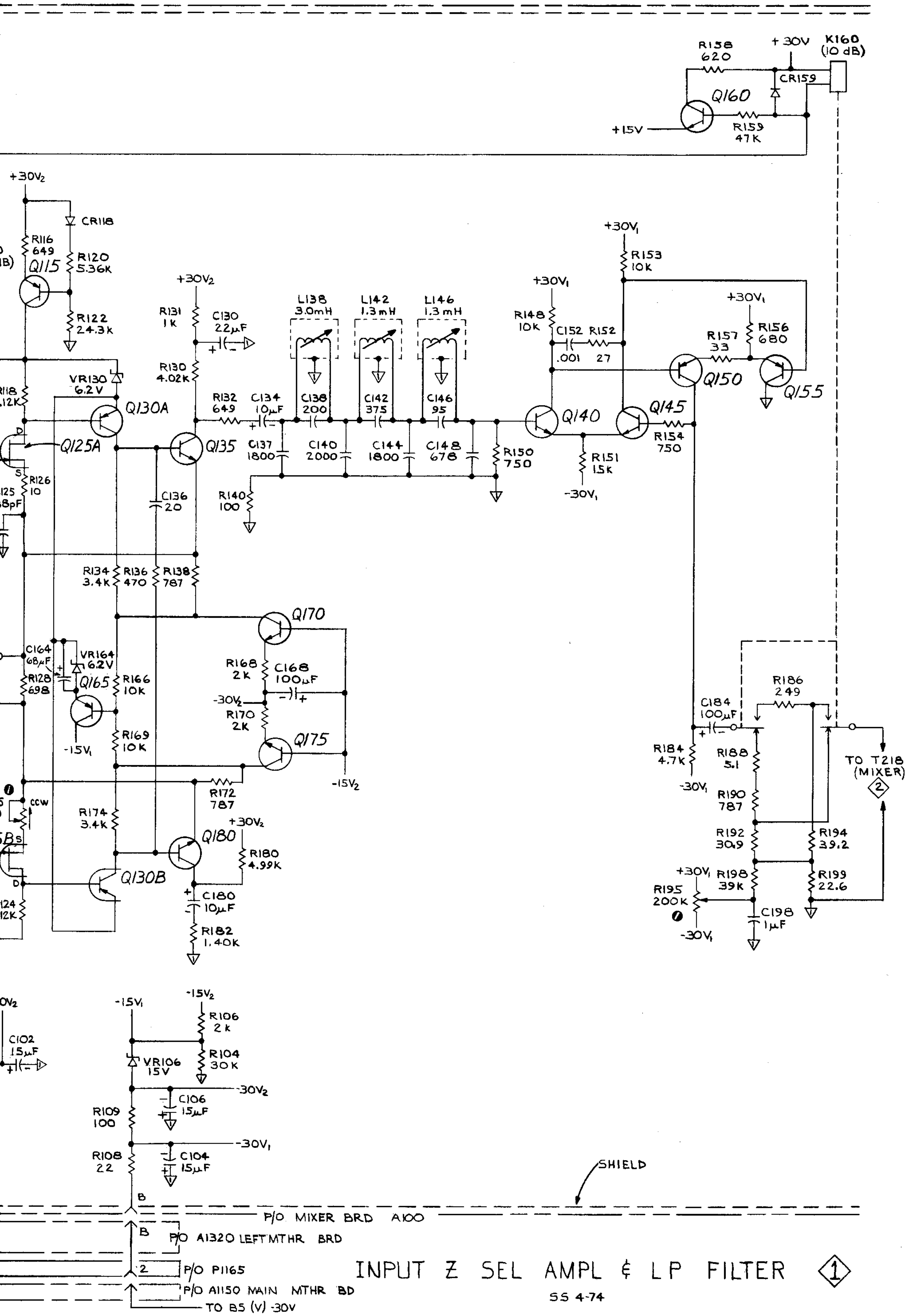

(B) Marker location with SPAN/DIV set at 5 kHz and SPAN correctly adjusted.

**Fig. 3-2. Freq Span calibration.**

| Ckt No. | Tektronix Part No. | Serial/Model No. Eff | Dscont | Name & Description | Mfr Code | Mfr Part Number |
|---|---|---|---|---|---|---|
| R492 | 321-0371-00 | | | RES.,FXD,FILM:71.5K OHM,1%,0.125W | 75042 | CEAT0-7152F |
| R493 | 321-0154-00 | | | RES.,FXD,FILM:392 OHM,1%,0.125W | 75042 | CEAT0-3920F |
| R494 | 321-0251-00 | | | RES.,FXD,FILM:4.02K OHM,1%,0.125W | 75042 | CEAT0-4021F |
| R496 | 321-0373-00 | | | RES.,FXD,FILM:75K OHM, 1%,0.125W | 75042 | CEAT0-7502F |
| R500 | 321-0203-00 | | | RES.,FXD,FILM:1.27K OHM,1%,0.125W | 75042 | CEAT0-1271F |
| R502 | 321-0371-00 | | | RES.,FXD,FILM:71.5K OHM,1%,0.125W | 75042 | CEAT0-7152F |
| R504 | 315-0113-00 | | | RES.,FXD,COMP:11K OHM,5%,0.25W | 01121 | CB1135 |
| R506 | 321-0251-00 | | | RES.,FXD,FILM:4.02K OHM,1%,0.125W | 75042 | CEAT0-4021F |
| R508 | 315-0153-00 | | | RES.,FXD,COMP:15K OHM,5%,0.25W | 01121 | CB1535 |
| R510 | 315-0682-00 | | | RES.,FXD,COMP:6.8K OHM,5%,0.25W | 01121 | CB6825 |
| R512 | 315-0104-00 | | | RES.,FXD,COMP:100K OHM,5%,0.25W | 01121 | CB1045 |
| R514 | 315-0105-00 | | | RES.,FXD,COMP:1M OHM,5%,0.25W | 01121 | CB1055 |
| R516 | 321-0154-00 | | | RES.,FXD,FILM:392 OHM,1%,0.125W | 75042 | CEAT0-3920F |
| R518 | 321-0251-00 | | | RES.,FXD,FILM:4.02K OHM,1%,0.125W | 75042 | CEAT0-4021F |
| R520 | 321-0373-00 | | | RES.,FXD,FILM:75K OHM, 1%,0.125W | 75042 | CEAT0-7502F |
| R522 | 321-0235-00 | | | RES.,FXD,FILM:2.74K OHM,1%,0.125W | 75042 | CEAT0-2741F |
| R524 | 321-0203-00 | | | RES.,FXD,FILM:1.27K OHM,1%,0.125W | 75042 | CEAT0-1271F |
| R526 | 321-0371-00 | | | RES.,FXD,FILM:71.5K OHM,1%,0.125W | 75042 | CEAT0-7152F |
| R528 | 321-0371-00 | | | RES.,FXD,FILM:71.5K OHM,1%,0.125W | 75042 | CEAT0-7152F |
| R530 | 315-0113-00 | | | RES.,FXD,COMP:11K OHM,5%,0.25W | 01121 | CB1135 |
| R532 | 315-0153-00 | | | RES.,FXD,COMP:15K OHM,5%,0.25W | 01121 | CB1535 |
| R533 | 315-0562-00 | | | RES.,FXD,COMP:5.6K OHM,5%,0.25W | 01121 | CB5625 |
| R534 | 321-0251-00 | | | RES.,FXD,FILM:4.02K OHM,1%,0.125W | 75042 | CEAT0-4021F |
| R536 | 315-0105-00 | | | RES.,FXD,COMP:1M OHM,5%,0.25W | 01121 | CB1055 |
| R538 | 321-0139-00 | | | RES.,FXD,FILM:274 OHM,1%,0.125W | 75042 | CEAT0-2740F |
| R540 | 315-0104-00 | | | RES.,FXD,COMP:100K OHM,5%,0.25W | 01121 | CB1045 |
| R541 | 321-0373-00 | | | RES.,FXD,FILM:75K OHM, 1%,0.125W | 75042 | CEAT0-7502F |
| R542 | 321-0251-00 | | | RES.,FXD,FILM:4.02K OHM,1%,0.125W | 75042 | CEAT0-4021F |
| R544 | 321-0235-00 | | | RES.,FXD,FILM:2.74K OHM,1%,0.125W | 75042 | CEAT0-2741F |
| R546 | 321-0218-00 | | | RES.,FXD,FILM:1.82K OHM,1%,0.125W | 75042 | CEAT0-1821F |
| R548 | 321-0371-00 | | | RES.,FXD,FILM:71.5K OHM,1%,0.125W | 75042 | CEAT0-7152F |
| R552 | 321-0371-00 | | | RES.,FXD,FILM:71.5K OHM,1%,0.125W | 75042 | CEAT0-7152F |
| R554 | 315-0224-00 | | | RES.,FXD,COMP:220K OHM,5%,0.25W | 01121 | CB2245 |
| R556 | 315-0104-00 | | | RES.,FXD,COMP:100K OHM,5%,0.25W | 01121 | CB1045 |
| R558 | 321-0251-00 | | | RES.,FXD,FILM:4.02K OHM,1%,0.125W | 75042 | CEAT0-4021F |
| R560 | 315-0153-00 | | | RES.,FXD,COMP:15K OHM,5%,0.25W | 01121 | CB1535 |
| R562 | 315-0113-00 | | | RES.,FXD,COMP:11K OHM,5%,0.25W | 01121 | CB1135 |
| R566 | 315-0153-00 | | | RES.,FXD,COMP:15K OHM,5%,0.25W | 01121 | CB1535 |
| R580 | 321-0257-00 | | | RES.,FXD,FILM:4.64K OHM,1%,0.125W | 75042 | CEAT0-4641F |
| R581 | 315-0101-00 | | | RES.,FXD,COMP:100 OHM,5%,0.25W | 01121 | CB1015 |
| R582 | 321-0161-00 | | | RES.,FXD,FILM:464 OHM,1%,0.125W | 75042 | CEAT0-4640F |
| R584 | 315-0620-00 | | | RES.,FXD,COMP:62 OHM,5%,0.25W | 01121 | CB6205 |
| R586 | 315-0103-00 | | | RES.,FXD,COMP:10K OHM,5%,0.25W | 01121 | CB1035 |
| R588 | 315-0222-00 | | | RES.,FXD,COMP:2.2K OHM,5%,0.25W | 01121 | CB2225 |
| R590 | 315-0330-00 | | | RES.,FXD,COMP:33 OHM,5%,0.25W | 01121 | CB3305 |
| R592 | 315-0102-00 | | | RES.,FXD,COMP:1K OHM,5%,0.25W | 01121 | CB1025 |
| R593 | 315-0103-00 | | | RES.,FXD,COMP:10K OHM,5%,0.25W | 01121 | CB1035 |
| R594 | 315-0472-00 | | | RES.,FXD,COMP:4.7K OHM,5%,0.25W | 01121 | CB4725 |
| R596 | 315-0103-00 | | | RES.,FXD,COMP:10K OHM,5%,0.25W | 01121 | CB1035 |
| R598 | 315-0302-00 | | | RES.,FXD,COMP:3K OHM,5%,0.25W | 01121 | CB3025 |
| R599 | 315-0101-00 | | | RES.,FXD,COMP:100 OHM,5%,0.25W | 01121 | CB1015 |
| R600 | 311-1273-00 | | | RES.,VAR,NONWIR:200K OHM,10%,0.50W | | |
| R602 | 321-0423-00 | | | RES.,FXD,FILM:249K OHM,1%,0.125W | 75042 | CEAT0-2493F |
| R604 | 321-0423-00 | | | RES.,FXD,FILM:249K OHM,1%,0.125W | 75042 | CEAT0-2493F |
| R605 | 311-1273-00 | | | RES.,VAR,NONWIR:200K OHM,10%,0.50W | | |
| R606 | 315-0104-00 | | | RES.,FXD,COMP:100K OHM,5%,0.25W | 01121 | CB1045 |
| R608 | 321-0304-00 | | | RES.,FXD,FILM:14.3K OHM,1%,0.125W | 75042 | CEAT0-1432F |
| R610 | 321-0155-00 | | | RES.,FXD,FILM:402 OHM,1%,0.125W | 75042 | CEAT0-4020F |
| R612 | 321-0155-00 | | | RES.,FXD,FILM:402 OHM,1%,0.125W | 75042 | CEAT0-4020F |
| R614 | 321-0254-00 | | | RES.,FXD,FILM:4.32K OHM,1%,0.125W | 75042 | CEAT0-4321F |


S680
dBm/dBV
mV/DIV
µV/DIV
nV/DIV
PULL LIN
PUSH LOG
+15V
P/O A680A1 VERT GAIN SEL
P/O MAIN MTHR BRD A1150
P/O P1166
P/O LEFT MTHR BRD A1320
R110 620
+30V
K110 (20 dB)
CR112
Q110
R112 47K
+30V2
R116 649
Q115
R118 4.12K
VR130 6.2 V
CR114
CR116
-30V2
Q125A
R126 10
C125 0.8pF
P/O REFERENCE LEVEL & INPUT IMPEDANCE SELECTOR A50
INT TERMN
dBm 50Ω
dBm 600Ω
S54
S51
S52
INPUT
J5
P63
R50 2M
C50 4.7
C54 0.027
C56 2-10
F56 0.1A
T56
6T
C58 2-18
P64
R58 470
R54 50
R56 600
R52 2M
CR54
CR56
VR54 10V
VR56 10V
C60 0.027
C62 2-10
T62
C64 4.7
R161 2M
R160 500K
R162 1K
R164 39M
R163 2M
R114 75
C164 68µF
R128 698
R165 20
CCW
Q125B
R124 4.12K
DIFF INPUT
S5
SINGLE ENDED
+30V1
R102 100
C102 15µF
R100 22
C100 15µF
TO A5 (V)+30V

5L4N

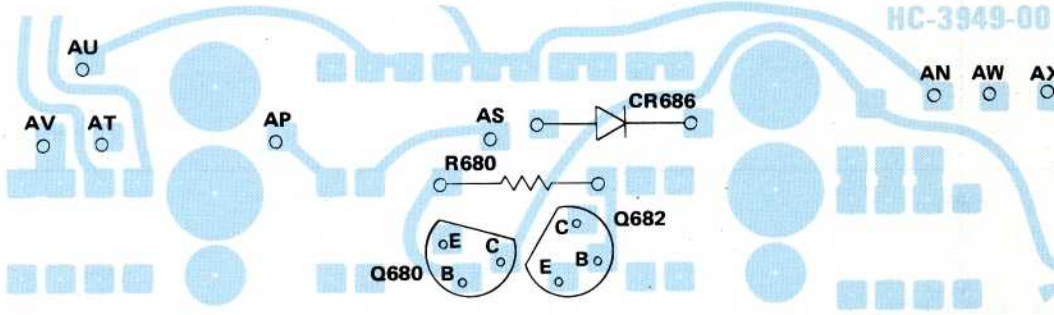



INPUT Z SEL AMPL & LP FILTER ⟨1⟩

SS 4-74

INPUT IMPD SEL AMPL & LP FILTER ⟨1⟩

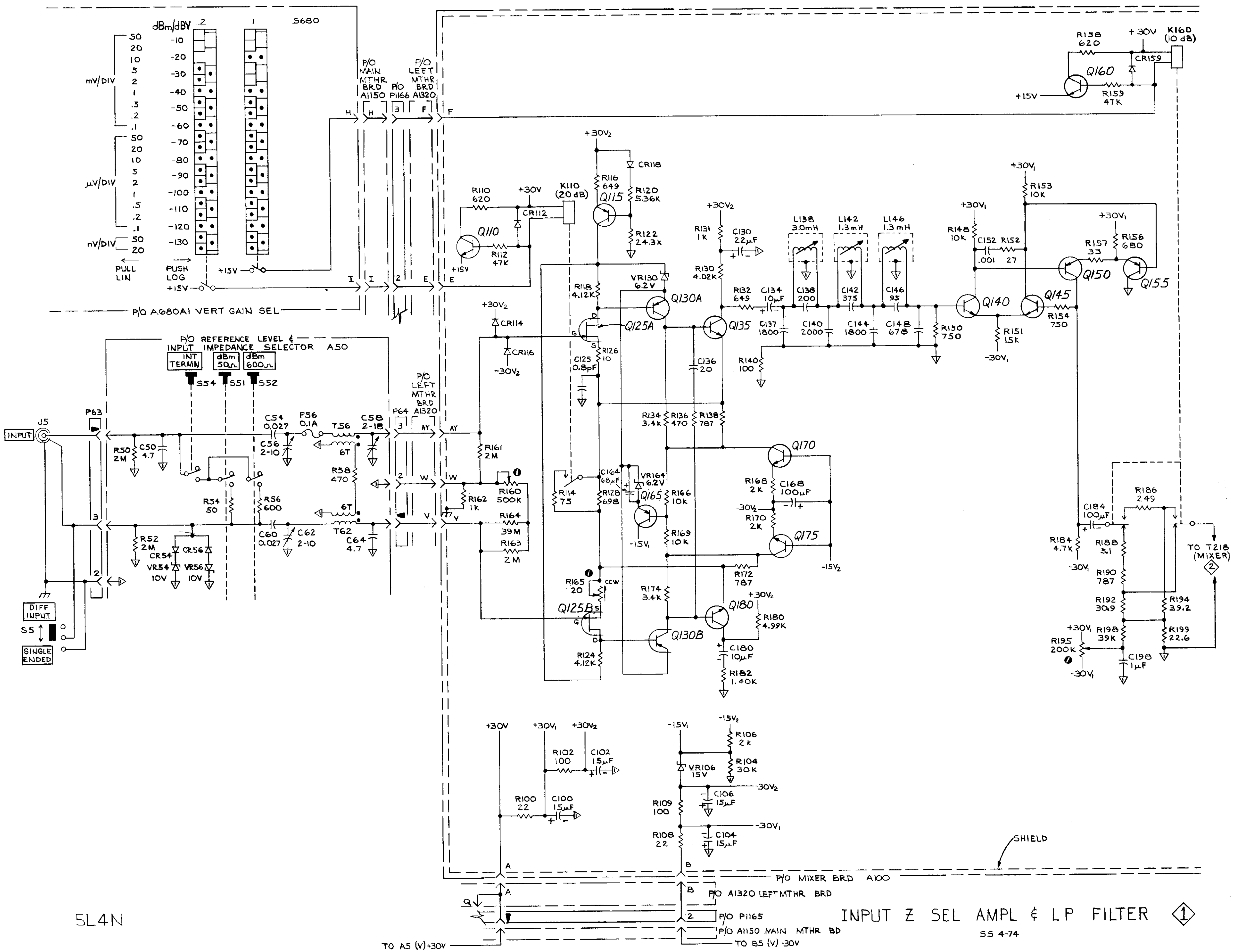
COMPONENT LOCATIONS
FOR DIAGRAM 2




P/O A680A1 Vertical Sensing Selector

A1150 Main Mother Board component location shown on back of Diagram 9


P/O A100 Input Amplifier, LP Filter, Mixer & 250




5L4N

INPUT Z SEL AMPL & LP FILTER ①

SS 4-74

INPUT IMPD SEL AMPL & LP FILTER ①

# STANDARD AUDIO TESTS

BY

CLIFFORD SCHROCK

ACKNOWLEDGEMENTS

The author would like to thank Linley Gumm and Gordon Long for their excellent technical assistance in the preparation of this paper. In addition, I would like to thank Joyce Lekas for her editorial assistance and Jeanne Galick for the illustrations and layout.

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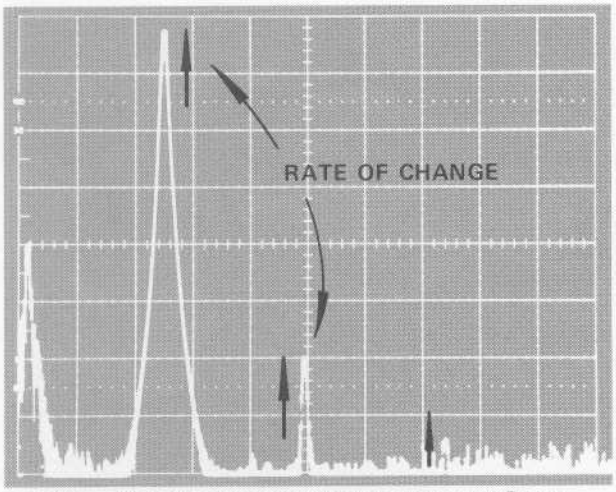


**Figure 10** Distortion Crossover Point for Measuring Power

5. For the new FTC test,[3,4] all channels of a multi-channel (stereo) amplifier should be driven to the maximum power point before power is measured.

6. Power is determined by assuming the full screen display to be the value of the load-matching combination. Switch to the 2 dB/DIV mode and note the number of dB down from the top graticule line, as shown in Figure 11. This is the power output in dB below the full screen display and can be converted directly to watts.

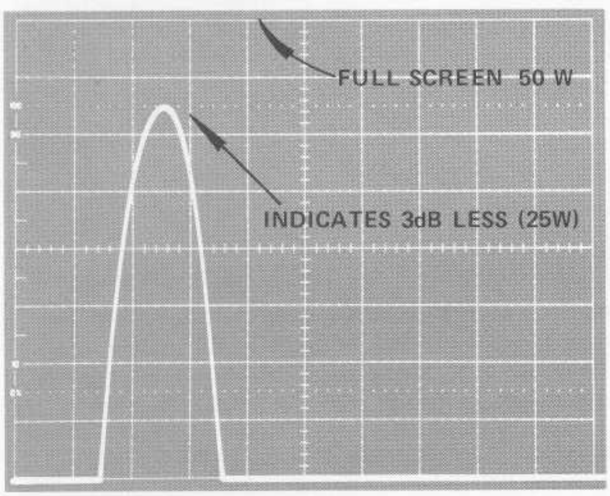


**Figure 11** Calculating Power Output

## Notes:

1. An alternative procedure for demonstrating maximum undistorted power is to simultaneously apply the 1 kHz tone through a plug-in vertical amplifier in the compartment next to the 5L4N and display the time domain sine wave on the scope. Increase the tone level until the sine wave visibly clips, as shown in Figure 12. The power level in dBV or dBM is then read on the spectrum analyzer display.

2. To satisfy the FTC[1] requirements, the rated power must be obtainable at all frequencies within the rated power band (width) without exceeding the total rated maximum harmonic distortion. Procedures on Power Bandwidth and Harmonic Distortion are contained in this application note and should be followed to satisfy the entire FTC regulation.

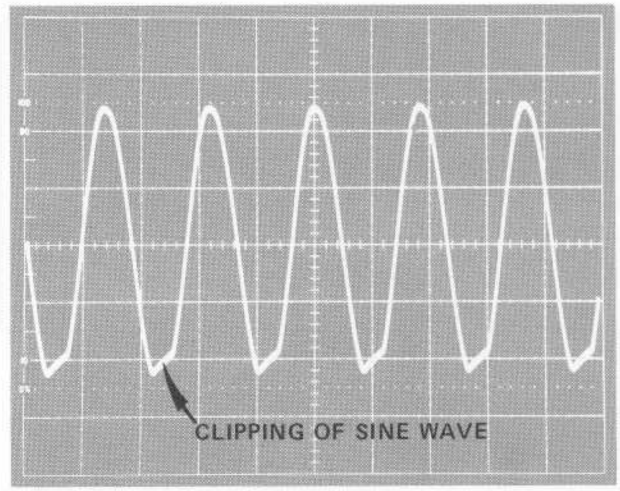


**Figure 12** Visible Clipping of sine wave

# Frequency Response

Frequency Response is a measure of the amplifier's ability to pass a wide range of frequencies in the audio spectrum. Ideally, one would strive to achieve a flat response; that is, all frequencies would pass through an amplifier with equal amplification. A Hi-Fi amplifier may have controls to modify the response. These may include tone controls (bass and treble), rumble and hum filters (low frequency rolloff), scratch filters (high frequency rolloff), and a variety of tailoring devices such as the RIAA, FM de-emphasis, and tape head equalization filters. The frequency response test should provide response information of the amplifier in the flat position and should also represent the limits and interaction of the tone controls and filters.

Response of a modern Hi-Fi system is generally measured from below 20 Hz to well beyond the 15 kHz audible limit. It is measured in dB of deviation across the audio spectrum.

The 5L4N Low Frequency Analyzer is ideally suited to frequency response testing since it has a self contained tracking generator and a log sweep 20 Hz to 20 kHz mode. An amplifier can be swept under a variety of different conditions in a matter of seconds, eliminating the need for tedious measurements and point to point plots. Multiple traces of conditions can be built up either on film or on a storage oscilloscope to obtain one picture of the complete response performance of an audio device.

The rated frequency response[3] is the frequency range over which the amplitude response does not vary more than plus or minus 3dB from the amplitude at 1000 Hz.

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3. EIA Standard Methods of Measurement for Audio Amplifiers Used in Home Equipment, RS-234-C (1971).
4. Larry Klein, "Amplifier Power-Output Ratings: A New FTC Trade Regulation Rule," Stereo Review, Vol. 35 No. 5, Page 79, November 1974.

# SERVICING HINTS

The combination Low Frequency Spectrum Analyzer-Oscilloscope offers tremendous flexibility to permit rapid servicing of high quality Hi-Fi and stereo equipment. An oscilloscope probe can be connected directly to the front panel of the 5L4N making it easy to pinpoint problem areas.

While it is impossible to list all the steps and techniques one might use, the following are some of the things we came across while preparing this applications brochure.

## A. BIAS VOLTAGE ADJUSTMENT

The adjustment of bias voltage on the output stage is traditionally done with a voltmeter or a distortion analyzer. The Low Frequency Analyzer can be connected to an amplifier and using a single tone (like 1 kHz) the bias can be quickly set for minimum harmonic amplitude. Then the output power can be reduced and the low level crossover distortion that sometimes occurs can be double checked.

## B. INAUDIBLE FREQUENCIES

Sometimes a Hi-Fi system doesn't seem to perform correctly and the problem can be traced to overloading or distortion due to INAUDIBLE frequencies being passed by the amplifier.

The more common causes of these frequencies are inaccurate adjustment of the stereo traps (letting 19 and 38 kHz into the audio channel); tape recorder bias traps improperly adjusted; improper bypassing of inputs letting radio frequency energy into the amplifier; and sometimes an amplifier will just oscillate all by itself.

By using the 10 kHz/DIV MODE of the analyzer routinely when checking an amplifier, these kinds of problems will be immediately visible. Figure 54.

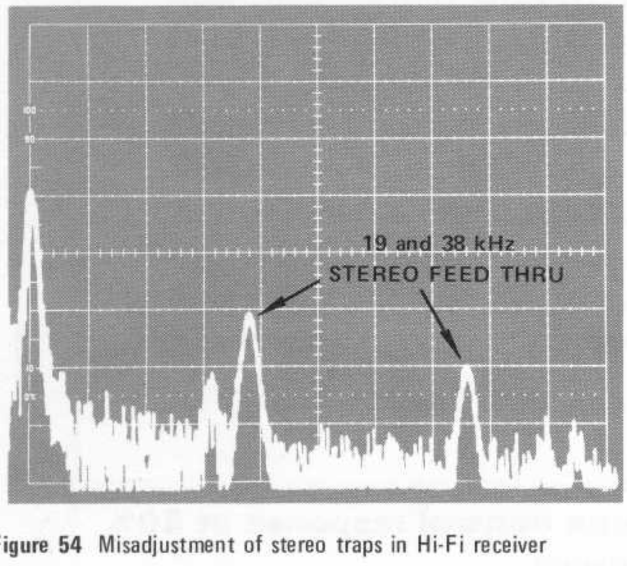


**Figure 54** Misadjustment of stereo traps in Hi-Fi receiver

## C. STAGE BY STAGE GAIN CHECK

Stage by Stage Gain Check are often used to find the source of a weak or distorted channel in an amplifier system. A modification of the stage by stage check can be performed with the Low Frequency Spectrum Analyzer using the tracking generator output. Insert the tracking generator into an amplifier input, and using a X10 oscilloscope probe, begin at the input stages of the amplifier and monitor the input and output of each stage.

Channels can be compared to each other or gain and response can be checked against the manufacturers' recommendations. Certain problems will be immediately obvious if they exist.

1. Gain differences will show up on the display.

2. Low frequency rolloff will indicate such things as defective stage coupling or output coupling capacitors.

3. High frequency rolloff could indicate defective emitter bypass capacitors or other associated problems.

The test can then be repeated with no signal on the amplifier input, watching the noise floor. A high noise floor rise between stages is characteristic of a defective or hot component.

Finally, using a 1 kHz tone, a stage by stage check can be performed while watching the 2nd and 3rd harmonics for signs of a stage with higher than normal distortion. Typically, the output stage should contribute most of the distortion in an amplifying system.

## D. STYLUS PRESSURE ADJUSTMENTS

Phono cartridge weight adjustments are often one of the least understood areas of Hi-Fi. The manufacture attempts to recommend the lowest stylus pressure that produces minimum distortion. By using a continuous tone test record, and starting with a new stylus, the pressure is increased progressively until the lowest distortion (2nd and 3rd harmonics) of the tone are noted. This test can be easily duplicated in the shop using the low frequency analyzer.

A little imagination, and a low frequency spectrum analyzer can go a long way toward taking the mystery out of Hi-Fi repairs. Other equipment such as tape recorders, speakers, and electronic instruments (like organs) can be analyzed. Complete PA systems used in auditoriums can be swept and analyzed, or the acoustics and noise levels of an auditorium could be checked.

This pamphlet only covers one small application area for the low frequency analyzer. We hope that you will have an opportunity to experiment with our applications and expand them to fit your individual needs.