SOLID STATE

VARIABLE FILTER

MODEL 3200(R) AND MODEL 3202(R)

SERIAL NO. 1061

OPERATING AND MAINTENANCE MANUAL

KROHN-HITE CORPORATION
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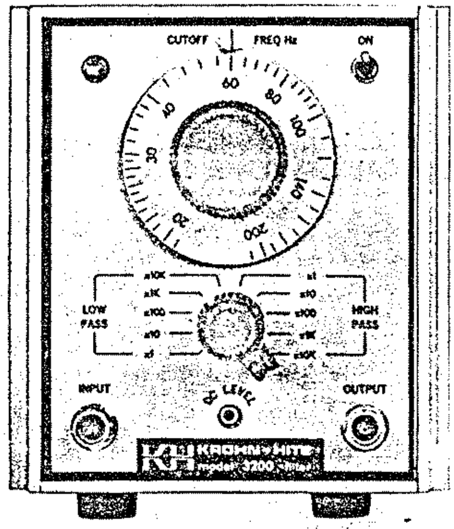
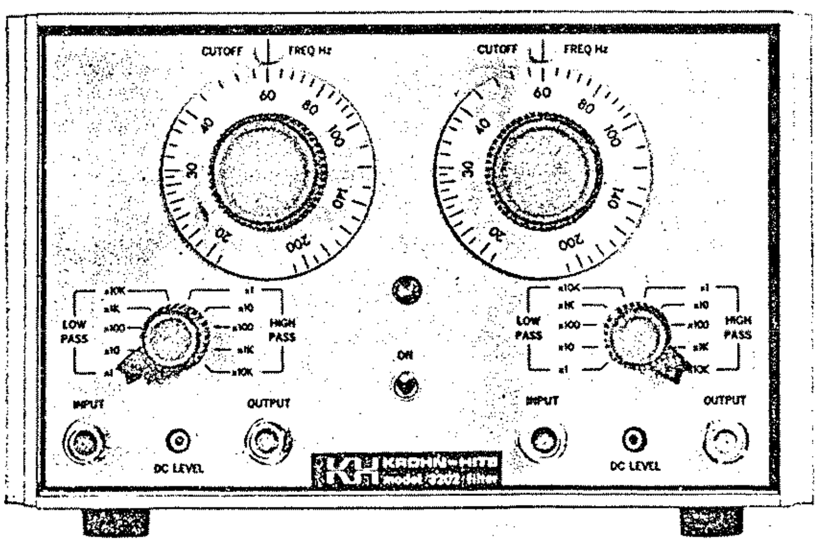


Model 3200



Model 3202

Figure 1. 3200 Series Filter

SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The Models 3200 and 3202, illustrated in Figure 1, are solid state variable electronic Filters with cutoff frequencies continuously adjustable over the frequency range from 20 Hz to 2 MHz. The pass-band gain is unity (0 db), with an attenuation rate of 24 db per octave outside the pass-band. Maximum attenuation is greater than 80 db and the output hum and noise is less than 100 microvolts.

The Model 3200 can function as either a High-Pass or Low-Pass Filter. In the High-Pass mode of operation the maximum input signal is 3 volts rms and the upper 3 db point occurs at approximately 10 MHz. In the Low-Pass mode the Filter is direct-coupled and the combined ac plus dc input signal should not exceed 4.2 volts peak.

The Model 3202 consists of two Model 3200's mounted in a single cabinet isolated from each other with independent power supplies, and input and output connectors. When these two filter channels are switched to the same mode of operation and connected in series with both dials set to the same cutoff frequency, the Model 3202 will function as a High-Pass or Low-Pass Filter with an attenuation rate of 48 db per octave. If the two channels are connected in series, and one channel is operated in the Low-Pass mode and the other channel in the High-Pass mode, the Model 3202 will function as a Band-Pass Filter with attenuation rate of 24 db per octave outside the pass-band.

When the two channels are connected in parallel, as described in Section 2.3, the Model 3202 will function as either a Band-Reject Filter with cutoff frequency limits from 20 Hz to 2 MHz or provide a sharp null at any frequency between 40 Hz and 800 kHz.

This Filter has a maximally flat or Butterworth characteristic when the RESPONSE switch(s), located on the rear of the chassis, is in the MAX FLAT position. For pulse-type waveforms this switch should be in the SIMPLE RC position, optimum for transent-free filtering.

1.2 SPECIFICATIONS

FREQUENCY RANGE

High-Pass and Low-Pass cutoff frequencies continuously adjustable from 20 Hz to 2 MHz in five bands.

BAND	MULTIPLIER	FREQUENCY (Hz)
1	1	20 - 200
2	10	200 - 2,000
3	100	2,000 - 20,000
4	1K	20,000 - 200,000
5	10K	200,000 - 2,000,000

FREQUENCY DIALS

Each channel has a single decade frequency dial (calibrated from 19 to 210) and an associated high-pass/low-pass band switch providing five multiplier ranges for each mode.

CUTOFF FREQUENCY CALIBRATION ACCURACY

±5%-bands one to four, ±10%-band five, with Response Switch in Max. Flat (Butterworth) position; less accurate in R-C position. Relative to mid-band level, the Filter output is down 3 db at cutoff in Max. Flat position, and approximately 13 db in R-C position.

BANDWIDTH (See "Input Characteristics")

Low-Pass Mode – Frequency response from dc to the cutoff frequency set within the range from 20 Hz to 2 MHz.

High-Pass Mode – Continuously adjustable between 20 Hz and 2 MHz with upper 3 db point at approximately 10 MHz.

Band-Pass Operation Model 3202 – Continuously variable within the cutoff frequency limits of 20 Hz to 2 MHz. For minimum bandwidth the high-pass and low-pass cutoff frequencies are set equal. This produces an insertion loss of 6 db, with the -3 db points at 0.8 and 1.25 times the midband frequency.

Band-Reject Operation Model 3202 – Continuously variable within the cutoff frequency limits of 20 Hz and 2 MHz or sharp null at any frequency between 40 Hz and 800 kHz. The low-pass band extends to dc. The high-pass band has its upper 3 db point at approximately 10 MHz. The null is sharper than that of a balanced "parallel T" filter, and is obtained by setting the high-pass cutoff at approximately twice the desired null frequency, and the low-pass cutoff at approximately one-half the desired null frequency. See Section 2.3.

RESPONSE CHARACTERISTICS (selected by rear panel switch)

Butterworth – Each channel exhibits maximally flat fourth order Butterworth response for optimum performance in frequency domain.

Simple RC – Fourth order RC response for transient-free time-domain performance.

Note: Higher order characteristics may be obtained by cascading individual channels.

ATTENUATION SLOPE

Nominal 24 db per octave per channel in high-pass or low-pass modes.

MAXIMUM ATTENUATION

Greater than 80 db.

INSERTION LOSS

Zero ±1/2 db to 2 MHz; 3 db at approximately 10 MHz. 6 db in Band-Reject operation.

INPUT CHARACTERISTICS

Maximum Input Amplitude - 3 v rms up to 2 MHz, decreasing to 1 v rms at 10 MHz.

Maximum DC Component -
Low-Pass Mode: Combined ac plus dc should not exceed 4.2 v, peak.
High-Pass Mode: 200 v.

Impedance - 100 k ohms in parallel with 50 pf.

OUTPUT CHARACTERISTICS

Maximum Voltage - 3 v, rms, to 2 MHz (1.5 v, rms, in Band-Reject operation).

Maximum Current - 10 ma (less in Band-Reject operation).

Internal Impedance - 50 ohms, approx. (higher in Band-Reject operation).

FLOATING (UNGROUNDED) OPERATION

A switch is provided on rear of chassis to disconnect signal ground from chassis ground.

HUM AND NOISE

Less than 100 microvolts rms for a detector bandwidth of 2 MHz, rising to 150 microvolts for a detector bandwidth of 10 MHz.

OUTPUT DC LEVEL STABILITY

±2 millivolt per degree C.

FRONT PANEL CONTROLS

CUTOFF FREQUENCY Hz Dial and Multiplier/Function switch.

POWER-ON Switch.

TERMINALS

Front panel and rear of chassis, one BNC connector for INPUT, one for OUTPUT.

POWER REQUIREMENTS

105-125 or 210-250 volts, single-phase, 50-400 Hz, 15 watts.

OPERATING TEMPERATURE RANGE

0°C to 50°C.

DIMENSIONS AND WEIGHTS

Model	Height	Width	Depth	Ship Wgt lbs/kg	Net Wgt lbs/kg
(Bench Models)					
3200	5 1/4"	4 3/4"	15 1/4"	14/7	9/4
3202	5 1/4"	8 5/8"	15 1/4"	22/10	14/7
(Rack Units)					
3200R	3 1/2"	19"	15 1/4"	16/8	11/5
3202R	3 1/2"	19"	15 1/4"	22/10	18/9

1.3 FILTER CHARACTERISTICS

BANDWIDTH ADJUSTMENT

The flexibility of adjustment of bandwidth is shown in Figure 2. Low-Pass and High-Pass operation is shown in curves (1) and (2). The solid lines show the Maximally Flat or Butterworth operation while the dotted lines show the simple R-C characteristic. Curve (3) shows Band-Pass operation for two different bandwidths illustrated by curves A and B. Curve B shows the minimum pass-band width obtained by setting the two cutoff frequencies equal. In this condition the insertion loss is 6 db, and the -3 db cutoff frequencies occur at 0.8 and 1.25 times the mid-band frequency. Band-Reject operation for a reject band with a cutoff frequency separation ratio of 10,000 is shown by curve 4C. Curve 4D illustrates a sharp null with 3 db points at approximately 0.5 and 2.0 times the null center frequency and is obtained by setting the high and low cutoff frequencies a factor of approximately 2 from the desired null frequency.

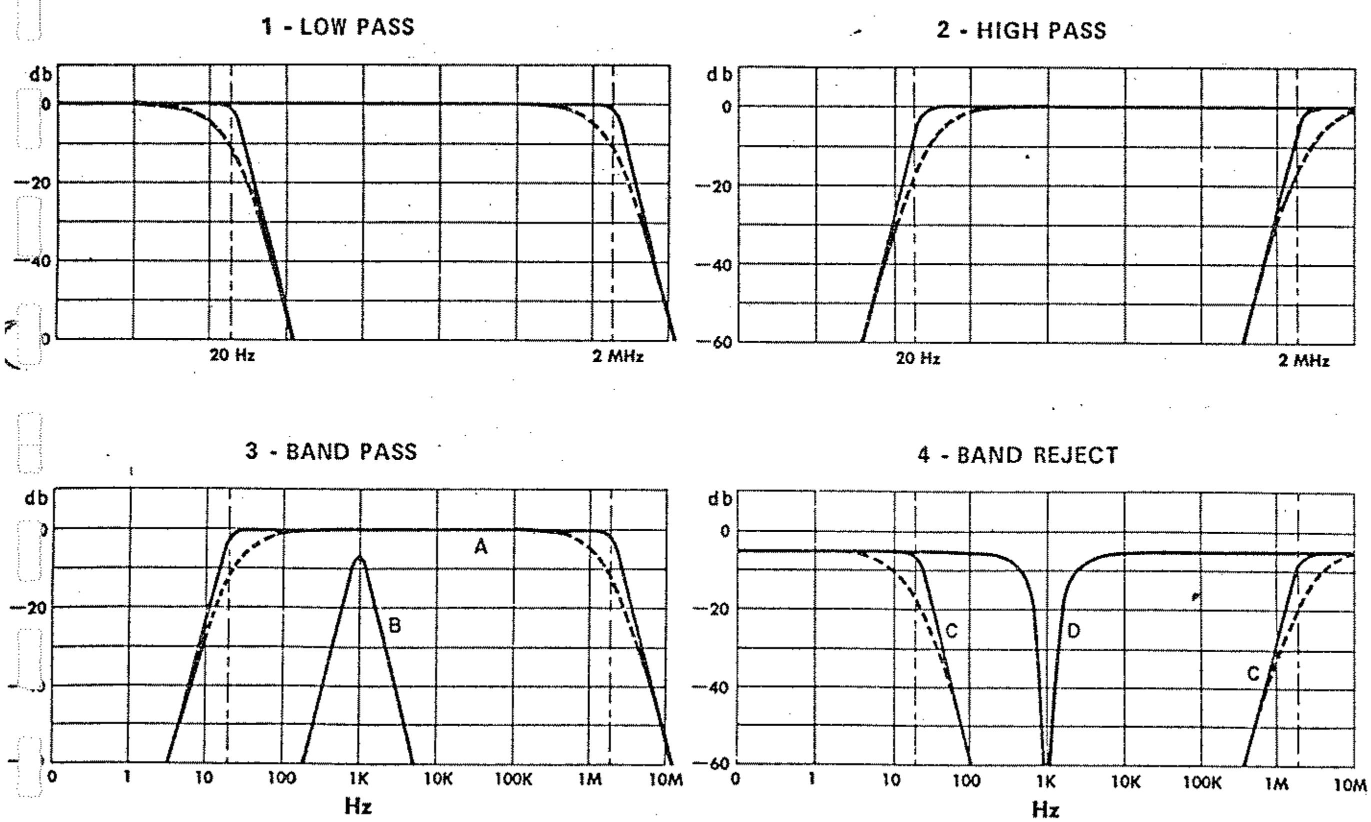
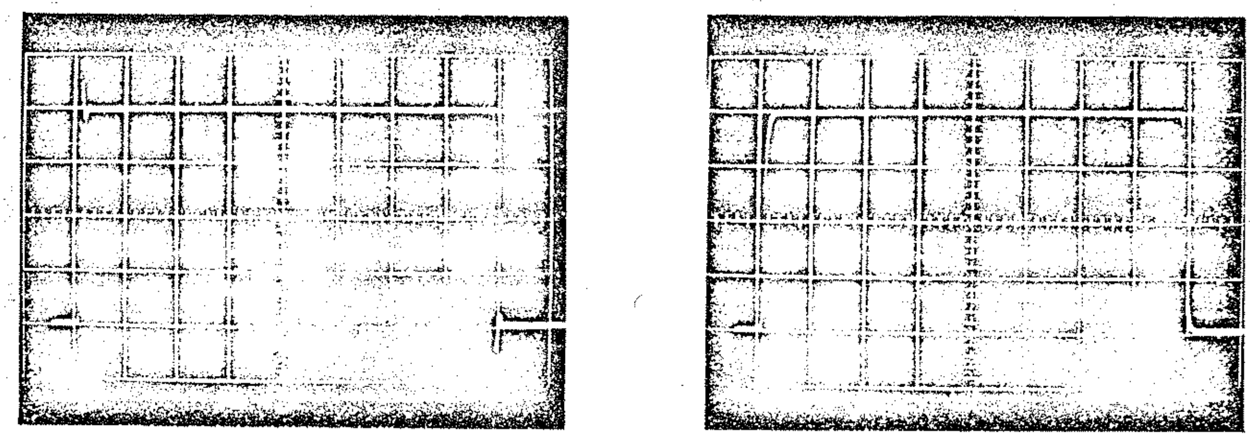


Figure 2. Multifunction Response of Butterworth (solid curves) and Simple R-C (dashed curves).

RANSIENT RESPONSE

The frequency response characteristics of this Filter closely approximates a fourth-order utterworth with maximal flatness, ideal for filtering in the frequency domain. For pulse-ype signals a RESPONSE switch(s) located at the rear of the chassis is provided to change he response characteristic to the Simple R-C type, optimum for transient-free filtering. Figure 3 shows a comparison of the Filter output response in these modes to a square wave input signal.



Response (in low-pass mode) to 1-kHz square wave, with cut-off at 1 MHz. Overshoot is approximately 1 db with Response Switch in "Max. Flat" position.

Response to same square wave with Response Switch in " R-C" position. Note slight rounding of leading edge, but complete removal of overshoot.

Figure 3. Square Wave Response Characteristics

UTOFF RESPONSE

The attenuation characteristics of the Filter are shown in Figure 4. With the RESPONSE switch(s) in the MAXIMALLY FLAT or Butterworth mode, the gain, as shown by the solid curve, is virtually flat until the -3 db cutoff frequency. At approximately two times the cutoff frequency the attenuation rate coincides with the 24 db per octave straight line asymptote. In the Simple R-C mode, optimum or transient-free filtering, the dotted line shows that the gain is down approximately 13 db at cutoff and has approximately 24 db per octave attenuation rate at five imes the cutoff frequency. Beyond this frequency the filter attenuation rate and maximum attenuation, in either mode, are identical.

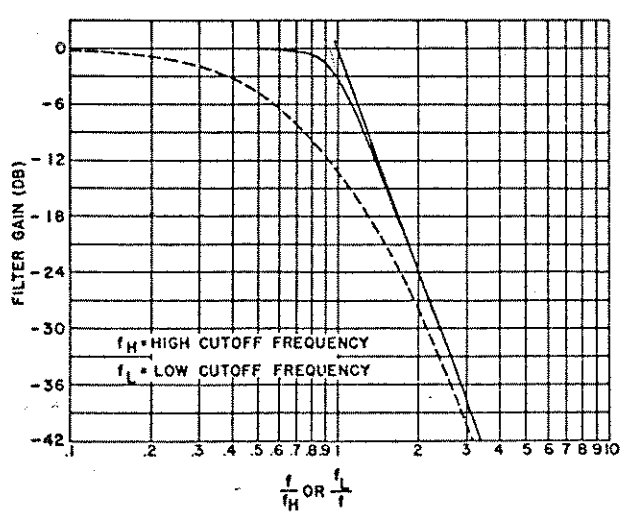


Figure 4. Normalized Attenuation

P...SE RESPONSE

...phase response of the Model 3200 or each channel of the Model 3202 can be obtained ...m Figure 5 which gives the phase characteristic for either mode of operation in degrees ...d (+) or lag (-) as a function of ratio of the operating frequency f to the low cutoff requency f_L (High-Pass mode) or high cutoff frequency f_H (Low-Pass mode). The solid ...urve is for the MAXIMALLY FLAT or Butterworth mode and the dotted curve is for the ...nsient-free or Simple R-C mode.

Example:

...termine the phase shift of the filter in the MAXIMALLY FLAT or Butterworth mode, ...h the function switch set to the High-Pass mode at the X1 position, the cutoff frequency f_L) set to 100 Hz and an input frequency (f) of 300 Hz.

$$\text{Since } \frac{f}{f_L} = \frac{300}{100} = 3$$

from Figure 5, 3 ≅ + 50°

The output of the filter leads the input by 50 degrees.

The phase response of the Model 3202 could be obtained in the same manner by taking the a...ebraic sum of the phase response of each channel.

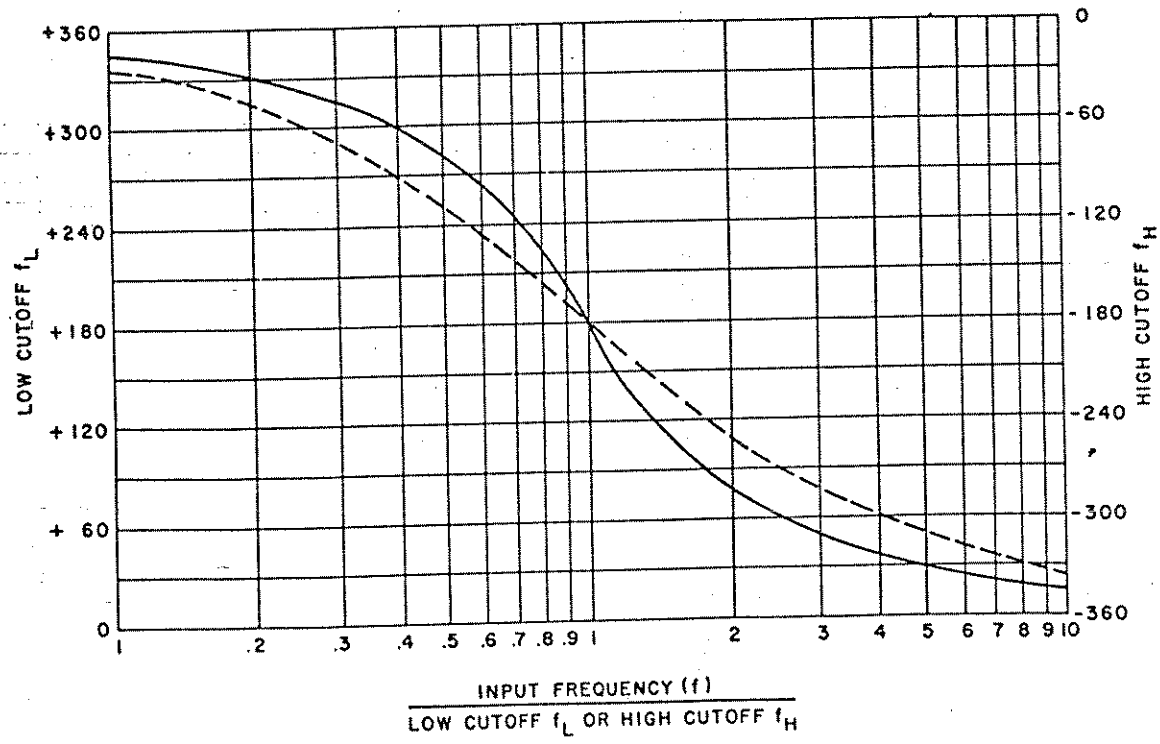


Figure 5. Normalized Phase Characteristics

SECTION 2

OPERATION

2.1 INTRODUCTION

On receipt of the Filter, carefully unpack and examine it for damage that may have occurred in transit. If signs of damage are observed, file a claim with the transportation agency immediately, and notify Krohn-Hite Corporation. Do not attempt to use the Filter if damage is suspected.

Rack-mounting models (designated by a suffix "R" after the model number) mount with four machine screws in the standard 19" rack space. No special brackets or attachments are needed.

2.2 FRONT AND REAR PANEL CONTROLS

The front panels of the Model 3200 and each channel of the Model 3202 includes a frequency dial, a band multiplier/function switch, two BNC coaxial connectors for the INPUT and OUTPUT signals, and a screwdriver control for the adjustment of the output dc level. A POWER-ON switch and indicator light is used in both models.

Each frequency dial is calibrated with a single logarithmic scale reading directly in Hz from 19 to 210. The dial is 2 1/4 inches in diameter with an effective scale length of approximately 6 inches per band, giving a total effective scale length of approximately 30 inches for the 20 Hz to 2 MHz range.

Each multiplier switch has ten positions, 5 bands for Low-Pass operation and 5 bands for High-Pass operation covering the frequency range as follows:

BAND	MULTIPLIER	FREQUENCY (Hz)
1	1	20 - 200
2	10	200 - 2,000
3	100	2,000 - 20,000
4	1K	20,000 - 200,000
5	10K	200,000 - 2,000,000

The rear chassis of the Model 3200 and each channel of the Model 3202 has two switches; one for selecting filter response of either the Butterworth type (Maximal flatness) or simple RC (Transient-free) and one for disconnecting the signal ground from chassis ground.

2.3 OPERATION

MODEL 3200

a. Make appropriate power connections as described in Section 2.5.

b. Make appropriate connections to the INPUT and OUTPUT connectors of the Filter. The rms INPUT voltage should not exceed 3 volts in the High-Pass mode and the combined ac and DC INPUT voltage should not exceed 4.2 volts peak in the Low-Pass mode. The Filter can sustain a combined ac and dc INPUT voltage of up to 200 volts peak without causing permanent damage. In the event of an overload the output waveform will appear distorted.

c. Set mode of operation and cutoff frequency by means of the band multiplier switch(s) and the frequency dial(s).

d. Turn power switch to ON.

e. After sufficient warm-up time check output dc level, if necessary, adjust DC LEVEL potentiometer(s) for zero volts on the output(s).

f. For normal Filter operation the FLOATING/CHASSIS GROUND switch(s), located on the rear of the chassis, should be in the CHASSIS position. If the Filter is used in a system where ground loops make ungrounded operation essential, this switch(s) should be in the FLOATING position.

CAUTION

> In FLOATING operation the signal ground should be connected to system ground to prevent excessive hum and noise.

g. When filtering consists principally of separating frequency components of a signal (frequency domain) the RESPONSE switch(s) located on the rear of the chassis, should be in the MAX-FLAT position. If the Filter is used to separate pulse-type signals from noise (time domain) this switch should be in the RC position.

MODEL 3202

TO OBTAIN HIGH-PASS OR LOW-PASS OPERATION WITH 48 DB PER OCTAVE ATTENUATION, PROCEED AS FOLLOWS:

a. Connect the two channels in series by connecting the output of the left channel to the input of the right channel.

b. Select identical mode of operation and multiplier position for both channels.

c. Set both dials to the same cutoff frequency.

NOTE

> When the two channels are in series and set to the same mode of operation with identical cutoff frequencies the gain at the cutoff frequency will be down 6 db from the pass-band gain with the two RESPONSE switches in the MAX-FLAT (Butterworth) position. In the Simple R-C position the gain at the cutoff frequency will be down approximately 26 db.

TO OBTAIN BAND-PASS OPERATION WITH 24 DB PER OCTAVE ATTENUATION, PROCEED AS FOLLOWS:

a. Connect the two channels in series.

b. Set the left channel to the High-Pass mode (this will control the Low-Cutoff frequency). Set the right channel to the Low-Pass mode (this will control the High-Cutoff frequency).

Band-Pass operation could also be obtained by setting the left channel to the Low-Pass mode and the right channel to the High-Pass mode. The first method has the advantage that the Low Cutoff Frequency (High-Pass mode) is on the left and the High Cutoff frequency (Low-Pass mode) is on the right, which is a logical arrangement since it coincides with our customary graphical representation of a Band-Pass Filter. This may be disadvantageous since the output is dc coupled because the Low-Pass channel is on the right. If the first method is used the output is ac coupled which is desirable in some applications where no dc fluctuations on the output can be tolerated.

c. The minimum Pass-Band is obtained by setting the high cutoff frequency equal to the low cutoff frequency. In this condition the insertion loss is 6 db, and the -3 db cutoff frequencies occur at 0.8 and 1.25 times the mid-band frequency. See curve B in Figure 2.

TO OBTAIN BAND-REJECT OR NOTCH FILTER OPERATION, PROCEED AS FOLLOWS:

a. Connect the two channels in parallel by connecting the input signal to the BNC INPUT connector of both channels simultaneously. The OUTPUT from both channels should be added through two equal external resistors in series with each output. The junction of these resistors become the output of the Filter. It is recommended that the resistors be approximately 1,000 ohms and of the carbon or metal film type if the Filter is used at high frequencies. If the two resistors are not equal the gain on one side of the notch will be different than the gain on the other. The smaller the adding resistors the greater the loss will be through the Filter in the Pass-Band region, due to the loading effect of the 50 ohm Filter output impedance.

b. The first channel should be set for Low-Pass operation.

c. The second channel should be set for High-Pass operation.

d. It should be noted that the output impedance in the band-reject mode will not be 50 ohms, but approximately one half the resistance of one adding resistor. The maximum input should not exceed 3 volts rms and the maximum output voltage in this mode will be 1.5 volts rms open circuit.

e. An accessory kit, which facilitates the procedure of paralleling the Model 3202 to obtain Band-Reject and notch Filter operation, is available. It consists of a small enclosure that contains two 1,000 ohm adding resistors and the necessary BNC connectors and cables.

2.4 TERMINALS

BNC coaxial connectors are provided on the front panel and on the rear of the chassis for both INPUT and OUTPUT connections.

2.5 LINE VOLTAGE AND FUSES

The Filter, unless otherwise specified is wired for operation from an ac power source of 105-125 volts, 50 to 400 Hz.

The Model 3200 uses a 1/8 ampere slo-blow line fuse and the Model 3202 uses a 1/4 ampere slo-blow line fuse that are mounted on the rear of the chassis. They may be modified to operate from a 210-250 volt line by removing the two jumpers connecting terminals 1 to 3, and 2 to 4 of the power transformer(s), and adding a jumper between terminals 2 and 3 of the power transformer(s). In the model 3202 there are two power transformers and both should be modified when the line voltage is changed. For 210-250 volt operation, a 1/16 ampere slo-blow fuse should be used for the Model 3200, and a 1/8 ampere slo-blow fuse for the Model 3202.

SECTION 3

CIRCUIT DESCRIPTION

1 INTRODUCTION

As shown in the Simplified Schematic Diagram, Figure 6, the Model 3200 and each channel the Model 3202 consists of a four-pole variable electronic filter than can be operated as ther a Low-Pass or a High-Pass Filter. It has a variable cutoff frequency that is adjustable between 20 Hz and 2MHz by means of a tuning dial and a ten-position multiplier switch; five positions for the Low-Pass mode and five positions for the High-Pass mode. the Low-Pass mode, it is direct-coupled and, in the High-Pass mode, its upper 3 db oint is approximately 10 MHz. A Response switch selects either Butterworth (maximally flat response) or a Simple RC frequency characteristic, which improves the transient response by eliminating overshoot when pulsed input signals are used.

he Schematic Diagram of the Model 3200 Filter, Figure 8, is at the end of this manual. Bold lines on the Schematic Diagram show the main signal paths, while the dashed lines dicate feedback signal paths.

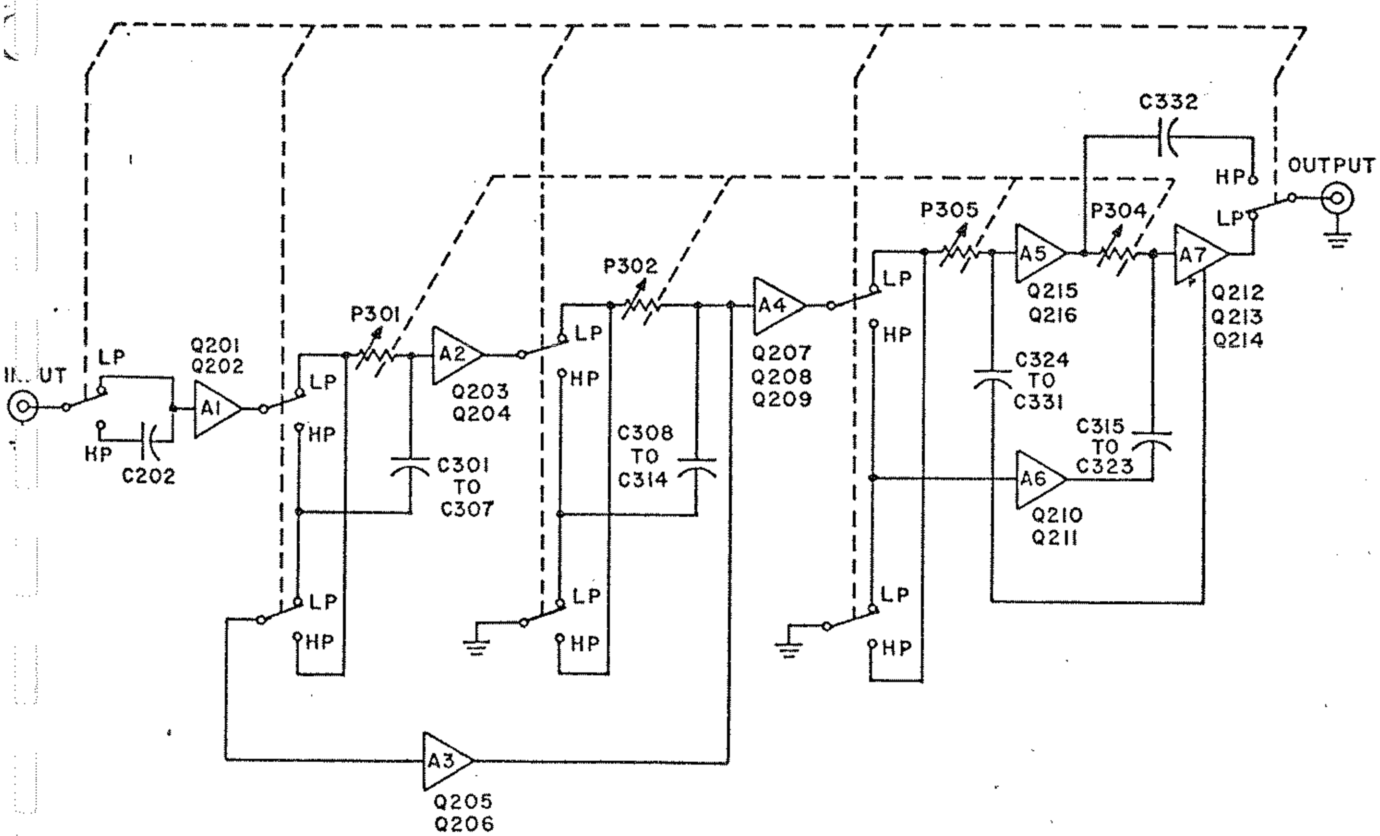


Figure 6. Simplified Schematic Diagram of Model 3200

As shown in Figure 6, the Model 3200 consists of four RC tuning elements isolated from each other by buffer amplifiers A2, A4, A5 and A7. The resistive part of the tuning elements P301, P302, P304 and P305, are potentiometers ganged by means of a gear train. The capacitors are ganged by a band switch that serves as both a multiplier and a "mode of operation" switch. The cutoff frequency is tuned capacitively in decade steps by the band switch, and continuously within each decade by the potentiometer assembly. Except for the highest band, the same capacitors are used in both the High-Pass and the Low-Pass mode. At the higher frequencies, separate capacitors are used to enable individual compensation for stray capacities in either mode of operation.

The Model 3200 Filter consists of two two-pole filters. Each two-pole filter has the correct response to give a Butterworth characteristic when they are cascaded. The first two-pole filter has very little loop gain and its response is very much like two cascaded R-C elements, i.e. the gain at the cutoff frequency is approximately 6 db down from mid-band gain. The second two-pole filter has more loop gain, resulting in a gain of approximately 3db at the cutoff frequency, so that when the first and second filters are cascaded the overall gain at the cutoff frequency is 3 db down.

3.2 DETAILED DESCRIPTION

The input amplifier A1, consisting of emitter followers Q201 and Q202, isolates the input and provides the low impedance source necessary to drive the first RC filter network of potentiometer P301 and band capacitors C301 to C307, whichever is applicable. The signal input is direct-coupled in the Low-Pass mode, via current limiting series resistors R203, R206 and R207, to the input amplifier. Clamping diodes CR201 and CR202 in conjunction with these current limiting resistors prevent component damage in the event of excessive input signal. In the High-Pass mode the signal input is capacitor-coupled to the input amplifier through C202. A potentiometer P201 provides an offset voltage that maintains the Filter output dc level, in the Low-Pass mode, independent of the internal resistance of the input signal source. A divider network consisting of resistor R279 and thermistor R280, shown in the Filter Schematic Diagram Figure 8, generates a themally sensitive offset voltage, that is added to the input amplifier via resistor R205, to maintain the Filter output dc level independent of ambient temperature variations. This thermal offset voltage is connected to the input stages of all the amplifiers in the Filter that require it.

The output of the first RC filter network is isolated by amplifier A2, which is similar to A1 and consists of transistors Q203 and Q204. This provides the required drive for the second RC filter network comprising potentiometer P302 and applicable band capacitor C308 to C314. A thermal offset voltage is also applied to amplifier A2 via resistor R213. Another offset voltage is applied to amplifier A2 via R214 to maintain the Filter output dc level independent of tuning. This voltage is derived from the divider network comprising potentiometer P206 and resistor R278, as shown in the Power Supply Schematic, Figure 9.

The output of the second RC filter network is connected to the input of amplifier A3 and A4. Amplifier A3, consisting of transistors Q205 and Q206, provides the necessary feedback gain to obtain the desired response for the first two-pole filter. Amplifier A4 is a two stage amplifier with a differential input stage using transistors Q207 and Q208. The output from the collector of the second stage, Q209, is fed back to the input stage through a network consisting primarily of resistors R238 and R242, and Potentiometer P202 that is used for unity gain adjust in the Low-Pass mode.

Amplifier A4, in the Low-Pass mode, drives the third RC filter network of potentiometer P305 and applicable band capacitor C324 to C331. The output of the third RC filter network is fed to amplifier A5, which consists of emitter followers Q215 and Q216. This amplifier, in the Low-Pass mode, drives the fourth RC Filter network of potentiometer P304 and applicable band capacitor C315 to C323. The output of the fourth RC filter network connects to amplifier A7, which consists of emitter followers Q212, Q213 and Q214. In the Low-Pass mode the output of the Filter comes from Q213 via resistor R313.

e High-Pass mode of operation the circuit configuration of the second two-pole filter odified. The output of amplifier A4 is connected to the input of amplifier A6, which is -stage degenerative amplifier and consists of transistors Q210 and Q211. The gain is amplifier varies with band switching. It is increased on the highest band by insert- a network, consisting of R248, C212 and P203, in the degenerative feedback path. mplifier A6 drives the fourth RC filter network and the output of this network is fed to lifier A7 which drives the third RC filter network. The output of the third filter net- k connects to amplifier A5, and its output, via capacitor C332, is the output of the iter.

ERWORTH/RC RESPONSE

his Filter has a maximally flat or Butterworth characteristic when the RESPONSE tch(s), S301, located on the rear of the chassis, is in the MAX FLAT position. To vide minimum overshoot to fast rise pulses the feedback of the second two-pole filter disconnected by S202 when the RESPONSE switch(s) is in the SIMPLE RC position.

ER SUPPLIES

Power Supplies deliver a + 10 and -10 regulated voltage. It consists of a bridge recti- CR101 and filter capacitors C101 and C102 to provide the necessary unregulated dc oltage. The -10 volt regulated supply is a typical series type using a zener reference, 101, and amplifiers Q105 and Q108 which drives a series regulator Q106. To prevent age when short circuits of the regulated voltage occur, a current limit circuit, con- ting of Q102 and R103, turns off the -10 volt supply if the current in R103 exceeds a redetermined value. The + 10 volt supply uses the -10 volts as a reference. A divider etwork, consisting of R122 and R123, sets the proper voltage level for the amplifiers 7 and Q104, which drive the series regulator Q103. Q101 and R102 limit the current e + 10 volt supply.

SECTION 4

MAINTENANCE

4.1 INTRODUCTION

If the Filter is not functioning properly and requires service, the following procedure may facilitate locating the source of trouble. Access to the Filter is accomplished easily without any hand tools by removing the top and bottom covers. It is first necessary to loosen (not remove) the two black thumb screws centered on each side at the rear of the chassis and then pulling out the two side covers. This unlocks the top and bottom covers which then may be pulled out.

The general layout of major components, test points, screwdriver controls and adjustments is shown in Figure 7. Detailed component layout for the printed circuit card is included in the Schematic Diagram, Figure 8 which is attached to the inside rear cover. Various check points are shown on the Schematic Diagram and are also marked on the printed circuit card. To allow for ease of service, the printed circuit card is provided with a swing-out mounting. Removal of two screws, one on each end, will allow the card to lift and provide access to the components. It is first necessary to move the card slightly towards the front panel, while lifting the card, to free it from its locking device which permits the card to remain in a vertical position to facilitate servicing.

Many troubles may easily be found by visual inspection. When a malfunction is detected, make a quick check of the unit for such things as broken wires, burnt or loose components, or similar conditions which could be a cause of trouble. Any trouble-shooting of the Filter will be greatly simplified if there is an understanding of the operation of the circuit.

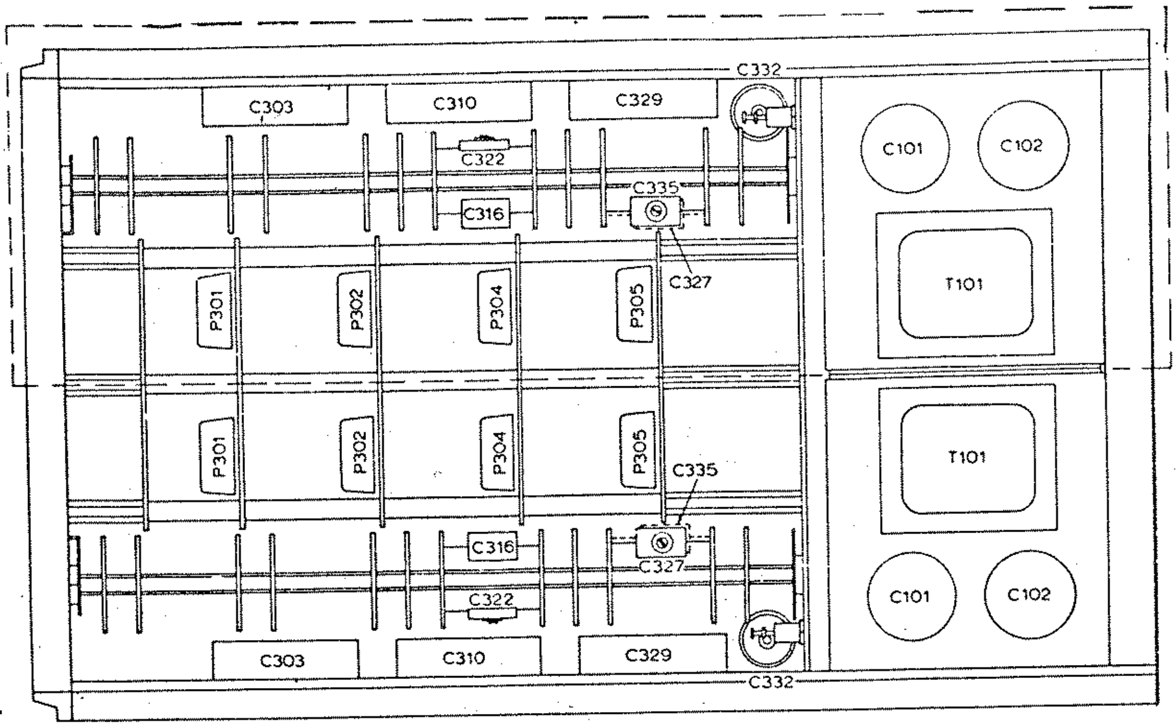
Before any detailed trouble-shooting is attempted, reference should be made to Circuit Description, Section 3, to obtain this understanding.

4.2 POWER SUPPLY

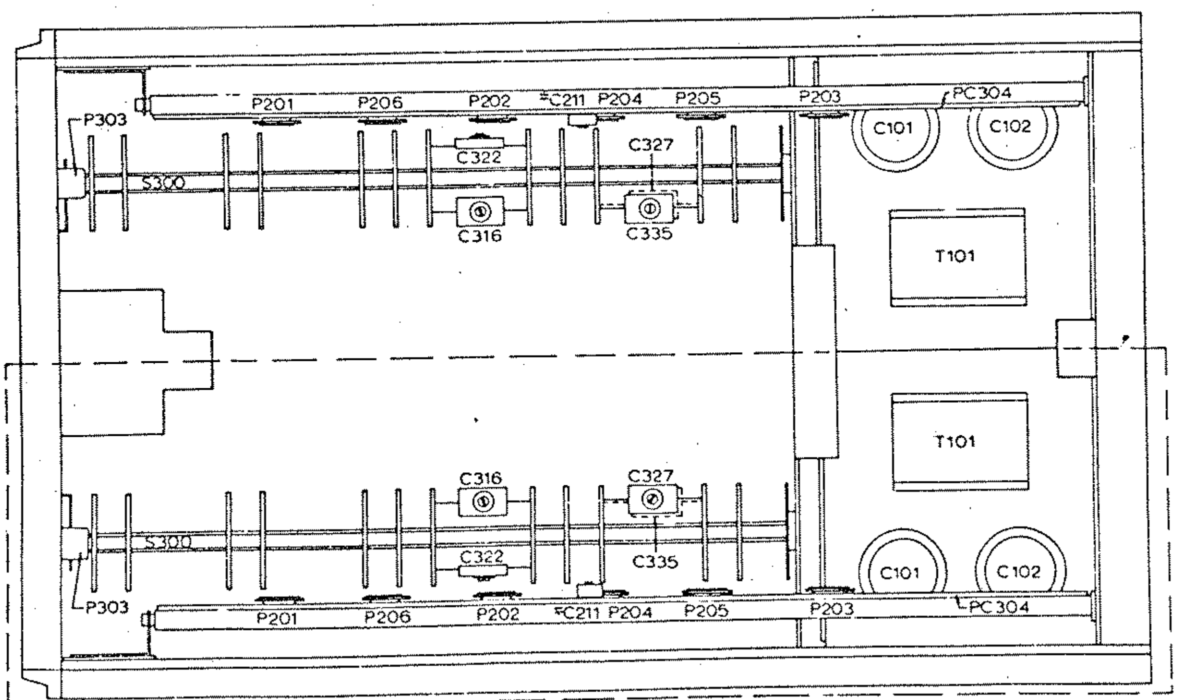
If the Filter does not seem to be working properly, the two power supplies should be checked first. The supplies should measure + 10 volts ± 5% and - 10 volts ±5%. If the two supplies appear to be correct, refer to the signal tracing analysis, Section 4.3.

If the -10 volt supply is slightly out of tolerance and exceeds its upper limit of -10.5 volts, R116 should be increased or R118 should be reduced. When the -10 volt supply is slightly below its lower limit of -9.5 volts, R116 should be decreased or R118 increased. If the -10 volt supply is correct and the + 10 volt supply is slightly out of tolerance, R122 or R123 may be defective. A fuse, F101 (1/8A for 115v or 1/16A for 230v operation), located at the rear of the chassis, is provided to protect the power supply from short circuits and overloads. The rating of this fuse was selected for proper protection of the Filter, and it should be replaced with one of the same type and rating.

Two regulated supplies are used to provide + 10 volts and -10 volts with respect to the chassis. The -10 volt supply uses a zener (Z101) as its reference, while the + 10 volt supply uses the minus supply as its reference. This fact should be kept in mind when doing any work on the supply, as an error in the minus will be reflected in the plus. Both supplies



TOP VIEW



BOTTOM VIEW

Model 3200: Shown within dotted area.
Model 3202: As shown.
*On some models C211 is located on S300.

Figure 7. Top and Bottom View of Model 3200 and 3202

are provided with current limiting circuits that will shut down the supply when excessive current is being drawn from it. Because of this, an apparent power supply malfunction may be caused by an overload elsewhere in the Filter. This may be determined by measuring the voltage across R102 and R103. It should not exceed 0.4 volts.

If the supply does not appear to be working properly, the error signal thus developed should be traced through the regulator loop to find the faulty component. Correct voltages for various points in the supply are shown on the Schematic Diagram, Figure 8. As an example of the method of trouble-shooting, let us assume that the -10 volt supply is very low. This should make the base of Q108 more positive than normal, while making its collector more negative. The base of Q106 should then be made more positive than normal and the collector more negative, thus correcting the output of the supply. If a faulty component is present in the regulating loop this corrective action would be blocked. That component would then be found at the point in the loop where the action was blocked. The plus supply uses approximately the same type of circuit and the same basic method of trouble-shooting may be used there as well.

4.3 SIGNAL TRACING ANALYSIS

If the power supplies appear to be functioning properly, but the Filter is not working in one or both modes of operation, the following procedure should localize the malfunction.

4.3.1 Low-Pass and High-Pass Malfunction

If the Filter does not function properly in both the Low-Pass and High-Pass modes, it is recommended that the following signal tracing analysis, in the Low-Pass mode, be followed: Set the multiplier switch to the X10 position in the Low-Pass mode. Set the dial to 60. Connect a 600 Hz, 1 volt rms sine wave signal to the input of the Filter. If a 0.7 volt signal does not appear at the output, the malfunction may be localized by determining where the signal first deviates from normal in the Filter.

Table 1 shows various test points with their correct signal levels. If a test point is found whose signal differs appreciably from the correct value, the circuitry immediately proceding that test point should be carefully checked. The test points basically trace the signal through the entire Filter, and should be checked in the order given. DC level voltages are shown on the schematic to aid in determining the defective component.

TABLE 1. TEST POINT VOLTAGES FOR LOW-PASS OPERATION

MODE OF OPERATION:	LOW-PASS
CUTOFF FREQUENCY:	600 Hz
RESPONSE SWITCH:	MAX FLAT
INPUT: 1 VOLT RMS	600 Hz
Test Point	**Correct rms volts**
3	1.0
4	.95
5	.72
7	.71
8	.51
12	.57
22	.83
19	.82
18	.72
21	.71
output	.71

..2 High-Pass Malfunction

..e Filter appears to operate normally, and calibrates properly in the Low-Pass mode, .. not in the High-Pass mode, the most likely source of trouble would be capacitors C202, ..32, amplifier Q210, Q211 and associated circuitry, or a defective multiplier switch. 'hese components and circuitry are not common to the Low-Pass mode. The following ..nal tracing analysis should localize the malfunction: Set the multiplier switch to the ..h-Pass mode and the cutoff frequency to 600 Hz. Connect a 600 Hz, 1 volt rms sine ..ave signal to the input of the Filter. If a 0.7 volt signal does not appear at the output, ..he malfunction may be localized by determining where the signal first deviates from nor-..l in the Filter.

..able II shows various test points with their correct signal levels. If a test point is found ..hose signal level differs appreciably from the correct value, the circuitry immediately ..eceding that test point should be carefully checked. The test points basically trace the ..gnal through the entire Filter, and they should be checked in the order given.

TABLE 2.

TEST POINT VOLTAGES FOR HIGH-PASS OPERATION

MODE OF OPERATION:	HIGH-PASS
CUTOFF FREQUENCY:	600 Hz
RESPONSE SWITCH:	MAX FLAT
INPUT: 1 VOLT RMS	600 Hz

Test Point	Correct rms volts
2	1.0
4	.98
5	.75
7	.74
8	.52
12	.58
13	.58
17	.62
18	.92
20	.81
22	.72
23	.71
output	.71

..1 TUNING CIRCUITS

I.. signal tracing shows one of the tuning circuits to be faulty, it should be determined if the trouble is in the resistive or capacitive element. If there is trouble in a capacitive ..ement, this will show up only on a particular multiplier band. If there is a problem in a ..sistive element, the trouble will be of a general nature and will show up on all multiplier bands.

..he range-determining capacitors, associated with the multiplier mode switch S300, are ..pecially selected for close capacitance tolerance. All capacitor values fall within ±5% of the specified value, but in order to maintain accurate frequency calibration over the entire ..ial range and also between decade ranges, the capacitors are matched within ±2% of each ..her and generally within ±2% in decade ratios. The values of capacitance used on the ..igher bands are selected to compensate for stray capacitance and are therefore not com-..letely in decade ratios of those used on the lower bands. For replacement purposes, ..capacitor within ±1% of the specified value can be used with negligible effect on the overall calibration accuracy. If more than one capacitor on a particular range is to be changed, it is recommended that several other capacitors on the switch be carefully measured on a capacitance bridge to determine the average percentage deviation from the nominal value. Any capacitors except those used on the two highest frequency ranges may be measured to determine this tolerance. Replacement can then be made with capacitors of exact value, and calibration will not be impaired.

The variable resistance element consists of four potentiometers ganged together with a gear assembly. Each potentiometer has series and shunt trims to insure proper tracking. The trims and the angular orientation of the potentiometers are carefully adjusted at the factory. If it becomes necessary to change one of these potentiometers in the field, it should be replaced only with a unit supplied by the factory complete with proper trims. The angular orientation should then be carefully adjusted following the procedure supplied with the parts.

SECTION 5

CALIBRATION AND ADJUSTMENT

1 INTRODUCTION

The following procedure is provided for the purpose of facilitating the calibration and adjustments of the Filter in the field. The steps outlined follow very closely the operations which are performed on the instrument by our Final Test Department, and strict adherence to this procedure should restore the instrument to its original specifications. It should be noted that some of the tolerances given in this procedure are much tighter than our general specifications. This is to ensure, in test, that all general specifications are met with adequate safety factor. These nominal tolerances, therefore, should not be used for purposes of accepting or rejecting the instrument. If any difficulties are encountered, please refer to Maintenance, Section 4. If any questions arise which are not covered by this procedure, please consult our Factory Service Department.

2 DETAILED SPECIFICATIONS

CUTOFF FREQUENCY CALIBRATION

The high and low cutoff frequencies, as defined below, should be within ±5% of the corresponding dial reading with exception of the highest band where the calibration accuracy is ±10%. KROHN-HITE Filters are calibrated to conform to passive Filter terminology. The cutoff frequency in the maximally flat or Butterworth mode is the frequency at which the gain of the Filter is 3 db down from the gain at the middle of the pass-band. This pass-band varies with separation of the cutoff frequencies as shown in Figure 2. In the Simple RC or transient-free mode, this cutoff frequency gain is approximately 13 db down.

PASS-BAND GAIN

The Filter output voltage under open circuit conditions will be within ±1/2 db of the input voltage for all frequencies within the pass-band.

To determine the pass-band gain accurately, the high and low cutoff frequencies must be separated by a factor of at least four, and the measuring frequency must be the geometric mean of these frequencies.

ATTENUATION SLOPE

A typical attenuation curve is shown in Figure 4. At the cutoff frequency, in the maximally flat or Butterworth mode, the slope is approximately 12 db per octave, and at the 12 db point the slope has essentially reached its nominal value of 24 db per octave. The slope of the straight portion of the curve may vary slightly from 24 db per octave at certain frequencies because of cross-coupling effects.

MAXIMUM ATTENUATION

This Filter has a maximum attenuation specification of 80 db which applies over most of the frequency range. At the high frequency end this attenuation is reduced due to unavoidable cross coupling between input and output.

OUTPUT IMPEDANCE

The Filter will operate into any load impedance providing the maximum output voltage and current specification is not exceeded. For a matched load impedance of 50 ohms the insertion loss will be approximately 6 db. Lower values of load resistance will not damage the instrument but will increase the distortion. Higher values of external load may be used with no sacrifice in performance and correspondingly lower insertion loss. In KROHN-HITE Filters, there is no requirement for the load impedance to match the output impedance.

INTERNALLY GENERATED HUM AND NOISE

The internally generated hum and noise measurement is based on the use of a Ballantine Model 310 Voltmeter, or equivalent. The measurement is made with the input connector shorted, with no other external signal connections to the instrument, and the voltmeter leads shielded.

DISTORTION

Filter distortion is a function of several variables and is difficult to specify exactly. In general, if the Filter is operated within its ratings, distortion products introduced by the Filter and not present in the input signal will not exceed 0.5% of the output signal. In most cases distortion will be considerably less than 0.5%.

5.3 TEST EQUIPMENT REQUIRED

a. Oscillator - capable of supplying at least 3 volts rms from 20 Hz to 10 MHz with frequency calibration better than ±1%, distortion less than 0.1% and frequency response within ±0.2 db.

b. AC VTVM - frequency response, 10 Hz to 10 MHz; full scale sensitivity from 1.0 mv to 10 volts rms with db scale; input capacitance should be less than 20 pf. Ballantine Model 310 or equivalent.

c. Oscilloscope - having direct coupled horizontal and vertical amplifiers with equal phase characteristics to at least 20 kHz and vertical sensitivity of 10 mv per division.

d. Vacuum Tube Voltmeter - 15 volts dc full scale.

e. Variable Auto-transformer - to adjust line voltage.

f. AC Voltmeter - to measure line voltage.

5.4 POWER SUPPLIES

With the Filter operating at 115 or 230 volts line, whichever is applicable, check the plus and minus 10 volt supplies with respect to chassis ground. The floating/chassis grounding switch, located at the rear of the chassis, should be in the chassis position. The + 10 volt supply may be checked most easily at the plus side of C109 (100ufd 25 volt electrolytic) and the -10 volt supply may be checked most easily at the negative side of C110 (100ufd 25 volt electrolytic). If the minus 10 volt supply is slightly out of tolerance and exceeds its upper limit of -10.5 volts, R116 should be increased or R118 should be reduced. When the -10 volt supply is slightly below its lower limit of minus 9.5 volts, R116 should be decreased or R118 increased.

.5 DETAILED TEST PROCEDURE

ble 3 contains a detailed test procedure to check the performance of the Model 3200. he procedure is to be performed in the given order (1 through 17). For the Model 3202 is procedure should be repeated for the 2nd filter section. At the end of Table 3 there are some checks that apply to the Model 3202 only (steps 18 through 21). These will check performance of the Model 3202 when both sections are used. For all steps, the AC nput line voltage should be at 115 or 230 volts, whichever is applicable.

Throughout the procedure, Low-Pass operation is abbreviated LP and refers to the operaion using one of the 5 Low-Pass multipliers. High-Pass operation is abbreviated HP and efers to one of the 5 High-Pass multipliers.

The general layout of major components, test points, screwdriver controls and adjustents is shown in Figure 7.

In the event the Filter does not meet the correct tolerance as specified in each step of the Detailed Test Procedure, reference should be made to Section 4, Maintenance.

efore using this detailed test procedure, it is recommended that the output dc level of the 3200 and both output dc levels of the Model 3202 be zeroed. This should be done after the Filter has been operating for at least one half hour with the dust covers in position. Reove bottom cover only when it is necessary to adjust the internal controls and then replace it after this adjustment is completed.

a. With the input shorted and the Filter in the Low-Pass mode, adjust the output dc vel front panel potentiometer(s) P303 for zero output dc level.

b. Adjust potentiometer P201 (see Figure 7 for location) for minimum output dc level hange when short is removed from input.

c. Adjust potentiometer P206 (see Figure 7 for location) for minimum output dc level change when tuning dial from 200 to 20.

d. Repeat step a if necessary.

TABLE 3. DETAILED TEST PROCEDURE

<table>
<tr><th rowspan="2">STEP</th><th rowspan="2">PROCEDURE</th><th colspan="3">FREQUENCY SETTING</th><th colspan="2">INPUT SIGNAL</th></tr>
<tr><th>Dial</th><th>LP Multiplier</th><th>HP Multiplier</th><th>VOLTS (RMS)</th><th>Frequency</th></tr>
<tr><td>1.</td><td>LP dial calibration at 60</td><td>60</td><td>X10</td><td>-</td><td>1.0</td><td>600Hz</td></tr>
<tr><td></td><td colspan="6">Connect oscillator output to scope horizontal input; adjust scope for horizontal deflection of 20 divisions. Remove oscillator output from scope horizontal input and connect to scope vertical input; adjust scope for vertical deflection of 20 divisions. Remove oscillator output from scope and connect to Filter input. Connect scope horizontal input to input of Filter and scope vertical input to Filter output. Set response switch (rear of chassis) to max flat position. Adjust dial to close the ellipse at about a 135 degree angle. If necessary, loosen dial screws and set dial to 60.</td></tr>
<tr><td>2.</td><td>LP dial gain calibration at 60</td><td>60</td><td>X10</td><td>-</td><td>1.0</td><td>600Hz</td></tr>
<tr><td></td><td colspan="6">Switch LP frequency multiplier to X100 position. Connect AC VTVM to Filter output. Adjust oscillator output until VTVM indicates exactly 20 db. Return LP frequency multiplier to X10 position. Adjust P205 until VTVM indicates 17 db. If P205 requires adjustment, recheck 20 db reference level.</td></tr>
<tr><td>3.</td><td>LP dial gain calibration at 22</td><td>22</td><td>X10</td><td>-</td><td>1.0</td><td>220Hz</td></tr>
<tr><td></td><td colspan="6">Switch LP frequency multiplier to X100 position. Adjust oscillator output until VTVM indicates exactly 20 db. Return LP frequency multiplier to X10 position. Adjust LP dial until VTVM indicates 17 db. Tolerance is a dial setting from 21.0 to 23.0.</td></tr>
<tr><td>4.</td><td>LP dial gain calibration at 180</td><td>180</td><td>X10</td><td>-</td><td>1.0</td><td>1800Hz</td></tr>
<tr><td></td><td colspan="6">Switch LP frequency multiplier to X100 position. Adjust oscillator until VTVM indicates exactly 20 db. Return LP frequency multiplier to X10 position. Adjust LP dial until VTVM indicates 17 db. Tolerance is a dial setting from 170 to 190.</td></tr>
<tr><td>5.</td><td colspan="6">LP dial gain calibration at 60 on all bands</td></tr>
<tr><td>a.</td><td>X10K band calibration</td><td>60</td><td>X10K</td><td>-</td><td>1.0</td><td>60kHz</td></tr>
<tr><td></td><td colspan="6">Adjust oscillator output until VTVM indicates exactly 20 db. Change oscillator frequency to 600 kHz. Adjust C322 until VTVM indicates 17 db. Check 22 on the dial using an oscillator frequency of 22 kHz and 220 kHz. Tolerance is a dial reading of 20 to 24. Check 180 on the dial using an oscillator frequency of 180 kHz and 1.8 MHz. Adjust C335 for a dial reading between 160 and 200. If C335 is adjusted, recheck 22 and 60.</td></tr>
<tr><td>b.</td><td>X1K band calibration</td><td>60</td><td>X10K</td><td>-</td><td>1.0</td><td>60kHz</td></tr>
<tr><td></td><td colspan="6">Adjust oscillator output until VTVM indicates exactly 20 db. Switch LP multiplier to X1K position. Adjust dial until VTVM indicates 17 db. Tolerance is a dial setting from 57 to 63.</td></tr>
<tr><td>c.</td><td>X100 band calibration</td><td>60</td><td>X1K</td><td>-</td><td>1.0</td><td>6kHz</td></tr>
<tr><td></td><td colspan="6">Adjust oscillator output until VTVM indicates exactly 20 db. Switch LP multiplier to X100 position. Adjust dial until VTVM indicates 17 db. Tolerance is a dial setting from 57 to 63.</td></tr>
<tr><td>d.</td><td>X1 band calibration</td><td>60</td><td>X10</td><td>-</td><td>1.0</td><td>60Hz</td></tr>
<tr><td></td><td colspan="6">Adjust oscillator output until VTVM indicates exactly 20 db. Switch LP multiplier to X1 position. Adjust dial until VTVM indicates 17 db. Tolerance is a dial setting from 57 to 63.</td></tr>
<tr><td>6.</td><td>Unity gain adjustment at 5kHz LP</td><td>35</td><td>X10K</td><td>-</td><td>1.0</td><td>5kHz</td></tr>
<tr><td></td><td colspan="6">With VTVM, compare AC signal on input Filter with AC signal on output. If necessary, adjust P202 for unity gain.</td></tr>
<tr><td>7.</td><td>Unity gain adjustment at 5kHz HP</td><td>100</td><td>-</td><td>X1</td><td>1.0</td><td>5kHz</td></tr>
<tr><td></td><td colspan="6">With VTVM compare the A-C signal on the input of the Filter with the A-C signal on the output. If necessary, adjust P204 for unity gain.</td></tr>
</table>

TABLE 3. DETAILED TEST PROCEDURE (Cont.)

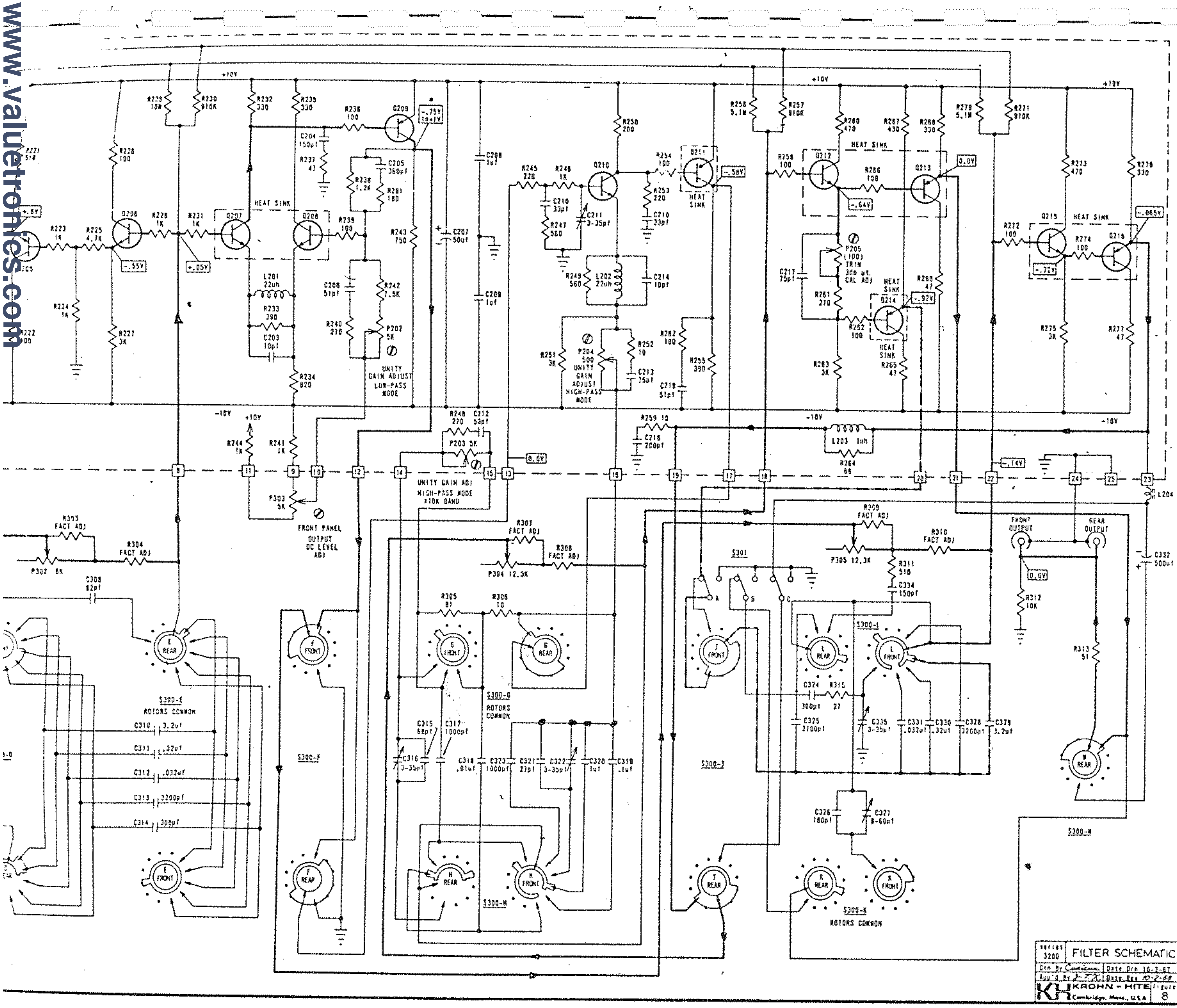
STEP	PROCEDURE	FREQUENCY SETTING			INPUT SIGNAL	
		Dial	LP Multiplier	HP Multiplier	VOLTS (RMS)	Frequency
8.	Frequency response	20	-	X1	.05	2MHz
	Adjust C211 for unity gain from input to output. Switch HP multiplier from X1 to X10K. Check that amplitude stays within 0.5 db.					
9.	HP dial calibration at 60	60	-	X10	1.0	600Hz
	Connect oscillator output to scope horizontal input; adjust scope for horizontal deflection of 20 divisions. Remove oscillator output from scope horizontal input and connect to scope vertical input; adjust scope for vertical deflection of 20 divisions. Remove oscillator output from scope and connect to Filter input. Connect scope horizontal input to input of Filter and scope vertical input to Filter output. Adjust dial to close ellipse at about a 135 degree angle. Tolerance is a dial setting of 58 to 62.					
10.	HP dial gain calibration at 60	60	-	X10	1.0	600Hz
	Switch HP frequency multiplier to X1 position and adjust oscillator output until VTVM indicates exactly 20 db. Return HP frequency multiplier to X10 position. Adjust dial until VTVM indicates 17 db. Tolerance is a dial setting of 58 to 62.					
11.	X10K band calibration	22	-	X100	0.5	600kHz
a.	Switch HP multiplier to X10K position. Adjust P203 for minimum change (less than 0.3 db) in output amplitude when switching HP multiplier from X100 position to X10K position.					
b.	Change input frequency to 110 kHz, switch HP multiplier to X100 position. Adjust oscillator amplitude until VTVM indicates exactly 14db on output of Filter. Switch HP multiplier to X10K position. If necessary, adjust C316 until VTVM indicates output of Filter is down 23 db to 25 db and repeat part a.					
c.	Change input frequency to 220 kHz. Switch HP multiplier to X1K position. Adjust oscillator amplitude until VTVM indicates exactly 14 db on output of Filter. Switch HP multiplier to X10K position. Adjust HP dial until VTVM indicates 11 db. Tolerance is a dial setting from 20 to 24. If off (dial reading high) increase C327 and decrease C316 and if dial reading is low, decrease C327 and increase C316. Repeat parts a and b respectively.					
d.	Set dial to 180. Set output frequency to 1.8 mHz. Switch HP multiplier to X1K position. Adjust oscillator amplitude until VTVM indicates exactly 14 db on output of Filter. Switch HP multiplier to X10K position. Adjust dial until VTVM indicates 11 db. Tolerance is a dial setting of 160 to 200.					
e.	Set dial to 60. Set input frequency to 600kHz. Switch HP multiplier to X1K position. Adjust oscillator amplitude until VTVM indicates exactly 14db on output of Filter. Set HP multiplier to X10K position. Adjust dial until VTVM indicates 11db. Tolerance is a dial setting from 54 to 66. If out of tolerance, divide the error between 22 and 180 on the dial.					
12.	HP dial gain calibration at 60 on all bands					
a.	X1 Calibration	60	-	X1	1.0	As noted
	Connect VTVM to Filter output. Set oscillator frequency to 600Hz. Adjust oscillator output until VTVM indicates exactly 20 db. Change frequency to 60 Hz. Adjust dial until VTVM indicates 17 db. Tolerance is a dial setting from 57 to 63.					
b.	X100 calibration	60	-	X1	1.0	6kHz
	Adjust oscillator output until VTVM indicates exactly 20 db. Set HP frequency multiplier to X100 position. Adjust dial until VTVM indicates 17 db. Tolerance is a dial setting from 57 to 63.					
c.	X1K Calibration	60	-	X100	1.0	60kHz
	Adjust oscillator output until VTVM indicates exactly 20 db. Set HP frequency multiplier to X1K position. Adjust dial until VTVM indicates 17 db. Tolerance is a dial setting from 57 to 63.					

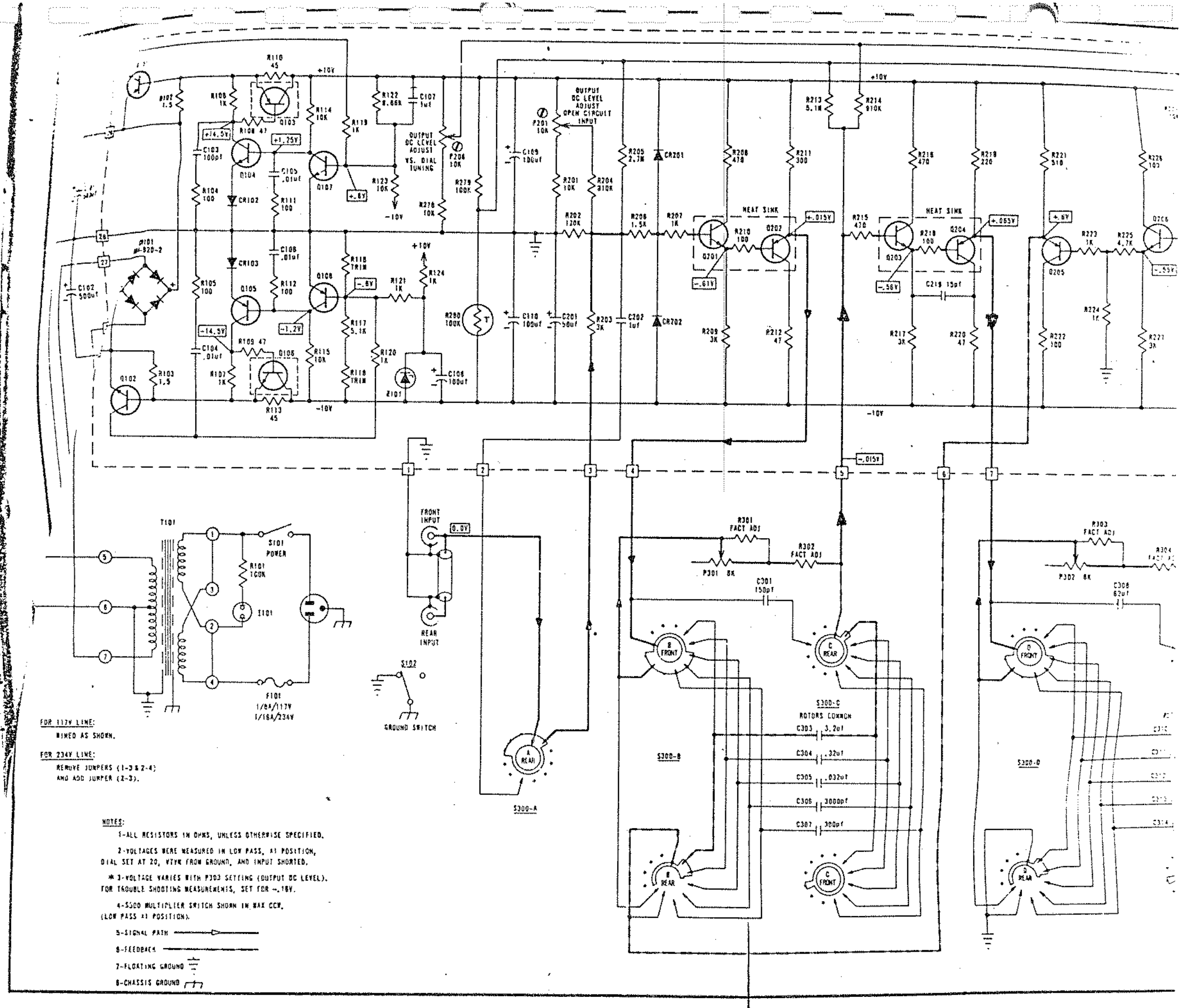
TABLE 3. DETAILED TEST PROCEDURE (Cont.)

STEP	PROCEDURE	FREQUENCY SETTING Dial	FREQUENCY SETTING LP Multiplier	FREQUENCY SETTING HP Multiplier	INPUT SIGNAL VOLTS (RMS)	INPUT SIGNAL Frequency
13.	Maximum attenuation at 25kHz	20	X100		3.0	25kHz
	Output signal should be below 300 microvolts.					
14.	Maximum input voltage	100		X1	3.0	220kHz
	Check that output signal is not distorted.					
15.	Output impedance	20		X1	1.0	1kHz
	Connect 50 ohm resistor to Filter output. Output signal should decrease to approximately 0.5 volts.					
16.	Hum and Noise	20		X1	.0	
	Connect VTVM only to Filter output and a shorting jumper across the input connector. Replace all covers. Output signal level should be below 100 microvolts. Caution! If output level is greater than 100 microvolts, monitor output to be sure excessive output is not due to radio or television station interference. Vary line voltage from 115 to 105 and from 125. Output signal level should stay below 100 microvolts.					

MODEL 3202 ONLY

STEP	PROCEDURE	FREQUENCY SETTING LEFT SECTION Dial	LEFT SECTION LP Mult.	LEFT SECTION HP Mult.	RIGHT SECTION Dial	RIGHT SECTION LP Mult.	RIGHT SECTION HP Mult.	INPUT SIGNAL Volts	INPUT SIGNAL Frequency
17.	Minimum Pass-Band Band Pass Operation	100	-	X10	100	X10	-	1.0	1kHz
	Connect output of left section to input of right section. Connect oscillator to input of left section. Output signal of right section should be 0.45 to 0.55 volts.								
18.	48 db slope Low Pass Operation	100	X10	-	100	X10	-	1.0	1kHz
	Adjust oscillator output until VTVM reads 20 db. Set oscillator to 2kHz. Output signal should be 2.8 to 5.8 mv.								
19.	48 db slope High Pass Operation	100	-	X10	100	-	X10	1.0	1kHz
	Set oscillator to 500Hz. Output signal should be 2.8 to 5.8 mv.								
20.	Band Reject Operation	30	X10	-	120	-	X10	3.0	600Hz
	Connect right section output and left section output together through two 1000 ohm non-inductive adding resistors. Connect both filter inputs to oscillator. Adjust both dials as often as required for a null. Output signal as viewed on oscilloscope should be less than 1.5 mv.								


FILTER SCHEMATIC
Series 3200
Figure 8
KROHN-HITE
Cambridge, Mass., U.S.A.
HEAT SINK
UNITY GAIN ADJUST LOW-PASS MODE
UNITY GAIN ADJUST HIGH-PASS MODE
UNITY GAIN ADJ HIGH-PASS MODE X10K BAND
FRONT PANEL OUTPUT DC LEVEL ADJ
FRONT OUTPUT
REAR OUTPUT
S300-E ROTORS COMMON
S300-F
S300-G ROTORS COMMON
S300-H
S300-J
S300-K ROTORS COMMON
S300-L
S300-M
S301


FOR 117V LINE:
WIRED AS SHOWN.
FOR 234V LINE:
REMOVE JUMPERS (1-3 & 2-4)
AND ADD JUMPER (2-3).
NOTES:
1-ALL RESISTORS IN OHMS, UNLESS OTHERWISE SPECIFIED.
2-VOLTAGES WERE MEASURED IN LOW PASS, X1 POSITION, DIAL SET AT 20, VTVM FROM GROUND, AND INPUT SHORTED.
* 3-VOLTAGE VARIES WITH P303 SETTING (OUTPUT DC LEVEL). FOR TROUBLE SHOOTING MEASUREMENTS, SET FOR -.18V.
4-S300 MULTIPLIER SWITCH SHOWN IN MAX CCW. (LOW PASS X1 POSITION).
5-SIGNAL PATH
6-FEEDBACK
7-FLOATING GROUND
8-CHASSIS GROUND
S300-A
S300-B
S300-C
ROTORS COMMON
S300-D
FRONT INPUT
REAR INPUT
GROUND SWITCH
HEAT SINK
OUTPUT DC LEVEL ADJUST OPEN CIRCUIT INPUT
OUTPUT DC LEVEL ADJUST VS. DIAL TUNING
S101 POWER
F101 1/8A/117V 1/16A/234V
T101