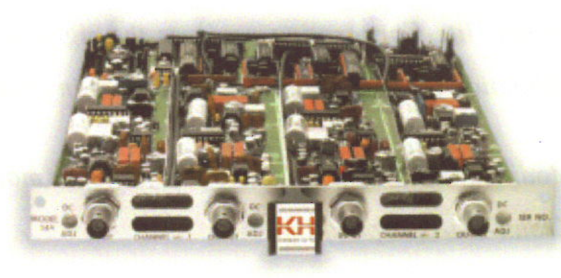
Model 34A

3Hz to 2MHz
2-Channel Butterworth/Bessel
HP, LP, BP, BR
Plug-In Filter Card
for Model 3905/3916 Chassis

Operating and Maintenance Manual



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MODEL 34A

DUAL CHANNEL/BUTTERWORTH/BESSEL
LOW-PASS/HIGH-PASS/BAND-PASS/BAND-REJECT
PLUG-IN FILTER MODULE

OPERATING AND
MAINTENANCE MANUAL

Serial No.	Serial No.

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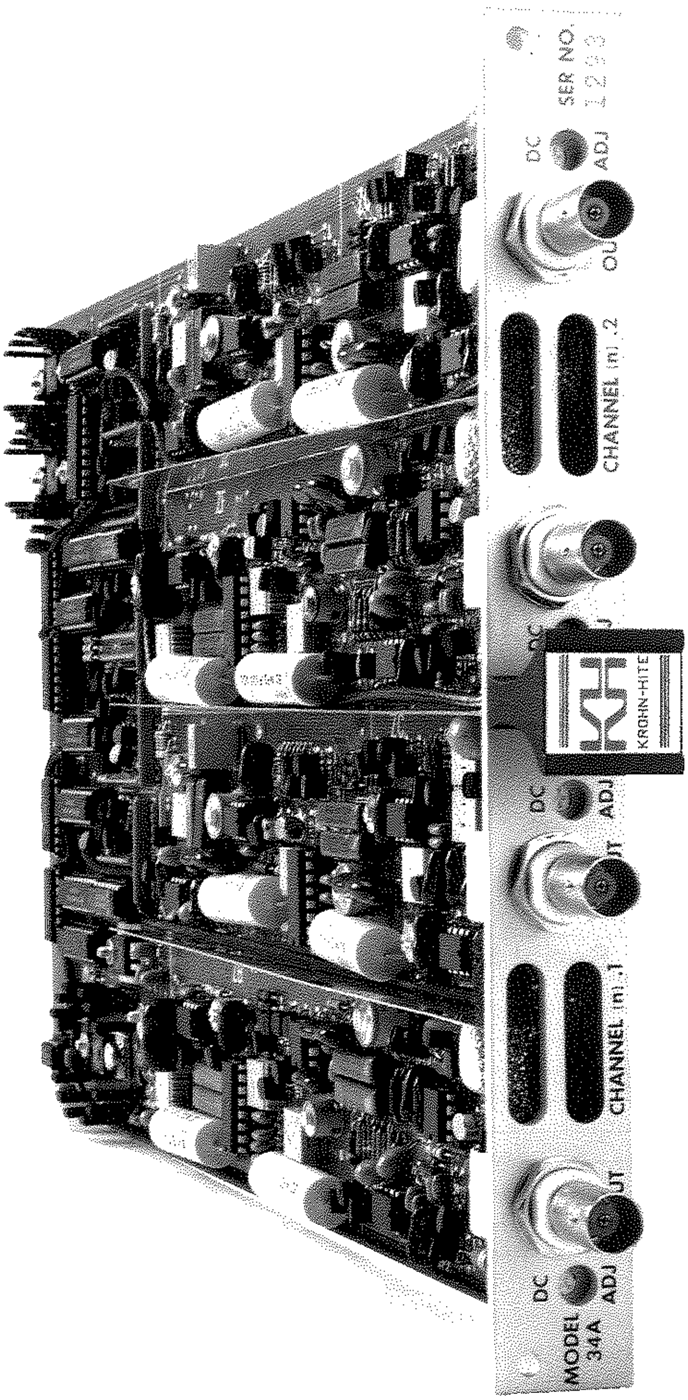
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MODEL 34A

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SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The Model 34A is a dual filter with two identical channels covering a tunable frequency range from 3Hz to 2MHz. Each channel can function independently with either low-pass or high-pass response at 24dB/octave attenuation or connected in series in the same mode to provide 48dB/octave attenuation. Band-pass or band-reject operation at 24dB/octave can be obtained. Either maximally flat (Butterworth) response or linear phase (Bessel) operation for pulse signal filtering is selectable. Both input and output amplifiers provide either 0dB or 20dB of gain.

The Model 34A is a plug-in filter card which is operational only when inserted in the five-card Model 3905A/3905B/3905C or the sixteen-card Model 3916A/3916B/3916C Mainframe. Each Mainframe includes a microprocessor plug-in card; the Model 39A-05 for the 3905A/3905B/3905C, and the 39A-16 for the 3916A/3916B/3916C. The filter and microprocessor cards are easily accessible from the rear of the Mainframe. The filer is controlled by the Mainframe which provides local/IEEE-488 programming, displays for the input and output gain, cutoff frequency and channel selection. Non-volatile, battery-backed, CMOS memory permits the storing and recalling of 85 selectable groups in the 3905A/3905B/3905C and 25 in the 3916A/3916B/3916C. Storing and recalling group settings is accomplished with only one command. Self-testing of the digital circuitry occurs upon power-up.

This Operating and Maintenance Manual is for the Model 34A filter module only. A separate manual is provided for the Model 3905A/3905B/3905C or 3916A/3916B/3916C Mainframe.

1.2 SPECIFICATIONS

FILTER CHARACTERISTICS

Functions: two independent channels of low-pass, high-pass or by-pass; one channel of band-pass or band-reject.
Type: 4-pole Butterworth (maximally flat) or Bessel (linear phase).
Frequency Range (f_c): 3Hz to 2MHz
Frequency Resolution: 1Hz from 3Hz to 1kHz; 10Hz up to 2kHz; 100Hz up to 100kHz; 1kHz up to 1MHz; 10kHz up to 2MHz.
Frequency Accuracy (f_c): ±2% or least significant digit (which ever is greater) 20Hz to 500kHz; ±5% to 2MHz.
Relative Gain at f_c: Butterworth, -3dB; Bessel, -7.58dB.
Bandwidth: dc to f_c, dc coupled; 0.2HZ to f_c, ac coupled (low-pass); f_c to 10MHz (high-pass).
Attenuation: 24B/octave per channel.
Stopband Attenuation: >80dB.
Insertion Loss (0dB Input/Output gain): ±0.5dB to 2MHz.

GAIN

Input (pre-filter): 0dB or 20dB ±0.2dB.

Output (post-filter): 0dB or 20dB ±0.2dB.

INPUT

Coupling: ac or dc.
Impedance: 1 megohm in parallel with <30pf (<100pf in a Model 3905B with front panel BNC's).
Maximum Signal (at 0dB gain): ±4.5V peak at f_c <1MHz; ±4V peak at 2MHz.
Maximum DC Component: ±200V in ac coupled mode.

OUTPUT

Impedance: 50 ohms.
Maximum Voltage: ±6.5V peak into ≥500 ohms; ±1.3V peak into ≥50 ohms.
Maximum Current: ±25mA.
Distortion: -80dB at 1kHz at 1V rms.
Noise (RTI): <200μV with 2MHz bandwidth detector (20μV w2ith 20dB input gain).
DC Offset: adjustable to 0V.
DC Stability: ±1mV/°C.
Input/Output Connectors: BNC.
Phase Match Between Channels*: 1° to 500kHz f_c (Bessel only); 2° to 1MHz; 3° to 2MHz (max difference between any two channels).

GENERAL

Power: 15 watts.
Weight: 1.75 lbs. (0.8kg) net.
Operating Temperature: 0° to 45°C.

Specifications apply at 25°C ±10C, 20Hz to 2MHz.

*For cards in same chassis, otherwise consult factory.

SECTION 2
OPERATION

2.1 INTRODUCTION

The Model 34A is a dual filter covering the frequency range from 3Hz to 2MHz. It is one of a series of plug-in filter cards available for the five-card Model 3905A/3905B/3905C or the sixteen-card Model 3916A/3916B/3916C Mainframes. All filter parameters are programmable via the Mainframe front panel controls or remotely over the IEEE-488 (GPIB) bus. For information on remote programming, refer to Section 3 of the Model 3905A/3905B or 3916A/3916B Operating and Instruction Manual and Section 3 of this manual.

Either channel of the 34A can operate independently in either the low-pass or high-pass mode and provide 24dB/octave attenuation. The two channels can be connected in series *externally* in the same mode to attain 48dB/octave attenuation when set to the same cutoff frequency.

If the two channels are interconnected externally with one channel set to high-pass and the other to low-pass, the filter will now function as a band-pass filter, passing the band of frequencies selected by the high and low cutoff frequencies.

If the two channels are interconnected externally using a band-reject kit (BR-30), the filter will then function as a band-reject filter, rejecting the band selected by the high and low cutoff frequencies.

2.2 OPERATING PROCEDURE

2.2.1 Channel Selection

Up and down controls [↑] and [↓] increase or decrease channel setting shown on the DISPLAY. When held, channels will cycle through all active channels continuously. Channel selection can also be accomplished by entering the desired channel number in the keyboard and momentarily pressing either up [↑] or down [↓] channel controls.

2.2.2 All Channel Key Procedure

When frequency, input/output gain, type, mode or coupling are entered or changed, and the LED in the [ALL CHAN] key is on, the new setting will also be entered in all other filters of the same card type.

2.2.3 Cutoff Frequency

Data entry keyboard controls [0] to [9] and [.] set the numeric value of the cutoff frequency desired. To program 1.5kHz press the [1][.][5] data keys and parameter keys [KILO] and [FREQ]. The cutoff frequency will be entered only in the channel displayed and indicated in Hertz in the four digit DISPLAY.

2.2.4 Input Gain (Pre-Filter)

Up and down GAIN SET controls [↑] and [↓] increase or decrease the input amplifier by 20dB. The two digit DISPLAY will indicate either 00 or 20dB.

2.2.5 Output Gain (Post-Filter)

Up and down GAI SET controls [↑] and [↓] increase or decrease the output amplifier by 20dB. The two digit DISPLAY will indicate either 00 or 20dB.

2.2.6 Mode of Operation

When the [MODE] key is pressed, the DISPLAY indicates the mode of operation in the channel displayed, alternating as the [MODE] key is pressed between low-pass "L.P.", high-pass "h.P.", band-pass "b.P.", band-reject "b.r." and by-pass "bYP." which connect input to output.

2.2.7 Filter Type

The DISPLAY will indicate the filter type in the channel displayed when the [TYPE] key is pressed, alternating between Butterworth "bu." and Bessel "bES." response.

2.2.8 Input Coupling

Pressing the [SECONF FUNCTN] key followed by the [TYPE] key will display the input coupling, indicating "AC" or "dC", and will alternate when the two key are pressed again only when in the low-pas and band-reject mode. High-pass and band-pass mode are AC only.

2.2.9 Clear Entry Key Operation

When entering a numeric value in the keyboard, but not specifying a parameter, pressing the clear entry key will function as an error correction procedure and restore DISPLAY to its previous set-up.

When a numeric value and its parameter has been entered and the numeric value is then changed, pressing the [CE] key will restore DISPLAY to the previous value of that parameter.

When either the [SECOND FUNCTN][STORE] or [RECALL] key is pressed, the next memory location will be indicated on the DISPLAY. Pressing the [CE] key will restore DISPLAY to its previous setting.

When the DISPLAY contains information other than the frequency, pressing the [CE] key will restore the DISPLAY to the current frequency.

If the Model 3905B or 3916B is operating via the IEEE-488 bus (the front panel REMOTE LED is 'on'), pressing the [CE] key will return unit to LOCAL operation.

2.2.10 Storing Set-Ups

If a memory location is entered into the keyboard, pressing the [SECOND FUNCTN][STORE] key will store the entire five card (Model 3905B) or sixteen card (Model 3916B) set-ups into the memory location selected. The maximum number of memory locations is 85 in the Model 3905B and 25 in the Model 3916B.

When the [SECOND FUNCTN][STORE] key is first pressed, the DISPLAY indicates the number of the next memory location available. For example, the DISPLAY will indicate the following: "n=09". Pressing the [SECOND FUNTN][STORE] key again will store the set-up currently in all channels into that memory location. If another memory location is desired enter that location on the keyboard and then press the [SECOND FUNTN][STORE] key.

When the [SECOND FUNCTN][STORE] key is pressed to indicate the next memory location only, pressing the clear entry key [CE] will restore the DISPLAY to the current frequency.

2.2.11 Recalling Set-Ups

If a memory location is entered into the keyboard, pressing the [RECALL] key will recall the entire five (Model 3905B) or sixteen (Model 3916B) card set-ups from the memory location selected.

When the [RECALL] key is first pressed, the DISPLAY indicates the number of the next memory location to be recalled. For example, the DISPLAY will indicate the following: "n=09". Pressing the [RECALL] key again will recall the se-up of all five (Model 3905B) or sixteen (Model 3916B) cards from that memory location.

When the [RECALL] key is pressed to indicate the next memory location to be recalled only, pressing the clear entry key [CE] will restore the DISPLAY back to the previous setting.

2.2.12 Second Function Key Operation

The [SECOND FUNCTN] key in conjunction with other keys provides additional filter characteristics and permits GPIB front panel data entry.

Pressing the [SECOND FUNCTN] key followed by the [AC/DC] key will display the input coupling, indicating "AC" or "dC", and will alternate when the two keys are pressed again only in the low-pass and band-reject mode. High-pass and band-pass modes are AC only.

When the [SECOND FUNCTN] key followed by the [ADDR] key are pressed, the DISPLAY will indicate the existing GPIB address setting. To select a different one, enter it in the data keys from [0] to [30] and press the [SECOND FUNCTN] and [ADDR] keys (See Section 3.2.1 of the 3905B or 3916B manual).

When the [SECOND FUNCTN] key followed by the [ALL CHAN] key are pressed, the DISPLAY will indicate the existing Line Termination Code Sequence. To select a different one, enter it in the data keys from [0] to [30] and press the [SECOND FUNCTN] and [ALL CHAN] keys (See Section 3.2.1 of the 3905B or 3916B manual).

2.3 FILTER CHARACTERISTICS

2.3.1 Introduction

The Model 34A, as shown in Figure 2.1, is a dual filter with two identical channels that can function independently. Each channel can operate in either the low-pass mode or high-pass mode and provide 24dB/octave attenuation, or both channels can be set to the same mode and connected in series *externally* to obtain 48dB/octave attenuation. The interconnection of the two channels, by front panel data key entry, to provide band-pass, band-reject or null operation is shown in simplified format in Figures 2.2 and 2.3.

2.3.2 Variable Band-Pass and Band-Reject Operation

Variable band-pas response is obtained by applying the input signal to channel n.1 (i.e. 1.1, 2.1, 3.1, etc.), setting the channel number to "n.1", setting the filter to the band-pass mode "b.P." using the [MODE] key, and entering the desired low-cutoff frequency. Set the filter to channel n.2 and enter the desired high-cutoff frequency. The band-pass response appears at the channel n.1 output BNC connector only.

Note. In the band-pass mode, there is a phase shift of 180° from input to output. To achieve a 0° phase shift through the filter connected Channel n.1 output to Channel n.2 input externally, and set n.1 to high-pass and n.2 to low-pass.

For band-reject response, set the filter to channel n.1, the band-reject mode to "b.r" and enter the desired low-cutoff frequency. Set the filter to channel n.2 and enter the desired high-cutoff frequency. A null can be obtained by setting the low cutoff frequency to approximately 0.58 of the desired null frequency, the high cutoff frequency to approximately 1.7 of the null frequency and fine tune both cutoff frequencies. The resolution of the Model 34A will limit the extent of the null. The channel 1.2 output is the high-pass section only.

2.3.3 Amplitude Response

Each channel of the Model 34A can operate in either the low-pass or high-pass mode at 24dB/octave attenuation and provide either maximally flat (Butterworth) amplitude response or linear phase (Bessel) operation. Comparative amplitude response characteristics in both modes are shown in Figure 2.4 and Figure 2.5.

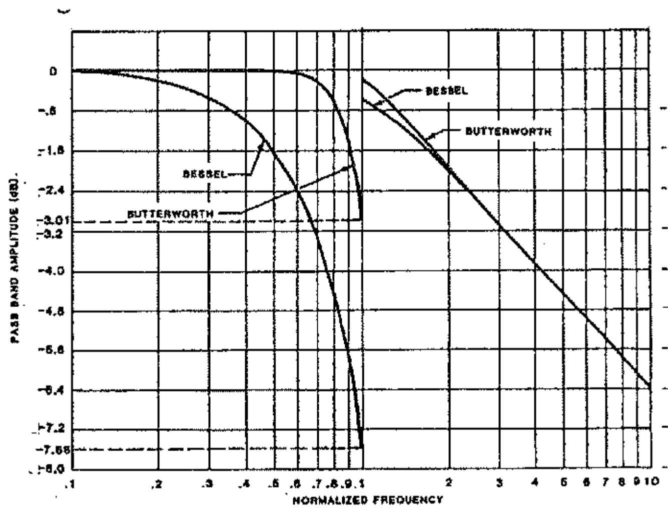

Figure 2.4 Low-Pas Response

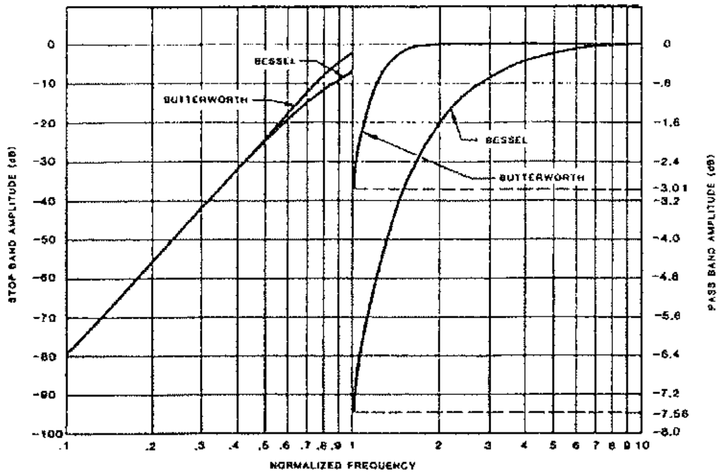

Figure 2.5 High-Pass Response

2.3.4 Phase Response

Phase characteristics of the Model 34A are shown in Figure 2.6. It provides output phase relative to the input with the filter operating in the low-pass mode with Butterworth and Bessel response.

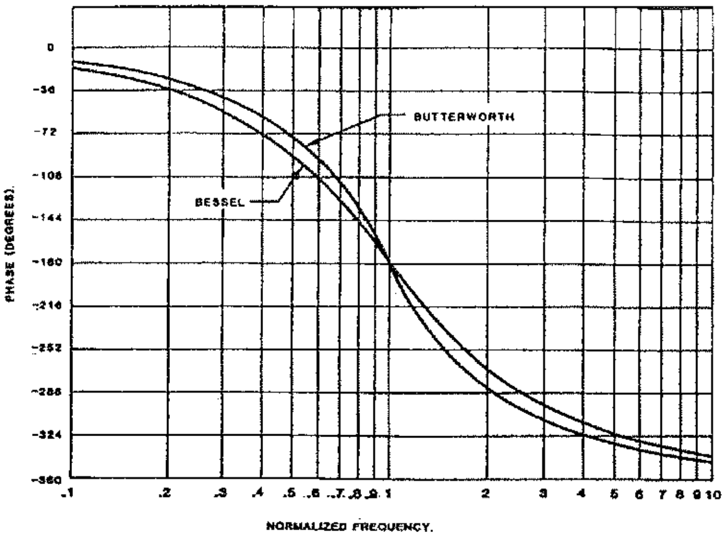

Figure 2.6 Low-Pass Phase Response

2.3.5 Transient Response

The normalized response for a unit step voltage applied to the input of the Model 34A operating in the low-pass mode with both Butterworth and Bessel response is shown in Figure 2.7.

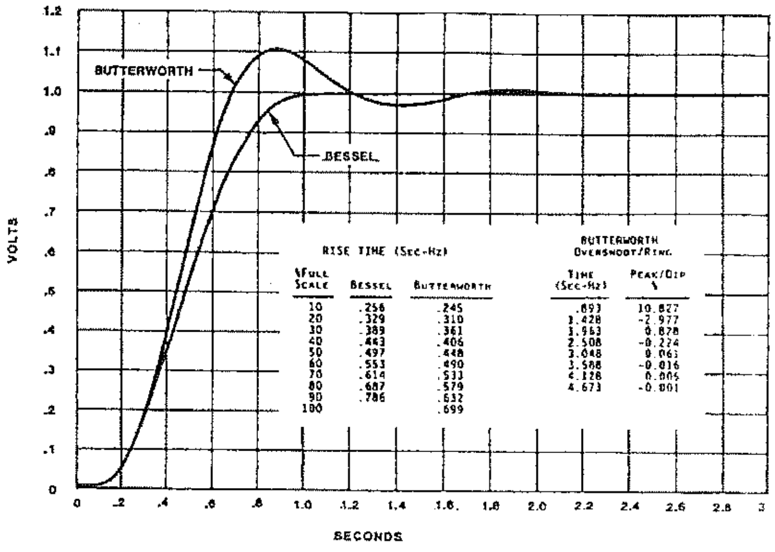

Figure 2.7 Normalized Step Response

2.3.6 Group Delay

Group delay[1], shown in Figure 2.8, is defined as the derivative of radian phase with respect to radian frequency, which is the slope of the phase curve. A flat group delay is considered a linear phase response which corresponds to a constant slope of the phase curve. With linear phase response the distortion of complex data signals will be minimized because their various frequency components, due to a constant time delay, will not shift relative phase

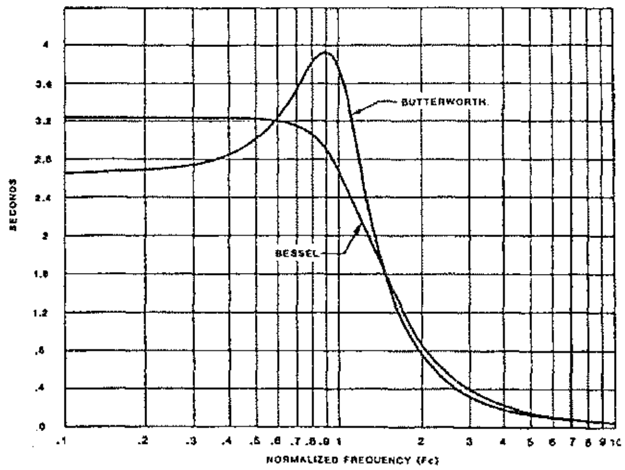

Figure 2.8 Low-Pass Group Delay

In numeric terms, zero frequency phase slope is –149.7°/Hz for Butterworth and –183.4°/Hz for Bessel, when normalized for a cutoff frequency of 1Hz. This will be 2π times greater in °/Hz for a cutoff of 1 radian/sec or –940.7°/H and –1152.4°/Hz respectively. Dividing by 360, converts °/Hz to radians/radians-per-sec yields a group delay time of 2.61s for Butterworth and 3.20s for Bessel.

[1] *IEEE Standard Dictionary of Electrical and Electronic Terms*, Institute of Electrical and Electronic Engineers, IEEE-SDSTD 100-1977, Second Edition, 1977, page 296.

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SECTION 3
IEEE-488 STD (GPIB) PROGRAMMING

3.1 INTRODUCTION

Complete information on remote programming is incorporated in the Model 3905B/3916B Mainframe operating and instruction manual. Detailed information about the filter type, modes of operation and device clear command not described in the 3905A/3905B/3905C or 3916A/3916B/3916C manual are specified below.

3.2 FILTER TYPE

1 Butterworth
2 Bessel

3.3 MODE OF OPERATION

1 Low-Pass
2 High-Pass
3 Band-Pass
4 Band-Reject
5 By-Pass

3.4 DEVICE CLEAR

When the device clear command is sent the following parameters, irregardless of their existing setting, are set as follows:

INPUT GAIN	0dB
OUTPUT GAIN	0dB
RESPONSE	Butterworth
MODE	Low-Pass
CUTOFF FREQUENCY	100kHz
COUPLING	AC

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SECTION 4
INCOMING ACCEPTANCE

4.1 INTRODUCTION

The following procedure should be used to verify that the Model 34A filter card, inserted in a Model 3905A/3905B/3905C or 3916A/3916B/3916C Mainframe, is operating within specifications. These checks may be used for incoming acceptance and periodic performance checks. Tests must be made with all covers in place on the Model 3905A/3905B/3905C or 3916A/3916B/3916C, with filter cards inserted, operating for a minimum tie of ½ hour to reach thermal equilibrium. If not operating within specifications refer to Section 5, Calibration, before attempting any detailed maintenance. Before testing, follow the initial set-up and operating procedure in Section2 of this manual and the Model 3905A/3905B/3905C or 3916A/3916B/3916C Operating and Maintenance Manual.

4.2 TEST EQUIPMENT REQUIRED

The test equipment below is required to perform the following tests:

a. Low Distortion RC Oscillator: Krohn-Hite Model 4400A or equivalent.
b. RC Oscillator: 10Hz to 10MHz, frequency response of ±0.025dB from 10Hz to 500kHz. Krohn-Hite Model 4200B/4300B or equivalent.
c. AC Voltmeter: capable of measuring 100µV to 10Vrms, 10MHz bandwidth, Fluke Model 8920A or equivalent.
d. Frequency Counter.
e. Distortion Analyzer: Krohn-Hite Model 6900B or equivalent.

4.3 FILTER CHARACTERISTICS

4.3.1 Low Pass/High Pass Response

The Model 34A has two independent channels in either the low-pass, high-pass or by-pass mode; or one channel in the band-pas or band-reject mode. Either Butterworth (maximally flat) or Bessel (linear phase) response is selectable.

Set filter cutoff frequency to 1kHz in the low-pass mode "L.P." with Butterworth response "bu." and with 0dB Input and Output gain. Apply 1Vrms at 100Hz to the INPUT of the channel whose second digit ends in one (n.1). These settings can be entered into all cards of the same type simultaneously by pressing the [ALL CHAN] key (so its LED is on) prior to entering the above settings. When this LED is off, these settings will be entered only in the channel indicated in the channel DISPLAY.

Monitor the OUTPUT of the filter with an ac voltmeter and record the OUTPUT voltage. Set the oscillator frequency to 1kHz. The OUTPUT voltage should be approximately –3db. Set the frequency to 2kHz. The OUTPUT voltage should be approximately –24dB. Set the filter to

Bessel response "bES" and repeat the above. The OUTPUT voltage should be approximately –7.6dB and –25.4dB respectively.

Set the filter cutoff frequency to 1kHz in high-pass mode "h.P." with Butterworth response and with 0dB Input and Output gain. Apply 1Vrms at 10kHz to the INPUT of the filter. Monitor the OUTPUT of the filter with an ac voltmeter and record the OUTPUT voltage. Set the oscillator frequency to 1kHz. The OUTPUT voltage should be approximately –3dB. Set the frequency to 500Hz. The OUTPUT voltage should be approximately –24dB. Set he filter to Bessel response and repeat the above. The OUTPUT voltage should be approximately –7.6dB and –25.4dB respectively.

In the by-pass mode "bYP." the INPUT is connected directly to the OUTPUT. Monitor the INPUT and OUTPUT to verify this mode of operation.

4.3.2 Cutoff Frequency Accuracy

Connect the oscillator at 1Vrms at 50Hz to the INPUT of a filter set to Butterworth response. Set the cutoff frequency to 1kHz in the low-pass mode wit 0dB Input and Output gain.

Monitor the OUTPUT of the filter with a frequency counter and an ac voltmeter, and record the OUTPUT voltage. Set the oscillator to 1kHz and adjust its frequency so the OUTPUT voltage is –3dB. The oscillator frequency should be within ±2% of the cutoff frequency of 1kHz. Repeat above at a filter cutoff frequency of 100kHz, 500kHz and 1MHz. The tolerance should be within ±2% at 100kHz and 500kHz, and ±5% at 1MHz.

Connect the oscillator at 1Vrms at 20kHz to the INPUT of the filter set to a cutoff frequency of 1kHz in the high-pass mode with 0dB Input and Output gain. Monitor the OUTPUT of the filter with a frequency counter and an ac voltmeter, and record the OUTPUT voltage. Set the oscillator to 1kHz and adjust its frequency so the OUTPUT voltage is –3dB. The oscillator frequency should be within ±2% of the cutoff frequency of 1kHz. Repeat above at a filter cutoff frequency of 100kHz, 500kHz and 1MHz. The tolerance should be within ±2% at 100kHz and 500kHz, and ±5% at 1MHz.

4.3.3 Band-Pass/Band-Reject Response

Variable band-pass response shown in Figure 4.1, is obtained by applying the input signal to channel n.1 INPUT, setting the channel DISPLAY to channel n.1 (or any channel where the second digit ends in one) and setting the filter to the band-pass mode ("b.P."). In the band-pass mode it is necessary that the [ALL CHAN] LED is off.

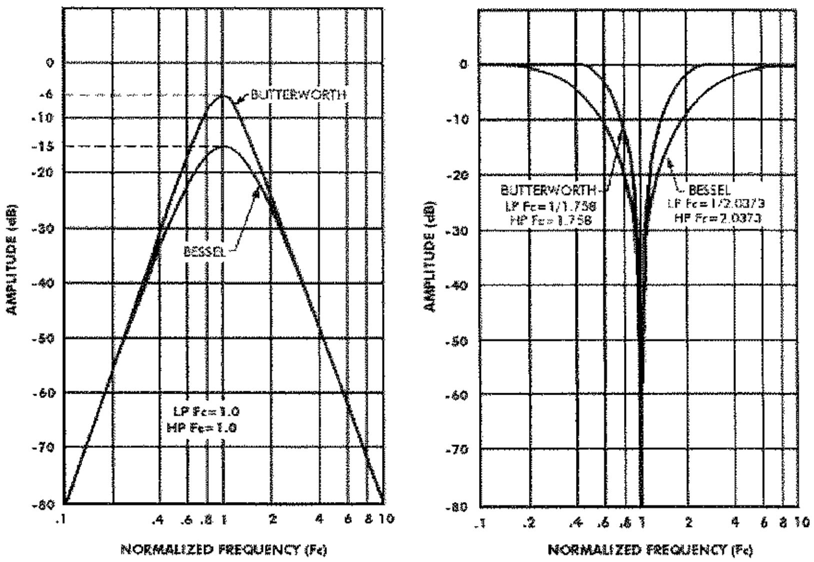

Figure 4.1 Band-Pass Response

Set the filter to Butterworth response and apply 1Vrms at 10kHz to the INPUT of channel n.1 set to a low cutoff frequency of 1kHz. Set the filter to channel n.2 and the high cutoff frequency to 100kHz.

Monitor the OUTPUT of channel n.1 with an ac voltmeter and record the voltage. Set the oscillator frequency to 1kHz and 100kHz. The OUTPUT voltage should be approximately –3dB at these frequencies. Set the oscillator frequency to 500Hz and 200kHz. The OUTPUT voltage should be approximately –24dB at these frequencies.

Variable band-reject response, shown in Figure 4.2, is obtained by applying the input signal to channel n.1 INPUT and setting the filter to the band-reject mode ("b.r.") with Butterworth response. Apply 1Vrms at 100Hz to the INPUT of channel n.1 and set the low cutoff frequency to 1kHz. Se the filter to channel n.2 and the high cutoff frequency to 100kHz.

Monitor the OUTPUT of channel n.1 with an ac voltmeter and record the voltage. Set the oscillator frequency to 1kHz and 100kHz. The OUTPUT voltage should be approximately –3dB at these frequencies. Set the oscillator frequency to 2kHz and 50kHz. The OUTPUT voltage should be –24dB at these frequencies.

4.3.4 Stopband Attenuation

Accurate stopband attenuation measurements require some simple precautions because of low level signals. The filter should be shielded with top and bottom covers of the Model 3905A/3905B or 3916A/3916B in place. BNC cables only should be used between oscillator, filter and voltmeter and no other instruments should be connected.

Connect the oscillator at 3Vrms at 20kHz to the INPUT of the filter set to a cutoff frequency of 1kHz with 0dB Input and Output gain. Connect the OUTPUT of the filter through a 6kHz passive high-pass filter, as shown in Figure 4.3, to the AC Voltmeter. Set the filter to the low-pass mode. The filter OUTPUT should be <300μVrms (-80dB).

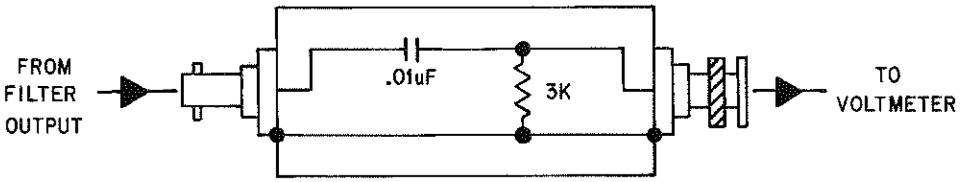

Figure 4.3 High-Pass Filter

4.3.5 Pre-Filter and Post-Filter Gain Accuracy

Set the filter to a cutoff frequency of 1kHz in the low-pass mode with 0dB Input and Output gain and apply 50mVrms at 100Hz to the INPUT.

Monitor the OUTPUT of the filter with an ac voltmeter and record the OUTPUT voltage. Set the GAIN of the pre-filter (Input) to 20dB. The OUTPUT of the filter should be a sinewave and within ±0.2dB of the pre-filter gain setting of 20dB. Set the gain of the pre-filter (Input) to zero and the gain of the filter post-filter (Output) to 20dB. The OUTPUT of the filter should be a sinewave and within ±0.2dB of the post-filter gain settings of 20dB.

4.3.6 Noise Check

Short the INPUT of the filter and set it to 0dB Input and Output gain, low-pass mode, Butterworth response at a cutoff frequency of 2MHz. Connect the OUTPUT of the filter using a shielded BNC cable in series with a 2MHz low-pass filter, shown in Figure 4.4, to the AC Voltmeter. Voltmeter reading should be <200μV. Set the cutoff frequency to 200kHz. Voltmeter reading should be <200μV. Set the filter to the high-pass mode at a cutoff frequency of 100Hz. Voltmeter reading should be <200μV. The 2MHz low-pass filter should be inserted in a shielded enclosure (Pomona Model 3231 or equivalent) and connected directly to the voltmeter. Nothing else should be connected to the filter and voltmeter.

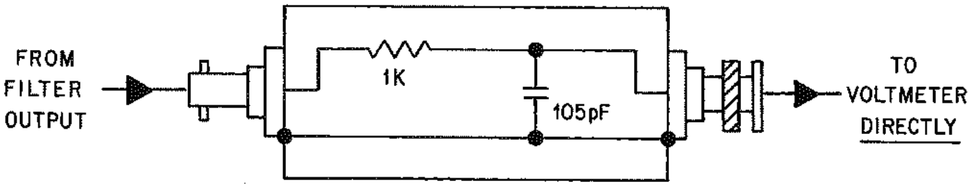

Figure 4.4 Low-Pass Filter

4.3.7 Distortion and Maximum Signal Checks

a. Set the filter to a cutoff frequency of 25.6kHz in the low-pass mode with 0dB Input and Output gain. Connect a low distortion oscillator to the Input and apply 1Vrms at 1kHz. Monitor the OUTPUT of the filter with a distortion analyzer. The distortion should be <0.01%.

CAUTION!
If the distortion is excessive, verify that the distortion of the oscillator being used is less than 0.005%.

b. Connect a 50 ohm terminator to OUTPUT of the filter. Distortion should be <0.01%. Remove terminator.
c. Set oscillator to 2.9Vrms. Distortion should be <0.1%.
d. Set oscillator to 460m Vrms and filter Output gain to 20dB. Distortion should be <0.1%. Set filter back to 0dB Output gain.
e. Set oscillator to 1Vrms and filter to 100Hz in HP mode. Distortion should be <0.01%.
f. Set oscillator to 2.8Vrms. Distortion should be <0.1%.
g. Disconnect oscillator and distortion analyzer.

4.3.8 AC/DC Coupling Check

Apply 1Vdc to the Input of the filter in the low-pass mode with 0dB of input and output gain. In the dc coupled mode, the Output of the filter should be approximately 1Vdc and approximately 0Vdc in the ac coupled mode.

All sections of this procedure, except Section 4.3.3, should be repeated to check the other channel where the channel number ends in two (2).

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SECTION 5
CALIBRATION

5.1 INTRODUCTION

The following procedure is provided for the calibration and adjustment of the Model 34A. Adherence to this procedure should restore the filter to its original performance specifications. If the filter cannot be calibrated by this procedure, see Section 7, Maintenance, or contact the Factory Service Department.

CAUTION
This procedure should be performed by qualified personnel only. It is recommended that precautions be taken with exposed circuitry, and insulated probes and tolls be used.

To calibrate the filter, it is desirable but not essential to use the Krohn-Hite card extender assembly (Part No. 39AME), which allows access to the filter remote from the mainframe. It is also necessary to remove the aluminum shield only (not the small copper shield). This procedure is shown below in Figure 5.1.

Without a card extender, it is necessary to remove the top cover of the 3905B. Remove the filter card from the mainframe, remove the aluminum shield, and reinsert the PC card only into station 1 (upper left viewed from the front panel) of the mainframe. The module under test should be operational when the front panel channel indicator is 1.1 or 1.2. In the Model 3916B, it is necessary to remove the aluminum shield from the plug-in filter card and insert the PC card only in station 16 (extreme left facing front panel). Without a card extender, access to all components and adjustments is obtained by positioning the Model 3916B on its side and removing all other filters. The filter under test will be operational when the front panel indicator is at 16.1 or 16.2.

5.2 TEST EQUIPMENT REQUIRED

a. AC rms Voltmeter: Fluke Model 8920A or equal.

b. Function Generator: Frequency range from 1Hz to 10MHz, frequency response ±0.025dB from 30Hz to 5MHz. Krohn-Hite Model 2100A-7 or equal.

c. Digital Voltmeter. Fluke Model 8012A or equal.

d. Two 50 ohm terminators.

5.3 CALIBRATION PROCEDURE

DC Adjustments

a. Short the channel 1.1 input. Set Filter to HP mode with 20dB output gain. Connect DVM to channel 1.1 output and adjust adjacent rear panel screwdriver control (R253) for 0Vdc ±1mVdc. Set output gain to 0dB, and adjust R268 for 0Vdc ±1mVdc. Repeat 20d and 0dB adjustment.

b. Set the cutoff frequency of 2kHz, Mode to LP, DC coupled. Connect a DVM to 1.1 output. Switching between 0dB and 20dB input gain, adjust the rear panel DC screwdriver control (R105) that is adjacent to the channel (n).1 BNC input connector, for no change ±1mVdc.

c. Set Filter LP mode 2kHz and adjust R176 for 0Vdc ±1mVdc.

d. Connect scope to output set to 10mV/cm vertical gain. Tune Filter between 2kHz and 2.1kHz. Adjust R136 to minimize switching transient. (After setting 2kHz and 2.1kHz, pressing [CE] will toggle between the frequencies).

1st Quadratic Frequency Calibration

a. Set Filter to 25kHz in LP mode with 0dB input and output gain, Butterworth response [bu.] and direct coupled [dC]. Connect Generator set to 200Hz in sinewave mode at 1Vrms. Insert a 50 ohm terminator at Filter input. Connect the AC voltmeter to test point TP4 (LP) of the Filter, and reference the voltmeter to 0dB.

b. Alternate both Generator and Filter frequency between 25.6Hz and 175kHz, ±0.1%. Adjust C167 to split the difference about –5.33dB.

c. Connect AC Voltmeter to TP2 (HP). Alternate both Generator and Filter between 25.6Hz and 175kHz ±0.1%. Adjust C147 to split the difference about –5.33dB.

d. Set Generator and Filter to 2.1kHz, ±0.1%. Adjust R12 to split the difference between TP2 and TP4 about –5.33dB.

e. Connect AC Voltmeter to TP4 (LP). Set Generator and Filter to 256kHz, ±0.1%. Adjust C164 for –5.33dB.

f. Set the Filter to HP mode and connect AC Voltmeter to TP2 (HP). Adjust C144 for –5.33dB.

g. Set the Filter to LP mode and connect AC Voltmeter to TP4 (LP). Alternate Generator and Filter between 25kHz and 250kHz, ±0.1%. Adjust R160 to split the difference about –5.33dB.

h. Repeat steps e (256kHz, TP4, LP) and f (256kHz, TP2, HP).

5.3.1 Passband Unity-Gain Adjust

a. Set Filter to 25kHz in bypass mode [bYP] and Generator to 200Hz. Connect AC Voltmeter to output. Reference the voltmeter to 0dB.

b. Set Filter to LP mode and adjust R250 for 0dB ±0.1dB.

c. Set Filter to 256Hz in bypass mode and generator to 10kHz. Reference voltmeter 0dB.

d. Set the Filter to HP mode and adjust R251 for 0dB ±0.1dB.

5.3.2 5.3.2 Output Frequency Response

(Rear panel BNC connectors should be used in this procedure)

a. Set Generator to 20kHz, 0.1Vrms. Set Filter to 2kHz, HP mode.

b. Connect AC Voltmeter to the Filter output and insert a 50 ohm terminator at the voltmeter end of the cable.

c. Reference the voltmeter to 0dB. Set Generator to 2MHz, 0.1Vrms and adjust R249 for 0dB ±0.01dB.

d. Set Generator to 5MHz, 0.1Vrms. Set Filter to 1.5MHz, HP mode. Adjust C265 to 0dB ±0.05dB.

e. Repeat steps c. and d. until both are correct.

f. Remove 50 ohm terminator from the voltmeter.

5.3.3 2nd Quadratic Frequency Calibration

2nd Quadratic Band 2 Adjust

a. Set Generator, and Filter in by-pass mode, to 175kHz, ±0.1%. Connect AC Voltmeter to Filter output and reference to 0dB.

b. Set Filter to LP.

c. Alternate Generator and Filter between 25.6kHz and 175kHz, ±0.1%. Adjust C237 to split the difference about –3dB.

d. Set Filter to HP.

e. Alternate Generator and Filter between 25.6kHz and 175kHz, ±0.1%. Adjust C237 to split the difference about –3dB.

f. Set Generator and Filter to 2.1kHz, ±0.1%. Adjust R230 to split the difference about –3dB when switching between HP and LP.

2^{nd} Quadratic High Band Adjust

a. Set Filter to LP mode. Set Generator and Filter to 256kHz, ±0.1%. Adjust C234 for –3dB.

b. Alternate Generator and Filter between 25kHz and 250kHz, ±0.1%. Adjust R228 to split the difference about –3dB.

c. Set Filter to HP mode. Set Generator and Filter to 256kHz, ±0.1%. Adjust C204 for –3dB.

d. Set Generator and Filter to 2MHz, ±0.1%. Readjust C204 to be between –2.36dB (-4%) and –3.75 (+4%). If necessary, recheck 256kHz to be between 2.76dB (-1.5%) and –3.29dB (+1.5%).

e. Set Filter to LP mode. Set Generator and Filter to 2MHz, ±0.1%. Readjust C234 to be between –2.36dB (-4%) and –3.75 (+4%). If necessary, recheck 256kHz to be between 2.76dB (-1.5%) and –3.29dB (+1.5%).

5.3.4 HP Gain Adjust (In Band-Reject Mode)

Since band-pass and band-reject operation requires both channels, it is necessary to calibrate both channel 1.1 and 1.2 before proceeding with this step. Repeat the above procedure for channel 1.2, adding 200 to all resistor and capacitor symbol numbers before proceeding with the following step.

a. Set channel 1.1 to band-reject mode [b.r.]. Set channels 1.1 and 1.2 to 256Hz. Set generator to 25kHz and adjust R256 for 0dB.

SECTION 6
CIRCUIT DESCRIPTION

6.1 INTRODUCTION

The Model 34A, shown in the simplified block diagram Figure 6.1, is a state variable dual filter with two identical channels which can function independently. Each channel has input and output amplifiers, and two quadratic filter sections with associated frequency determining RC network components. Both channels can operate in series in the low-pass or high-pass mode to provide 48dB/octave attenuation, or in the band-pass mode with one channel in the low-pass mode and the other in the high-pass mode with 24dB/octave attenuation.

Band-reject operation is obtained by connecting the input signal to channel n.1, applying the output of the channel n.1 input amplifier to the input of both channel n.1 and n.2 1st quadratic filter sections, setting channel n.1 to the low-pass mode and channel n.2 to the high-pass mode and summing both 2nd quadratic outputs in the channel n.1 output amplifier. By setting the cutoff frequency the cutoff frequency of the low-pass mode to approximately 0.58 of the desired null frequency and the high-pass mode to approximately 1.7 of the null frequency, a null will be obtained on the output of channel n.1.

The desired cutoff frequency gain, filter type and mode of operation are controlled remotely by the IEEE-488 bus or by front panel keyboard entry which selects the required frequency determining RC network components and circuit configuration by activating the appropriate relays and FET switches. Complete schematics of the filter are incorporated in Section 8 of this manual. Figure 8.1 is the analog portion and Figures 8.2 is the digital circuitry and five power supply regulators.

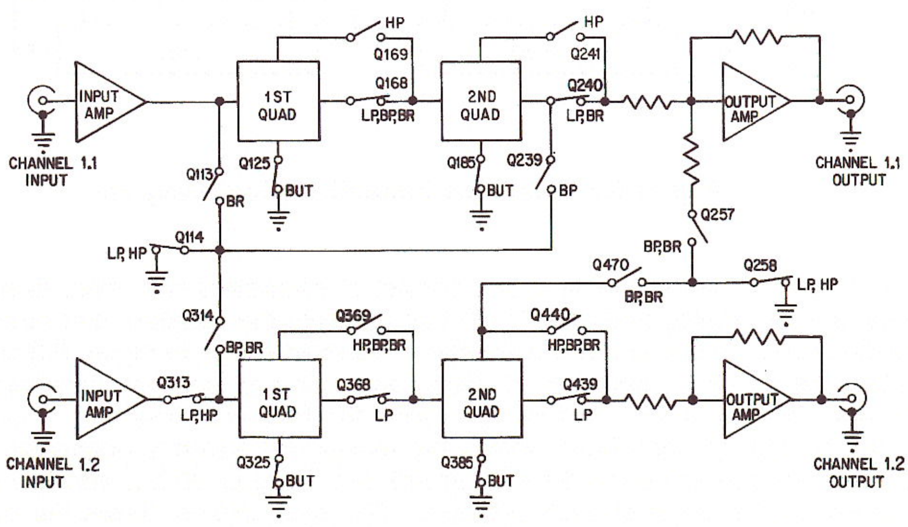

Figure 6.1 Model 34A Simplified Block Diagram

6.2 INPUT AMPLIFIER

The input amplifier consists of a FET Follower Q102 and amplifier U106 which has a gain of either unity (0dB) or 20dB. The input signal is applied to the amplifier U106 via relay K101, C100 (shorted by relay K100 in the DC mode) and buffer Q102. With FET switches Q109 and Q111 off, U106 has unity gain since its output is feedback directly to its input. When Q109 and Q111 are on, the feedback is attenuated by R107 and R110 resulting in a gain of 20dB. R105 adjusts the DC level at TP1.

6.3 QUADRATIC AMPLIFIER

Since all the four quadratic amplifiers are identical in operation, only the 1st quadratic in channel 1.1 will be described. As shown in the simplified block diagram Figure 6.2, the quadratic consists of a three stage amplifier. The first stage U120 acts as both a buffer to drive the RC network associated with the second stage U140 and as a variable gain amplifier to provide either Butterworth or Bessel filter response by adjusting the regenerative feedback from the second stage.

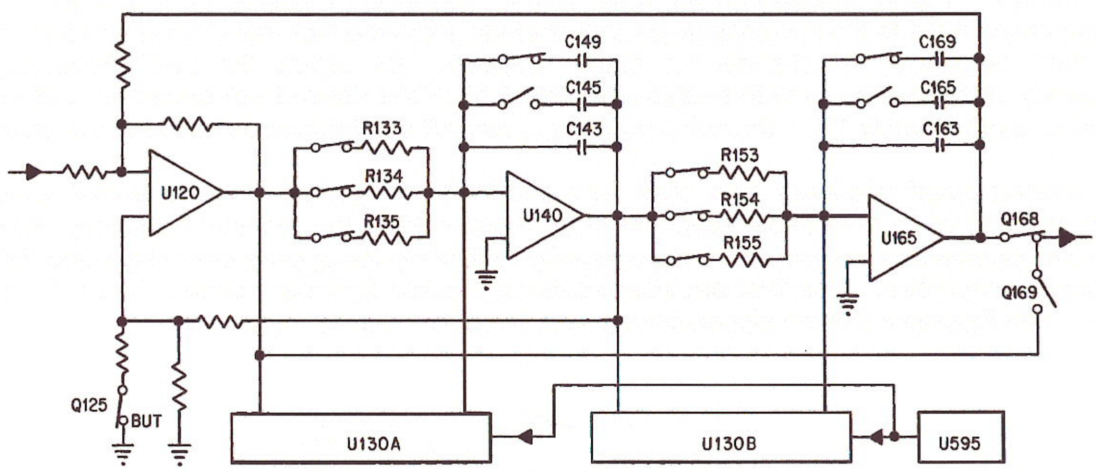

Figure 6.2 Quadratic Simplified Block Diagram

The second and third stage are identical and consist of integrators with three fixed network resistors and capacitors, and an analog multiplier U130 that parallels the resistors and functions as a variable resistor to provide continuous frequency coverage. The chart shown in Figure 6.3 shows the frequency coverage obtainable for all 8 segments of each band using all possible configurations of the three network resistors. With all three resistors in parallel, the filter is in segment 7, its highest frequency range. The left column of each band shows the minimum frequency obtainable in each segment. These frequencies are determined by the RC network *only* since U130 has very low conductance at the low frequency end of the range of each segment. The right column shows the maximum frequency obtainable for all 8 segments when U130 is set to it s minimum resistance by the DAC, U595.

	BAND 1 3Hz-2000Hz		BAND 2 2.01kHz – 200kHz		BAND 3 201kHz-2MHz	
SEGMENT	MINIMUM FREQUENCY Hz	MAXIMUM FREQUENCY Hz	MINIMUM FREQUENCY kHz	MAXIMUM FREQUENCY kHz	MINIMUM FREQUENCY kHz	MAXIMUM FREQUENCY kHz
0	3	255	2.01	25.5	201	255
1	256	504	25.6	50.4	256	504
2	505	752	50.5	75.2	505	752
3	753	1009	75.3	100.9	753	1009
4	1010	1259	101.0	125.9	1010	1259
5	1260	1499	16.0	149.9	1260	1499
6	1500	1749	150.0	174.9	1500	1749
7	1750	2099	175.0	200.9	1750	2000
NOTE: Resolution limited to 3 digits above 999 on display.						

Figure 6.3 Band and Segment Frequency Ranges

6.4 OUTPUT AMPLIFIER

With the exception of an additional summing network consisting of R255 and C255 in the channel 1 output amplifier, both amplifiers are identical. This summing network provides a dual input for the channel 1 output amplifier which is necessary in the band pass and band reject mode of operation.

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SECTION 7
MAINTENANCE

7.1 INTRODUCTION

This maintenance procedure should be performed by qualified personnel only. It is recommended that extra precautions be taken when working with exposed circuitry, and that insulated probes and tools be used.

For a list of the equipment required for this procedure, see Section 5.2 of the Calibration procedure.

WARNING!
Shut the power switch off and disconnect the line cord from the power source before repairing or replacing components.

This maintenance procedure will allow a competent service technician to localize a failure to a few components. *TO KEEP THE WARRANTY IN EFFECT, CARE SHOULD BE TAKEN TO INSURE PROPER MAINTENANCE.* After replacing the defective components(s), it may often be necessary to recalibrate either the whole instrument or at least the section which was affected.

When replacing components, a low wattage (10-25 watt) soldering iron should be used, and extreme care should be taken to avoid overheating the printed circuit foil. A suitable desoldering tool is highly recommended to clear the holes before inserting new components. Many of the integrated circuits are static sensitive. Both the unit and the person doing the work should be grounded before removing any integrated circuits.

7.2 MAINTENANCE PROCEDURE

This maintenance procedure is presented in a mix of flow chart format and text format. A circle in the flow charts symbolizes a connector to another section of the flow chart. A diamond symbolizes a decision, based on symptoms or measurements. The boxes are actions to be taken, and the oval is a starting or ending point.

When instructed to replace an IC, it is worthwhile checking the supply voltages and ground pins directly on the IC, which facilitates finding broken busses and bad IC sockets. If the replacement IC is not readily available, consider swapping it with another of the same type in the unit, then check to see if the symptoms have changed. There is a remote possibility that if an IC is bad, it could cause further damage. When several parts need to be replaced, they are listed in the order of likelihood to fail. Generally, in the instrument's digital sections, "low" is <0.8V and "high" is >3V.

When a flowchart terminates, back-up one or two steps, identify and attempt to understand each test, and check for continuity to all points to which each node (signal) connects. If there is a signal at the source end of a "wire" this doesn't necessarily mean it will reach its destination. Plated through holes and IC sockets are possible causes.

For maintenance, it is desirable, but not essential, to use the Krohn-Hite card extender assembly (Part No. ME-39A), that allows access to the filter remote from the mainframe. It is also necessary to remove the aluminum shield only (not the small copper shield). This shield removal procedure is shown in Figure 5.1 on page 5-1 of the Calibration procedure.

Without a card extender, it is necessary to remove the top cover of the 3905A/3905B/3905C, remove the filter module from the mainframe, remove the aluminum shield, and reinsert the PC card only into station 1 (upper left viewed from the front panel) of the mainframe. The card under test should be operational when the front panel indicator is at 1.1 or 1.2. In the Model 3916A/3916B/3916C, without a card extender it is necessary to remove the bottom cover, exposing the chassis slot on the extreme left station 16 viewed from the front panel. If the filter aluminum shield is removed and the PC card only is inserted in station 16, access to all components and adjustments is obtained by positioning the Model 3916A/3916B/3916C on its side and removing all other filters. The filter under test will be operational when the front panel indicator is at 16.1 or 16.2.

Using the most obvious symptom, select the appropriate section from Table 7.1.

Symptom	Ref.
Cutoff frequency (fc) incorrect. 1. Problem only at fc <2kHz (Band 1). 2. Problem only at fc >2kHz (Band 2). 3. Problem only at fc >200kHz (Band 3). 4. Problem only with a segment within any band.	Section 7.3, page 7-2
DC level incorrect.	Flowchart B, page7-9
Unity gain (with 0dB Input and Output gain) incorrect.	Flowchart C, page 7-10
20dB Input gain incorrect.	Flowchart D, page 7-11
20dB Output gain incorrect.	Flowchart E, page 7-12
LP response incorrect: HP OK.	Flowchart F, page 7-13
HP response incorrect: LP OK.	Flowchart G, page 7-14
Bessel response incorrect: Butterworth OK.	Flowchart H, page 7-15
Butterworth response incorrect: Bessel OK.	Flowchart I, page 7-16
BP response incorrect: LP and HP OK.	Flowchart J, page 7-17
BR response incorrect: LP and HP OK.	Flowchart K, page 7-18
Mainframe fails to acknowledge the filter card.	Section 7.4, page 7-7
Both channels have the same or similar problem.	Section 7.5, page 7-8

Table 7.1 Symptom Summary

Segment	Band 1(Hz)	Band 2(kHz)	Band 3(kHz)
0	3-255Hz	2.1-25.5k	201-255k
1	256-504	25.6-50.4	256-503
2	505-752	50.4-75.2	505-752
3	753-1009	75.3-100.9	753-1009
4	1010-1259	101-125.9	1010-1259
5	1260-1499	126-149.9	1260-1499
6	1500-1749	150-174.9	1500-1749
7	1750-2099	175-200.9	1750-2000

Table 7.2 Band and Segment Frequency Coverage

7.3 INCORRECT CUTOFF FREQUENCY (Fc) RESPONSE

Connect a sine wave generator to the input of the Model 34 filter in the Butterworth mode and set the generator and filter to the same frequency. Observe from Table 7.2 what band(s) and segment(s) do not have the correct response of –3dB ±0.3dB.

Before proceeding further check the DC control voltage at the end of the resistors shown in Table 7.3 which do not connect to the associated FET:

R185 (R385)	Butterworth = -15Vdc Bessel = +5Vdc
R125 (R385)	Butterworth = +5Vdc Bessel = -15Vdc
THE FOLLOWING IS ONLY VALID FOR BUTTERWORTH	
R132 (R332)	When set to segment 0, 2, 4, 6 = -15Vdc When set to segment 1, 3, 5, 7 = +5Vdc
R130 (R330)	When set to segment 0, 1, 4, 5 = -15Vdc When set to segment 2, 3, 6, 7 = +5Vdc
R131 (R331)	When set to segment 0, 1, 2, 3 = -15Vdc When set to segment 4, 5, 6, 7 = +5Vdc
R192 (R392)	When set to segment 0, 2, 4, 6 = -15Vdc When set to segment 1, 3, 5, 7 = +5Vdc
R190 (R390)	When set to segment 0, 1, 4, 5 = -15Vdc When set to segment 2, 3, 6, 7 = +5Vdc
R191 (R391)	When set to segment 0, 1, 2, 3 = -15Vdc When set to segment 4, 5, 6, 7 = +5Vdc

Cutoff frequency is determined by three fixed resistors and capacitors in each of the two poles in each quadratic, in one of seven configurations (segments 1-7 in Table 7.2), and a variable resistor (analog multiplier) in parallel with the fixed resistors. In segment 0 the fixed resistors are disconnected and cutoff frequency is determined only by the analog multipliers U130 (U330) and U190 (U390).

To facilitate trouble-shooting, remove the analog multipliers U130 (U330) and U190 (U390). Without the analog multipliers that parallel the frequency determining resistors, the effective cutoff frequency of the filter will be lower than the frequency entered in the front panel keyboard. The normal frequency range of segment 3 in band 1, as shown in Table 7.2, is 753Hz to 1000Hz. Without the analog multipliers the cutoff frequency is fixed at the low end of this range and drops to746Hz. Table 7.4A/B/C shows the proper frequency settings of both the generator and the filter to obtain the correct response of –3dB ±0.3dB in the LP mode with Butterworth response.

Assume the response of segment 3 in Band 1 is incorrect. Check output amplitude relative to input with the generator set to 746Hz and the cutoff frequency of the filter set to 753Hz. If the filter response of this segment, which was previously incorrect with the analog multipliers inserted, is now correct without them at –3dB ±0.3dB; the analog multipliers or associated components are most likely defective. Proceed to Section 7.3.8.

If the response of segment 3 in Band 1 (for example) is incorrect with the analog multipliers removed, the first or second quadratic amplifiers are most likely malfunctioning. Check the response of the first quadratic amplifiers at test point TP4 (TP11) with the filter set at 753Hz in the Butterworth mode and the generator set at 746Hz. It should be –5.33dB ±0.3dB. If incorrect proceed to Section 7.3.6. If correct proceed to Section 7.3.7.

	Band 1	
Segment	Generator Set To	Filter Set To
1	249Hz	256Hz
2	497Hz	505Hz
3	747Hz	753Hz
4	995Hz	1010Hz
5	1243Hz	1260Hz
6	1492Hz	1500Hz
7	1741Hz	1750Hz

Table 7.4B Response Set Procedure

	Band 2	
Segment	Generator Set To	Filter Set To
1	24.9kHz	25.6kHz
2	49.7kHz	50.5kHz
3	74.6kHz	75.3kHz
4	99.5kHz	101.0kHz
5	124.3kHz	126.0kHz
6	149.2kHz	150.0kHz
7	174.1kHz	175.0kHz

Table 7.4B Response Set Procedure

Segment	Band 3	
	Generator Set To	Filter Set To
1	249kHz	256kHz
2	497kHz	505kHz
3	747kHz	753kHz
4	995kHz	1010kHz
5	1243kHz	1260kHz
6	1492kHz	1500kHz
7	1741kHz	1750kHz

Table 7.4C Response Setup Procedure

1ST Quadratic Problem

Table 7.5 localizes the most likely component failure in the 1st quadratic by matching the response of the filter at TP4 (TP11) with the responses listed in each band and segment. Although 7.5 applies to band 1 only, it can be used in bands 2 and 3 by multiplying the generator frequency and filter cutoff frequencies by 100 in band 2 and by 1000 in band 3.

Set the generator and filter (in the LP mode with the Butterworth response) to the frequencies indicated in any band and segment in Table 7.5 that is malfunctioning. Compare the voltage in dB at TP4 (TP11) relative to the input of the filter and record the voltage. Match this voltage to a voltage listed in Table 7.5 in the column headed “response at TP4 (TP11) in dB”.

1st Quadratic				
Segment	Generator Set To	Filter Set To	Response at TP4 (TP11) in dB	FET's Most Likely Malfunctioning
1	249Hz	256Hz	-5.67	Q130 (Q330) shorted
			0.76	Q150 (Q350) shorted
			-5.89	Q131 (Q331) or Q135 (Q335) shorted
			1.00	Q151 (Q351) or Q155 (Q355) shorted
			-6.01	Q130 (Q330) and [Q131 (Q331) or Q135 (Q335)] shorted
			0.86	Q150 (Q350) and [Q151 (Q351) or Q155 (Q355)] shorted
2	497Hz	505Hz	-5.47	Q132 (Q332) shorted
			-2.12	Q152 (Q352) shorted
			-5.87	Q131 (Q331) or Q135 (Q335) shorted
			0.84	Q151 (Q351) or Q155 (Q355) shorted
			-5.94	Q132 (Q332) and [Q131 (Q331) or Q135 (Q335)] shorted
			1.03	Q152 (Q352) and [Q151 (Q351) or Q155 (Q355)] shorted
3	746Hz	753Hz	-8.70	Q130 (Q330) open
			-15.41	Q150 (Q350) open
			-5.64	Q132 (Q332) open
			-8.99	Q152 (Q352) open
			-5.73	Q131 (Q331) or Q135 (Q335) shorted
			0.21	Q151 (Q351) or Q155 (Q355) shorted
4	995Hz	1010Hz	-5.38	Q132 (Q332) shorted
			-3.47	Q152 (Q352) shorted
			-5.47	Q130 (Q330) shorted
			-2.12	Q150 (Q350) shorted
			-5.56	Q132 (Q332) and Q130 (Q330) shorted
			-1.14	Q152 (Q352) and Q150 (Q350) shorted
5	1243Hz	1260Hz	-12.88	Q131 (Q331) or Q135 (Q335) open
			-20.06	Q151 (Q351) or Q155 (Q355) open
			-5.41	Q132 (Q332) open
			-7.32	Q152 (Q352) open
			-5.44	Q130 (Q330) shorted
			-2.61	Q150 (Q350) shorted
6	1492Hz	1500Hz	-8.70	Q131 (Q331) and Q135 (Q335) open
			-15.41	Q151 (Q351) and Q155 (Q355) open
			-5.64	Q130 (Q330) open
			-8.99	Q150 (Q350) open
			-5.36	Q132 (Q332) shorted
			-4.03	Q152 (Q352) shorted

Table 7.5 Component Failure Identification

When a FET in Table 7.5 is listed as open, it may be a defective resistor which it switches (ie. Q132 switches R133, etc.) or a broken bus delivering the control signal through the 10M ohm resistor to the gate. Likewise, a shorted FET might actually be broken bus carrying the control signal to the gate of the FET.

If the above procedure does not isolate the problem, a relay is most likely defective. Set the generator and filter to the frequencies indicated for any band in Table 7.6 that is malfunctioning. Compare the voltage in dB at TP4 (TP11) relative to the input of the filter and record the voltage. Match this voltage. Match this voltage listed in Table 7.6 in the column headed "Response at TP4 (TP11) in dB".

1st Quadratic				
Band	Gen. Set To	Filter Set To	Response at TP4 (TP11) in dB	Relay Most Likely Malfunctioning
1	249Hz	256Hz	-5.33 -5.42 -6.45 0.01	K147 shorted K167 shorted K149 open K169 open
2	24.9kHz	25.6kHz	-39.83 -46.34 -6.26 0.74	K149 shorted K169 shorted K147 open K167 open
			-19.26	K147 shorted
3	249kHz	256kHz	-26.26	K167 shorted
			-59.99	K149 shorted
			-66.45	K169 shorted

Table 7.6 Relay Failure Identification

2nd Quadratic Problem

Remove U120 (U320), U140 (U340), and U165 (U365) and connect a jumper from TP1 (TP8) to the end of R180 (R380) which ties to Q168 (Q368).

Set the generator and filter (in the LP mode with the Butterworth response) to the frequencies indicated in any band and segment in Table 7.7 that is malfunctioning. Compare the voltage in dB at TP7 (TP14) relative to the input of the filter and record the voltage. Match this voltage to a voltage listed in Table 7.7 in the column headed "Response at TP4 (TP11) in dB".

When a FET in Table 7.7 is listed as open, it may be a defective resistor which it switches (ie. Q132 switches R133 etc.) or a broken bus delivering the control signal through the 10M ohm resistor to the gate. Likewise, a shorted FET might actually be a broken bus carrying the control signal to the gate of the FET.

2nd Quadratic				
Segment	Generator Set To	Filter Set To	Response at TP4 (TP11) in dB	FET's Most Likely Malfunctioning
1	249Hz	256Hz	-5.45	Q190 (Q390) shorted
			2.93	Q220 (Q420) shorted
			-6.10	[Q191(Q391) or Q195 (Q395)] shorted
			1.78	[Q221 (Q421) or Q225 (Q425)] shorted
			-1.21	Q190 (Q390) and [Q191 (Q391) or Q195 (Q395)] shorted
			1.27	Q220 (Q420) and [Q221 (Q421) or Q225 (Q425)] shorted
2	497Hz	505Hz	1.57	Q192 (Q392) shorted
			4.30	Q222 (Q422) shorted
			-0.13	[Q191 (Q391) or Q195 (Q395)] shorted
			2.93	[Q221 (Q421) or Q225 (Q425)] shorted
			-0.40	Q192 (Q392) and [Q191 (Q391) or Q195 (Q395)] shorted
			2.53	Q222 (Q422) and [Q221 (Q421) or Q225 (Q425)] shorted
3	746Hz	753Hz	-6.61	Q190 (Q390) open
			-9.67	Q220 (Q420) open
			0.78	Q192 (Q392) open
			-1.95	Q222 (Q422) open
			0.40	[Q291 (Q391) or Q195 (Q395)] shorted
			3.62	[Q221 (Q421) or Q225 (Q425)] shorted
4	995Hz	1010Hz	2.04	Q192 (Q392) shorted
			3.82	Q222 (Q422) shorted
			1.57	Q190 (Q390) shorted
			4.30	Q220 (Q420) shorted
			1.14	Q192 (Q392) and Q190 (Q390) shorted
			4.26	Q222 (Q422) and Q220 (Q425) shorted
5	1243Hz	1260Hz	12.20	[Q191 (Q391) or Q195 (Q395)] open
			-14.86	[Q221 (Q421) or Q225 (Q425)] open
			1.89	Q192 (Q392) open
			0.10	Q222 (Q422) open
			1.76	Q190 (Q390) shorted
			4.20	Q220 (Q420) shorted
6	1492Hz	1500Hz	-6.61	[Q191 (Q391) and Q195 (Q395)] open
			-9.67	[Q221 (Q421) and Q225 (Q425)] open
			0.78	Q190 (Q390) open
			-1.95	Q220 (Q420) open
			2.18	Q192 (Q392) shorted
			3.46	Q222 (Q422) shorted

Table 7.7 2nd Quadratic Failure Identification

If the above procedure does not isolate the problem, a relay is most likely defective. Set the generator and the filter (in the LP mode with the Butterworth response) to the frequencies indicated in any band in Table 7.8 that is malfunctioning. Compare the voltage in dB at TP7 (TP14) relative to the input of the filter and record the voltage. Match this voltage to a voltage listed in Table 7.8 in the column headed "Response at TP7 (TP14) in dB".

When a relay is listed as open, check the coil voltage. If it is <4V, check the drive IC, U516 (U535) and U517 (U534). If the voltage is OK, place an ohmmeter across the contacts to determine whether it is the relay, if the contacts are OK (closed), look for a broken bus. If the contacts are open, replace the relay.

2nd Quadratic				
Band	Gen. Set To	Filter Set To	Response at TP4 (TP11) in dB	Relay Most Likely Malfunctioning
1	249Hz	256Hz	-3.01 -3.09 -7.24 -5.22	K207 shorted K237 shorted K209 open K239 open
2	24.9kHz	25.6kHz	-44.9 -47.00 -6.65 -4.42	K209 shorted K239 shorted K207 open K237 open
			-23.7	K207 shorted
3	249kHz	256kHz	-27.48	K237 shorted
			-57.1	K209 shorted
			-64.7	K239 shorted

Analog Multiplier Problem

Put U130 (U330) and U190 (U390) back into their sockets if you removed them. Set the filter to 25.5kHz and measure U595 pines 1 and 2 (pins 19 and 20) for 6.38Vdc ±0.1V. Press 2.1kHz and measure the same pins for 520mVdc ±100mV.

If the voltages are incorrect, turn off the power, remove U595 from its socket and bend pins 1, 2, 19, 20 out at a 45 degree angle and put the IC back into its socket. Turn the power back on and check the pins above the correct voltages. If the voltages are OK, there may be too much load on the pin(s) which drive the analog multiplier(s) U130 for pin 1, U190 for pin 2, U390 for pin 19 and U330 for pin 20. The capacitors on the X input (pin 1) of the multipliers could also be shorted.

If the voltage on the pin(s) is still incorrect, even when it is lifted out of the socket, check the reference on U595 pin 4. It should be 6.4V ±0.1V. If it is not, check the cathode of VR596. If it is approximately 6.4V then it's the op amp U596, otherwise replace the VR596 or Q596.

If U595 pin 4 reference voltage is right, U550, U551, U552 may be defective, or there is a bad opto-coupler on the MPU board. To identify a bad data bit divide [the difference between the voltage measured on the bad pin and the right voltage] by .025V. This should be close to 1, 2, 4, 8, 16, 32, 64 or 128; which correspond to D0-D7 respectively. If it's 64 or 128 suspect U551, otherwise suspect the respective opto-coupler on the MPU module. Also try the procedure in Section 7.5.4.

7.4 MAINFRAME FAILS TO ACKNOWLEDGE THE FILTER CARD

When the ↑/↓ channel key is pressed repeatedly and the channel display skips over the channel which has a filter card inserted, and/or entering the desired channel on the numeric keyboard and then pressing one of the ↑/↓ channels keys results in dashes on the main display; the following procedure is recommended.

Turn the filter off and on again. If the filter module is changed with the power on it may not recognize the change properly.

Replace U550 and U590, static electricity can destroy this CMOS part.

Check the supplies using the procedure in Section 7.5. (Especially the +5Vdc, U570).

Check a good filter module in the same slot and the defective board in other slots. The chassis MPU may be malfunctioning. See the Model 3905B or 3916B Maintenance section.

7.5 BOTH CHANNELS HAVE THE SAME OR SIMILAR PROBLEMS

Check five supply voltages. With the tab of the regulator facing away from you, measure the right hand lead. Check U560 for +15Vdc ±0.6V; U565 for –15Vdc ±0.6V; U570 for +5Vdc ±0.2V; U575 for +7.5 to 8.5Vdc and U580 for –7.5 to –8.5Vdc.

Check pin 4 of the DAC, U595. It should be +6.3Vdc ±125mV. If correct, proceed to Section 7.5.1. If this is incorrect, remove U596 and check the collector of Q596 for 6.3Vdc, if it's incorrect go to 7.5.3. If it's correct the problem is U596 or U595. Remove U595 and put U596 back in. If U596 pin 6 is correct, replace U595, otherwise replace U596.

If the collector of Q596 was incorrect, check the base of Q596 for about 11.5V. If it's correct, replace Q596 or VR596. If it's bad replace VR597 or Q596.

Procedure to check for Shorted Data Lines

Set the filter to the Butterworth mode. Read the DC voltage on pin 2 of U595 for each of the following frequencies.

Record all readings outside of stated limits.

Set filter to 8Hz. Voltage should be 200mV ±8mV.
Set filter to 9Hz. Voltage should be 222mV ±9mV.
Set filter to 10Hz. Voltage should be 247mV ±10mV.
Set filter to 12Hz. Voltage should be 296mV ±12mV.
Set filter to 16Hz. Voltage should be 395mV ±16mV.
Set filter to 32Hz. Voltage should be 791mV ±30mV.

Set filter to 64Hz. Voltage should be 1.581V ±60mV.
Set filter to 128Hz. Voltage should be 3.16V ±120mV.
Set filter to 255Hz. Voltage should be 6.30V ±250mV.

If any incorrect voltages are found above, find them in the "Incorrect" column of Table 7.9, and then investigate the cause in the "Shorted bits" column. Voltages taken at frequencies in parenthesis may appear to be correct, but in fact, may be incorrect due to the resolution of those frequencies.

Bits marked as always hi or low may actually be shorted to a signal line other than a data bit (such as an address line or strobe line). When D6 or D7 are stuck it may be a defective U551, which generates these or a defective U550 pin 15 which strobes U551.

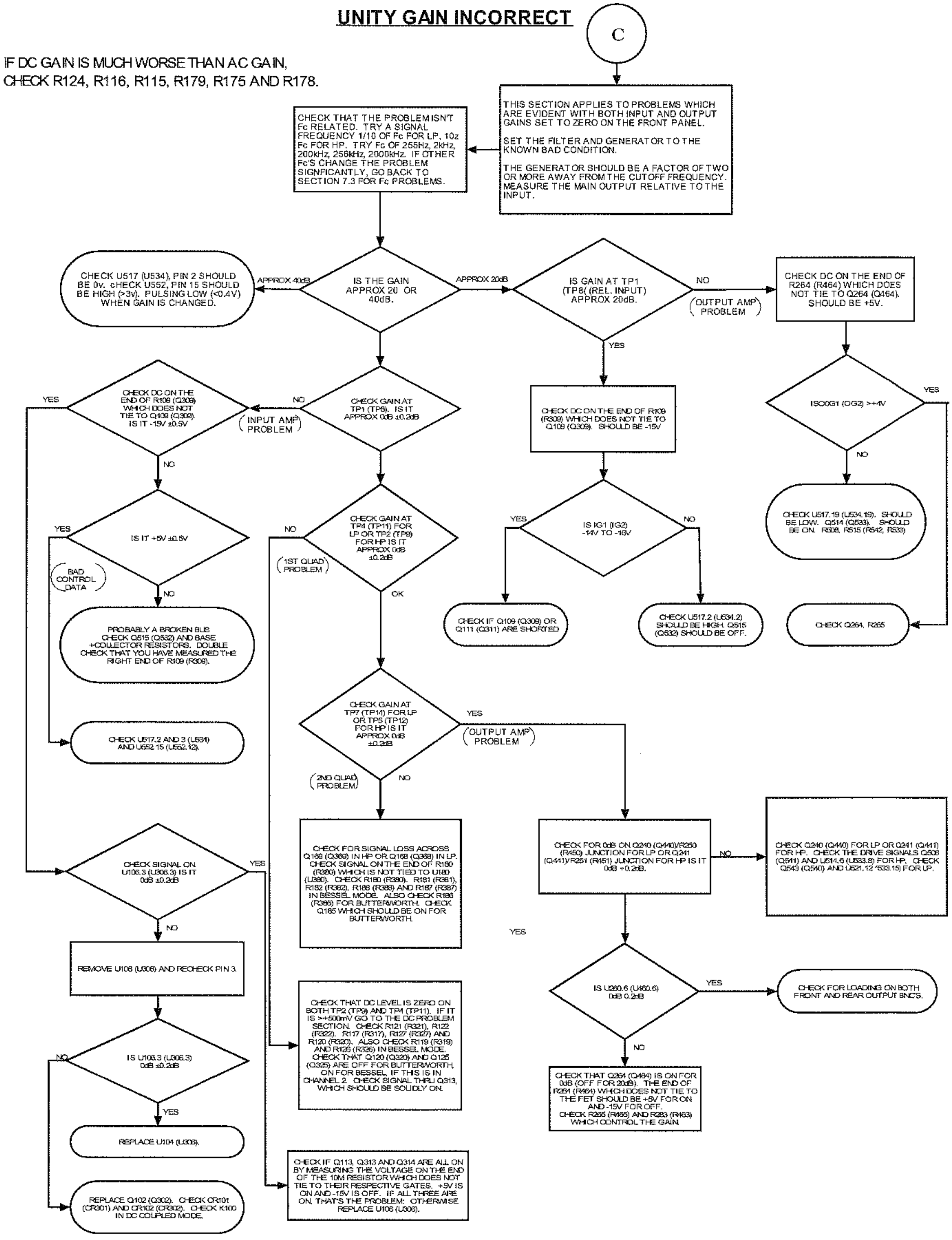
Finally, it is possible that U595 is defective. Recheck the above frequencies using pins 1, 19 or 20. If any of those pins seem to be significantly better, suspect U595.

Incorrect Frequency in Hz							Shorted Bits
8	9	10	-	-	-	-	D2, D3
8	9	10	12	(255)	-	-	D3 always low
8	9	10	12	16	-	-	D3, D4
8	9	10	12	16	32	64	D7 always hi
8	9	10	12	16	32	128	D6 always hi
8	9	10	12	16	64	128	D5 always hi
8	9	10	12	32	-	-	D3, D13
8	9	10	12	32	64	128	D4 always hi
8	9	10	12	64	-	-	D3, D6
8	9	10	12	128	-	-	D3, D7
8	9	10	16	32	64	(128)	D2 always hi
8	9	12	-	-	-	-	D1, D3
8	9	12	16	32	64	128	D1 always hi
8	10	12	-	-	-	-	D0, D3
8	10	12	16	32	64	128	D0 always hi
9	(25+5)	-	-	-	-	-	D0 always low
9	10	-	-	-	-	-	D0, D1
9	12	-	-	-	-	-	D0, D2
9	16	-	-	-	-	-	D0, D4
9	32	-	-	-	-	-	D0, D5
9	64	-	-	-	-	-	D0, D6
10	(255)	-	-	-	-	-	D1 always low
10	12	-	-	-	-	-	D1, D2
10	16	-	-	-	-	-	D1, D4
10	32	-	-	-	-	-	D1, D5
10	64	-	-	-	-	-	D1, D6
10	128	-	-	-	-	-	D1, D7
12	(255)	-	-	-	-	-	D2 always low
12	16	-	-	-	-	-	D2, D4
12	32	-	-	-	-	-	D2, D5
12	64	-	-	-	-	-	D2, D6
12	128	-	-	-	-	-	D2, D7
16	32	-	-	-	-	-	D4, D5
16	32	64	128	-	-	-	D3 always hi
16	64	-	-	-	-	-	D4, D6
16	128	-	-	-	-	-	D4, D7
16	255	-	-	-	-	-	D4 always low
32	64	-	-	-	-	-	D5, D6
32	128	-	-	-	-	-	D5, D7
32	255	-	-	-	-	-	D5 always low
64	128	-	-	-	-	-	D6, D7
64	255	-	-	-	-	-	D6 always low
128	255	-	-	-	-	-	D7 always low

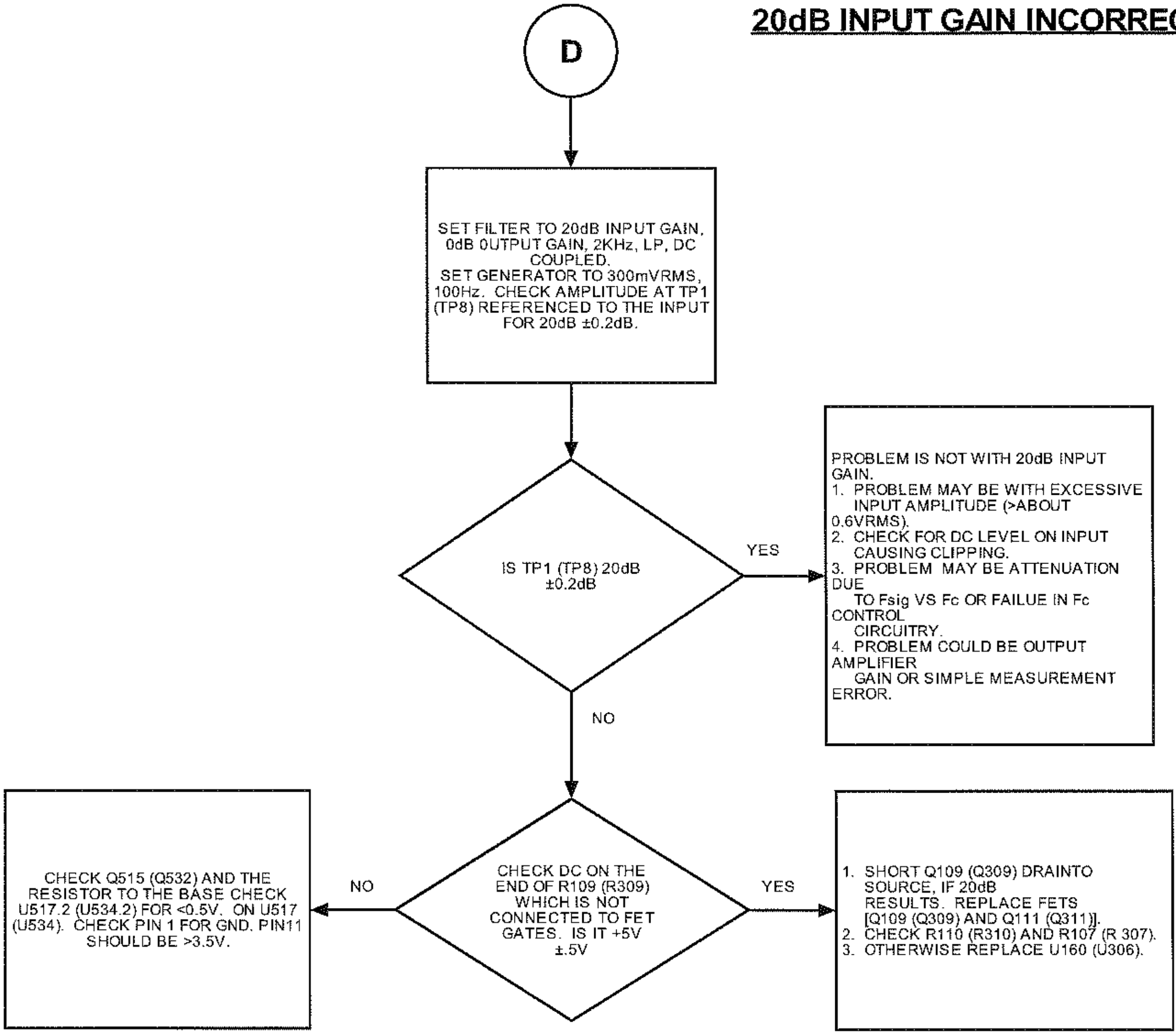
Table 7.9 Shorted Bits Identification

UNITY GAIN INCORRECT

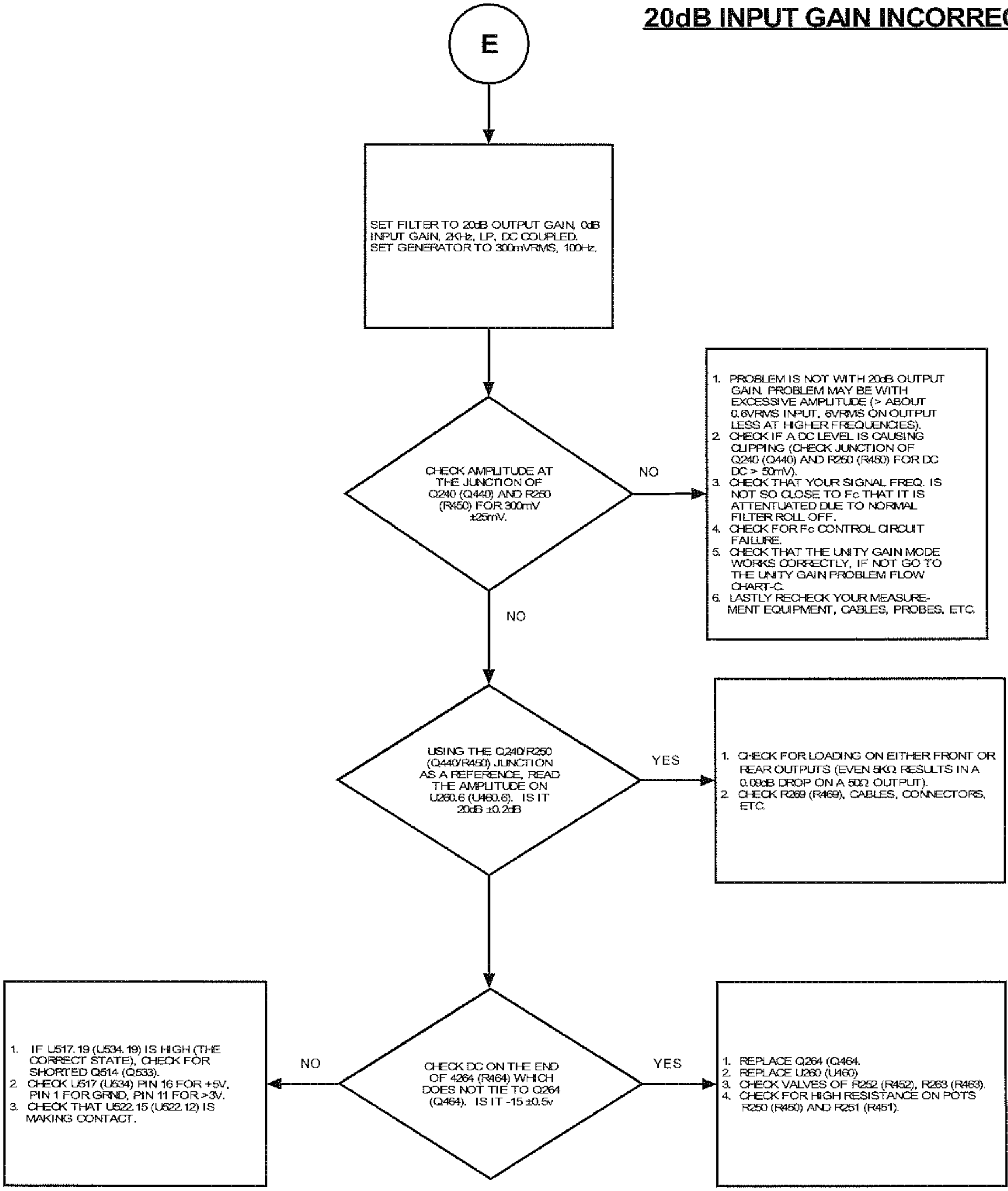
IF DC GAIN IS MUCH WORSE THAN AC GAIN,
CHECK R124, R116, R115, R179, R175 AND R178.



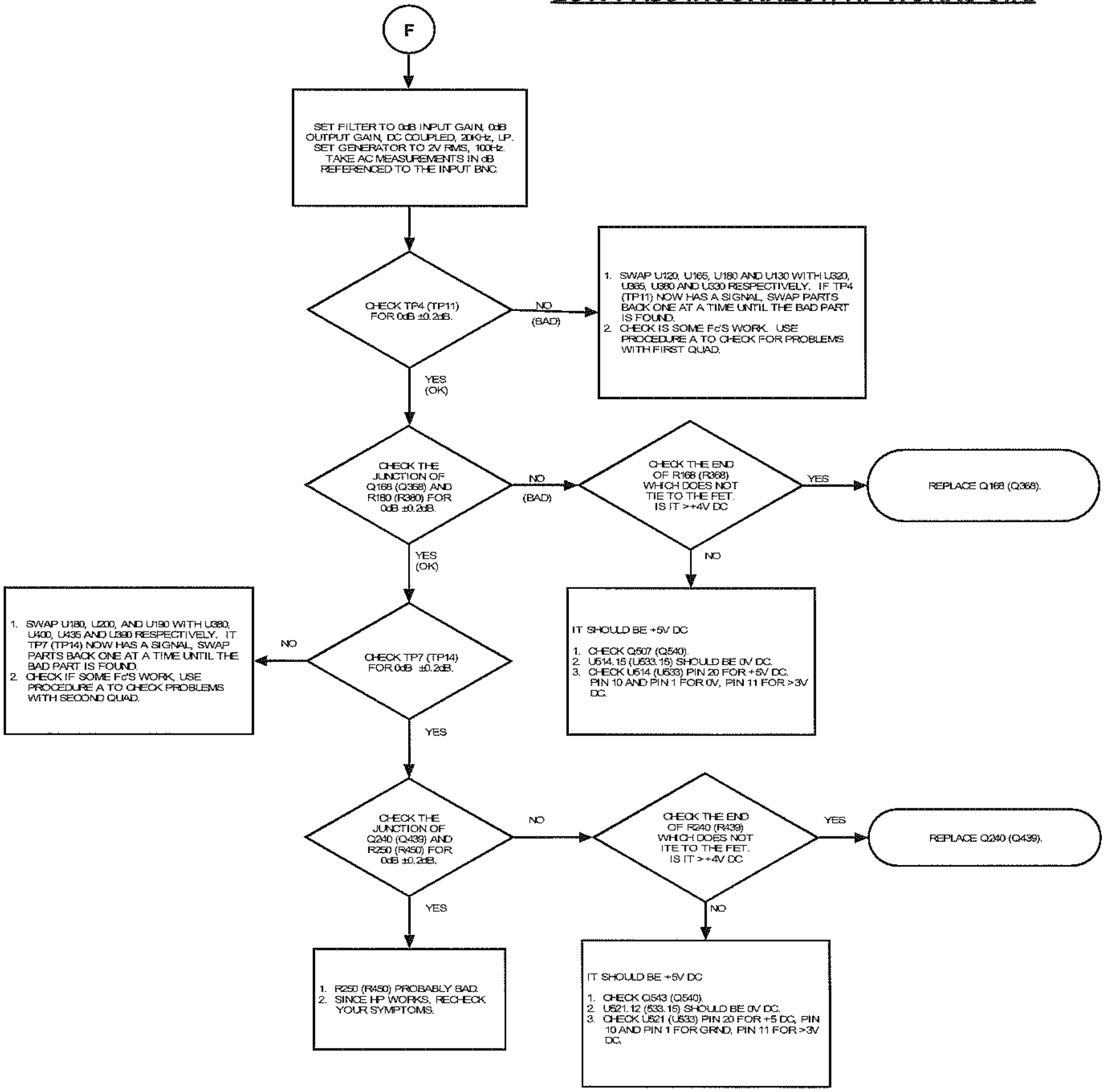
20dB INPUT GAIN INCORRECT



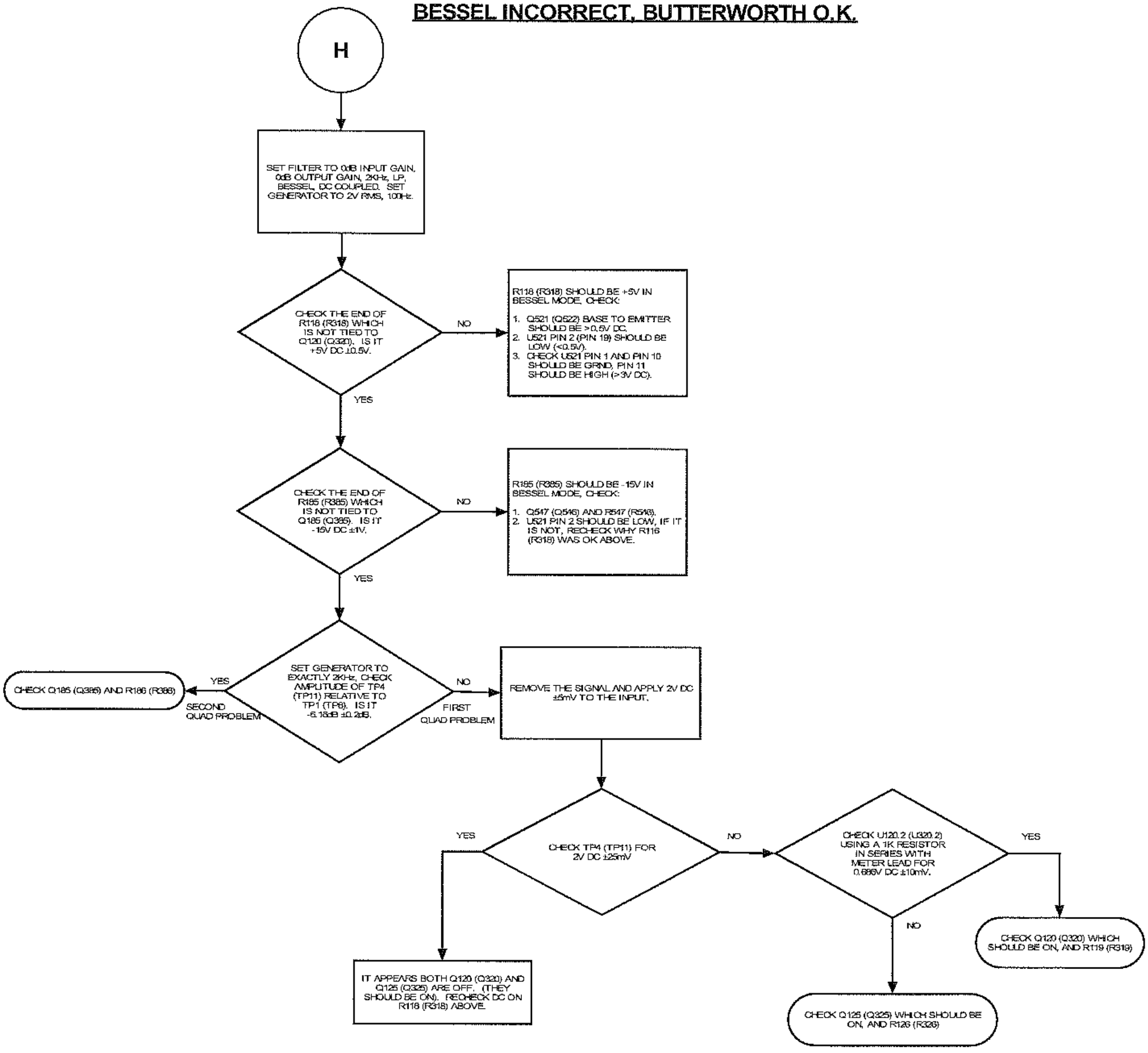
20dB INPUT GAIN INCORRECT



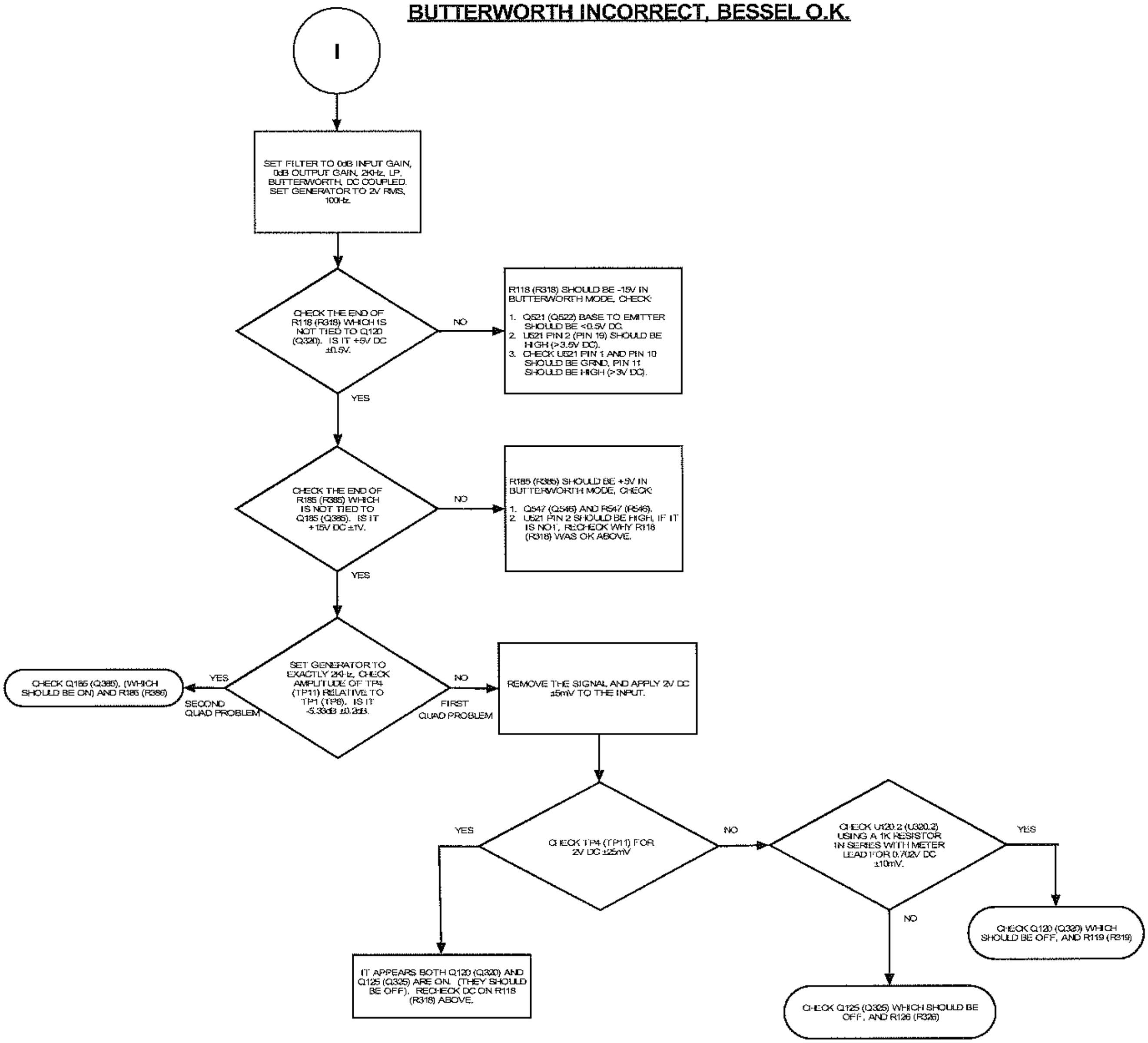
LOW PASS INCORRECT, HP WORKS O.K.



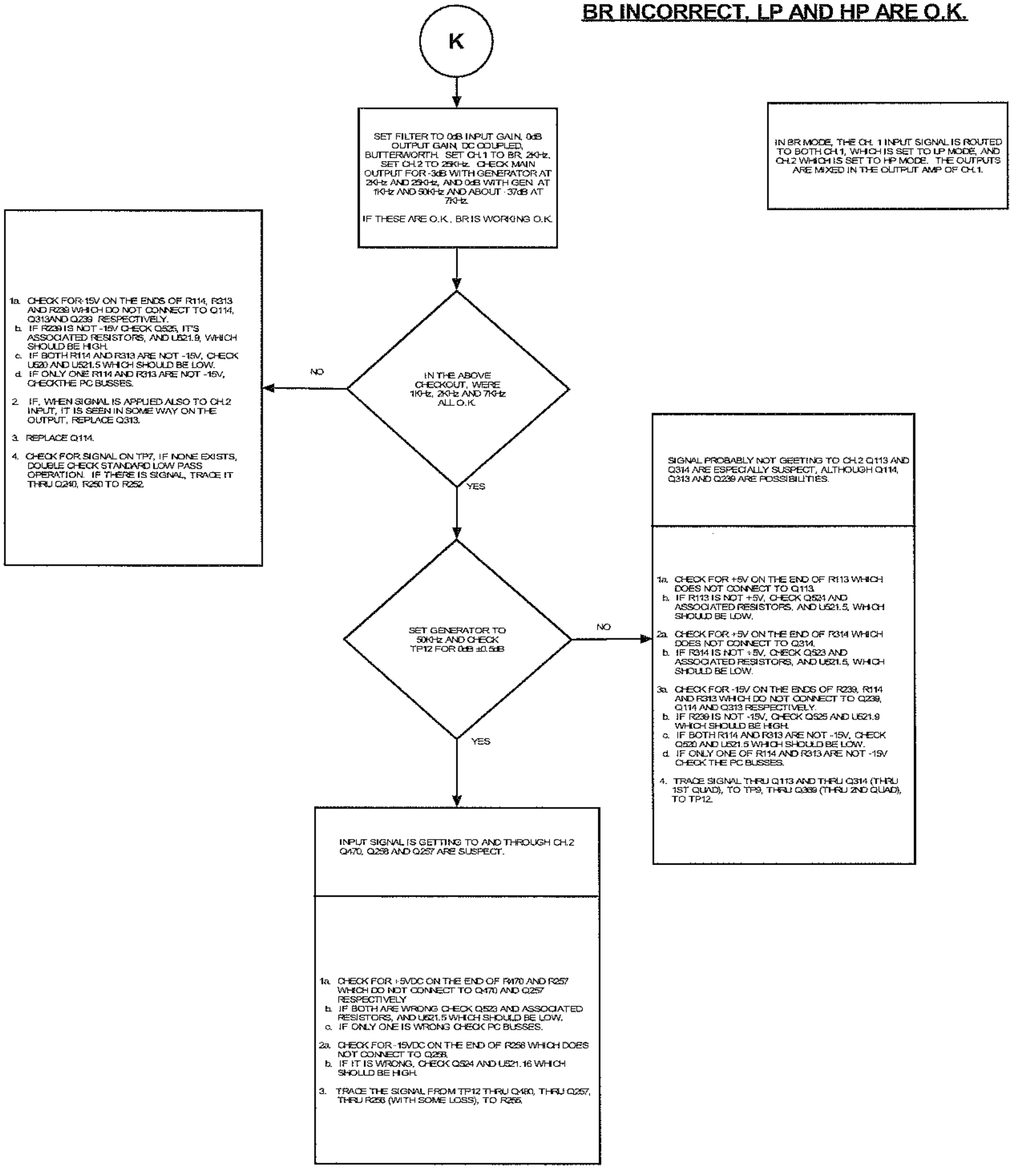
BESSEL INCORRECT, BUTTERWORTH O.K.



BUTTERWORTH INCORRECT, BESSEL O.K.



BR INCORRECT, LP AND HP ARE O.K.



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Model 34A Parts List

The following is a listing of all the parts on the Model 34A Plug-In Filter Card and the quantity that is used.

When ordering parts from Krohn-Hite, please indicate the following information:

Model Number
Serial Number
KH Part Number

Contact Krohn-Hite Sales Department at (508) 580-1660.

All written correspondence can be made to Krohn-Hite at the following address:

Krohn-Hite Corporation
15 Jonathan Drive, Unit 4
Brockton, MA 02301

You can also call the Krohn-Hite Service Department at (508) 580-1660 for more information regarding any service information you may need about your Krohn-Hite instrument.

KH Part Number	Item Description	Qty
003053	BUS BAR #B21297T	3
352971	SHIELD PER DWG. B4474	1
370403	CONNECTOR, RIGHT ANGLE BNC AMP #227161-1	4
352911	PC BOARD PER DWG. D4386	1
370404	1/2-28 BRASS HEX NUT NICKEL PLATE	4
370405	1/2 INTERNAL LOCKWASHER SHAKEPROOF #1924-02 NICKEL	1
029024	RELAY, PER DWG A4172-1 EPOXY COATED	20
029026	RELAY PER DWG. B4172-3 SPDT	4
036036	SOCKET, 20 PIN WITH RETENTION SOLDER TAILS	2
036042	SOCKET, 8 PIN WITH RETENTION SOLDER TAILS	17
036044	SOCKET,16 PIN AMP #2-641610-1	4
039100	TEST POINT RED #TP-104-01-02	16
039100B	TEST POINT BLACK #TP-104-01-00	2
201741	I.C. #UA741CP	1
204138A	I.C., MOTOROLA #MC74HC138AN	2
204174B	I.C., MOTOROLA #MC74HC174AN	1
204244A	I.C. MOTOROLA #MC74HC244AN	1
204374	I.C. MOTOROLA #MC74HC374AN	7
207417	I.C. FAIRCHILD DM7417N	2
207805	I.C. MOTOROLA MC7805CT	1
207905	I.C. MOTOROLA MC7905CT	1
280539	I.C. ANALOG DEVICES #AD539JN	4
280817	I.C. ANALOG DEVICES #AD817AN	10
280818	I.C. ANALOG DEVICES #AD818AN	2
280846	I.C. ANALOG DEVICES #AD846AN	2
280848	I.C. ANALOG DEVICES #AD848JN	2
287226	I.C. ANALOG DEVICES #AD7226KN	1
203640	TRANSISTOR, MOTOROLA MPS3640	4
203906	TRANSISTOR MOTOROLA 2N3906	42
205638	TRANSISTOR, 2N5638	72

272366	TRANSISTOR, LINEAR SYSTEMS #U402	2
230961	DIODE, ZENER 1N961B 10V	2
234149	DIODE, 1N4149	4
264577	DIODE, ZENER 1N4577A 6.4V SELECT TO +/-.1V 2PPM	1
280749	DIODE, ZENER 1N749A 4.3V	2
280300	DIODE, BKC #1N3595	4
411968	CAP, CERAMIC 6.8PF 10% 500V 9212-68910	2
411982	CAP, CERAMIC 8.2PF 500V 10%	4
412210	CAP, CERAMIC 1000PF 20% 500V 5GA-D10	2
412310	CAP, CERAMIC .01 MFD 500V 20% 5GAS-S10	1
413410	CAP., CER. .1MF 100V 20% RPE122Z5U104M100V	64
413447	CAP, CERAMIC .47MFD 100V AVX #SR301E474MAA	2
421127	CAP, MICA 270PF 5% 500V DM15C271J	8
422027	CAP, MICA 27PF 5% 500V DM15C270J	3
422062	CAP, MICA 62PF 5% 500V DM15C620J	2
422068	CAP, MICA 68PF 5% 500V DM15C680J	4
422115	CAP, MICA 150PF 10% 500V DM15C151K	2
422124	CAP, MICA 240PF 500V 5% DM15	4
423024	CAP, MICA 24PF 10% 500V DM15C240K	2
423082	CAP, MICA 82PF 10% 500V DM15C820K	2
423122	CAP, MICA 220PF 5% 500V DM15C221J	2
431222	CAP, FILM 2200PF 10% 100V WMF1D22	8
431256	CAP, FILM 5600PF 10% 100V WMF1D56	8
439999	CAPACITOR, TRIM (FILM OR MICA)	1
441511	CAP, FILM 1MFD 10% 200V #X663F-11	2
471510	CAP, TANTALUM 1MFD 35V 20% T350A105M035AS	4
471568	CAP, TANTALUM 6.8MFD 35V 20% T350F685M035AS	3
471647	CAP, LYTIC 47MF 10V 10% AVX #TAP476K010SCS	8
471733	CAP, 330MF 6V KEMET #T350L337K006AS	2
482008	CAP, TRIMMER 4 TO 34 PF #9309	10
482010	CAP, TRIMMER 4.5-65PF SPRAGUE GYC65000	8
NAC270	CAP, .27UF DIGI-KEY #P4668-ND	8
658011	POT 10 OHMS TYPE 72XW	2
658110	POT 100 OHM 10% 72PM	1
658121	POT 200 OHM 10% 72 PM	4
658210	POT 1K TYPE 72 PM	4
658310	POT 10K TYPE 72 PM	2
658410	POT 100K 10% TRIM BECKMAN TYPE 72 PM	8
658411	POT 100K 10% 72 XW	4
812210	RESISTOR, MF 1.0055K 1/4W 0.1% GP 1/4-T100	2
812216	RESISTOR, MF 1.676K 1/4W 0.1% GP 1/4-T100	2
812353	RESISTOR, MF 53.05K 1/4W 0.1% GP 1/4-T100	4
822117	RESISTOR, MF 177.2 OHMS 1/4W 0.1% GP1/4 T100	2
822140A	RESISTOR, MF 406.9 OHMS 1/4W 0.1% GP1/4 T100	2
822150	RESISTOR, MF 500 OHM 1/4W 0.1% GP 1/4-T100	2
822156	RESISTOR, MF 565.0 OHM 1/4W 0.1% GP 1/4-T100	2
8221567	RESISTOR, MF 567.4 OHMS 0.1% GP1/4 T100	8
822193	RESISTOR, MF 925.1 OHMS 1/4W 0.1% GP1/4 T100	3
822194	RESISTOR, MF 945.5 OHMS 1/4W 0.1% GP1/4 T100	3
822210	RESISTOR, MF 1.0K 1/4W 0.1% GP 1/4-T100	2
822210A	RESISTOR, MF 1.077K 1/4W 0.1% GP1/4 T100	2
822210E	RESISTOR, MF 1.026K 1/4W 0.1% GP1/4 T100	2
8222113	RESISTOR, MF 1.136K 0.1% GP1/4 T100	8
822222C	RESISTOR, MF 2.2K 1/4W 0.1% GP1/4 T100	2
8222293	RESISTOR, MF 2.293K 0.1% GP1/4 T100	8
822313	RESISTOR, MF 15.78K 1/4W 0.1% GP 1/4-T100	2
822316	RESISTOR, MF 16.2K 1/4W 0.1% GP1/4 T100	2
822319	RESISTOR, MF 20.0K 1/4W 0.1% GP 1/4-T100	2
822326A	RESISTOR, MF 26.91K 1/4W 0.1% GP1/4 T-100	1
822326B	RESISTOR, MF 26.35K 1/4W 0.1% GP1/4T100	1
822327	RESISTOR, MF 27.96K 1/4W 0.1% GP1/4T100	2
822340	RESISTOR, MF 40.0K 1/4W 0.1% GP 1/4-T100	4
850049	RESISTOR, MF 49.9 OHMS 1/4W 1%	2
850123	RESISTOR, MF 232 OHM 1/4W 1%	1
850127A	RESISTOR, MF 270 OHMS 1/4W 1% GP1/4 T100	2
850149	RESISTOR 499 OHMS 1/4W 1%	2

850218A	RESISTOR, MF 1.87K 1/4W 1%	3
850449	RESISTOR, MF 499K 1/4W 1% GP 1/4-T100	2
860410	RESISTOR ARRAY 100K SIP BECKMAN #L103C104	7
860433	RESISTOR ARRAY 330K SIP BECKMAN #L101C334	5
927033	RESISTOR 33.2 OHMS 1/4W 1%	2
927047	RESISTOR 47.5 OHM 1/4W 1%	4
927062	RESISTOR 62 OHM 1/4W 5%	2
927110	RESISTOR 100 OHM 1/4W 1%	14
927118	RESISTOR 182 OHM 1/4W 1%	1
927133	RESISTOR 332 OHM 1/4W 1%	6
927136	RESISTOR 360 OHM 1/4W 5%	2
927151	RESISTOR 511 OHM 1/4W 1%	2
927210	RESISTOR 1K 1/4W 1%	9
927218	RESISTOR 1.82K 1/4W 1%	2
927220	RESISTOR 2K 1/4W 1%	3
927251	RESISTOR 5.11K 1/4W 1%	1
927256	RESISTOR 5.62K 1/4W 1%	1
927268	RESISTOR 6.81K 1/4W 1%	1
927310	RESISTOR 10K 1/4W 1%	1
927320	RESISTOR 20K 1/4W 1%	2
927410	RESISTOR 100K 1/4W 1%	8
927510	RESISTOR 1M 1/4W 1%	2
927530	RESISTOR 3M 1/4W 5%	6
927947	RESISTOR 4.7 OHM 1/4W 5%	2
928010	RESISTOR 10 OHM 1/4W 1%	14
928015	RESISTOR 15 OHM 1/4W 1%	2
928022	RESISTOR 22.1 OHM 1/4W 1%	2
928082	RESISTOR 82.5 OHM 1/4W 1%	2
928139	RESISTOR 392 OHM 1/4W 1%	2
928427	RESISTOR 267K 1/4W 1%	2
928433	RESISTOR 332K 1/4W 1%	5
928515	RESISTOR 1.5M 1/4W 10%	2
928610	RESISTOR 10 M 1/4W 10%	60

NOTES