Model 35

170Hz to 25.6MHz, 24dB/Octave
Butterworth Tunable Active
Plug-In Filter Card

KROHN-HITE CORPORATION

Operating Manual

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Krohn-Hite Instruments are designed and manufactured in accordance with sound engineering practices and should give long trouble-free service under normal operating conditions. If your instrument fails to provide satisfactory service and you are unable to locate the source of trouble, contact our Service Department at (508) 580-1660, giving all the information available concerning the failure.

DO NOT return the instrument without our written or verbal authorization to do so. After contacting us, we will issue a Return Authorization Number which should be referenced on the packing slip and purchase order. In most cases, we will be able to supply you with the information necessary to repair the instrument, avoiding any transportation problems and costs. When it becomes necessary to return the instrument to the factory, kindly pack it carefully and ship it to us prepaid.

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MODEL 35

170Hz to 25.6MHz
LOW-PASS BUTTERWORTH
PLUG-IN FILTER CARD

OPERATING AND MAINTENANCE MANUL

PLUG-IN FILTER CARDS			
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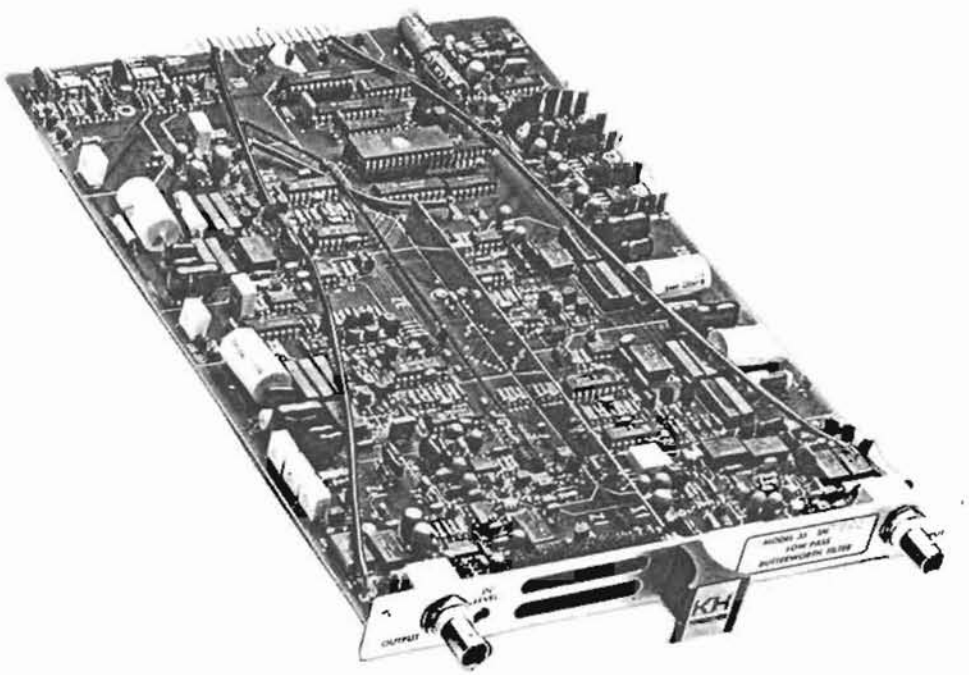

Model 35 Plug-In Filter Card

SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

The Model 35 is a low-pass, Butterworth (maximally flat) filter card, used in the Models 3905B and 3916B mainframes, providing 24dB/octave rolloff with a minimum stopband attenuation of up to 100dB. The Model 35 covers the frequency range of 170Hz to 25.6MHz with 2½ digits of resolution.

The filter card has selectable AC or DC coupling and selectable 1M or 50 ohm impedance. Programmable input gains of up to 20dB and output gains of up to 26dB are standard.

The Model 35 also has the capability to be configured in an Amplifier By-Pass mode to operate as an amplifier, by-passing the filter. This gives the user the ability to amplify without filtering when so desired.

The Model 35 is one of many Krohn-Hite filter cards used in conjunction with two GPIB programmable mainframes; the 3 1/2' high Model 3905B (5 plug-in card chassis) or the Model 3916B (16 plug-in card chassis).

1.2 SPECIFICATIONS

1.2.1 FILTER CHARACTERISTICS

Filter Type: 4-Pole, Butterworth, Low-Pass.

Tunable Cutoff Frequency Range: 170Hz to 25.6MHz.

Frequency Response:

Frequency Range	Resolution
170Hz to 2.56kHz	10Hz
2.6kHz to 25.6kHz	100Hz
26kHz to 256kHz	1kHz
260kHz to 2.56MHz	10kHz
2.6MHz to 25.6MHz	100kHz

Cutoff Frequency Accuracy: ±2% to 2.56MHz, ±5% to 25.6MHz.

Attenuation Slope: 24dB/Octave.

Stopband Attenuation: 100dB to 1MHz, 80dB at 10MHz, 70dB at 30MHz, 60dB at 50MHz, 50dB to 100MHz.

Amplified Bypass Mode Bandwidth: >50MHz.

Amplified Bypass Mode Rise and Fall Time: <7ns with 0dB input gain 6dB output gain, <10ns with +20dB input or output gain. <5% ringing or overshoot.

1.2.2 INPUT

Input/Output Coupling: AC or DC. AC coupling cutoff is approximately 16Hz at the input and 10Hz at the output with a 50Ω termination. Note that the internal 50Ω input termination is before the AC coupling.

Input Impedance: Selectable 1MΩ or 50Ω, ±2%, shunted by 45pF.

Passband Response: ±0.2dB up to 2.56MHz, ±0.5dB to 25.6MHz.

Input Gain (Pre-Filter): 0dB, +10dB, +20dB ±0.1dB.

Maximum Input Signal: ±1.5V peak with 0dB input gain, reduced in proportion to input gain selected.

Input DC Blocking Voltage: 200V. Note that the internal input termination is before the AC coupling and can only tolerate 7Vrms when ON.

Maximum Input Without Damage: 12Vrms with input terminator OFF, 7Vrms with input terminator ON.

1.2.3 OUTPUT

Maximum Output Signal: ±3V peak open circuit, ±1.5V peak into 50Ω.

Output Gain (Post-Filter): 0dB, +6dB, +20dB, +26dB, ±0.1dB.

Output Impedance: 50Ω, ±2%.

Distortion (1Vrms sinewave): >–60dB below signal up to 100kHz (0.1%). All harmonics below 50dB to 1MHz; below 40dB above 1MHz.

Output DC Offset: Adjustable to Zero.

Output DC Offset Drift: ±0.5mV/°C referred to input.

Noise Spectral Density (10kHz to 100MHz referred to input): Below –128dBm/Hz into 50 ohms. This translates into a wideband noise power or voltage for a 30MHz BW of below –53dBm or 0.50mVrms referred to input.

Spurious Signals: Below –80dBm to 65MHz; below –75dBm to 100MHz. Referred to input, represented in voltage form: 22μV and 40μV respectively.

1.2.4 GENERAL

Input/Output Connectors: BNC.

Power: 8 watts.

Weight: 1.75 lbs. (.8kg) net.

Operating Temperature: 0°C to 50°C.

Specifications apply at 25°C ±10°C.

Specifications subject to change without notice.

NOTE: *The Model 35 filter card must be used with the Model 3905B or 3916B mainframes.*

SECTION 2
OPERATION

2.1 INTRODUCTION

The Model 35 low-pass filter card covers the frequency range from 170Hz to 25.6MHz. It is one of a series of filter cards available for the 5 plug-in card mainframe, Model 3905B or the 16 plug-in card mainframe, Model 3916B mainframe. All filter parameters are programmable via the mainframes front panel or remotely over the IEEE-488 (GPIB) bus. For detailed information of the front panel controls and remote programming, refer to Section 2 and 3 of the Model 3905N/3916B mainframe's Operating and Maintenance Manual. Section 2.4 of this manual briefly describes the operation of the principal front panel controls and data key operation.

2.2 TURN-ON PROCEDURE

a. The line voltage range of the Model 3905B/3916B mainframe has been preset at the factory for either 115V or 230V operation. This range switch is located internally if a line voltage change is required. Check to see that a fuse with the correct rating is in the fuse receptacle.

b. Make certain that the POWER switch on the front panel of the unit is in the OFF position.

c. Plug the line cord into the unit first, then into an ac outlet.

CAUTION

For safety purposes, the line cord must be connected to a grounded 3-terminal ac outlet. Because of potentially dangerous voltages that exist within the mainframe, the covers should be removed only by qualified personnel.

d. If the Model 3905B/3916B is remotely programmed via the IEEE-488 (GPIB) bus, connect the bus cable to the rear panel 24 position "D" connector at this time. Programming information is provided in Section 3 of the Model 3905B/3916B Operating and Maintenance Manual, with additional information in Section 3 of this manual.

e. The POWER switch is a toggle type, located on the front panel of the Model 3905B/3916B. After familiarizing yourself with the self-test feature described next, turn-on the Model 3905B/3916B.

2.3 SELF-TEST FEATURE

When turned on, the Model 3905B/3916B microprocessor performs a Self-Test routine whereby the entire RAM and ROM operation is verified. During the test, the front panel LEDs and display will light up sequentially.

If there is a malfunction in the microprocessor, such as a defective RAM or ROM, the sequence will stop and the word "bAd" will appear in the display, followed by a number from 1 to 3. Refer to Section 7.6, Digital Circuit Maintenance, to find which RAM or ROM is defective; otherwise, when the Self-Test program is complete, the Model 3905B/3916B will return to the last set-up prior to turning off the unit.

The Model 3905B/3916B is now ready to be programmed for operation.

2.4 JUMPER SETTINGS FOR FRONT AND REAR PANEL OPERATION

To achieve clean high frequency signal performance from the rear panel input and output BNCs, it is necessary to disconnect the cabling connecting the front panel BNCs by moving the two jumpers on jumper blocks J201 (for input) and J517 (for output) shown in Figure 2.1 below. The Model 35 filter cards are shipped with the jumpers set with front panel BNCs active.

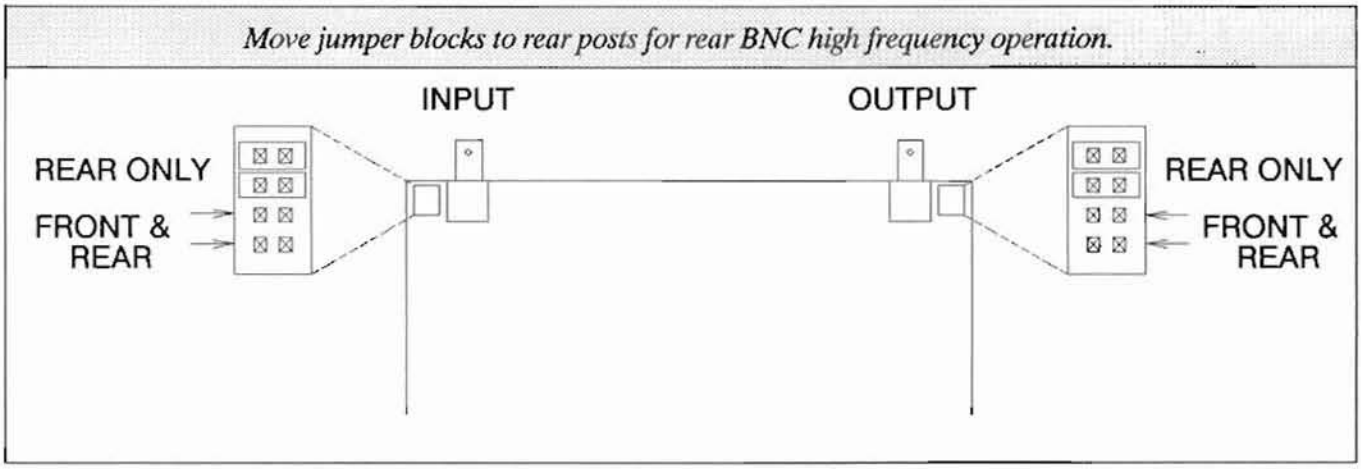

Figure 2.1 Front and Rear panel Jumper Blocks

2.5 FRONT PANEL CONTROLS AND DISPLAY

2.5.1 DATA KEYS

Data entry keyboard controls, [0]-[9] and [.], and associated 4 digit display set the numeric value of the parameter selected. If a cutoff frequency of 1.5kHz is required, press the [1][.][5] data keys, then press [KILO] and [FREQ] parameter keys. The cutoff frequency will be indicated in the 4 digit display.

2.5.2 [MODE] KEY

Indicates the mode of operation in the channel displayed, alternating between low-pass, "L.P." and amplifier by-pass, "GAin", which disconnects the filter.

2.5.3 [TYPE] KEY

Displays "bu.", indicating Butterworth filter.

2.5.4 CHANNEL

The two channel controls [⇑][⇓] and associated display, increment or decrement the channel setting. When held, the Model 3905B/3916B will cycle through all the channels continuously.

2.5.5 GAIN SET

Input and Output gain is controlled by the two GAIN SET controls [⇑][⇓] and associated two digit displays. Input gain is selectable to 0dB, 10dB or 20dB. Output gain is selectable to 0dB, 6dB, 20dB or 26dB.

2.5.6 INPUT OVERLOAD

With 0dB Input gain, the input overload indicator will turn on at approximately ±1.6V peak. At 10dB, approximately ±0.5V peak. At 20dB, approximately ±0.16V peak.

2.5.7 OUTPUT OVERLOAD

The output overload indicator will light at approximately ±3.2V peak output with the output not terminated, or ±1.6V peak output with the output terminated, for all gain settings except 0dB output gain. For 0dB output gain the values are ½.

2.5.8 [CE] CLEAR ENTRY KEY

Display will reset to the previous entry or toggle between present and previous settings.

2.5.9 [ALL CHANNEL] KEY

When on, parameter changes will be made simultaneously to all identical filter channels.

2.5.10 INPUT OHMS (Labeled White)

Pressing [SECOND FUNCTION], then input GAIN SET [[⇑][⇓], will indicate in the main display the current input termination setting; either "b50b" (50 ohms) or "bhib" (1M). If "b50b" is in the display, repeat the [SECOND FUNCTION] GAIN SET [[⇑][⇓] only again, then the input termination will be switched to "bhib".

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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 Maintenance Manual. Detailed information about the filter type, modes of operation and device clear command not described in the 3905B/3916B manual are specified below.

3.2 FILTER TYPE ——→

1	Butterworth

3.3 MODE OF OPERATION ——→

1	Low-Pass
2	Amplifier By-Pass

3.4 DEVICE CLEAR ——→

INPUT GAIN	0dB
OUTPUT GAIN	6dB
RESPONSE	Butterworth
MODE	Low-Pass
CUTOFF FREQUENCY	1MHz
COUPLING	DC
INPUT OHMS	50 Ohms

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SECTION 4
INCOMING ACCEPTANCE

4.1 INTRODUCTION

The following procedure should be used to verify that the Model 35 filter card, inserted in a Model 3905B or 3916B 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 and operating for a minimum time 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 Section 2 of this manual and the Model 3905B/3916B Operating and Maintenance Manual.

4.2 TEST EQUIPMENT REQUIRED

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

a. DC Voltmeter (DVM), capable of measuring 1mV to 20V, Fluke 8000 or equivalent.

b. AC RMS Voltmeter, capable of measuring 100μV to 10Vrms and useful bandwidth to 25MHz, Fluke 8920A or equivalent.

c. Squarewave Source ,2Vp-p squarewave with rise and fall times <5ns with <5% overshoot or ring, HP8012B or equivalent.

d. Low Distortion Sinewave Signal Source, <0.05% distortion to 100kHz, 0.1% to 1MHz, Krohn-Hite Model 4200B or equivalent.

e. Distortion Analyzer, capable of measuring distortion to 1MHz, Krohn-Hite Model 6900B or equivalent.

f. Sinewave Signal Source, covering the frequency range from 1MHz to 100MHz, Tektronix Model 191 or equivalent.

g. Spectrum Analyzer, HP Model 141T with RF section 8553B and IF section 8552B or equivalent.

h. Oscilloscope, 100MHz bandwidth, Tektronix Model 2245A or equivalent.

4.3 INITIAL SETTINGS

Input ohms: 50
Input Gain: 0dB
Input Coupling: DC
Cutoff Frequency: 10MHz
Output Gain: 6dB
Overload Mode: 2
Filter Mode: LP

NOTE: *Good "high frequency techniques" should be used at all times, which includes the use of good quality 50 ohm cabling for signal connections to and from the filter.*

4.4 DC OUTPUT LEVEL CHECKS

Connect the DVM set for DC operation to the filter Output.
Measure DC level for all Input and Output gain settings.
Should be <±10mVdc.

4.5 GAIN ACCURACY CHECK

Disconnect the DVM and connect the Fluke 8920A to the filter Output.
Connect a 0.1Vrms, 1kHz signal to the input (note that the filter Input is set for 50 ohms and will terminate a 50 ohm source producing a factor of 2 less in amplitude).
Set the filter Output gain for 0dB.
Set the Fluke 8920A for AC relative dB measurements, and zero reference the Fluke.
Check each Input and Output gain setting by switching each one up from 0dB independently.
All dB readings should be within 0.1dB of the filter gain setting.

4.6 DISTORTION CHECK

Disconnect the Fluke 8920A from the filter Output.
Set the filter for 0dB Input gain and 6dB Output gain.
Set the signal source for 1Vrms, 1kHz, sinewave and connect to the filter Input.
Connect the Distortion Analyzer to the filter Output through a 50 ohm cable terminated at the analyzer end.
Measure the distortion at the following frequencies:

Frequency	Tolerance
1kHz	0.1%
100kHz	0.1%
1MHz	0.3%

If necessary, verify that the signal source's distortion is below the above readings by measuring it separately.

4.7 SQUAREWAVE RISE AND FALL TIME CHECK

Disconnect the distortion analyzer and sinewave signal source from the filter.
Set the filter for GAIN mode.
The filter Input and Output gain should be 0dB and 6dB respectively, and Input Ohms set to 50.
Set the filter coupling to AC.
Connect the filter Input using a 50 ohm cable to the squarewave source set for 2Vp-p, 2.5MHz, squarewave.
Connect the filter Output to an oscilloscope with a 50 ohm cable terminated at the oscilloscope end.
Observe on the scope that overshoot and ringing is <5%.
Measure the rise and fall time from the 10% and 90% waveform points.
It should be <7ns.
Set the squarewave source for 0.2Vp-p.
Check the Output waveform first with 20dB Input gain and then with 26dB Output gain for <5% overshoot and ringing, and <10ns rise and fall time.

4.8 FREQUENCY CALIBRATION CHECK

Set the filter for the initial setting at the beginning of this Section.
Connect the filter Input via a 50 ohm cable to a 1Vrms, 1kHz, sinewave signal source.
Connect the Fluke 8920A to the Output of the filter with a 50 ohm cable.
Set the Fluke for relative dB operation.
Set the filter for a cutoff frequency of 1kHz and GAIN mode.
Zero reference the Fluke.
Set the filter for LOW-PASS (LP) mode and measure the drop in dB on the Output.
It should be within –2.67dB to –3.37dB for a ±2% calibration range.

Set the sinewave generator and filter cutoff to the following frequencies and zero referencing the Fluke in the filter GAIN mode, measure the drop in gain on the Output of the filter when switching the filter to the LP mode.

Frequency	dB at Cutoff Range	% Error Spec
1kHz	-2.67dB to -3.37dB	±2%
10kHz	-2.67dB to -3.37dB	±2%
100kHz	-2.67dB to -3.37dB	±2%
1MHz	-2.67dB to -3.37dB	±2%
10MHz	-2.21dB to -3.94dB	±5%

4.9 WIDEBAND NOISE CHECK

Set the filter for 25.6MHz, LP mode, 0dB Input gain and 26dB Output gain.
Disconnect the sinewave signal from the filter Input.
With the Fluke connected to the Output via a 50 ohm terminated cable, measure the wideband noise voltage present.
Wideband noise should be <5mV which translates to 500μV referenced to the Input, since the net gain from the filter Input to the meter is 20dB.

4.10 STOPBAND ATTENUATION CHECK

NOTE: *This test uses a spectrum analyzer to detect the rejected signal. Most spectrum analyzers have a maximum signal amplitude without damage limit. Care should be taken that this signal level limit is not exceeded. A simple precaution would be to use a 50 ohm inline 20dB attenuator at the analyzer Input. It is also advisable to set all the equipment before connecting the analyzer.*

Set the filter to the initial setting at the beginning of this Section.
Set the filter coupling to AC, cutoff frequency to 10kHz, and mode to GAIN.
Set the Tektronix 191 signal generator for 1MHz, 3Vp-p into 50 ohms.
Connect the Tektronix 191 to the filter Input.
Set the spectrum analyzer to measure the 3Vp-p, 1MHz signal into a 50 ohm termination at the filter Output and connect the filter Output to the analyzer.
Adjust the analyzer for 0dB, referencing level at the 1MHz signal.
Set the filter for LP mode.
The measured amount of 1MHz signal should be down 100dB.
Set the signal generator for 10MHz.
The measured amount of 10MHz signal should be down 80dB.
Set the signal generator for 30MHz.
The measured amount of 30MHz signal should be down 70dB.

NOTE: *Zero referencing of the spectrum analyzer at 100MHz must be done by connecting the signal generator to the spectrum analyzer Input.*

Set the signal generator for 100MHz.
The measured amount of 100MHz signal should be down 50dB.

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