# MODEL 30A SERIES

## LOW-PASS ELLIPTICAL
## PLUG-IN FILTER MODULES

**MODEL 30A-1: 1Hz to 99kHz**
**MODEL 30A-2: 0.1Hz to 9.9kHz**
**MODEL 30A-3: 0.01Hz to 990Hz**

# OPERATING MANUAL

| FILTER MODULES | | | |
|---|---|---|---|
| MODEL__________ | S/N__________ | MODEL__________ | S/N__________ |
| MODEL__________ | S/N__________ | MODEL__________ | S/N__________ |
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| MAINFRAME | |
|---|---|
| MODEL__________ | S/N__________ |

| MICROPROCESSOR | |
|---|---|
| MODEL__________ | S/N__________ |

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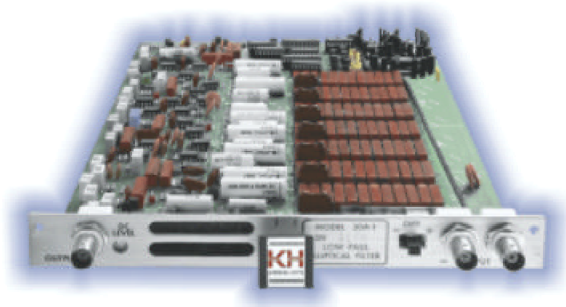

**Model 30A Plug-In Filter Module**

# SECTION 1
# GENERAL DESCRIPTION

## 1.1 INTRODUCTION

The Model 30A Series are low-pass, 7-pole, 6-zero elliptical plug-in filters providing 115dB/octave roll-off, a minimum stopband attenuation of >80dB, and a typical passband ripple of 0.22dB peak-to-peak. The Model 30A-1 covers the range from 1Hz to 99kHz. The Model 30A-2 operates from 0.1Hz to 9.9kHz and from 0.01Hz to 990Hz in the Model 30A-3.

With its 115dB/octave rolloff rate, the Model 30A provides a much narrower transition region than an 8-pole Butterworth, and much less passband attenuation near cutoff. The transition region from –3dB to –85dB is 64% of $f_c$ (cutoff), compared to 242% for the 8-pole Butterworth. From –0.3dB to –85.6dB, it becomes 70% of $f_c$ compared to 404%. This permits lower sampling rates and wider bandwidths, resulting in lower total system costs.

The Model 30A Series is part of an ever expanding line of plug-in filter cards for use in the Model 3905C and 3916C Mainframes, which accommodates 5 to 16 filter cards respectively.

## 1.2 SPECIFICATIONS

### FILTER CHARACTERISTICS

**Function:** Low-pass filter, voltage gain amplifier.
**Type:** 7-pole, 6-zero elliptical.
**Frequency Range $f_c$:** Model 30A-1: 1Hz to 99kHz.
Model 30A-2: 0.1Hz to 9.9kHz.
Model 30A-3: 0.01Hz to 990Hz.

Resolution:

Model 30A-1

| Band | Frequency | Resolution |
|---|---|---|
| 1 | 1Hz to 99Hz | 1Hz |
| 2 | 100Hz to 990Hz | 10Hz |
| 3 | 1kHz to 9.9kHz | 100Hz |
| 4 | 10kHz to 99kHz | 1000Hz |

Model 30A-2

| Band | Frequency | Resolution |
|---|---|---|
| 1 | 0.1Hz to 9.9Hz | 0.1Hz |
| 2 | 10Hz to 99Hz | 1Hz |
| 3 | 100Hz to 990Hz | 10Hz |
| 4 | 1kHz to 9.9kHz | 100Hz |

Model 30A-3

| Band | Frequency | Resolution |
|---|---|---|
| 1 | 0.01Hz to 0.99Hz | 0.01Hz |
| 2 | 1Hz to 99Hz | 0.1Hz |
| 3 | 100Hz to 99Hz | 1Hz |
| 4 | 100Hz to 990Hz | 10Hz |

**Relative Gain at $f_c$:** -0.22dB at $1.01f_c$ nominal.
**Cutoff Frequency Accuracy:** ±2%.
**Stopband Attentuation:** >80dB.
**Stopband Frequency ($f_s$):** $1.7f_c$.
**Insertion Loss:** 0dB; ±0.1dB.
**Pre-Filter Gain:** 0dB, 10dB, 20dB, 30dB, 40dB; ±0.2dB
**Post-Filter Gain:** 0dB, 20dB; ±0.2dB.
**Input Coupling:** ac or dc.
**Wideband Noise (RFI):** min. gain, 1kHz cutoff, <400µV; 99kHz cutoff, <1mV. Max. gain, <20µV.
**Harmonic Distortion:** -80dB at 1kHz.
**Intermodulation Distortion:** -80dB below full scale volts at 70kHz and 90kHz input frequency.
**Spurious Components:** -80dB below full scale with input source <50 ohms.
**DC Stability:** Typically ±10µV/°C.
**Crosstalk Between Channels:** -85dB below full scale with input source <50 ohms.

## AMPLIFIER CHARACTERISTICS

**Bandwidth:** >1MHz min. gain; >400kHz max. gain.
**Insertion Loss:** 0dB; ±0.05dB.
**Gain:** 10dB to 60dB in 10dB steps; ±0.1dB.
**Input:** Differential or single-ended + (in phase), -(inverted).
- **CMRR:** >60dB to 10kHz; >50dB to 99kHz.
- **Sensitivity:** 10mV peak with 60dB total gain for 10V peak output.
- **Maximum Input:** ±10V peak at 0dB gain reduced in proportion to gain setting.
- **Impedance:** 1 megohm in parallel with 100pf.
- **Coupling:** ac or dc.
- **Maximum dc Component:** ±100V in ac coupled mode.

**Output:**
- **Maximum Voltage (o.c.):** 7Vrms to 200kHz; 3Vrms to 500kHz; 1Vrms to 1MHz.
- **Impedance:** 50 ohms.
- **DC Offset:** Adjustable to zero volts.
- **Harmonic Distortion (1V output):** -80dB (0.01%) to 10kHz; -60dB (0.1%) to 100kHz.
- **Wideband Noise (referred to input, 2MHz BW detector):** 150µV min. gain; 25µV max. gain.
- **DC Stability (RFI):** Typically ±10µV/°C.
- **Crosstalk Between Channels:** >85dB below full scale with input source <50 ohms.

## GENERAL
**Switch: For select of Input, +(in phase), Differential or –(inverted).**
**Input/Output Connectors: BNC.**
**Power:** 15 watts.
**Weight:** 1.75 lbs. (0.8kg) net.

Specifications apply at 25°C ±5°C.

**NOTE:** Model 30A Series filter cards must be used with the Model 3905B and 3916B Mainframes.

# SECTION 2
# OPERATION

## 2.1 INTRODUCTION

The Model 30A Series are low-pass plug-in filter modules covering the frequency range from 1Hz to 99kHz (Model 30A-1); 0.1Hz to 9.9kHz (Model 30A-2); 0.01Hz to 990Hz (Model 30A-3). It is one of a series of filter modules available for the vide channel Model 3905 or the sixteen channel 3916 Mainframes. 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 Sections 2 and 3 of the Model 3905/3916 Mainframes 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 3905/3916 Mainframes 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 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 moved by qualified personnel.* |

d. If the Model 3905/3916 is remotely programmed via the IEEE-488 GPIB, connect the bus cable to the rear panel outlet of the Model 39/39A microprocessor module at this time. Programming information is provided in Section 3 of the Model 3905/3916 Operating and Maintenance Manual.

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

## 2.3 SELF-TEST FEATURE

| NOTE |
|---|
| *If there is a malfunction in the micro processor, 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.* |

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

When the Self-Test program is complete, the Model 3905/3916 will return to the last set-up prior to turning off the unit.

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

## 2.4 FRONT PANEL CONTROLS and DISPLAY

**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 and parameter keys [KILO] and [FREQ]. The frequency will be indicated in the 4 digit display.

**[MODE] Key:**
Indicates the mode of operation in the channel displayed, alternating between low-pass, "L.P.-1" and by-pass, "bYP.", which connects the input to the output. The "-1" indicates suffix of the filer module Model 30A, i.e. "L.P.-1" is the Model 30A-1.

**[Type] Key:**
Displays "EL-7", indicating a 7-pole Elliptical filter.

**Channel:**
The two channel controls [⇑] [⇓] and associated display increment or decrement the channel setting. When held, the Model 3905/3916 will cycle through all the channels continuously. The Model 3905 has a 1 digit display, the Model 3905A has 2 digits. The Model 3916 has a 2 digit display, the Model 3916A has 3 digits.

**Gain Set:**
Input and Output gain is controlled by two GAIN SET controls [⇑] [⇓] and associated 2 digit displays in 10dB steps. Input gain 0dB to 40dB. Output gain 0dB to 20dB.

**Input Overload:**
With 0dB Input gain, the input overload indicator will turn on with approximately 8Vrms input signal. At 10dB, approximately 2.5Vrms. AT 20dB, approximately 0.8Vrms. At 30dB, approximately 0.25Vrms. AT 40dB, approximately 80mVrms.

**Output Overload:**
With 0dB Input and Output gain, the output overload indicator will turn on with approximately 8Vrms output signal. At 10dB, approximately 2.5Vrms. At 20dB, approximately 0.8Vrms.

**[CE] Clear Entry Key:**
Display will reset to the previous entry or toggle between present and previous settings.

**[ALL CHANNEL] Key:**
When on, parameter changes will be made simultaneously to all identical filter channels.

## 2.5 FILTER CHARACTERISTICS

### 2.5.1 INTRODUCTION

The Model 30A is an Elliptical (Cauer) filter used in applications where frequency response (fast rolloff) is the primary objective and phase distortion, transient and passband response are secondary requirements. It is an ideal filter for A/D conversion (anti-aliasing), D/A conversion (smoothing) and many other applications requiring signal conditioning.

### 2.5.2 NORMALIZED RIPPLE RESPONSE

The Theoretical 7-pole, 6-zero elliptic low-pass filter response, shown in Figure 2.1, has 0dB gain at low frequencies with three peaks and valleys of 0.22dB p-p amplitude as the frequency approaches the cutoff frequency of $f_c$. The cutoff frequency occurs where the filter response is equal to the most negative excursion of the ripple amplitude.

The response of the filter at frequencies greater than the cutoff frequency is attenuated at an average rate of 115dB/octave, and as shown in Figure 2.1, has three peaks and nulls of attenuation in the stopband. Minimum attenuation (A min) occurs at frequency $f_s$ ($1.7f_c$) and at three frequencies where the amplitude peaks in the stopband.

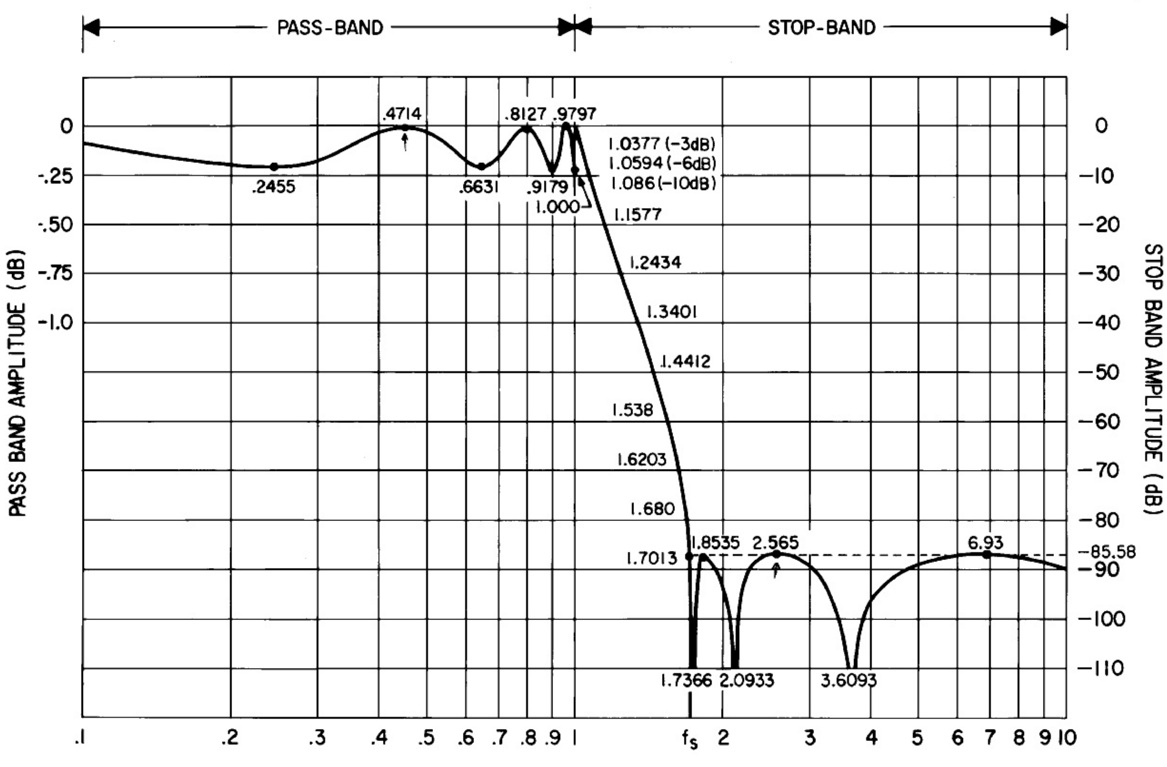


**Figure 2.1 Normalized Ripple Response**

## 2.6 VARIABLE BANDPASS and BAND REJECT OPERATION

Variable bandpass response can be obtained easily using a Model 30A low-pass filter in series with a Model 31 high-pass filter and setting the low-pass filter to an equal or high cutoff frequency than the high-pass filter. Selecting the cutoff frequencies provides the desired bandpass response.

Variable band reject response is obviously obtained in a manner similar to the variable bandpass response except that the low-pass cutoff frequency is set at a lower cutoff frequency than the high-pass filter to provide the desired band reject range.

Null operation is obtained by setting the low cutoff frequency, of the Model 30A (Curve A in Figure 2.2), a factor of 0.58 below the desired null frequency and the high cutoff frequency, of the Model 31 (Curve B), a factor of 1.7 above the null frequency.

When maximum selectivity (Curve C of Figure 2.2) at a specified frequency is required to obtain minimum bandwidth, the Model 30A and Model 31 should be set to the same cutoff frequency. To prevent the possibility of excessive attenuation due to calibration error, when both cutoffs are set to the same frequency all Krohn-Hite elliptical filters are offset by 1% from the keyboard setting. The low-pass filter at 100Hz cutoff frequency is actually tuned to 101Hz and the high-pass filter to 99Hz to provide the correct peak amplitude in narrowband operation.

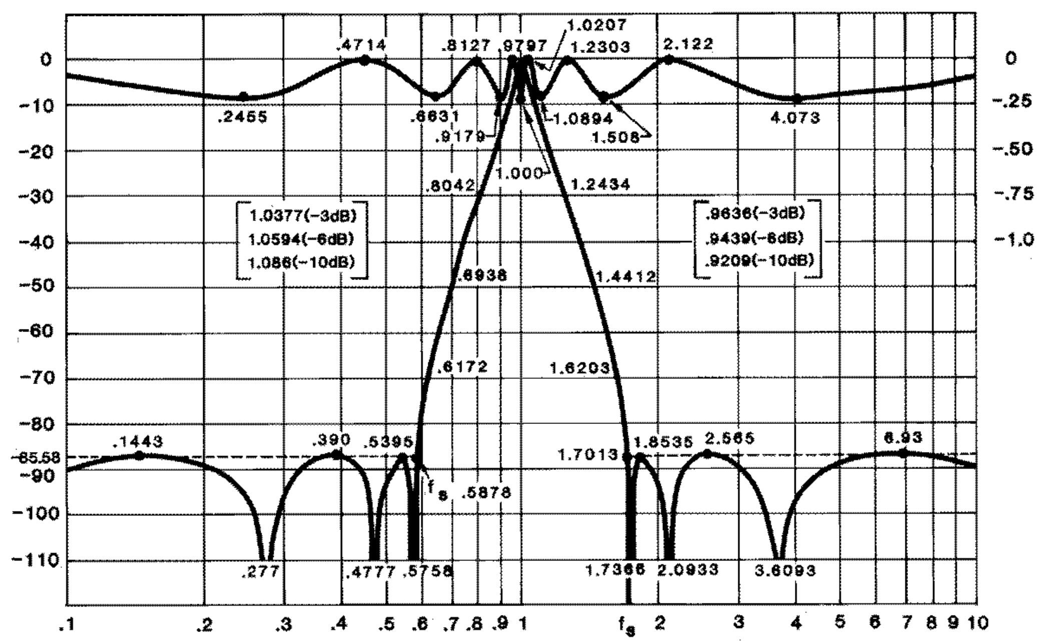


**Figure 2.2 Normailzed Band-Pass Response**

## 2.7 TRANSIENT RESPONSE

The normalized response for a unit step voltage applied to the input of the Model 30A filter is shown in Figure 2.3. A delay time in seconds for the output of the filter to reach 50% of its input voltage is determined by the formula $0.869/f_c$. With a cutoff frequency of $f_c$ of 1Hz, the delay time at point A on the response curve is 0.869 seconds. Since the delay time is inversely proportional to frequency, the delay time for $f_c$ of 0Hz would be 1/10 that of 1Hz or 0.0869 seconds.

The delay time for the output voltage of the filter to increase from 10% to 90% of its input voltage (point B to point C) is determined by the formula $0.541/f_c$ or 0.541 seconds for a normalized frequency of 1Hz. The inverse relationship reduces the time delay proportionally at high cutoff frequencies.

The normalized impulse response of the Model 30A filter is shown in Figure 2.4. An impulse will produce a damped sinewave whose maximum amplitude over shoot (point D) will be 30% of the input pulse amplitude and the damped sine wave will approach zero amplitude in approximately 10 cycles.

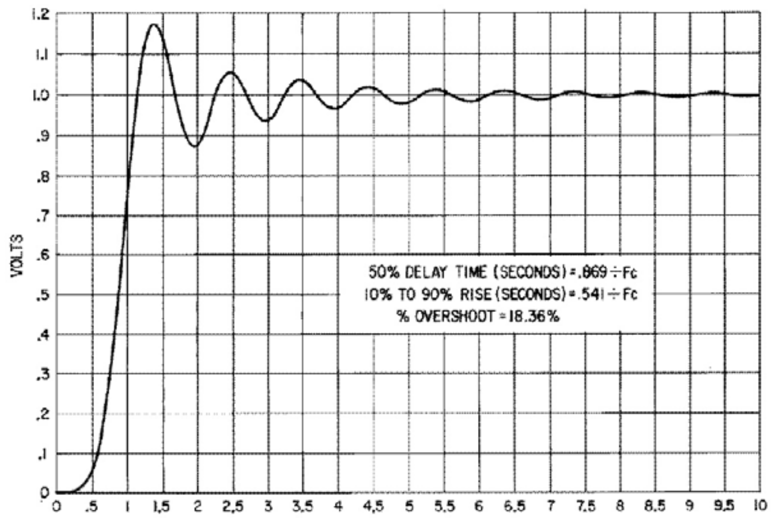


**Figure 2.3 Normalized Unit Step Response**

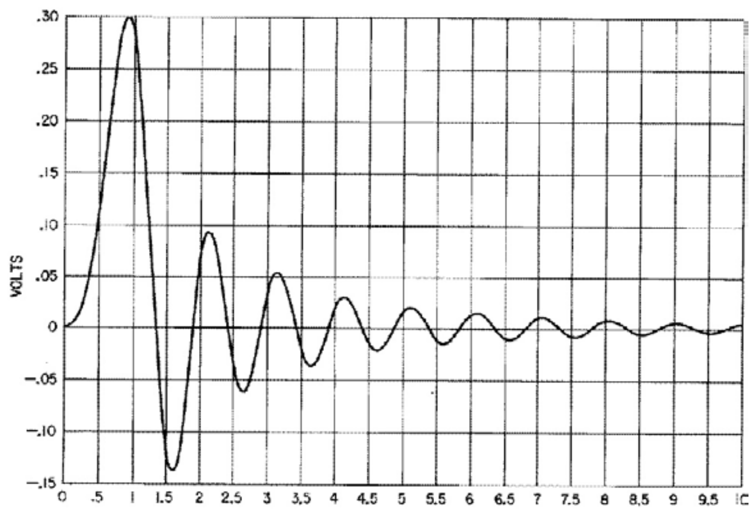


**Figure 2.4 Normalized Impulse Response**

## 2.8 PHASE RESPONSE

Phase characteristics of a 7-pole, 6-zero elliptical filter as shown in Figure 2.5, provides output phase relative to the input (Curve A) over a 10/1 frequency range. The phase response of linear phase and Curve C gives the phase distortion, which is the difference in phase response, between linear phase and elliptical filter.

When the input frequency of the filter is less than 4/10 the cutoff frequency, the phase response is practically linear and can be calculated by using the formula $\theta$=-293.17xf/$f_c$, which is referred to as the zero frequency phase response. At a frequency 1/10 the cutoff, the phase shift would be –29.317 degrees and –2.9317 degrees at 1/100 of the cutoff frequency (not shown on Curve A).

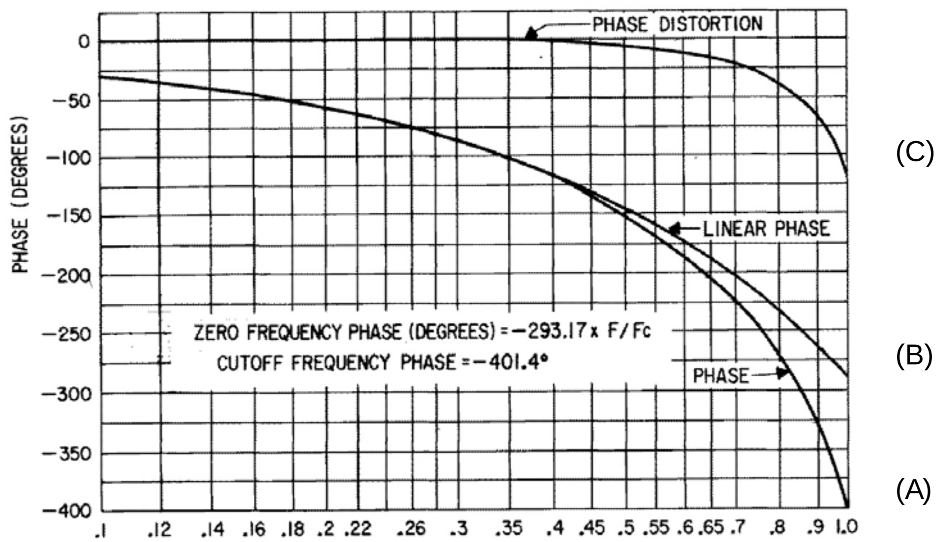


**Figure 2.5 Phase Response**

## 2.9 DELAY TIME

Delay time shown in Figure 2.6 is the time delay before the output voltage of the Model 30A filter responds to an applied input voltage. With applied input frequency and cutoff frequency of 1Hz, the delay time (point B) is 1.16 seconds. At an applied input frequency of 0.6Hz (point A), the delay time is 0.86 seconds. If the applied input frequency and cutoff frequency is increased to 1kHz, the delay time is 1.16 milliseconds. When the input frequency is less, than 1/10$^{th}$ the cutoff frequency, the delay time can be calculated by using the formula t=0.814/$f_c$, which is referred to as zero frequency delay time in seconds.

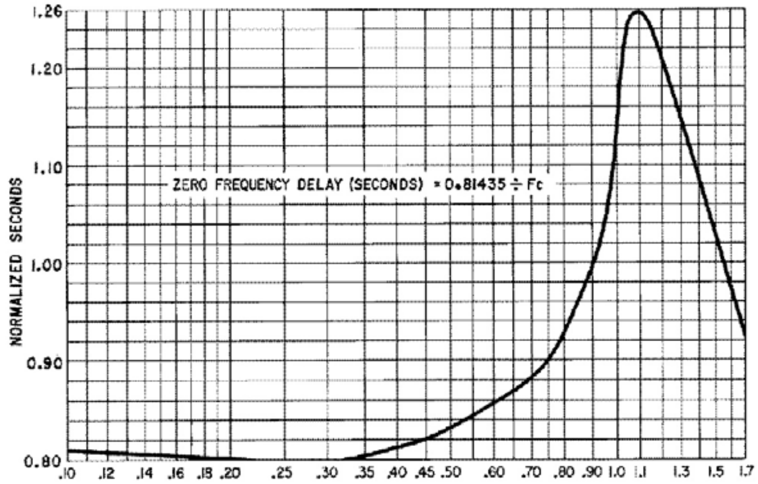


**Figure 2.6 Delay Time**

## 2.10 GROUP DELAY

Group delay[1], shown in Figure 2.7, 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 in 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.

In numeric terms the phase response shown in Figure 2.5 shows a zero frequency phase of –293.17°/Hz, when normalized for a cutoff frequency of 1Hz. This will be 2π times greater in °/Hz for a cutoff of 1 radian/sec or -1842°/Hz. Dividing by 360 converts °/Hz to radians/radians-per-sec yields a group delay time of 5.12s as shown in Figure 2.7.

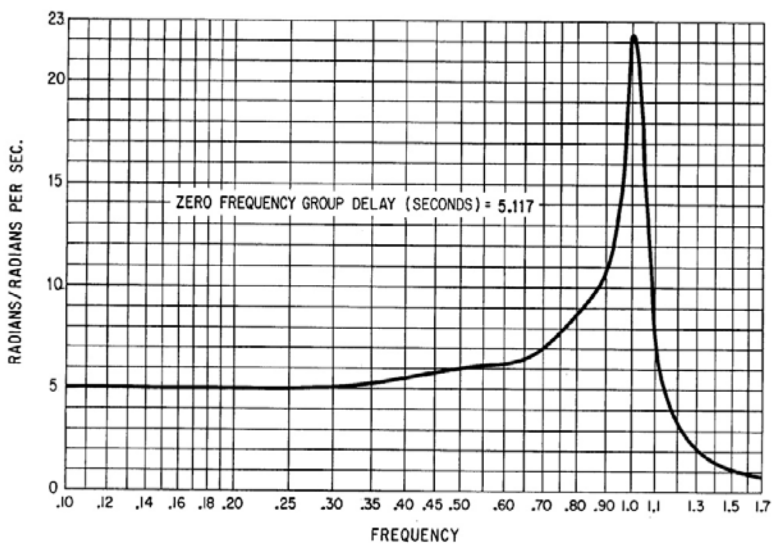


**Figure 2.7 Normalized Group Delay**

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

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# SECTION 3
# IEEE-488 (GPIB) PROGRAMMING

## 3.1 INTRODUCTION

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

## 3.2 FILTER TYPE

| | |
|---|---|
| 1 | Elliptical |

## 3.3 MODE OF OPERATION

| | |
|---|---|
| 1 | Low-Pass |
| 2 | By-Pass |

## 3.4 DEVICE CLEAR

When the device clear command is sent, the following parameters are set as follows:

| MODEL | 30A-1 | 30A-2 | 30A-3 |
|---|---|---|---|
| INPUT GAIN | 0dB | 0dB | 0dB |
| OUTPUT GAIN | 0dB | 0dB | 0dB |
| CUTOFF FREQUENCY | 1kHz | 100Hz | 10Hz |
| COUPLING | DC | DC | DC |

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# SECTION 4
# INCOMING ACCEPTANCE

## 4.1 INTRODUCTION

The following procedure should be used to verify that the Model 30A Series filter module, inserted in a Model 3905/3916 Mainframe is operating within specifications.

These checks may be used for incoming acceptance and periodic performance checks. Test must be made with all covers in place on the Model 3905/3916, with filter modules inserted, 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 procedures given in Section 2 of this manual, or if necessary, in Section 2 of the Model 3905/3916 Operating and Maintenance Manual.

## 4.2 TEST EQUIPMENT REQUIRED

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

a. RC Oscillator, with a frequency range of .01Hz to 1MHz. Krohn-Hite Model 4100A or equivalent.

b. RC Oscillator, with a frequency range of 10Hz to 10MHz. Frequency response of ±0.025dB from 10Hz to 500khz. Krohn-Hite Model 4200B/4300B or equivalent.

c. Oscilloscope, bandwidth of DC to 50MHz, vertical input sensitivity of 5mV/cm, Tektronix 465 or equivalent.

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

e. AC Voltmeter, capable of measuring 100µV to 10Vrms, Fluke Model 8920A or equivalent.

f. Frequency Counter.

## 4.3 PRE-FILTER, POST-FILTER AND UNITY GAIN ACCURACY

Set all filters to a cutoff frequency of 900Hz with 0dB Input and Output gain and apply 50mVrms at 100Hz to INPUT of each filter module. Monitor the OUTPUT with an ac voltmeter. Should be 50mV ±1mV.

Set gain of pre-filter (input) to 10dB, 20dB, 30dB and 40dB. Fluke on the OUTPUT of the filter should be within ±0.2dB of all four pre-filter gain settings.

Set gain of pre-filter and post-filter to 0dB and apply a 0.7Vrms signal to the INPUT of the filter. Monitor the OUTPUT of the filter with an ac voltmeter and record the OUTPUT voltage. Set gain of post-filter (output) to 10dB and 20dB. Fluke on the OUTPUT of the filters should be within ±0.2dB of both post filter gain settings.

## 4.4 PASSBAND GAIN AND DISTORTION TESTS

To verify that the filter is functioning correctly in the passband, set all filter modules to a cutoff frequency of 900Hz and pre-filter and post-filter amplifier gain to 0dB (unity gain). Apply a 7Vrms signal at 50Hz to the INPUT of each filter module and monitor the OUTPUT of each filter with a scope, ac voltmeter and a distortion analyzer. The OUTPUT should be within ±0.2dB of the INPUT and the distortion should be <0.1%.

**CAUTION:** *If the distortion is excessive, verify that the distortion of the oscillator being used is <0.1%.*

### 4.4.1 LOW BANDS RIPPLE RESPONSE (FIGURE 4.1)

Connect oscillator at 3Vrms at 50Hz to INPUT of filter. Set front panel channel indicator to the channel of the filter under test. Set filter to 900Hz cutoff frequency with 0dB of INPUT and OUTPUT gain. Monitor OUTPUT of filter with ac voltmeter. Record OUTPUT voltage. Set filter to 90Hz cutoff frequency.

Check the response of the three peaks at 42.9Hz, 73.9Hz and 89.1Hz. Check the response of the three valleys at 22.3Hz, 60.3Hz and 83.4Hz. The adjacent peak-to-valley ripple should not exceed 0.4dB. If necessary, refer to Section 5, Calibration.

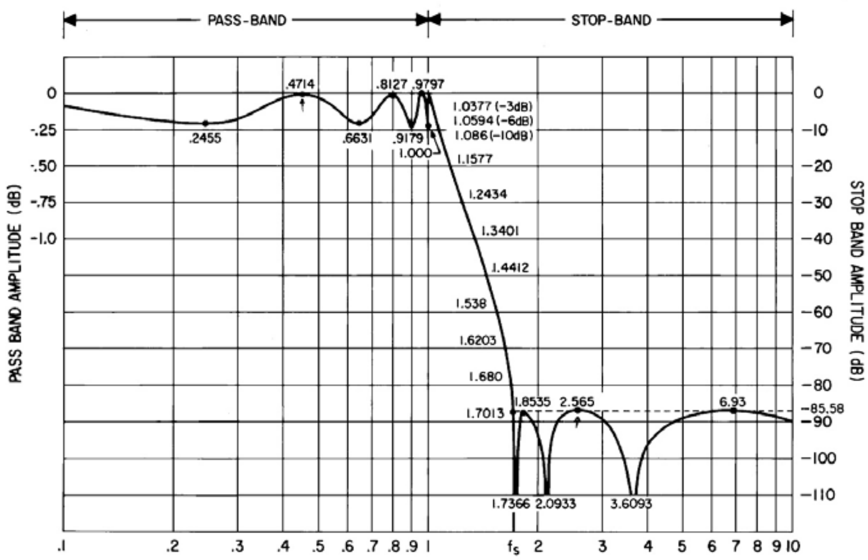


**Figure 4.1 Normalized Ripple Response**

### 4.4.2 HIGH BAND RIPPLE RESPONSE (Model 30A-1)

Connect oscillator at 3Vrms at 100Hz to INPUT of filter. Set front panel channel indicator to the channel of the filter under test. Set the filter to 10kHz cutoff frequency with 0dB Input and Output gain. Monitor OUTPUT of filter with ac voltmeter. Record OUTPUT voltage.

Check the response of the three peaks at 4.7kHz, 8.2kHz and 9.9kHz. Check the response of the three valleys at 2.4kHz, 6.8kHz and 9.2kHz. The adjacent peak-to-valley ripple should not exceed 0.4dB. If necessary, refer to Section 5, Calibration.

### 4.4.3 HIGH BAND RIPPLE RESPONSE (Model 30A-2)

Connect oscillator at 3Vrms at 50Hz to INPUT of filter. Set front panel channel indicator to the channel of the filter under test. Set the filter to 1kHz cutoff frequency with 0dB Input and Output gain. Monitor OUTPUT of filter with scope and ac voltmeter. Record OUTPUT voltage.

Check the response of the three peaks at 470Hz, 820Hz and 985Hz. Check the response of the three valleys at 240Hz, 680Hz and 920Hz. The adjacent peak-to-valley ripple should not exceed 0.4dB.

**NOTE:** *Check the accuracy of the ac voltmeter at low frequencies. If necessary, compare the OUTPUT with the INPUT to eliminate any error.*

### 4.4.4 HIGH BAND RIPPLE RESPONSE (Model 30A-3)

Connect oscillator at 3Vrms at 50Hz to INPUT of filter.

Set front panel channel indicator to the channel of the filter under test. Set the filter to 900Hz cutoff frequency with 0dB Input and Output gain. Monitor OUTPUT of filter with ac voltmeter. Record OUTPUT voltage and use as reference. Set filter to 100Hz.

Check peaks and valleys of ripple at 47Hz, 82Hz, 99Hz and 24Hz, 68Hz and 92Hz respectively.

## 4.5 STOPBAND ATTENUATION

### 4.5.1 BAND 1

*MODEL 30A-1*

Set filter to 10Hz with 0dB Input and 20dB Output gain, dc coupling. Set oscillator to 17.5Hz at 7Vrms. Connect scope to OUTPUT. Signal should be less than 20mV p-p. Set oscillator to 18.7Hz, 25.9Hz and 70Hz. Signal should be less than 20mV p-p.

*MODEL 30A-2*

Do in same manner as Model 30A-1 setting filter to 1Hz and oscillator to 1.75Hz, 1.87Hz, 2.59Hz and 7.0Hz.

*MODEL 30A-3*

Do in same manner as Model 30A-1 setting filter to 0.1Hz and oscillator to 0.175Hz, 0.187Hz, 0.259Hz and 0.70Hz.

### 4.5.2 BAND 2

*MODEL 30A-1*

Same as Band 1 setting the filter to 100Hz and oscillator to 175Hz, 187Hz, 259Hz and 700Hz.

*MODEL 30A-2*

Same as Band 1 setting the filter to 10Hz and oscillator to 17.5Hz, 18.7Hz, 25.9Hz and 70.0Hz.

*MODEL 30A-3*

Same as Band 1 setting the filter to 1Hz and oscillator to 1.75Hz, 1.87Hz, 2.59Hz and 7.0Hz.

### 4.5.3 BAND 3

*MODEL 30A-1*

Same as Band 1 setting the filter to 1kHz and oscillator to 1.75Hz, 1.87kHz, 2.59kHz and 7.0kHz.

*MODEL 30A-2*

Same as Band 1 setting the filter to 100Hz and oscillator to 175Hz, 187Hz, 259Hz and 700Hz.

*MODEL 30A-3*

Same as Band 1 setting the filter to 10Hz and oscillator to 17.5Hz, 18.7Hz, 25.9Hz and 70.0Hz.

### 4.5.4 BAND 4

*MODEL 30A-1*

Same as Band 1 setting the filter to 10kHz and oscillator to 17.5kHz, 18.7kHz, 25.9kHz and 70.0kHz.

*MODEL 30A-2*

Same as Band 1 setting the filter to 1kHz and oscillator to 1.75kHz, 1.87kHz, 2.59kHz and 7.0kHz.

*MODEL 30A-3*

Same as Band 1 setting the filter to 100Hz and oscillator to 175Hz, 187Hz, 259Hz and 700Hz.

## 4.6 CUTOFF FREQUENCY ACCURACY

Connect oscillator a 3Vrms at 42.9Hz to INPUT. Set filter to 90Hz with 0dB Input and Output gain. Monitor OUTPUT with ac voltmeter. Record voltage at Output. Adjust input frequency near 90.9Hz to obtain –0.22dB. Frequency should be between 89.12Hz and 92.7Hz.

Set filter and oscillator to 100Hz – adjust oscillator frequency for –0.22dB. Frequency should read between 99Hz and 103Hz.

***MODEL 30A-1 and 30A-2 ONLY***

Set filter and oscillator to 1kHz – adjust oscillator frequency for –0.22dB. Frequency should read between 990Hz and 1.03kHz.

***MODEL 30A-1 ONLY***

Set filter and oscillator to 10kHz – adjust oscillator frequency for –0.22dB. Frequency should read between 9.9kHz and 10.3kHz.

## 4.7 NOISE MEASUREMENTS (use 2MHz limited detector)

***MODEL 30A-1 ONLY***

Short the INPUT of the filter. Connect ac voltmeter to the OUTPUT of filter. Set filter to 1kHz with 0dB Input and Output gain. OUTPUT should be less than 0.5mV. Set filter to 99kHz with 0dB Input and Output gain. OUTPUT should be less than 1mV.

Set filter to 99kHz with 0dB Input and 20dB Output gain. OUTPUT should be less than 10mV. Set filter to 1kHz with 0dB Input and 20dB Output gain. OUTPUT should be less than 5mV.

Set filter to 1kHz with 40dB Input and 20dB Output gain. OUTPUT should be less than 10mV.
Set filter to 99kHz with 40dB Input and 20dB Output gain. OUTPUT should be less than 60mV.

Set filter to 99kHz with 40dB Input and 0dB Output gain. OUTPUT should be less than 6mV.
Set filter to 1kHz with 40dB Input and 0dB Output gain. OUTPUT should be less than 1mV.

***MODEL 30A-2***
Same as Model 30A-1 using 1kHz and 9.9kHz.

***MODEL 30A-3***
Set filter to 990Hz.

Output should be less than 0.5mV with 0dB Input and Output gain.
Output should be less than 5mV with 0dB Input and 20dB Output gain.
Output should be less than 10mV with 40dB Input and 20dB Output gain.
Output should be less than 1mV with 40dB Input and 0dB output gain.

**NOTE:** *The scope presentation should consist of random noise voltage only, with no line voltage or its harmonic signals.*

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