# SECTION 1

# GENERAL DESCRIPTION

## 1.1 INTRODUCTION

The Model 3103A-4, illustrated in Figure 1, is a variable band-pass Filter with a low cutoff frequency range adjustable from 10Hz to 1MHz and a high cutoff range adjustable from 30Hz to 3MHz. The pass-band gain is unity (0dB), with attenuation rate of 18dB per octave outside the passband, and a maximum attenuation of 80dB. Maximum input signal amplitude is 3 volts rms and output hum and noise is less than 100 microvolts.

## 1.2 SPECIFICATIONS

FREQUENCY RANGE: Low cutoff frequency independently adjustable from 10Hz to 1MHz in five bands.

| Band | Multiplier | Frequency Hz |
|---|---|---|
| 1 | 1 | 10-100 |
| 2 | 10 | 100-1K |
| 3 | 100 | 1K-10K |
| 4 | 1K | 10K-100K |
| 5 | 10K | 100K-1M |

High Cutoff Frequency independently adjustable from 30Hz to 3MHz in five bands.

| Band | Multiplier | Frequency Hz |
|---|---|---|
| 1 | 1 | 30-300 |
| 2 | 10 | 300-3K |
| 3 | 100 | 3K-30K |
| 4 | 1K | 30K-300K |
| 5 | 10K | 300K-3M |

FREQUENCY DIALS: Separate low cutoff and high cutoff dials are individually calibrated with logarithmic scales reading directly in Hz.

CUTOFF FREQUENCY CALIBRATION ACCURACY: ±5% (± 10% band 5) with RESPONSE switch in MAX FLAT (Butterworth) position; less accurate in RC position. Relative to mid-band level, the Filter output is down 3dB at cutoff in MAX FLAT position, and approximately 11dB in RC position.

BANDWIDTH: Continuously variable within the cutoff frequency limits of 10Hz and 3MHz.

ATTENUATION SLOPE: Nominal 18dB per octave.

MAXIMUM ATTENUATION: Greater than 80dB. See Section 5.2

PASS-BAND GAIN: 0dB ±1/2dB.

HUM AND NOISE: Less than 100 microvolts.

FREQUENCY RESPONSE: Standard response is 3rd order Butterworth, maximally flat. A RESPONSE switch converts to simple RC response, optimum for transient-free performance.

INPUT CHARACTERISTICS:

Maximum Input Amplitude: 3 volts rms, decreasing to 2.5 volts at 3MHz.

Impedance: 100K ohms in parallel with 50pF.

Maximum DC Component: 200 volts.

OUTPUT CHARACTERISTICS:

Maximum Voltage: 3 volts rms, decreasing to 2.5 volts at 3MHz.

Maximum Current: 10 milliamperes rms

Internal Impedance: Approximately 50 ohms.

FLOATING (ungrounded) OPERATION: A chassis GROUND switch is provided on the rear panel to disconnect signal ground from chassis ground.

Note: For a more in depth definition of specifications, refer to Section 5.2

## 1.3 TERMINALS

On the front and rear panels, one BNC connector for INPUT, one for OUTPUT.

## 1.4 FRONT PANEL CONTROLS:

LOW CUTOFF FREQUENCY dial and multiplier switch.

HIGH CUTOFF FREQUENCY dial and multiplier switch.

RESPONSE switch for MAX FLAT (Butterworth) or RC (Transient-free) mode.

ON/OFF switch.

## 1.5 POWER REQUIREMENTS:

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

## 1.6 DIMENSIONS AND WEIGHTS:

14"/35.6cm wide, 3.5"/9cm high, 8.5"/21.6cm deep, 8lbs./3.6Kgs.

An optional Rack Mounting Kit, (Part No. RK314), is available for installing the Filter into a standard 19" rack.

## 1.7 FILTER CHARACTERISTICS

BANDWIDTH ADJUSTMENT

The flexibility of adjustment of bandwidth is illustrated in Figure 2. Band-pass operation in the MAX FLAT (Butterworth) mode for two different bandwidths is illustrated by curves A and B. Curve B shows the minimum pass-band width obtained by setting the two cutoff frequencies equal. In this condition the pass-band gain is 6dB, and the -3dB cutoff frequencies occur at 0.8 and 1.25 times the mid-band frequency. The minimum pass-band for a 0dB pass-band gain is shown by curve A with the cutoffs set at 0.5 and 2 times the mid-band frequency.

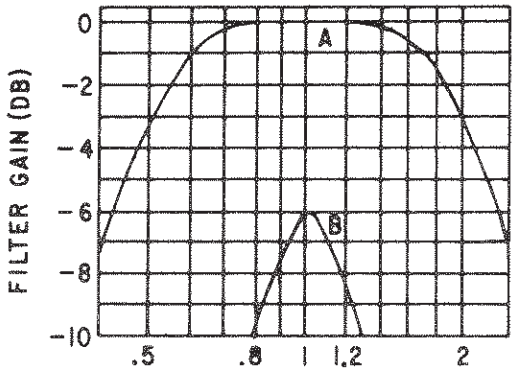


Figure 2. Normalized Filter Response

TRANSIENT RESPONSE

The frequency response characteristic of this Filter closely approximates a third order Butterworth with maximal flatness, ideal for filtering in the

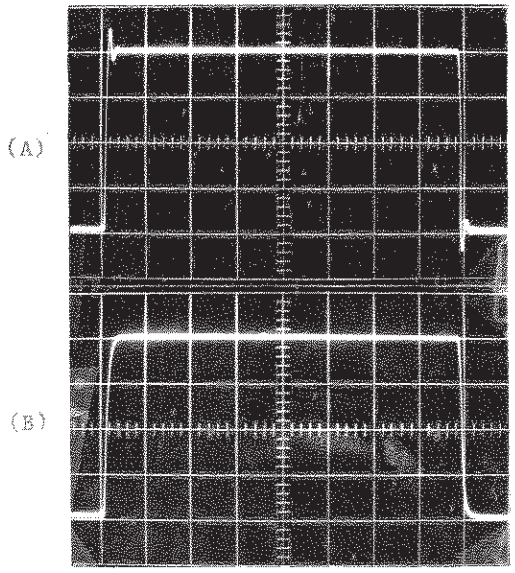


Figure 3. Response to 10kHz Square Wave with Cutoffs at 10Hz and 1MHz. (A) Butterworth (B) RC

frequency domain. For pulse or transient signal filtering, a RESPONSE switch is provided to change the frequency response to the RC mode, optimum for transient-free filtering. Figure 3 shows a comparison of the Filter output response in these modes to a square wave input signal.

CUTOFF RESPONSE

The attenuation characteristics of the Filter are shown in Figure 4. With the RESPONSE switch in the MAX FLAT (Butterworth) mode, the gain, as shown by the solid curve, is virtually flat until the -3dB cutoff

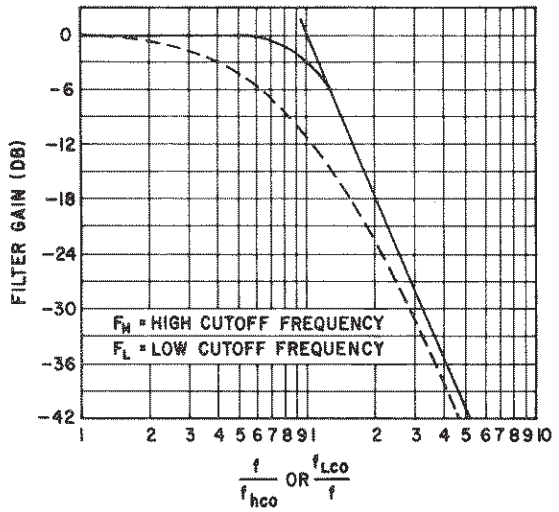


Figure 4. Normalized Attenuation Characteristics

frequency. At approximately two times the cutoff frequency, the attenuation rate coincides with the 18dB per octave straight line asymptote. In the RC mode, optimum for transient-free filtering, the dotted line shows that the gain is down approximately 11dB at cutoff and reaches 18dB per octave attenuation rate at ten times the cutoff frequency. Beyond this frequency the filter attenuation rate and maximum attenuation, in either mode, are identical.

PHASE RESPONSE

Due to the high-pass and low-pass sections of the Filter, the phase angle at any frequency is the sum of the angles. Figure 5 gives the phase characteristics for either section in degrees lead (+) or lag (-), as a function of the ratio of the operating frequency (f) to low cutoff frequency ($f_{lco}$) or high cutoff frequency ($f_{hco}$). The solid curve is for the MAX FLAT (Butterworth) mode and the dotted curve is for the RC mode.

Example:

Determine the phase shift through the filter, in the MAX FLAT (Butterworth) mode with the low cutoff ($f_{lco}$) at 200Hz, the high cutoff ($f_{hco}$) at 600Hz and an input frequency (f) at 300Hz.

Phase shift due to low cutoff ($f_L$)

$$\frac{f}{f_L} = \frac{300}{200} = 1.5$$

from Figure 5; 1.5 = +80°

Phase shift due to high cutoff ($f_H$)

$$\frac{f}{f_H} = \frac{300}{600} = .5$$

from Figure 5; .5 = -60°

Total phase shift

= +80° -60° = +20°

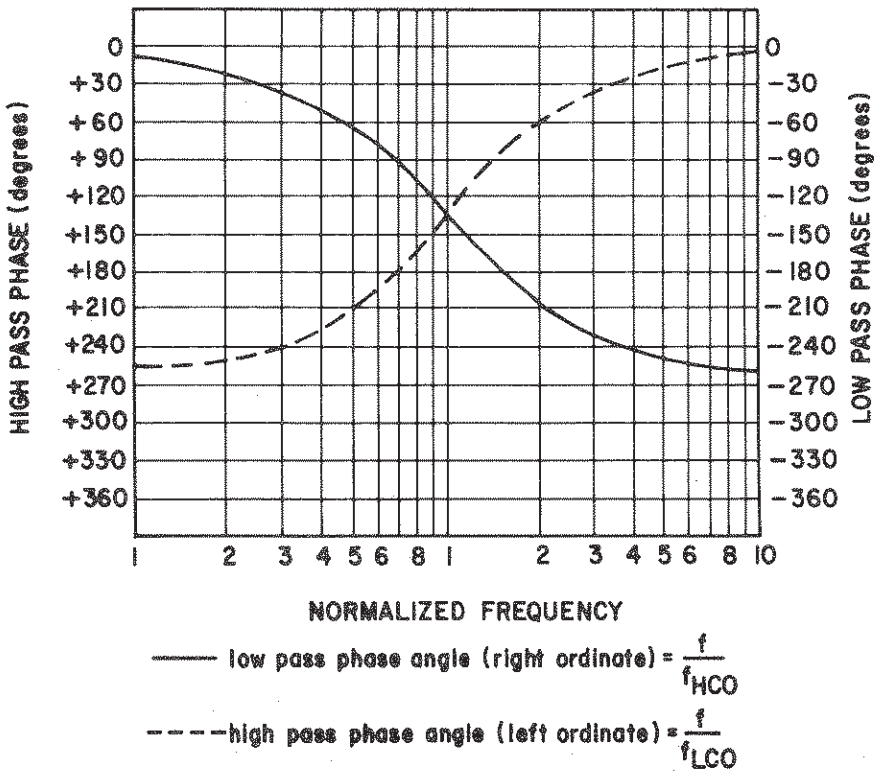


Figure 5. Normalized Phase Characteristics