TECH BRIEF

# Equalizer Series

## Gain Equalizers

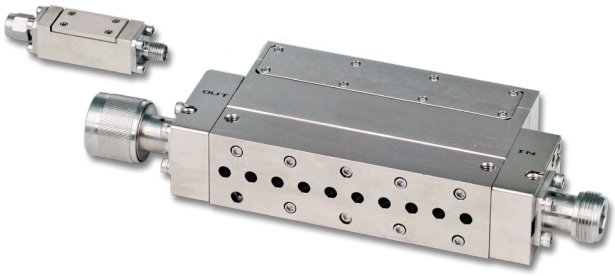
*Harmonic Phase Shifters and Integrated Equalizer Assemblies*

Mercury Systems designs and manufactures a series of integrated equalizers assemblies and harmonic phase-shifter product designs cover all microwave frequency bands from communication to ultra-broadband with a wide selection of IF bands and input power levels. These integrated assemblies can consist of isolators, filters, harmonic phase-shifters and couplers (along with multiple equalization functions) integrated into a single package.

## Linear Slope Equalizers — 500 MHz to 26.5 GHz

NEGATIVE SLOPE: Attenuation decreases linearly with frequency (see Fig. 1). Negative slope equalizers are primarily used for compensating the gain slope in systems where large amounts of cabling may cause excessive loss at higher frequencies over the operating band. Refer to the coaxial cable manufacturers' specifications for attenuation v/s frequency curves, as it applies to a particular system's accumulative cable length.

POSITIVE SLOPE: Attenuation increases linearly with frequency (Fig. 2). Positive slope equalizers are primarily used for compensating the gain variation in systems where long lengths of waveguide may cause excessive loss at the lower frequencies. Mercury is continually expanding its engineering, manufacturing and testing capabilities to meet future high-reliability requirements. Our experienced staff works with our customers to develop a thorough understanding of their needs.

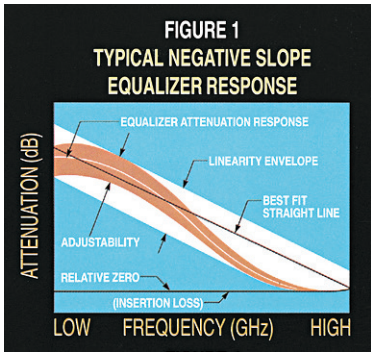


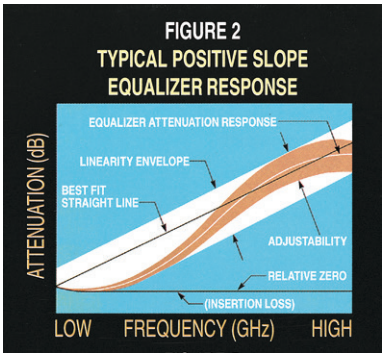
## Parabolic Shaped Equalizers — 500 MHz to 26.5 GHz

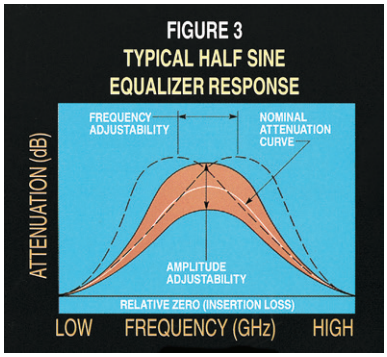
HALF SINE: Attenuation increases and decreases monotonically with frequency, and with the maximum attenuation occurring at mid-band. The relative zero attenuation points or minimums are at both band ends (Fig. 3). Half sine equalizers are primarily used for compensating the gain variation present in wide band traveling wave tubes or solid-state amplifiers where the maximum gain is at or near mid-band.

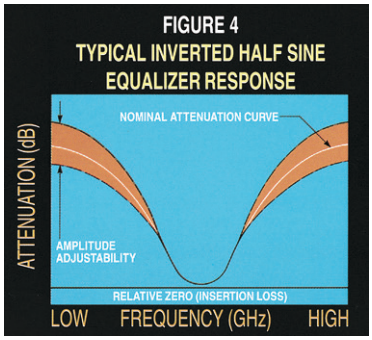
INVERTED HALF SINE: Attenuation decreases monotonically with frequency from both band ends to mid-band where relative zero attenuation occurs. This type of equalizer compensates for accumulative gain variations of a system when the gain is greatest at the highest and lowest operating frequencies, with minimum gain at or near to mid-band.

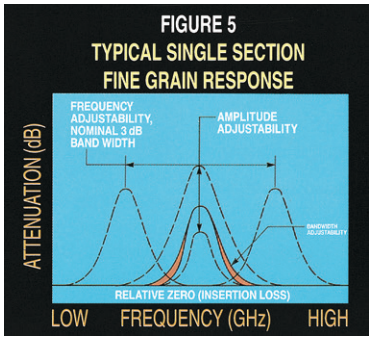
The approximate level of insertion loss would be 1.25 dB maximum at both ends unless otherwise specified.

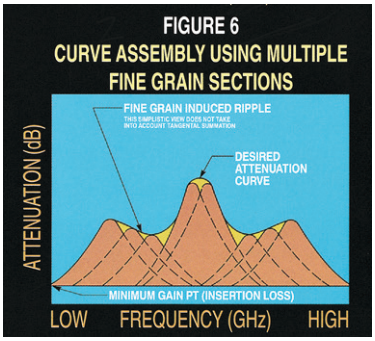





The insertion loss of these devices is the sum of both absorptive and reflective losses, measured at the highest and lowest frequency of operation for the Half Sine, and at mid-band for the Inverted Half Sine (Fig. 3 and Fig. 4). This parameter is specified as a maximum and is referred to at the relative zero attenuation point. Therefore, the specified attenuation level is relative to the insertion loss. A typical method for approximating insertion loss, would be to take 10% of the maximum attenuation point and add 0.25 dB to that value. For example, if specifying insertion loss of a 10 dB half sine equalizer, the approximate level of insertion loss would be 1.25 dB maximum at both ends unless otherwise specified.

## Fine Grain Equalizers — 1.5 GHz to 26.5 GHz

Multiple attenuation responses that can be adjusted in frequency and amplitude (Fig. 5). Fine Grain Equalizers are primarily used for minimizing gain ripple or gain spikes present in wide band traveling wave tubes, solid state amplifiers or systems where the phasing in and out of VSWR's cause excessive amplitude ringing. This type of equalizer can also be used for assembling attenuation curves of all shapes and amplitudes within its adjustment range. This is accomplished by setting each section to a different frequency and amplitude adjacent to one another (Fig. 6).

**TUNING AND OPERATIONAL CONCEPTS:** The operation of our fine grain adjustable equalizers can be briefly described as follows. By forward or reverse movement of each resonator short, the electrical length can be varied. Therefore, the center frequency of these loss responses can be located anywhere within their operating frequency range. Adjustment of other parameters associated with each section allows the bandwidth, as well as the amplitude, to be set independently. Bandwidths of each section may vary as a function of frequency.

## Integrated Equalizers — 1500 MHz to 26.5 GHz

Integrated equalizer assemblies can consist of isolators, filters, harmonic phase-shifters and couplers (along with multiple equalization functions) integrated into a single package. Integrated equalizers can be used for many applications. The following are just a few of many possible combinations:

**ISO EQUALIZER:** Integrated with input and output isolators, these equalizers can be installed practically anywhere in a system while providing isolation to minimize any adverse effect, such as frequency pulling or mismatch distortion.

**TWT "OPTIMIZER":** This combination includes an adjustable equalizer and harmonic phase shifter, integrated into a single package. This allows traveling wave tube gain equalization, while providing harmonic injection capabilities for gain enhancement.

**FINE GRAIN COMBINATION EQUALIZER:** MICA can provide fine grain options on linear and half sine curve shapes. This combination allows system equalization and control over fine grain ripple.

### HARMONIC PHASE SHIFTERS — ATTENUATION LEVEL: 0.5 dB to 40 dB

Our harmonic phase-shifter devices are manufactured in frequency ranges from 500 MHz to 26.5 GHz and provide a differential phase-shift between the fundamental and harmonically related frequencies. Applications include optimization and enhancement of traveling wave tubes or amplifiers when a significant amount of power is contained in the harmonic frequency band or emphasis or de-emphasis of harmonic levels is required.

***Visit our website at http://rf.mrcy.com for more information regarding our proven equalizer solutions or to connect with our equalizer engineers for detailed engineering support.***

 2960.01E-1013-TB-Equalizer Series

MERCURY SYSTEMS™

*Innovation That Matters™*

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