Section VI

Gain Amplitude Equalizers

Gain Amplitude Equalizers

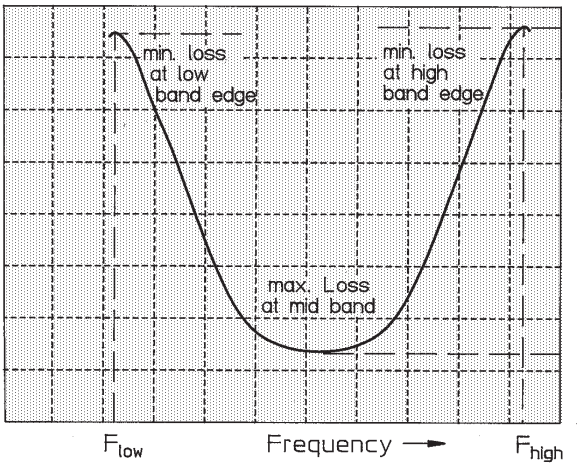
Spectrum Elektrotechnik GmbH has been succesfully developing and manufacturing Gain Amplitude Equalizers showing particular attenuation characteristics, and allowing the compensation of the frequency response of certain components in a system. Gain amplitude equalization is utilized on TWT amplifiers, long coaxial cables, delay lines, oscillators and solid state amplifiers. Spectrum Elektrotechnik GmbH offers its capability to design, develop and to manufacture custom designed Gain Amplitude Equalizers to satisfy distinct requirements. Rugged construction assures high performance in military and commercial applications as well.

Fundamentals:

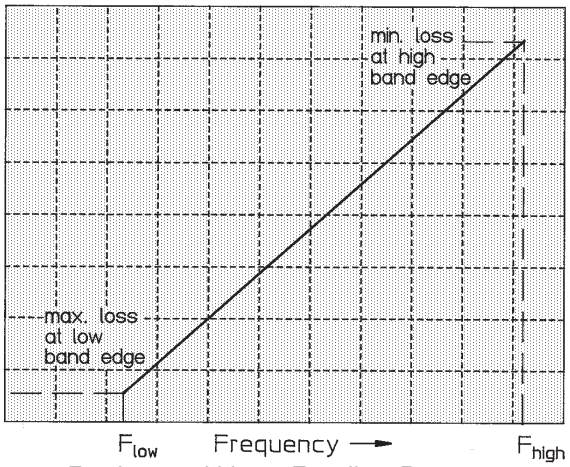
The Gain Amplitude Equalizer is an absorptive device having a particular attenuation curve. Two significant categories can be described:

Parabolic or Sinusoidal Equalizers. These devices are mainly used at TWT's to compensate the saturated gain. The maximum attenuation is expected in mid band, the minimums are at the band ends. The maximum attenuation can be a few dB or even more than 30 dB. At the band edge losses of less than 1 dB are desirable.

Linear or Slope Equalizers. The application of these units is to compensate the frequency dependant loss of long coaxial cable assemblies or delay lines. The maximum loss at the low band edge can be a few dB or as much as 30 dB, while at high band end edge losses as little as possible are desirable. The loss at the higher frequency limit is usually less than 1 dB.



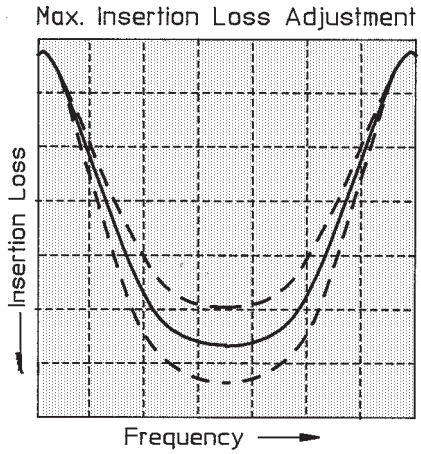
Fundamental Parabolic Equalizer Response

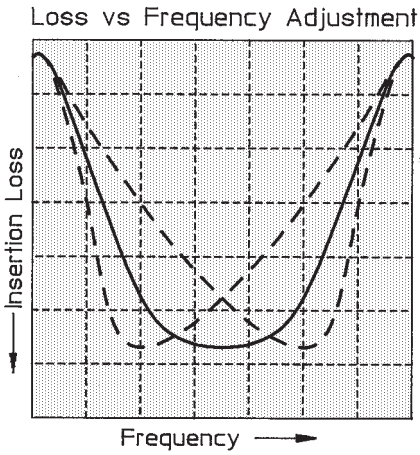


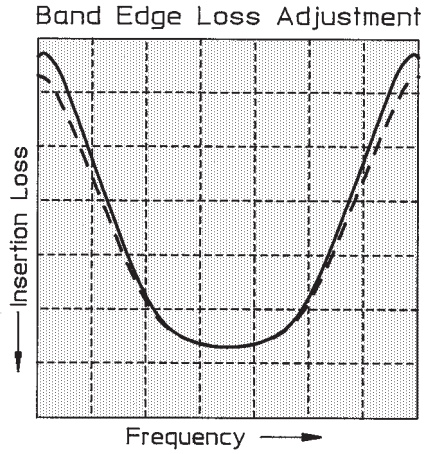
Fundamental Linear Equalizer Response

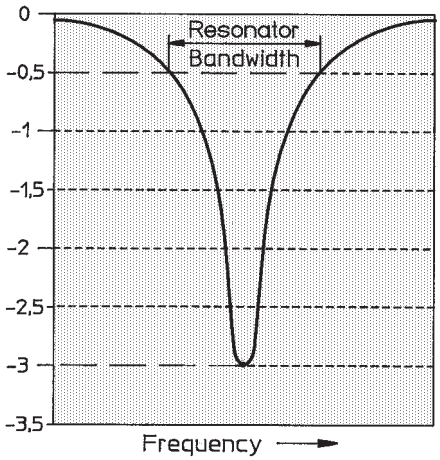
The parabolic as well as the linear equalizers can be subdivided into three groups:

1.) **Fixed Equalizer.** The insertion loss curve of the unit is engineered to meet the customer requirements in the system. The attenuation curve is set to the specification. This type of unit is normally used on components that are very predictable.









2.) **Adjustable Equalizer.** The fixed insertion loss versus frequency is specified. All units will be set to meet this predetermined curve. Additionally, if the system requires a similar but a slightly different loss curve, a certain number of adjustments will be available to change the nominal attenuation curve. The type of adjustments can be rising or lowering the maximum attenuation value, shifting the maximum value of the response from the center to lower or higher frequencies, or establishing a change of the attenuation at the band edges, upper, lower or both. A unit can be designed to meet all these requirements for adjustment.

3.) **Fine Grain Equalizer.** This group of devices usually combines with all the characteristics of the "Adjustable Equalizers", but has added a certain number or resonators capable of individual fine grain cancellation. By specification the bandwidths of the resonators can be equal or different , measured at a certain insertion loss characteristic and when its peak l oss is set to a specific value. A typical resonator bandwidth can be any value between 100 MHz and 1.0 GHz measured e.g. at the 0.5 dB point, when for example its peak loss is 3 dB. The device can be equipped with as many as 20 resonators of different values. The frequency range for tunability of the individual resonators for fine grain cancellation can be specified anywhere in the frequency range of the equalizer.

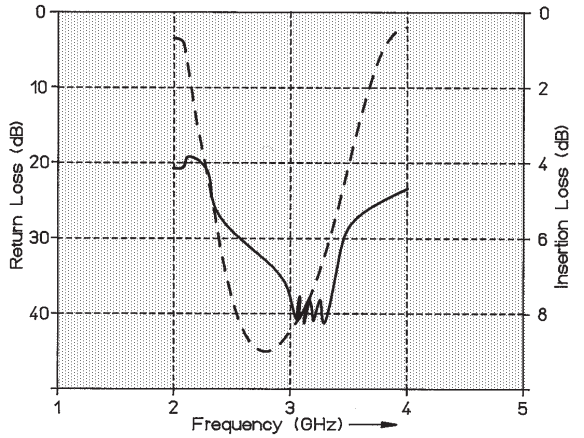
Frequency Range and Bandwidth. The current capability covers the frequency range from 1.0 GHz to over 30.0 GHz. Bandwidths were achieved, ranging from only a few percent to almost three octaves. Several examples are shown on page 80.

Gain Amplitude Equalizers

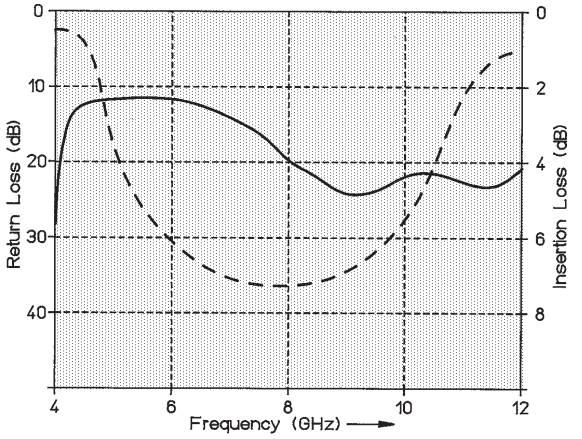
The diagrams shown on this page are actual data from existing designs.

- - - Insertion Loss (dB)
—— Return Loss (dB)

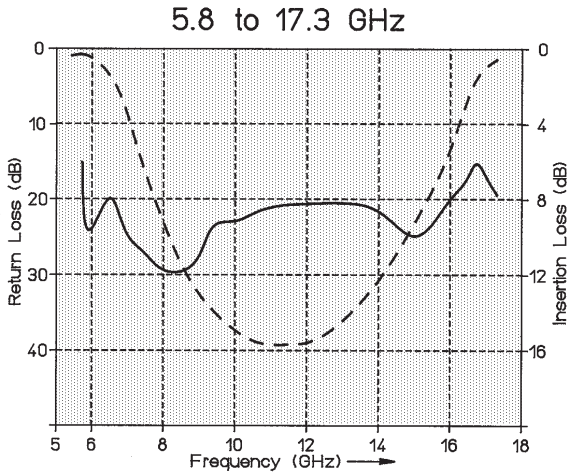
2.0 to 4.0 GHz



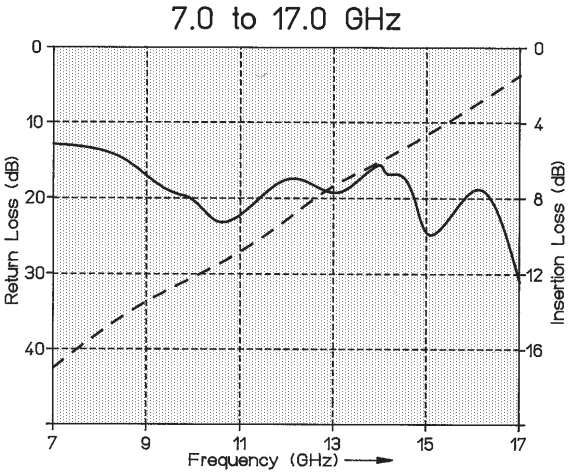
4.0 to 12.0 GHz



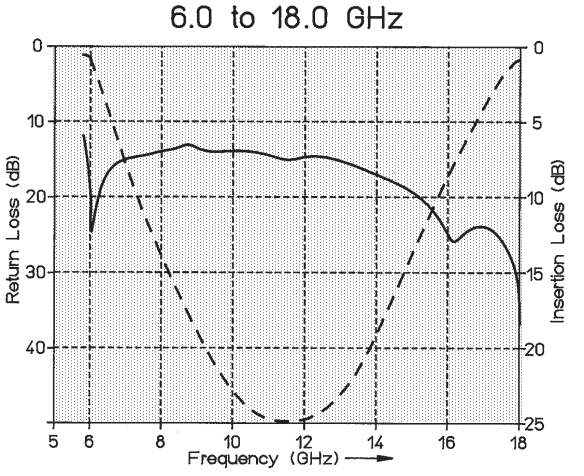
5.8 to 17.3 GHz



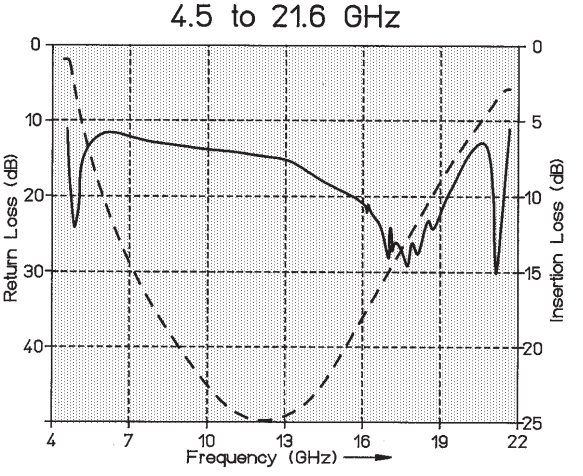
7.0 to 17.0 GHz



6.0 to 18.0 GHz



4.5 to 21.6 GHz



1compo3.pm6

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Standard Gain Amplitude Equalizers

Parabolic (half sine)

Frequency (GHz)	Insertion Loss at upper Frequency Limit (dB, max.)	Insertion Loss at Mid-Band (dB)	Return Loss (dB) min.	Dimensions (mm)	Connectors
2.0 - 4.0	0.9	5.0 - 30.0	12		SMA
2.0 - 8.0					
4.0 - 8.0					
4.0 - 20.0	The insertion loss of the upper frequency limit may be optimized with most models to show loss below 0.7 dB.	Designs are available to set the differential loss within the limits shown, or even below and above.	Return loss can be optimized on special request. Broad band units have been designed showing a return loss of 19 dB min. over full bandwidth.	The dimensions depend on the differential loss. As soon as the differential loss is specified, the dimensions can be advised.	Connectors other than SMA can be supplied upon request.
4.0 - 21.0					
6.0 - 18.0					
6.0 - 20.0					
7.0 - 17.0					
7.0 - 18.0					
8.0 - 16.0					

Linear

Frequency (GHz)	Insertion Loss at upper Frequency Limit (dB, max.)	Insertion Loss at lower Frequency Limit (dB)	Return Loss (dB) min.	Dimensions (mm)	Connectors
4.0 - 8.0	1.0	5.0 - 25.0	12		SMA
6.0 - 12.0					
6.0 - 18.0	The insertion loss of the upper frequency limit may be optimized with most models to show loss below 0.7 dB.	Designs are available to set the differential loss within the limits shown, or even below and above.	Return loss can be optimized on special request. Broad band units have been designed showing a return loss of 19 dB min. over full bandwidth.	The dimensions depend on the differential loss. As soon as the differential loss is specified, the dimensions can be advised.	Connectors other than SMA can be supplied upon request.
6.0 - 20.0					
10.0 - 15.0					
12.0 - 18.0					

Equalizers

Spectrum Elektrotechnik GmbH has been developing state-of-the-art components for a number of very special programs, such as very unique gain amplitude equalizers.

The waveguide gain equalizer, as shown above, has been designed for a Ka-Band Jamming System in a military program. The equalizer´s sinosoidal loss curve is matched to the gain curves of both, the Driver TWT and the subsequently following Power TWT. The equalizer has very little loss around the band edges, which is desired, as the TWTs do have only little gain there. In midband the loss rises to a maximum, as needed. The curve is smooth and does not show ripples.

For delivery, the equalizer is set to a nominal insertion loss curve, as specified. The tuning and set screws are not locked and not sealed, allowing the customer to do final adjustments in the system, several dBs in insertion loss and a certain shift of the insertion loss curve versus frequency. Thus, the equalizer´s loss curve can be perfectly matched to the TWTs gain curves for optimum system performance. After the final adjustment the customer can lock and seal the unit.

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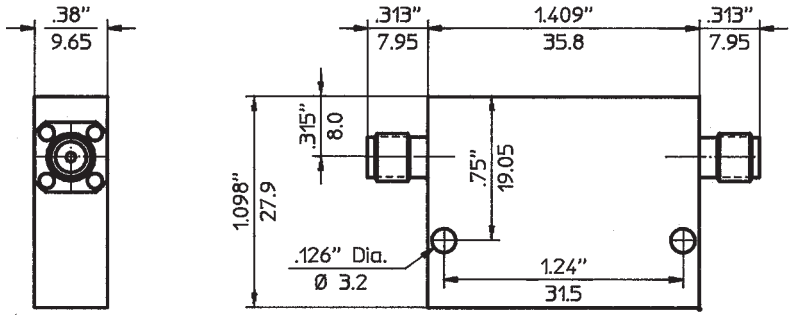
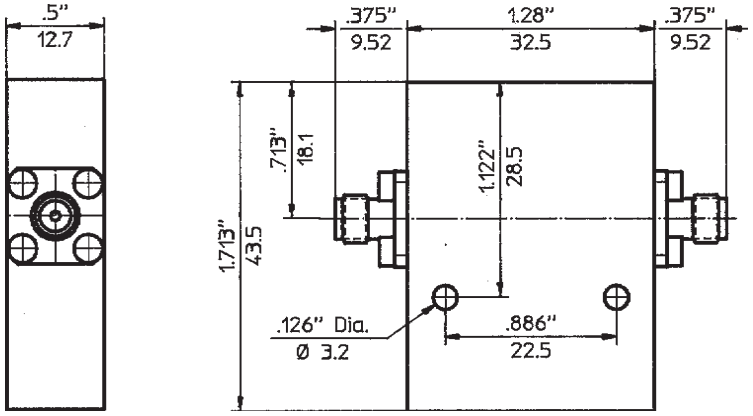
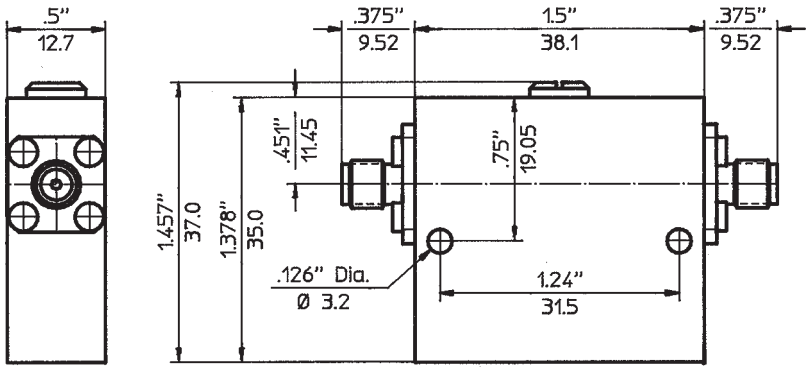


Housing Style H1



Housing Style H2



Housing Style H3

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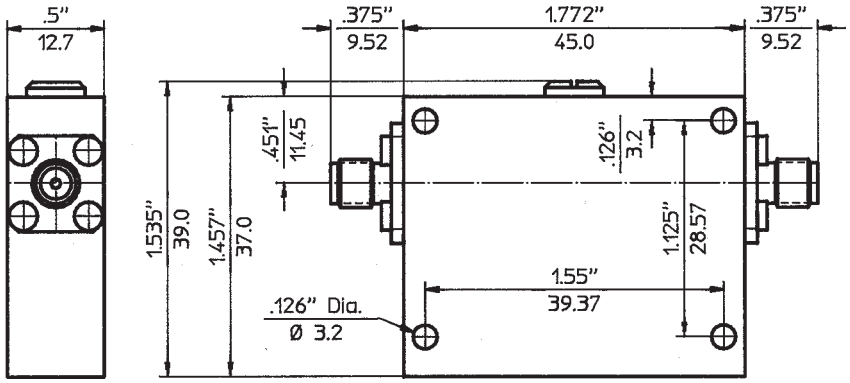
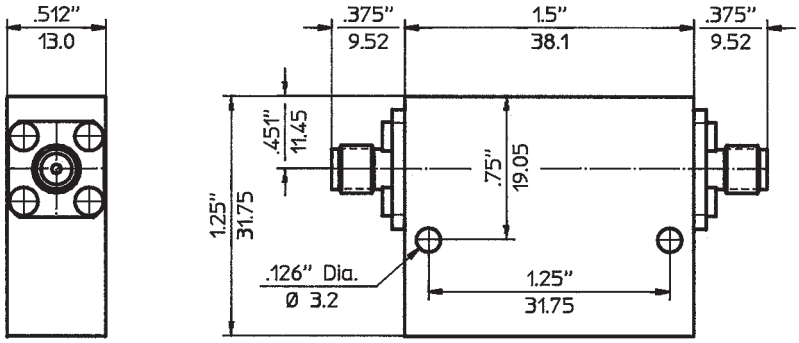
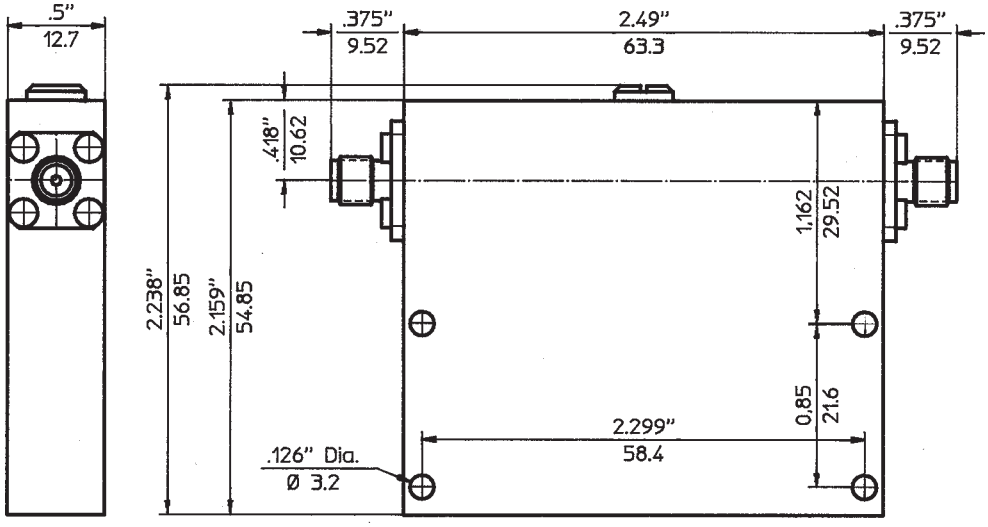
Equalizer Outline Drawings



Housing Style H4



Housing Style H5



Housing Style L1

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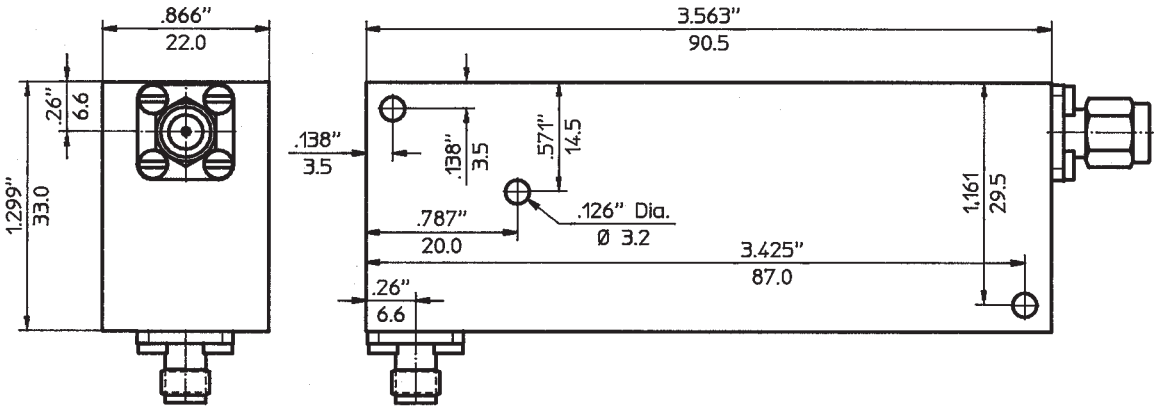
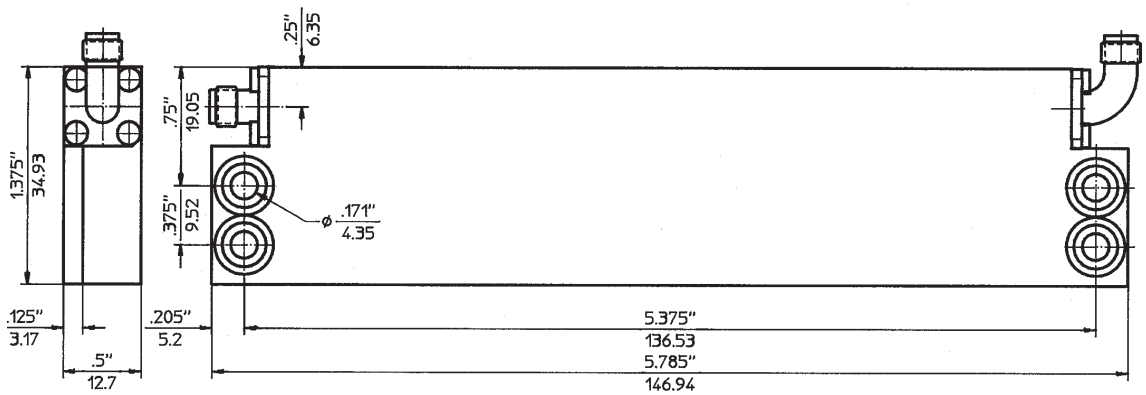
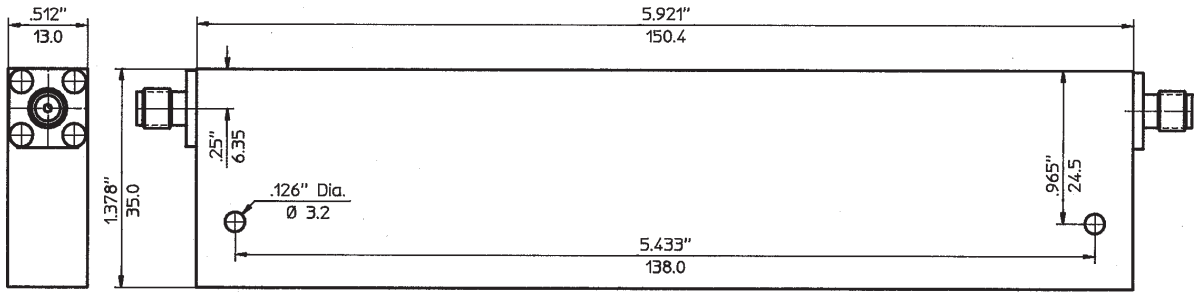


Housing Style F1



Housing Style F2



Housing Style F3

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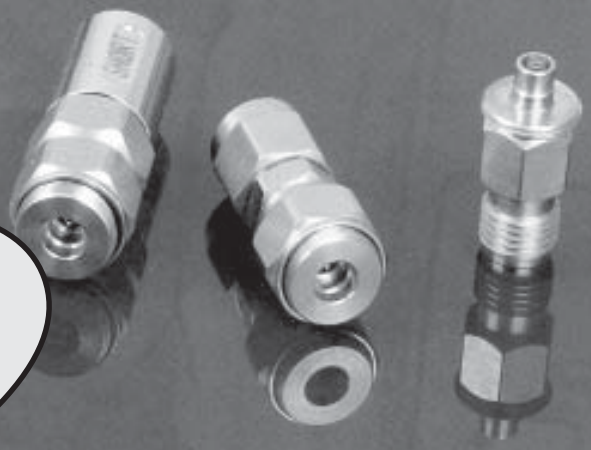
Are you a Believer ?
Or: Can you test your SMP-Component and -Assembly?



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