Mass-Producible Low Cost Filters

Mini-Circuits, P.O. Box 350166, Brooklyn, NY 11235

1.0 Introduction

Wireless markets are exploding with innovations in new services and technology. Increased competition has resulted in the demand for low-cost, highly reliable hardware. At the RF and microwave component level, there is need for function blocks with repeatable performance and packaging for automated assembly:

- Low variation (small sigma)
- Small size
- Pick-and-place suitability
- Cleaning technology compatibility
- Uniform footprint for PC board layout efficiency

RF filters with multiple-element design have now joined mixers, power splitters, directional couplers, and RF transformers as building block components having these desirable characteristics. For filters this is an especially significant break-through, in that typically 7 components are incorporated into an ultra-small package that is elegant in its simplicity. The filters are produced in an automated manufacturing environment utilizing custom robotics:

- Pick-and-place assembly
- Testing
- Branding
- Tape-and-reel packaging

The low-cost, patent-pending package for RF and microwave components was recently introduced by Mini-Circuits[1]. RF filters using this package are shown to exhibit excellent repeatability.

2.0 Applications

Receivers provide applications for these filters at several stages.

- Pre-selection between the antenna and the first amplifier stage, to avoid overload of the front end by out-of band signals. A typical application is in mobile radios.
- Clean-up of signals coming from a mixer. Where improved IM (intermodulation) performance is needed, a constant-impedance design can be designed to provide good match in the stopband as well as the passband.
- IF stages of receivers, such as in cellular base stations and mobile radios.

Transmitters, especially in hand-held equipment, can benefit by using small surface mount filters to ensure suppression of harmonics ahead of the antenna.

Reference signals for synthesizers frequently use low-pass filters. An example is in CDMA base stations. All CDMA signals need to be synchronized. The reference signal is either down-converted GPE, or a rubidium source; a filter is used to prevent PLL (phase-locked loop) malfunction by removing harmonics.

The output of a VCO (voltage controlled oscillator) typically uses a filter to suppress harmonics. VCOs themselves are typically specified at only 12 to 20 dB suppression.

PCMIA cards find ideal application for these low-height filters. Any kind of card which has an RF output can use them. Examples are Wireless LAN cards or other data links, such as those that use cell phones in the 900 MHz band. These filters could be used on the transmitter output to make sure that the PCMCIA card complies with FCC rules.

3.0 Construction

The package for the filters consists of a temperature-resistant plastic body with integral leads. Novel features of this package are:

- Small height, as low as 0.080 inch in some models
- Uniform footprint with 0.100 inch lead pitch
- Shortest length of internal leads for best high frequency performance
- Solder-plated molded-in leads for excellent solderability and stress resistance
- Raised open bottom to allow water or cleaning solvent to drain
- Flat upper surface for efficient automated handling and ample space for part marking

The internal construction utilizes a PC board, with the filter components soldered to both sides via reflow. All connections to the leads are made by welding. Fig.1 shows the bottom (internal) view of the filter. The completed unit is oriented with the open side downward, so that the leads can be soldered to the user’s PC board. The top surface, shown in Fig. 2, accommodates the part marking as required. The dimensions of the case are 0.31”(L) X 0.28”(W) X 0.15”(H).

4.0 Electrical Performance

Fig.3 shows the insertion loss vs. frequency of a Mini-Circuits ADLP- series model which is being readied for release to production. Nominal cutoff frequency is 370 MHz at 3 dB. Note that the statistical performance of the filter is indicated by five curves on the graph: average, average +/-3 sigma, and average +/-4.5 sigma; ‘sigma’ is the standard deviation.

Fig 4 shows the insertion loss characteristic in the pass-band frequency range, in a similar manner. Sigma is 0.1 dB typical in the pass band and 0.5 dB in the stop band.

Fig 5 shows the return loss as a function of frequency. Sigma is typically 0.5 dB in most of the pass band, except about 1.5 dB at 250 MHz where the response is approaching the cutoff frequency.

These graphs are intended to show the unit to unit variability, as a tool for capability prediction. They indicate that the performance is very repeatable.

5.0 Summary

A novel packaging concept and automation in manufacturing have minimized manufacturing steps, handling, and throughput time. The result is a lower cost product. Automated manufacturing also reduces variability of performance. Welded construction is used for all wire interconnects, to enhance reliability. The low height of the package is commensurate with short internal path lengths, which help to minimize parasitic reactances and provide the best performance.

6.0 Reference

1. Radha Setty, Daxiong Ji, Weiping and Harvey Kaylie, " High-Performance, Low-Cost, Low-Profile Surface-Mount RF components", Proc. of the 6th annual Wireless Symposium, PP 16-20, Feb 9-13, 1998, Santa Clara, CA

Fig. 1 Bottom view of the filter

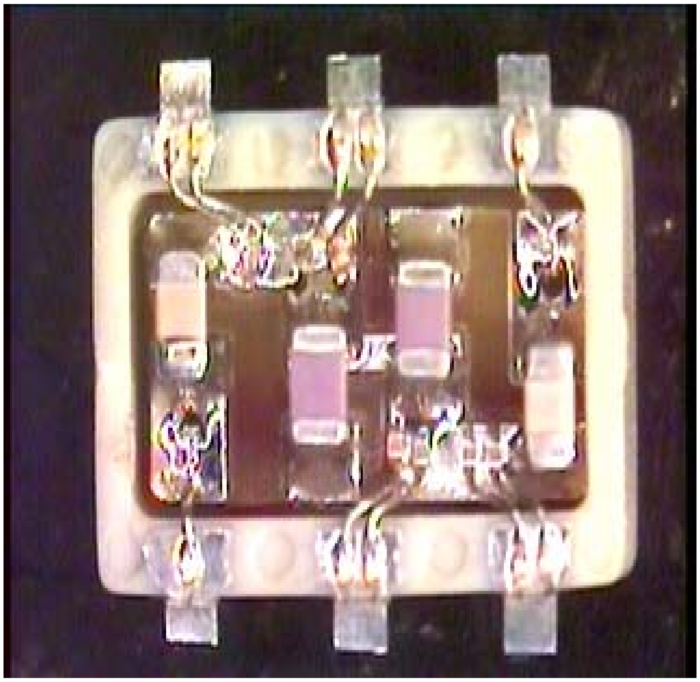


Fig. 2 Top view of the filter

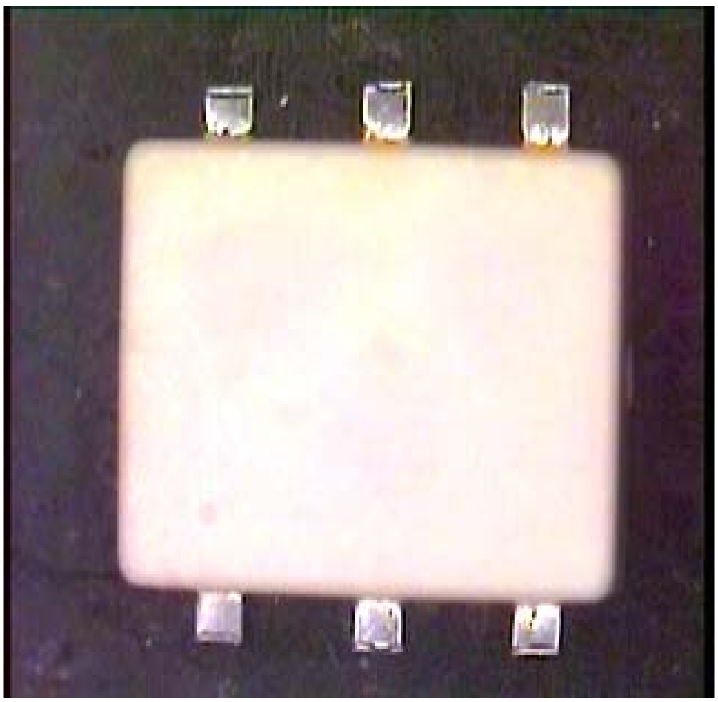


Fig. 3 Insertion Loss

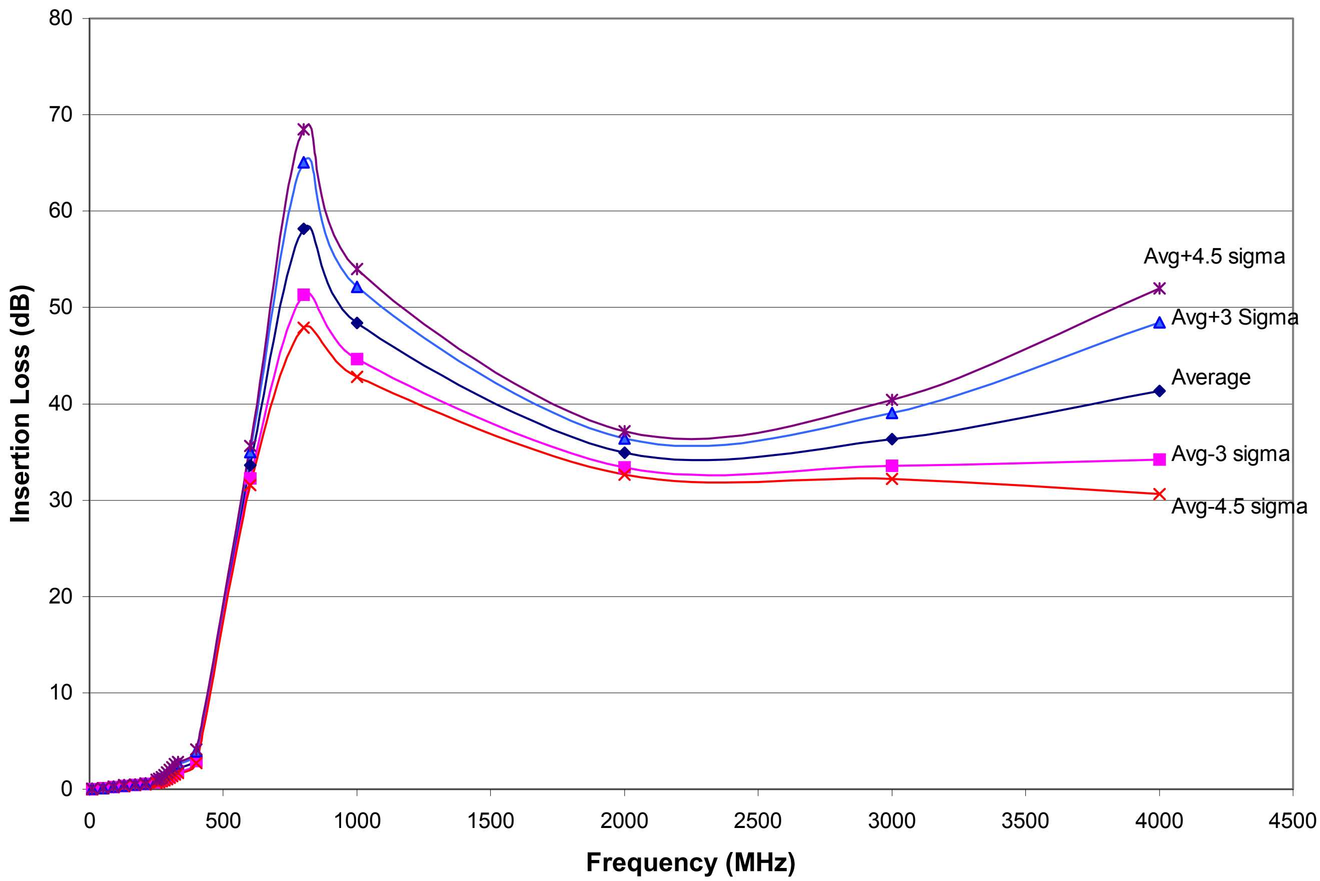
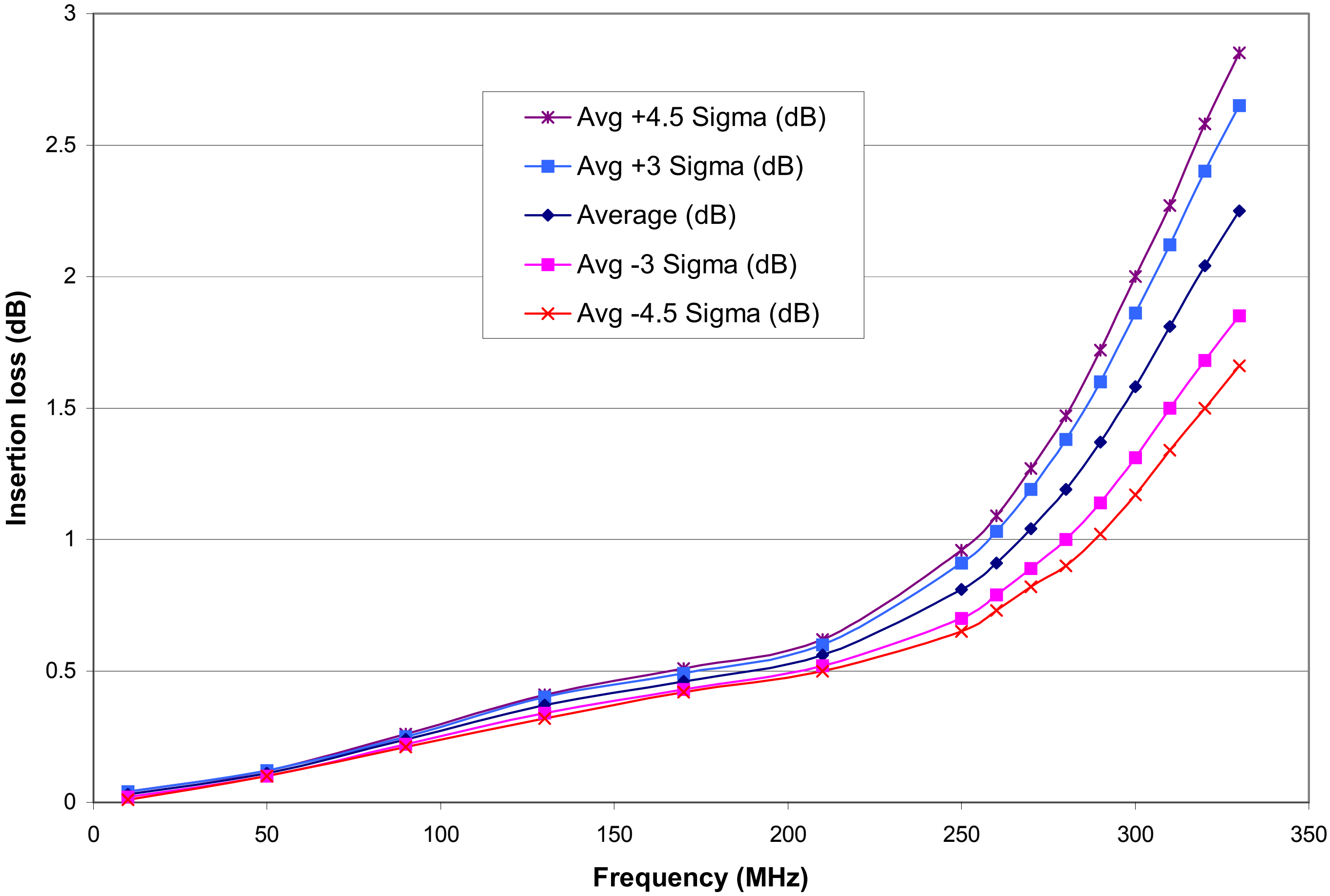
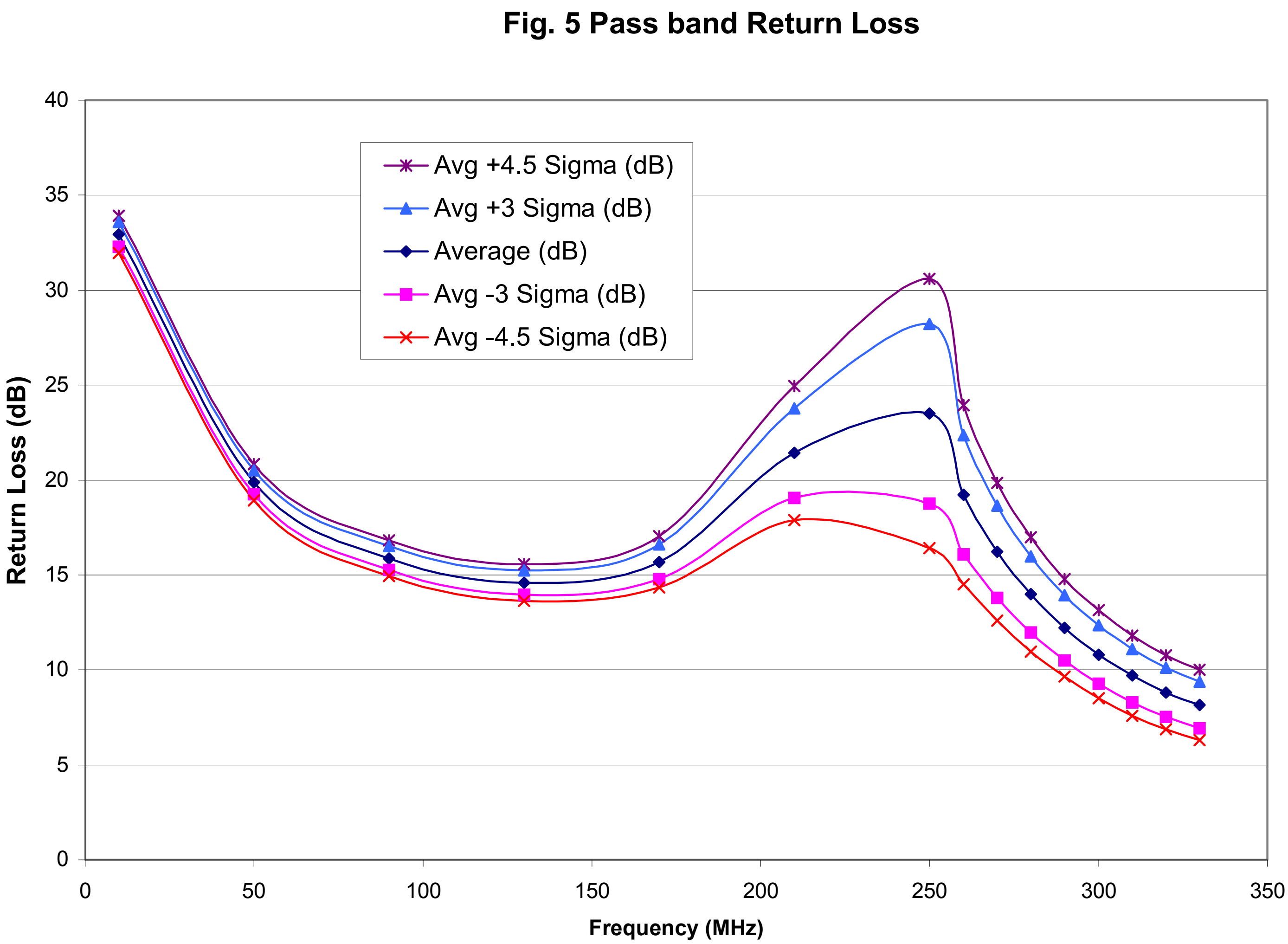


Fig. 4 Pass band Insertion Loss





AN-75-002 Rev OR (M79325)