EMI Control

Introduction

EMI control is a key design goal in electronic systems. Three terminal FeedThru capacitor filters are one component option that can be used to simplify designs needing a broadband EMI filter response. The proper selection and use of SMT FeedThrus can lead to a variety of system improvements such as: reduced overall component count, less complex PCB layout, increasing manufacturability, improved reliability, and lower weight. It is because of these potential advantages that three terminal capacitors are now accepted in designs ranging from avionics to cell phones, automobiles to SMART grid controllers. This list of applications is growing as FeedThru capacitors evolve into smaller packages, obtain AEC Q200 qualification, and increase current ratings.

This paper describes the basics of SMT FeedThru devices and their performance characteristics.

Background

Many times a discrete LC filter is designed to address a specific EMI concern in a system. This consists of determining the optimal filter type, selecting the proper components, laying out the PCB, and then manufacturing the end system with the new components resulting in increased weight, size, and process steps. The possibility of finding a single component to address EMI is attractive (and practical) when considering filtering across a broad frequency range. When broad frequency filtering is needed, the low Q – wideband filter response of a SMT FeedThru is very beneficial. A single SMT FeedThru filter can replace 2 discrete ferrites and a capacitor in a package as small as 0805.

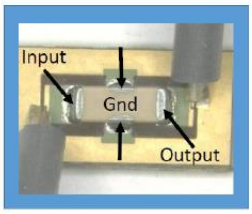
FeedThru filters are designed to be a broadband filter – typically offering greater than –30dB frequency attenuation across a 300 MHz spectrum width.

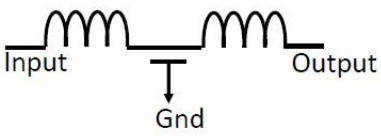
A single component solution dramatically reduces design time. One component vs multiple components reduce board layout & increases process throughput. Reliability is even improved through a smaller number of components that could fail to a reduction in the number of solder joints. Reliability is improved to such an extent that this solution is a preferred option for small spacecraft.

SMT FeedThru Capacitor Basics

SMT FeedThru filters have 4 terminations on the body of the device. They are commonly referred to as 3 terminal devices. Pin outs consist of an input, output, as well as a pair of center tap ground terminations. The particular FeedThrus discussed here are 0805 and 1206 case size and have the equivalent circuit of an LC T configured filter (see below illustration). The filter's inductive elements are formed by electrode geometry rather than by a ferrous material system. The series input/output leg of the filter has both a steady state current rating and resistance rating associated with it depending upon the component series (low or high current rated devices).

The series resistance of the filter is either 150 or 600 milliohms. Maximum series currents (steady state current carrying capability) are 300ma, 1000ma or 2000ma.



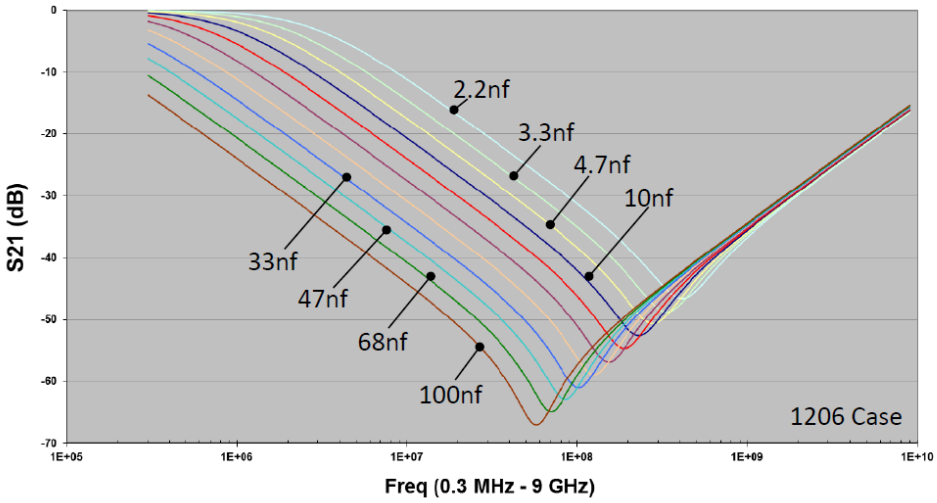


SMT FeedThrus offer a broad frequency response because the filter's parallel inductance is minimized while its series inductance in maximized. This is very advantageous when dealing with the attenuation of broadband noise. The parallel leg (ground terminals) of the filter have a capacitance loading associated to the filter. Dielectrics for the capacitor are either C0G (NPO) or X7R. Capacitance loading varies by case size and dielectric, but can range as low as 22pF to as large as 100nF.

SMT FeedThru filters are generally considered to be a low Q filter capable of broadband EMI filtering. There are high Q SMT FeedThru filters available in zinc oxide dielectrics. The High Q ZnO based FeedThrus offer EMI filtering in the off state and high voltage bi-directional transient protection in the on state. Further, the High Q device has an impressive radiation resistance capability and is actively flown on small to mid-sized space programs. Specific details of this device are not discussed in this text.

In comparison to discrete LC T filters, FeedThru filters offer a single broad attenuation spectrum due to minimized parasitic features of the internal electrode stacks.
Examples of forward transmission loss characteristics (S21) are shown in the below illustration. As expected, attenuations vary in accordance with the capacitance value of the filters and case size (where the case size predominantly impacts the magnitude of series inductance). The data sheets for FeedThru filters contain detailed information on specific filter response such as S21, Impedance vs. Frequency and temperature rise by current drive level.
Proper pad layout is critical to the optimal use of SMT FeedThru filters. Pad dimensions should be in accordance with recommended dimensions see details at:

For additional information regarding AVX FeedThru Filters:
http://www.mouser.com/new/AVX/avx-rf-products/



Summary

The use of miniature SMT FeedThru filters can potentially impact system weight, reliability and manufacturability. SMT FeedThrus are a single chip solution to EMI issues. Sizing of the device can be as easy as matching the filters attenuation range to that of the noise spectrum on concern. Capacitance loading should be taken into consideration as well as steady state current of the device. Common application of FeedThru Filters includes EMI filtering on I/Os, power lines, RF devices as well as brick wall filters on mixed logic.