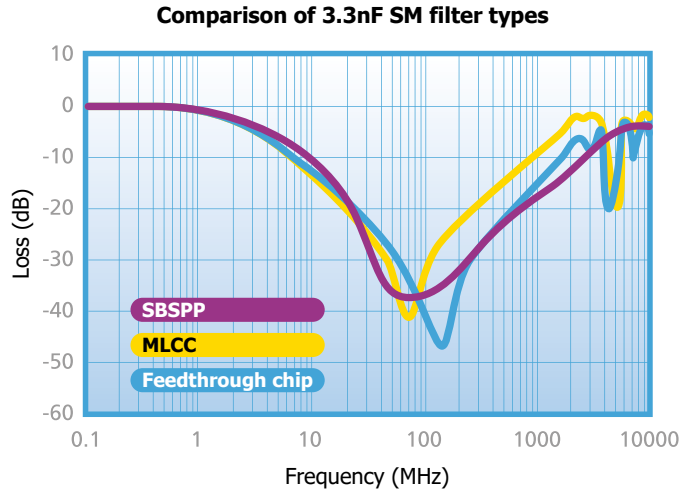


# Introduction to Surface Mount EMI Filters

Surface Mount Filters are designed to be mounted directly to printed circuit boards using conventional mounting techniques in the same way as standard MLCC's.

Solder connections are made to each end (signal lines) and each side band (earth or ground).



They are categorised into 3 distinct families:

### 1. E01 / E07 'C' Filter EMI Chips (also known as 3-terminal chips)

These use conventional MLCC manufacturing techniques to form a filter which is short circuit end-to-end and has a capacitance between the end terminals and the side (ground) terminals. The signal is carried through the internal electrodes. The current carrying capacity is defined by the cross section and number of the electrodes in the filter and is therefore linked with the capacitance of the filter.

Compared to conventional 2-terminal MLCC devices the internal inductance between line and ground is reduced, giving improved attenuation.

### 2. Surface mount 'Pi'/'C' Filters

'Pi' filters incorporate 2 capacitors and an inductor together to make a multi-element filter, giving sharper cut-off and better low frequency performance than straight 'C' filters. The Syfer range of SM 'Pi' filters use conventional MLCC manufacturing techniques to form the capacitive element of the filter, but the inductive element is created separately either by means of a bead inductor placed over a through conductor pin, or by means of a buried layer surface mount inductor with the signal carried by the buried internal layers. Current carrying capacity is defined by the characteristics of the conductor and is independent to the capacitance of the filter.

### 3. X2Y Filters

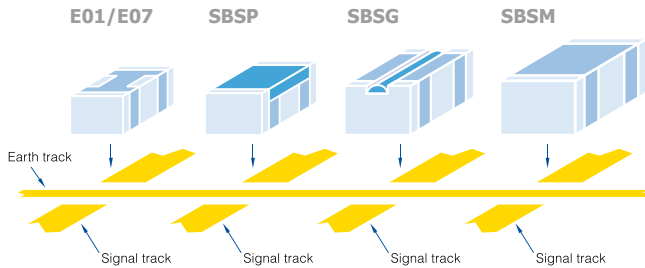
X2Y filters are manufactured in the same way as conventional MLCC's but have a special internal architecture that results in ultra-low ESL (Equivalent Series Inductance) through opposing current flows in adjacent parallel plates. They are not feedthrough devices, but act as bypass filters so are not current limited - the only signal passing through the chip is the filtered noise to ground. They are ideal for twin-line applications such as motors, amplifier inputs or twisted pair (balanced line) applications, where they are fitted between the lines with the centre terminal taken to ground. Incorporating the capacitors in a single ceramic element eliminates any capacitance shift through temperature variation.



# Insertion Loss

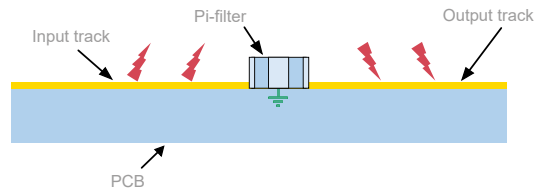
## Insertion Loss figures

Insertion loss plots and figures supplied are typical only and are measured on 50Ω stripline open boards, 0.8mm thick FR4 with gold plated tracks. Solder pads are 'T' bar with respect to the track and dimensionally match the recommendations given. The boards are mounted to brass support jigs for mechanical stability and electrical grounding. All measurements are taken using a Vector Network Analyser in a 50Ω system, no load.

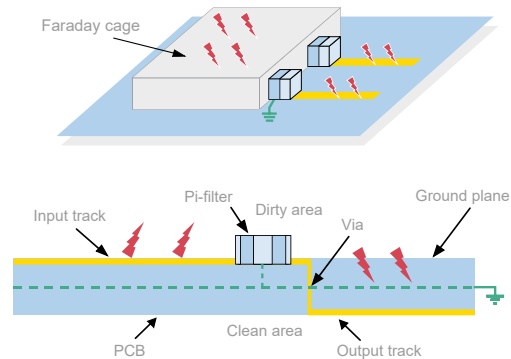


It is important to recognise that the board material, thickness and layout, the plating finish, the grounding efficiency and the circuit impedances will all have an effect on the actual performance of the filter in operation. The effect of the board makes it difficult to directly compare parts unless the mounting details are defined. It is therefore important to test the filters in circuit to determine the performance level achieved.

## Filters mounted on open pcb



## Improved shielding

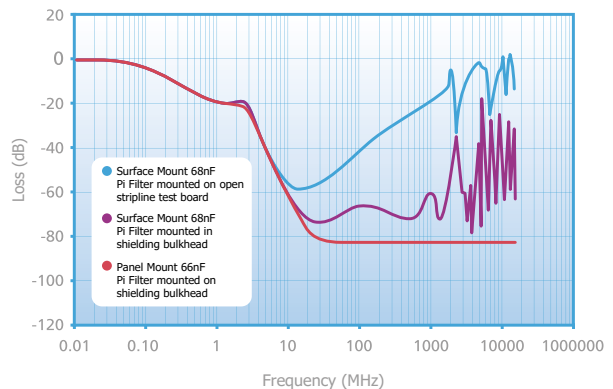


## Effects of mounting method on Insertion Loss

'C' and 'Pi' filters are mounted to PCBs and soldered in identical manner to chip capacitors. Solder connections made to each end (signal lines) and each side band (earth track).

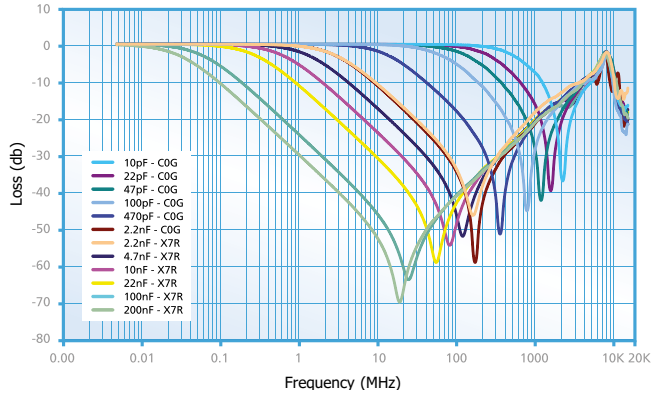
Whilst SBSG, SBSM and SBSP filters can be mounted conventionally on PCBs, they are also suitable for mounting in a wall or partition on a board. This greatly improves the screening between filter input and output, thereby enhancing the high frequency response.

The following insertion loss curves based on actual measurements, show the effect. It can be seen that the filters conventionally mounted exhibit a drop in attenuation at higher frequencies. Shielding methods maintain improved suppression characteristics to 1GHz and above.



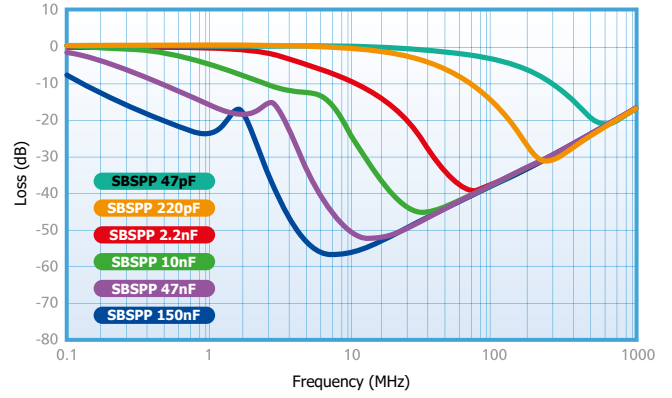
# Insertion Loss - SM High Current and Pi Filters

**E01 & E07 Insertion Loss**



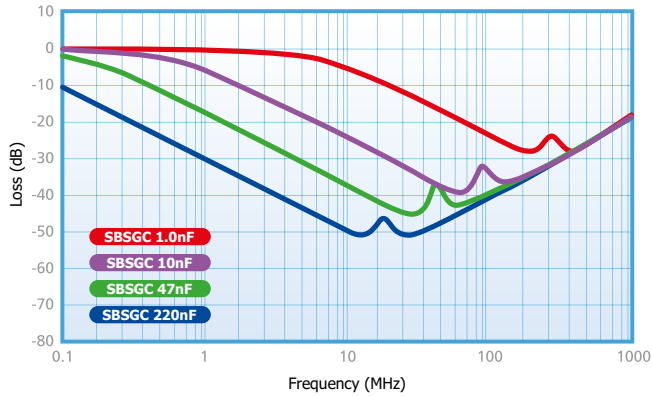
See page 15/16

**SBSPP Insertion Loss**  
Open Board Stripline jig. 50ohm System



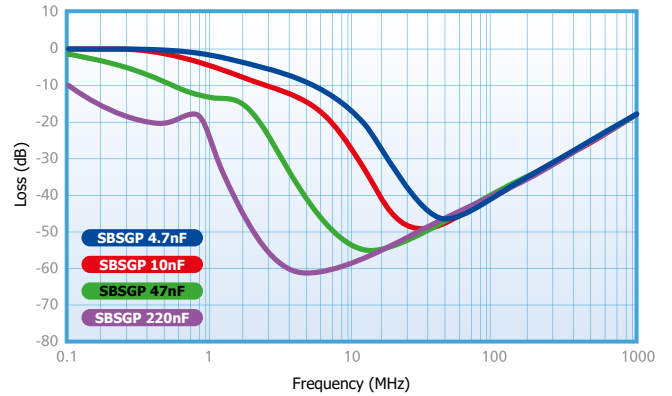
See page 17

**SBSGC Insertion Loss**  
Open Board Stripline jig. 50ohm System



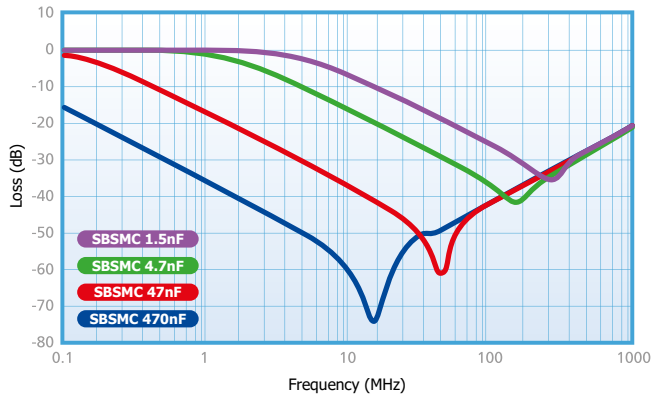
See page 18

**SBSGP Insertion Loss**  
Open Board Stripline jig. 50ohm System



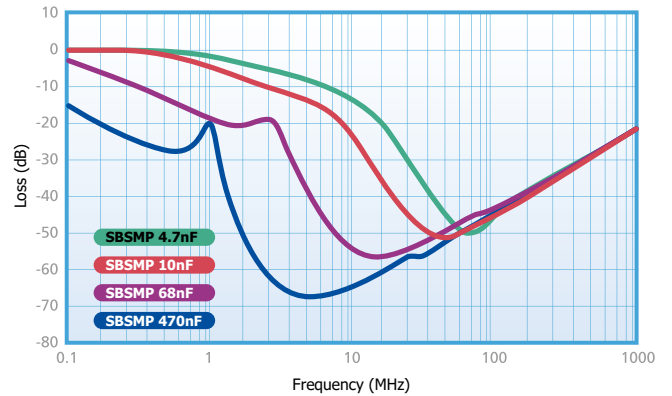
See page 19

**SBSMC Insertion Loss**  
Open Board Stripline jig. 50ohm System



See page 20

**SBSMP Insertion Loss**  
Open Board Stripline jig. 50ohm System



See page 21