Piezoelectric Traps

Introduction

Piezoelectric ceramic traps are band reject filters originally designed to remove the sound signal in a television receiver. The ceramic traps operate at the same frequencies as the MHz sound IF filters (3.58MHz to 7.0MHz) However, they have found wide use in other areas of the communications industry.
A band reject filter is a filter that allows all but a certain range of frequencies to pass unaffected. Figure 50 shows an example of an ideal band reject filter.

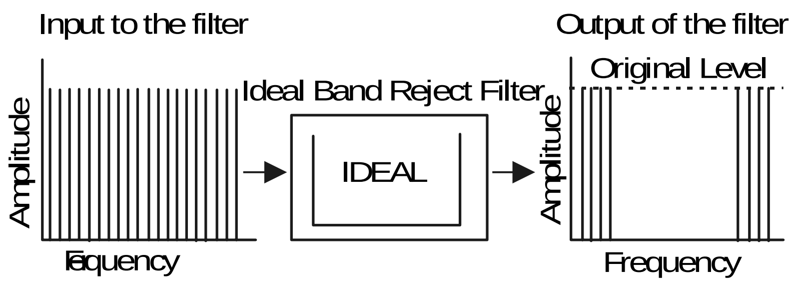

Figure 50: Ideal Band Reject Filter

Practically, such performance is not physically possible. There will be some attenuation of all frequencies and the sides of the band will not be perfectly straight. This is due to parasitic losses associated with the physical properties of the filter. Figure 51 shows a practical band reject filter.

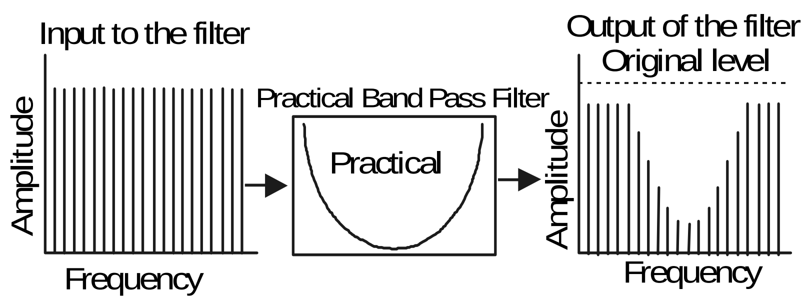

Figure 51: Practical Band Reject Filter

As can be seen from the figures, the outputs are quite different. The next section will go into how the trap works.

How Does It Work

A ceramic trap is essentially a ceramic resonator. It has the impedance response shown in Figure 52.

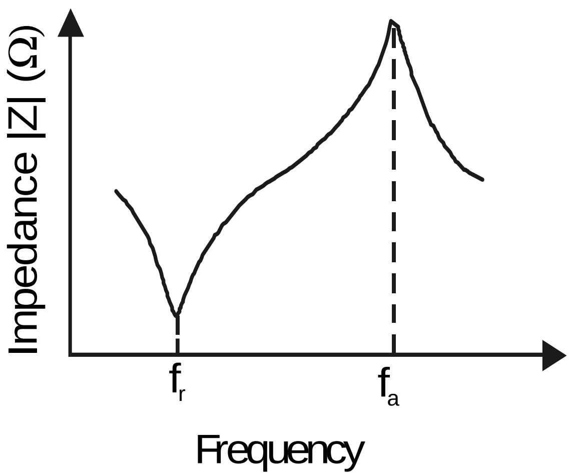

Figure 52: Resonator Impedance Response

A ceramic resonator has an impedance minimum at the resonant frequency, f_r, and an impedance maximum at the anti-resonant frequency, f_a. The resonator is designed so that the resonant frequency is at the frequency that is to be removed. The resonator is then placed to ground in the circuit (Figure 53).

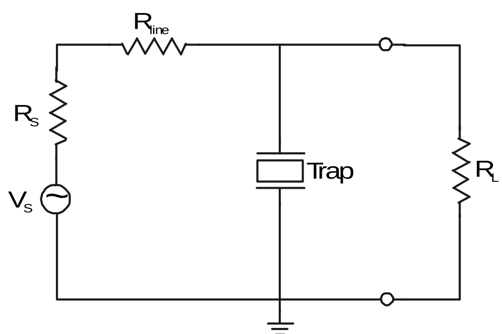

Figure 53: Single Element Trap Circuit

Frequencies at and near the resonant frequency see a low impedance to ground and are pulled down. All other frequencies see a large impedance and go past the trap to the rest of the circuit. The resulting filter trap response is shown in Figure 54.

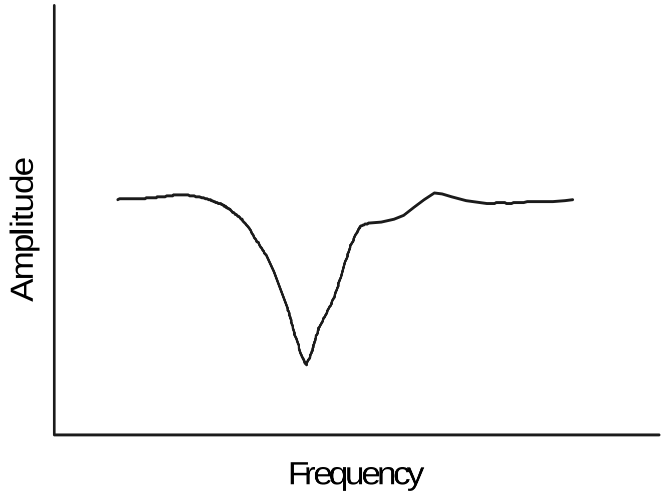

Figure 54: Trap Response

There are two types of trap: single element and double element.

- Single Element Trap

Single element traps have two terminals attached to electrodes on either side of a ceramic substrate (Figure 55).

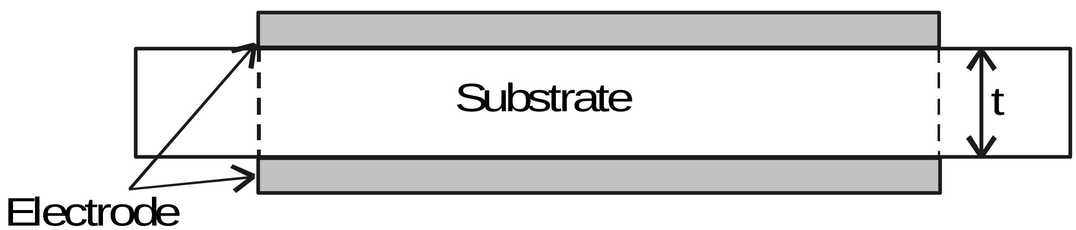

Figure 55: Single Element Trap

These traps are low cost, non-tunable devices that offer good attenuation over a set bandwidth.

- Double Element Trap

With a double element trap, one electrode is cut into two. This allows multi-coupling mode operation and provides better attenuation (Figure 56).

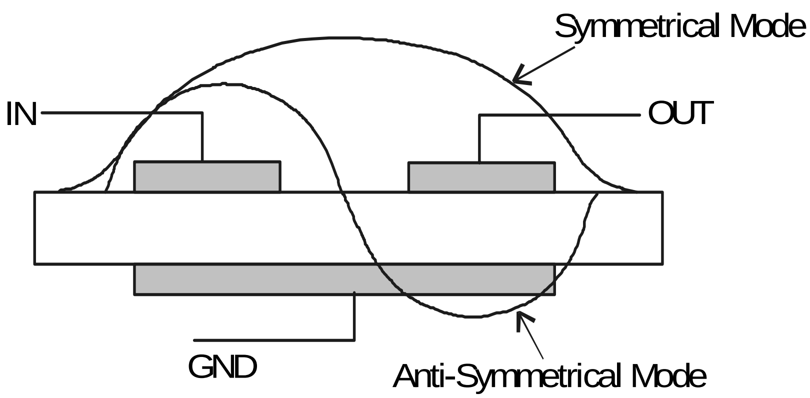

Figure 56: Double Element Trap

These traps provide better attenuation than the single element traps and are still non-tunable. One other difference is that the bandwidth of these traps can be changed by placing an inductor between the two terminals of the cut electrode (Figure 57). By changing the inductance of the inductor, the bandwidth can be altered to meet the needs of a specific application.

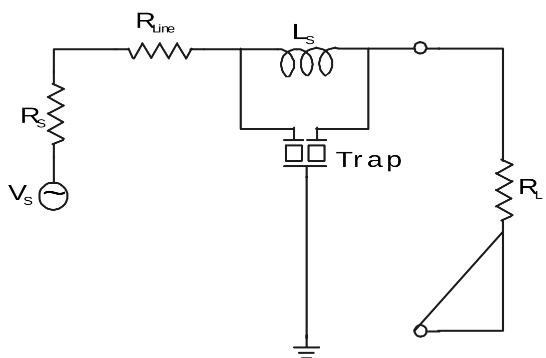

Figure 57: Double Element Trap Circuit

This circuit was simulated on a computer using four different values for the inductor. Figure 58 shows the resulting trap responses for the different values. Figure 59 shows the same responses over a narrower frequency range.

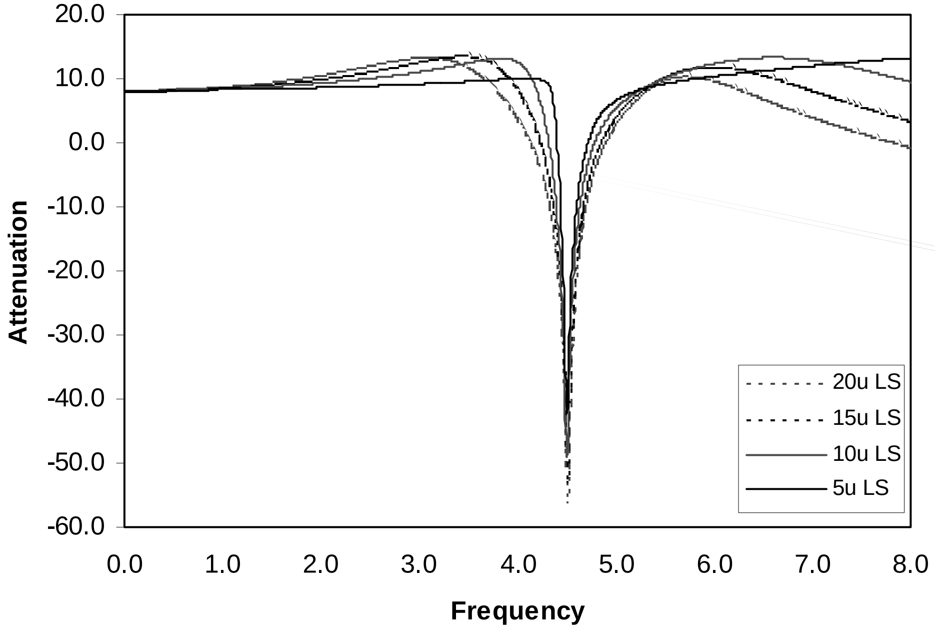

Figure 58: Computer Simulation of a Double Element Trap

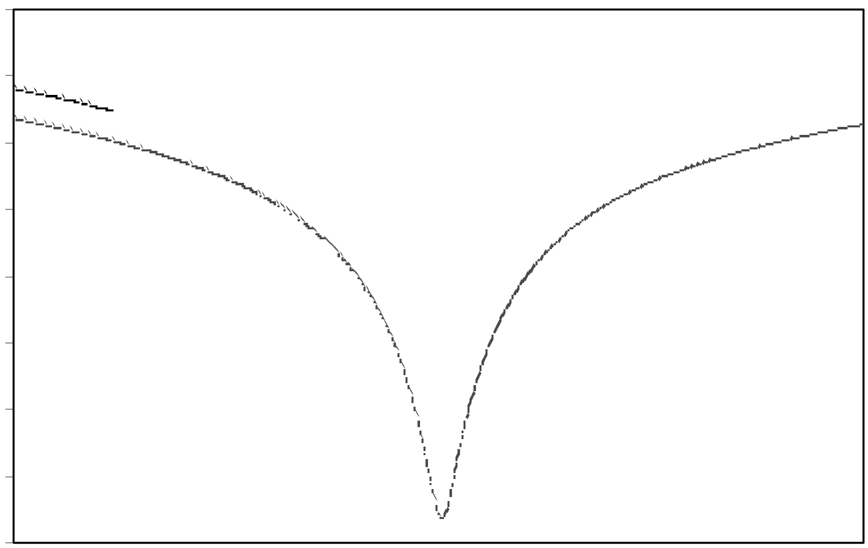

Figure 59: Computer Simulation of a Double Element Trap

Murata also makes traps with two and three responses for systems that have multiple IFs. As an example, the PAL TV system used primarily in Europe has multiple sound Ifs depending on the language used. Multiple trap responses are needed to remove the signals that are in the undesired language.

Applications

Ceramic traps were originally designed to be used in TV receivers to remove the sound signal. Figure 60 illustrates a television signal.

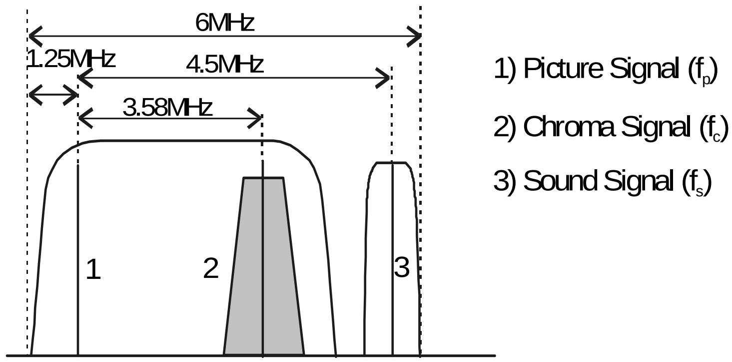

Figure 60: TV Channel Spectrum Description (NTSC-M)

The sound signal is centered at the high end of the channel while the picture and color or chroma signals are centered at the low end of the channel. Figure 61 shows a block diagram of a television receiver.

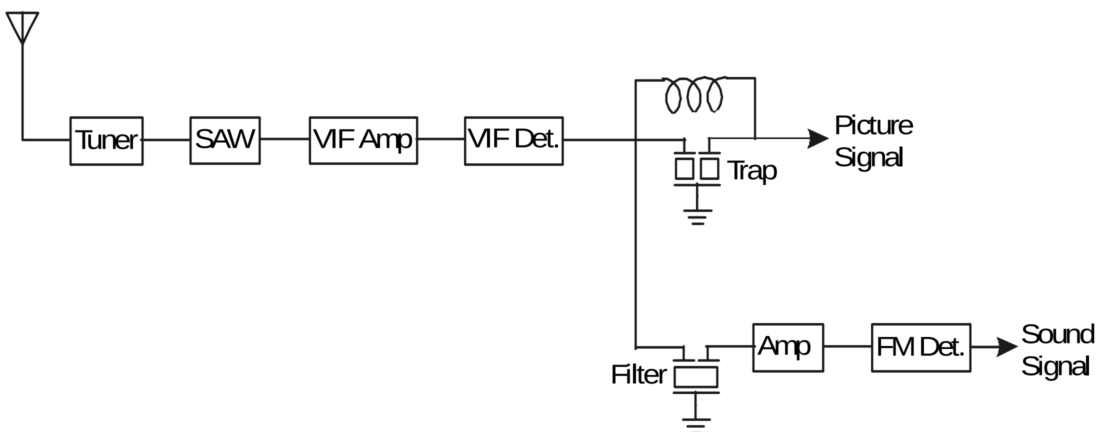

Figure 61: Inter-Carrier System

In the receiver, the tuner down-converts the desired channel to the IF frequencies. The SAW filter then selects the IF frequencies and the amplifier increases the signal strength. A VIF detector strips away the carrier wave from the picture signal. From here the signal is split into two. The first signal passes through a filter, which filters out the picture and chroma signals and passes the sound signal. It then goes to a detector, which strips away the carrier wave and then to the speaker on the television set. The second signal goes through the trap, which removes the sound signal and then to the video processing circuits that drive the picture tube. It is necessary to remove the sound signal because it could cause interference in the picture signal.

Parts

Figure 62 shows an example of the Murata part numbering system for ceramic traps.

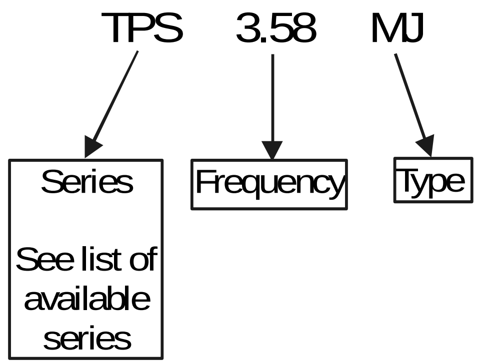

Figure 62: Trap Part Numbering system

Table 11 lists the different series of traps offered by Murata. Some older parts are listed for reference purposes, therefore if a part series has an asterisk (*) by it, then it is obsolete or no longer available for new designs.

Trap Series	Description
TPS…MJ	2 terminals, for sound IF in B/W receivers or chroma signal in video
TPS…MB*	3 terminals, 2 elements, for sound IF of TV/CATV receivers
TPSRA-M-B	3 terminals, 2 elements, for sound IF of TV/CATV receivers
MKT	High frequency trap

Table 11. Trap Series Description