TECHNICAL PAPER

LCD Driver Circuit EMI Filtering Options

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Abstract

A review of EMI filter component options, comparing product performance, device characteristics and related factors (eg PCB board area, placement cost, etc.).

KYOCERA AVX

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EMC design and compatibility is a key design parameter for electronic designers creating LCD drivers and interfaces on PDAs and cell phones.

This paper is a result of a study done for a major consumer supplier to compare the effectiveness of various EMI filter options available to designers. Size, weight and broadband EMI filtering are key concerns for the end customer. Simple filters based upon L-C, R-C configurations are compared to integrated FeedThru filters for the following performance characteristics: S21, board area consumed and cost.

Cell Phone Flex Connector Filtering – Low Pass Filter or Band Reject Filter

The ideal filter for an LCD flex connector would provide a high attenuation of the RF output in the region around cell phone frequencies (900 & 1800 MHz for example).

It would also provide as much EMI filtering for the LCD driver circuits and associated glue logic within the phone as possible without distorting the data used in the system.

Cost, filter size and weight are becoming a major concern for the filters associated with the LCD drivers.

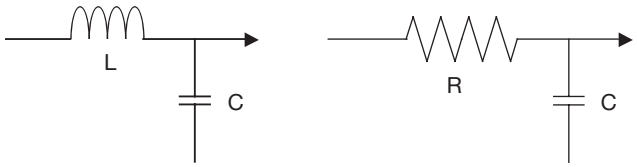
Designers have used single capacitors with their resonant point chosen to coincide with the maximum frequency spectrum of concern. However, the capacitance values needed to give even moderate filtering in the 900 & 1800 MHz band were electrically large and caused data skew as well as timing limitations in the circuit.

As a result designers have used simple RC and LC filters to offer a broader frequency filter characteristic while keeping the capacitance and insertion loss acceptable to reliable circuit operation.

R-C and L-C Filter Configuration

Designers used either a R-C or L-C filter of the configuration shown below.

This study used 0603 size ferrite beads and capacitors in the configurations below to create a simple filter and then measure the forward transmission characteristics (S21).



Initial investigations were done using either ferrite beads having 33 ohms and 120 ohms of impedance at 100 MHz. Resistors of 33 ohms and 100 ohms resistance were used in the R-C investigation.

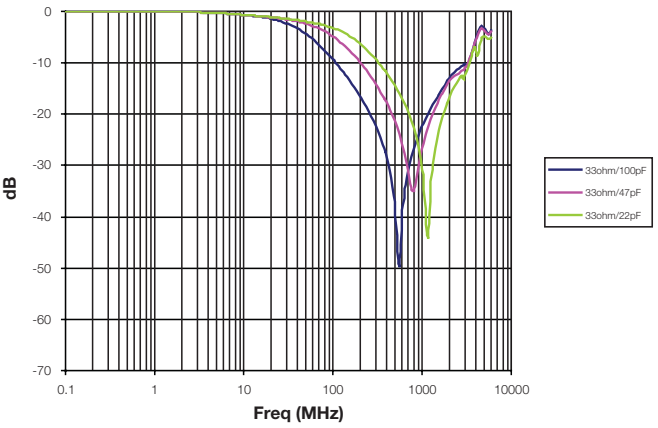
The two different value resistor and ferrite beads were in turn connected to three different capacitance values 22pF, 47pF and 100pF. We opted to show the performance using this matrix to provide designers with examples of circuit performance that could be applied to a broad variety of LCD driver requirements.

Capacitance values of 22pF, 47pF and 100pF were chosen to be connected and tested due to their general ability to be used on high speed, medium speed and relatively low speed digital circuitry without causing signal/data skew. It is interesting to note that the ESR of the 47pF capacitor was high relative to the expected value and the values experienced with the 22pF and 100pF capacitors. This resulted in attenuation response that was less than expected on the 47pF capacitor S21 response in both the L-C and R-C cases.

The LC filter pcb area is 4.81 square mm per line to be filtered based upon standard pad layout and component to component spacing requirements.

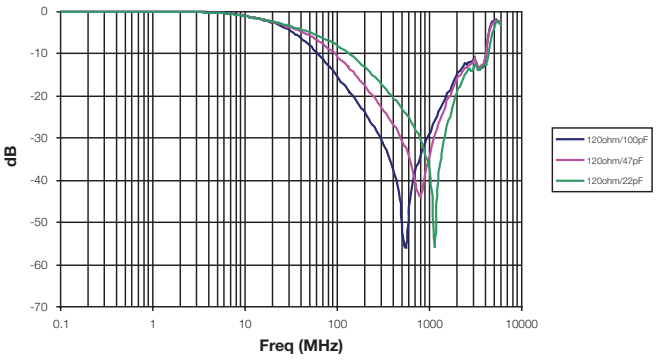
LC FILTER S21

33ohm Ferrite Bead (at 100 MHz), 22pF, 47pF, 100pF Capacitor



LC FILTER S21

120ohm Ferrite Bead (at 100 MHz), 22pF, 47pF, 100pF Capacitor

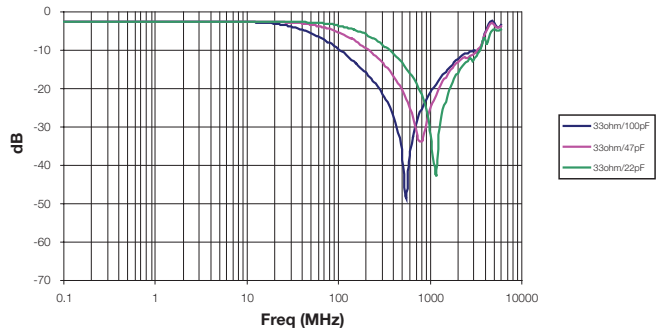


Changing the ferrite beads to resistors created much greater insertion loss for the filter. The levels of insertion loss varied from approximately -2.5 db in the case of the 33 ohm resistor to nearly –6 db for the 100 ohm resistor. Such levels of insertion loss begin to impact circuit operation and power consumption (depending on the particular lines of implementation).

Though the insertion loss of these RC filters would help low frequency EMI compliance the RC filters could negatively impact the signal to noise ratio of the flex connector. Additionally, the RC discrete filter option is large. The pad layout alone for 0603 elements took up an area of 4.81 square mm per line to be filtered based upon standard pad layout and component to component spacing requirements.

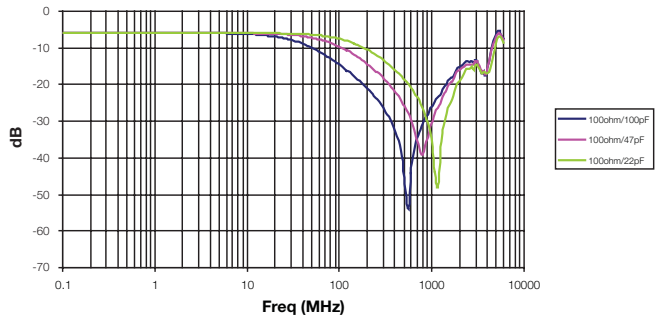
RC LOW PASS FILTER S21

33ohm Resistor, 22pF, 47pF, 100pF Capacitor



RC LOW PASS FILTER S21

100ohm Resistor, 22 pF, 47pF, 100pF Capacitor



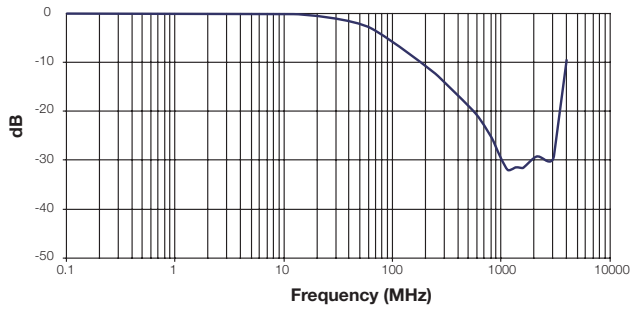
Feedthru Filters

The response of a 47pF FeedThru array filter is shown below. This array is constructed in a 0508 package. FeedThrus are based upon integrating a non-ferrite based series inductance with a parallel capacitance in a single ceramic package. They exhibit a wide S21 due to the integrated inductance within the package providing a relatively low Q, which therefore yields a broad frequency response. This allows designers to create the equivalent of broadband block filters by selecting the particular frequency response filter corresponding to the frequencies of interest.

The table provides designers with additional data for FeedThru filters with capacitance loading of 22pF and 100pF.

PRELIMINARY

AVX W3F41A4708 AT Typical S21



FeedThru Filter	3db (MHz)	20 db (MHz)	Max attenuation	Filter Capacitance
0508 4 element array	220	1665 - 5644	-30db, 3464 MHz	22pF
0508 4 element array	85	666 - 4996	-30db, 1474 MHz	47pF
0508 4 element array	60	462 - 3913	-36db, 1154 MHz	100pF

Summary

FeedThru filters save large amounts of board area. A 4-element array FeedThru filter would use 9.97 sq. mm of pcb area. In comparison a 4-element RC or LC filter built with 0603 size discrete components would consume 19.24 sq. mm of pcb area. A 4-element RC or LC array built with 0402 discrete components would consume 13 sq. mm of pcb area.

Solution	PCB Area 0402 Components	PCB Area 0603 Components	Required Pick & Place Operations
FeedThru	9.97 sq. mm	9.97 sq. mm	1
RC relative to FeedThru	13 sq. mm	19.24 sq. mm	8
LC Relative to FeedThru	13 sq. mm	19.24 sq. mm	8

FeedThru filter arrays save pick and place costs vs discrete filters. The cost of pick and place operations vary greatly by volume of components placed and factory overhead. What can be said is that the cost of placement of FeedThru filter arrays is 1/8th the cost of placing discrete filter array. FeedThru filters also exhibit excellent reliability – typically a failure rate < 1 FIT.

FeedThru filters have a high voltage rating (100v) and a 300ma steady state current rating and are therefore useful on filtering the output of power supplies. A general comparison of 3 db points and 20 db pass band is shown in table above. Additional parameters such as capacitive loading, voltage rating and current capability are given.

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