TA0318
TECHNICAL ARTICLE

EMI and ESD consideration for LCD and Cameras in wireless handsets

1. Bring EMI immunity to Cameras and LCDs in cellular handsets

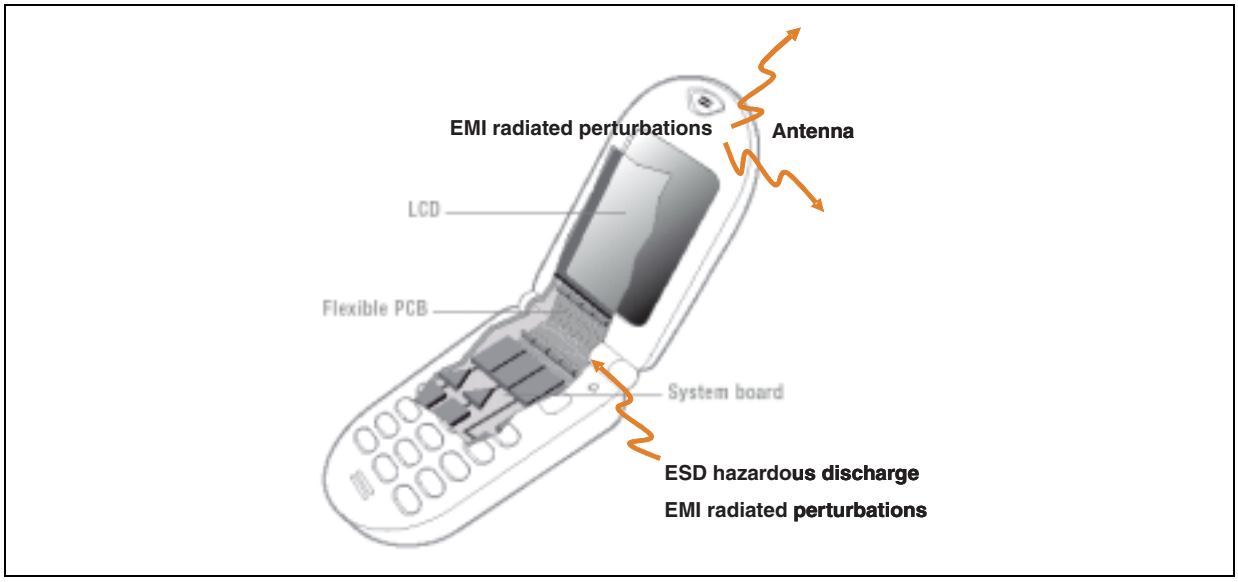
As wireless market continues to evolve, the next mobile phone generation requires increased functionality with more colourful displays, at least two per handset, and the arrival of high-resolution cameras exceeding 1 Mpixels.

Still driven by compact design trend, the implementation of high resolution LCDs and cameras will pose several challenges for designers. One of the major design considerations for camera and LCDs is the electromagnetic interferences sensibility for these new modules.

For many popular handsets, especially clamshell-style flip phones, the color LCD or cameras CMOS sensors are connected to the base band controller via a flexible or a long tracks PCB, connected in between two major parts of the phone.
On one side, this cable is still subjected to the parasitic GSM/CDMA frequencies radiated by the antenna.
On the other side, because of the introduction of high-resolution CMOS sensor and TFT modules, data signals are clocked at higher frequency and the connection cable can, consequently, behave as an antenna for radiating EMI/RFI or for conducting ESD hazardous events.

Anyway, in both case, all of these EMI and ESD perturbation can disrupt the video signal integrity or damage definitively the base band controller circuitry.
To suppress these EMI radiation while preserving data transfers, several filters solution can be implemented. This can be accomplished using discrete resistors and capacitors or integrated EMI filters.

Figure 1: Noise and ESD transmission paths around LCD module



2. EMI and ESD noise suppressing methods

Considering design constraints as space board saving, high filtering performances at mobile phone frequencies and preservation of signal integrity, the current used solution are going to reach their technological limits.
The discrete filters are not any more space saving solutions and they provide poor filtering characteristics with narrow bandwidth attenuation so most of designers are going to consider integrated EMI filter.

On new mobile phones, equipped with high resolution LCDs and embedded cameras, the signal is transmitted from the base band ASIC to these modules using specific frequency which depends of the resolution.
More the video resolution increase, more the data are clocked with high frequency signals. Up today we see data clock around 6 to 20 MHz and the resolution race will push cameras makers to increase this data rate up to 40-60 MHz

To comply with the increase of the signal speed data and to not disturb video signals, low capacitance filters have to be selected taking into consideration a theoretical rule recommending that the filter cut off frequency ($1/2_{\Pi RC}$) has to be around 5 times the clock frequency value.

In current wireless terminals, the clock frequency is in between 6 to 12 MHz for the 300k to 600k pixels LCD and Cameras models. Therefore, the filter cut off frequency is recommended to be in the range of min. 30 MHz to 50 MHz respectively. A number of filter solutions can withstand this recommendation, but with the resolution increase resulting in clock signal higher than 40 MHz, the filter cut off frequency has to be in the range of 200 MHz. So Some filter solutions are going to reach their limits.

Table 1: Cut off frequency and clock signal compatibility versus filter solutions

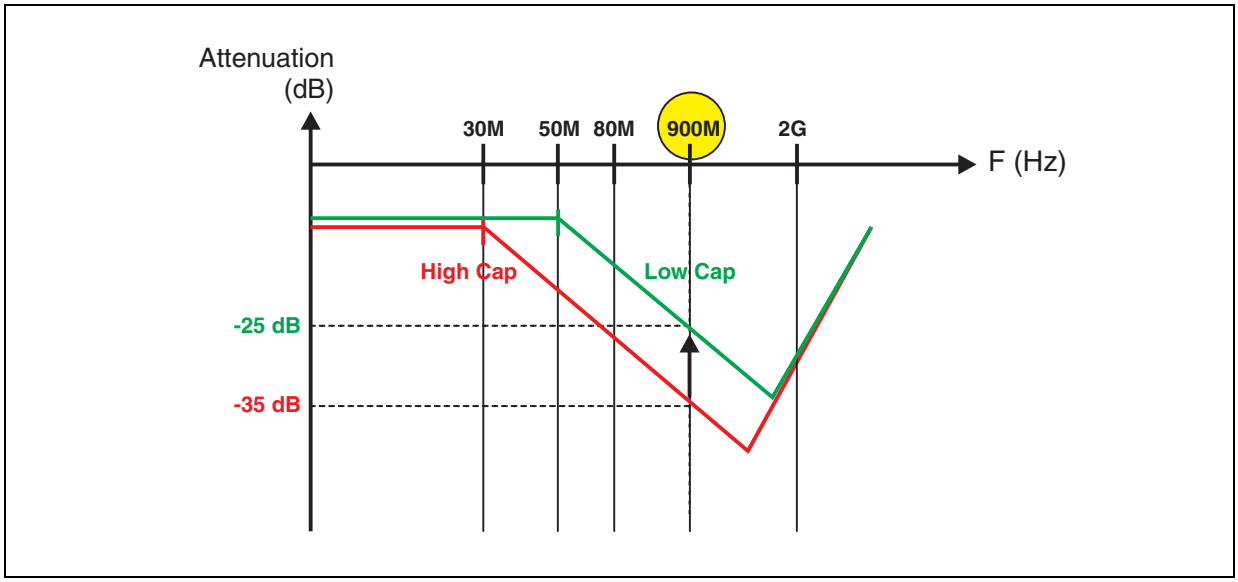
	R serial	Capa	Fc (Cut off freq)	12 Mhz compatibility	50 Mhz compatibility
Discrete filter	100 Ω	27 pF	59 MHz	**YES**	No
Standard EMI filter	100 Ω	15 pF	106 MHz	**YES**	No
Low Cap EMI Filter	100 Ω	8.5 pF	190 MHz	**YES**	**YES**

The table 1 shows a comparison of the filter capacitance value versus the cut off frequency. Clock compatibility is given as recommendation. That's demonstrated that the lowest capacitance filter is the most compliant solution with high-speed signals clocked at high frequency.

Nevertheless, designers know the unsolvable trade off between the cap filter value and filter attenuation performance at GSM/CDMA frequencies. Lower cap structure will affect the filter performance at high frequency and most of the low cap current filters are not able to provide more than -25 dB attenuation at 900 MHz. See the figure 2 on next page showing EMI filter capacitance effect on GSM frequency attenuation.

In addition to the worth effect on the filtering performance, a lower capacitance filter will affect the ESD performance as well. Taking into consideration that lower diode capacitance will dramatically reduce ESD surge capability; it's challenging to find the best trade off between good attenuation, ESD performance and low capacitance filter structure

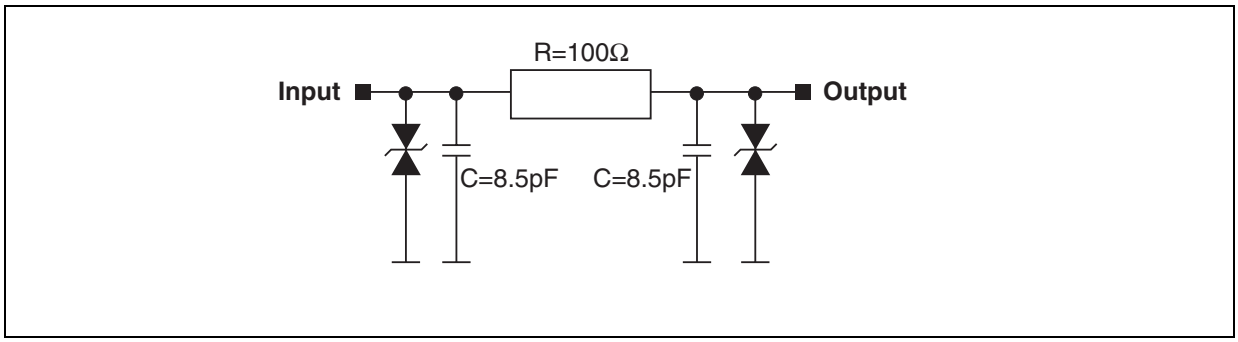
Figure 2: GSM attenuation frequency versus filter capacitance



3. Low Cap EMI filters improved performances

To address the incompatible need that is the implementation of low capacitance filters by keeping high filtering performances at the same time, STMicroelectronics offers a new EMI filter generation combining high frequency attenuation at 900 MHz and ultra low capacitance structure.
Using the IPAD™ technology (Integrated Passive and Active Devices), these new EMI filter arrays are based on standard PI filter structure with integrated ESD protection. The figure 3 shows a basic filter cell configuration with serial resistance and capacitance values.

Figure 3: New filter cell structure (R serial 100 Ω, line cap 17 pF)

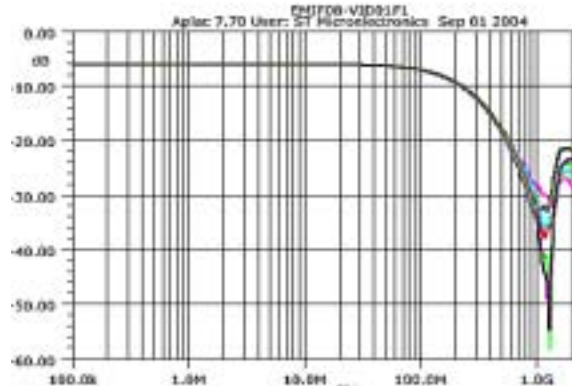


This new low capacitance structure has been designed to provide cut off frequency in the range of 200 MHz supporting data rate with clock frequencies higher than 40 MHz.

Despite the fact that the diode capacitance has been drastically reduced at 8.5 pF, it results excellent filtering performances even better than -35 dB attenuation for frequency range around 900 MHz.

The figure 4 shows a S21 parameter measurement based the filter basic cell architecture. It shows -35 dB attenuation at 900 MHz, which is an unrivalled performance, reaches with a 17 pF line capacitance integrated EMI filter.
In addition, to the filtering functions, the integrated input zener diode can suppress ESD strikes of up to 15 kV air discharge, a level of performance required by the IEC61000-4-2 level 4 industry standard.

Figure 4: New low Cap EMI Filter S21 measurement

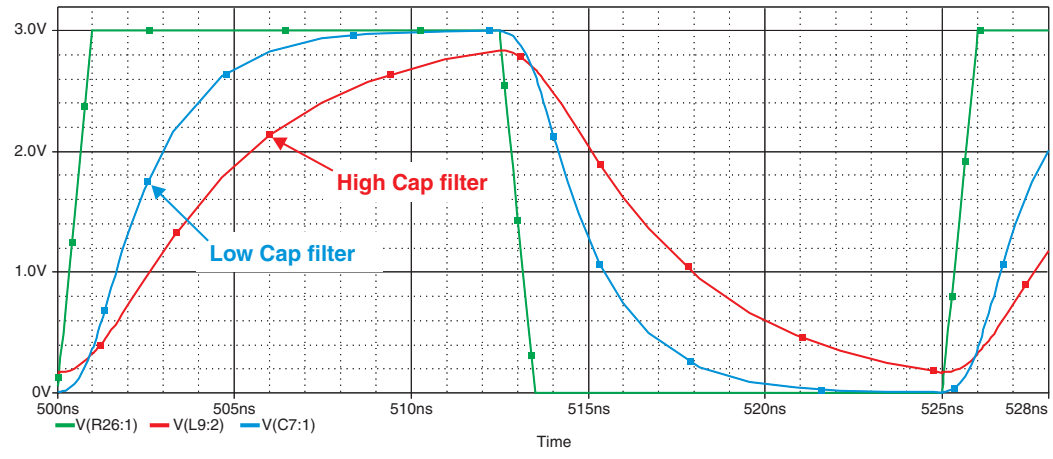


4. High speed data compatibility

In order to not disturb the video signal, the new low cap filter has been designed with optimized line capacitance value to support up more than 40 Mhz frequency clock chipset.
It results extremely low impact on the rise and fall times and no delay on the signal between the input and the output of the device.
Some simulations have been processed with a signal input R_t (Rise time 10-90%) and F_t (Fall time 10-90%) values in the range of 1 ns max. at 2.8 Volts. It results that the induced delay time by the filter (difference between the output and input signal) does not exceed 1ns. It makes sure that data integrity is fully preserved even for high resolution LCDs or Cameras.

The figure 5 presents a 3.0 Volts video signal transmission test at 40 Mhz clock frequency through the new low capacitance filter in comparison with higher capacitance structure. We see that the high capacitance structure induce a delay time 5 or 6 times superior than the low cap structure. In this condition, the signal output voltage might not be received properly.

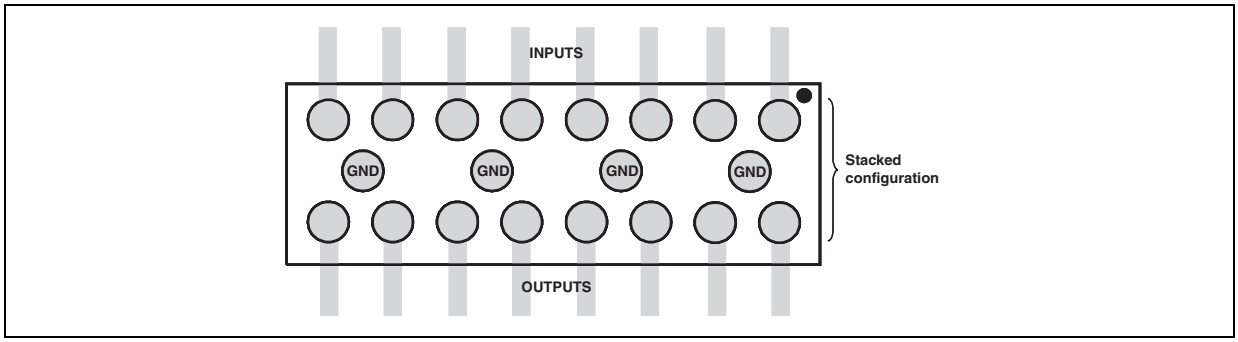
Figure 5: 40Mhz data transmission test through high and low cap filters



5. High integration solution

In comparison with discrete designs, the use of the highly integrated EMI filters designed in Flip-Chip packages with stacked bumping configuration, simplify printed circuit board layout while providing up to 80% board space savings respectively.

Figure 6: Board space saving illustration



It results in a line integration ratio (PCB space/number of lines) around 0.6. It means that these new filters offer EMI filtering function and ESD protection with 0.6mm^2 PCB space consumption per line. No other solutions on the market can bring better integration performance.

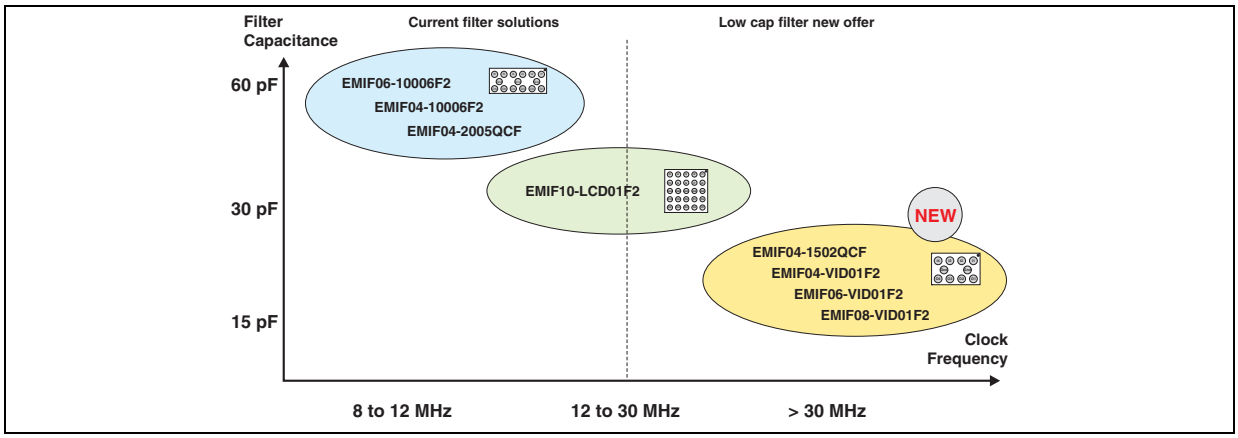
The new filter family is proposed with 4, 6 and 8 "PI" lines configuration to offer flexibility to designers and to address most of all high speed data line designs. Their PCB area consumptions are respectively 2.4mm^2, 3.7mm^2 and 5.0mm^2, so almost unless than a classical SOT323 plastic package.

6. Conclusion

The new ST low capacitance EMI filters supports 4, 6 and 8 lines with each one containing RC filter network flanked with Zener diodes. A series resistors value of 100 Ω and a line capacitance value of 17 pF are used to achieve 30 dB minimum attenuation form 0.8 MHz to 2 GHz. The devices low capacitances means that they can be used on next LCD displays and cameras sensor with clock frequency in excess of 40 MHz.

With the introduction of this new family, STMicroelectronics offers now a full EMI filter range for video applications covering low to high-end mobile phone applications. More information can be obtained on ST web site (www.st.com).

Figure 7: STMicroelectronics EMI filters portfolio for Cameras and LCDs



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