

PROTECTION PRODUCTS

Protecting Color LCD Displays in Cellular Phones

Clamshell and slider style handsets that incorporate cameras and large color LCD displays have become extremely popular. While increased functionality is made possible by the clamshell and slider designs, ESD and EMI concerns present certain design challenges. The interconnecting flexible printed circuit can act as an antenna for conducting harmful ESD and EMI events. These events can disrupt or even damage the controller circuitry in the baseband ASIC. In a typical design, low pass filters are used to suppress EMI while TVS diodes are used for ESD protection. This application note addresses the EMI/ESD concerns that designers will face when implementing next generation phone designs, as well as potential solutions to these problems.

ESD/EMI Issues for Flex Printed Circuits

In modern clamshell phone designs, a flex printed circuit (FPC) is used to send data from the baseband IC to the color display or camera module. The clock and data rates range from 12MHz to 50MHz and are increasing. These fast data rates mean that the FPC becomes an EMI generator that can cause upset in the phone functions. In addition to being a source of EMI, the FPC can act as an antenna for conducting EMI from nearby RF circuits. Again, this can cause intermittent problems, particularly with the display. To combat this issue, designers typically utilize a low pass pi-filter on each of the affected lines. A typical pi-filter consists of a C-R-C network and must provide 20 – 30dB attenuation in the cellular frequencies from 800MHz to 2.7GHz.

The second issue encountered by designers is electrostatic discharge (ESD). ESD can enter the phone at any path from the outside world to the internal circuitry. This includes data and I/O connectors, audio ports, multi media card ports, keyboards, and the interface between the display and the main system board (i.e. the interconnecting flex cable). ESD is normally generated by the human body, but the FPC can also store charge since it is a triboelectric material (i.e. it becomes charged when rubbed with another material). This means the mere act of rubbing the FPC with the phone case during opening and closing can generate a charge on the FPC sufficient to cause catastrophic damage. Cell phones typically must meet the ESD requirements of

IEC 61000-4-2, Level 4 as a minimum. Level 4 requires contact discharges with a magnitude of +/- 8kV and air discharges of +/-15kV. The IEC 61000-4-2 standard requires 10 discharges in each polarity at vulnerable parts of the phone. The ESD pulse contains little energy, but an unprotected circuit can suffer damage due to the ESD current flow or the high magnitude of the ESD voltage. In addition, the fast nature of the ESD pulse (rise time <1ns) can even generate EMI, causing upset to nearby circuits. Therefore, in addition to proper EMI filtering, each line connected by the FPC must include adequate ESD protection. This is accomplished with an external Transient Voltage Suppressor (TVS).

ESD/EMI Protection Solutions

A typical 16-bit color LCD bus would require at least 48 discrete components for EMI filtering and an additional 16 ESD protection devices for a total of 64 components. As board space is always at a premium in modern handset designs, this is clearly not a desirable option. A better solution is to use an integrated device that includes both ESD protection and EMI filters. While several such devices exist, the characteristics of these devices can vary greatly. Proper device selection will insure a reliable design. Some of the device characteristics that a designer must consider include:

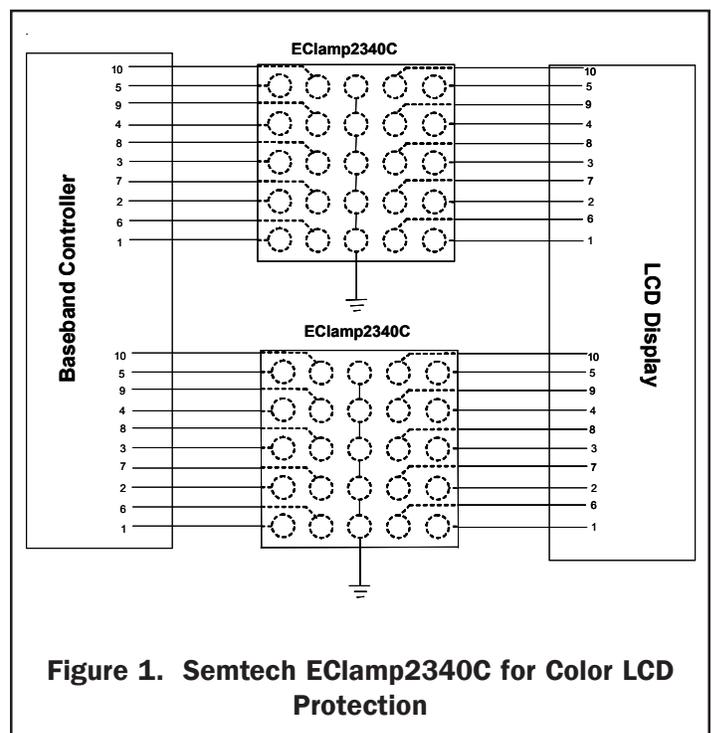


Figure 1. Semtech EClamp2340C for Color LCD Protection

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- Device package: A flip chip package will require less board space as opposed to packaged devices.
- Number of protected lines: More lines per device means less packages are required.
- Device layout: A flow thru design means ease of layout and improved signaling characteristics.
- Filter characteristics: The device must adequately suppress unwanted EMI signals across the cellular band.
- Component values: The resistor and capacitor values must provide adequate filter characteristics without attenuating the signal or causing time delay issues.
- TVS working voltage: The working voltage of the TVS should be as closely matched as possible to the normal operating voltage of the protected line.
- TVS Clamping Voltage: The protection device must be able to clamp a positive and negative polarity, 8kV (contact discharge), 30A ESD pulse to a level low enough as to prevent damage or stress to the protected IC.

Examples of two integrated solutions for color LCD protection are the Semtech EClamp2340C and EClamp2342N. The EClamp2340C is in a 2.6 x 2.6 x 0.7mm flip chip package and is designed to provide ESD protection and EMI filtering for 10 lines, replacing up to 40 discrete components. The EClamp2342N is in a 3.0 x 3.0 x 1.0mm QFN plastic package and is designed to provide ESD protection and EMI filtering for 8 lines, replacing up to 32 discrete components. Each line in both devices contains a low pass C-R-C pi-filter network that is flanked by TVS diodes at either end. The EClamp2340C is designed with a series resistor value of 100 Ohms and a capacitance value of 18pF (VR = 2.5V) to achieve 25dB minimum attenuation from 800MHz to 3GHz for each pi configured filter. The EClamp2342N also contains 100 Ohm series resistors but with a slightly lower capacitance value of 12pF (VR = 2.5V) per line. The low capacitance means these devices can be used on next generation LCD displays with clock frequencies in excess of 20MHz. The TVS diodes are designed to suppress ESD surges in excess of the IEC 61000-4-2, Level 4 requirements of +/-8kV contact and +/-15kV air discharge.

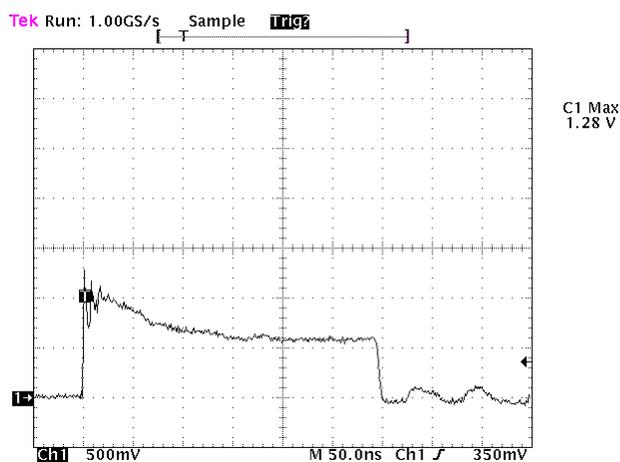


Figure 2a. Response to a +8kV ESD Pulse per IEC 61000-4-2

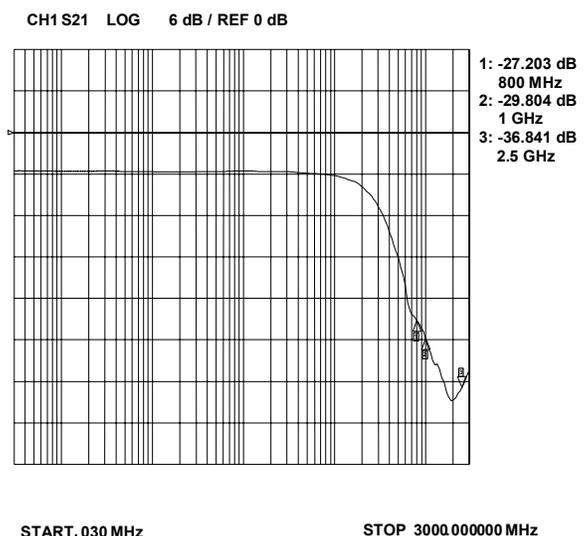


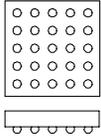
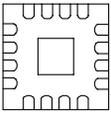
Figure 2b. Typical Filter Characteristic

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Implementation Example

A typical implementation example is shown in Figure 1. Two devices are required to protect a typical 16-bit bus. Note that the device is placed on the main system board and not on the LCD module. The reason is that the main system board is the source of the EMI. Also, the baseband controller IC required the ESD protection. Additionally, the device should be as near as possible to the transient entry point. In this case, that means near the connector for the FPC on the baseband board. All path lengths between the TVS and the protected lines should be kept as short as possible to minimize the effects of parasitic inductance in the board traces. A good ground is also important, particularly in the case of ESD. All ground connections should be utilized with the path to ground kept as short as possible.

Figure 2a shows a typical response for these devices to an 8kV ESD pulse per IEC 61000-4-2. The device clamps the pulse to less than 13 volts. Figure 2b shows the typical filter response. Signals are attenuated to greater than 30dB from 800MHz to 2.5GHz.

Package		
Flip Chip 10 - Lines 5 x 5 Bump 2.6 x 2.6 x 0.65 mm 	EClamp2340C R = 100 Ohms C = 18pF (VR = 2.5V) >25dB 800MHz – 2.7GHz	SFC2309-200 R = 200 Ohms C = 47pF (VR = 0V) >30dB 800MHz – 2.7GHz
QFN 8 - Lines 16-Pin 3 x 3 x 1 mm 	EClamp2342N R = 100 Ohms C = 12pF (VR = 2.5V) >25dB 800MHz – 2.7GHz	EClamp2350N R = 200 Ohms C = 12pF (VR = 2.5V) >30dB 800MHz – 2.7GHz

Semtech Products for Color LCD Protection