FCC CONSIDERATIONS

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ABSTRACT

Flat panel technology in computing devices is our focus here but this paper will apply in most cases to system-level applications. This is due to the fact that one cannot foresee every varying configurationof systems for a particular flat-panel display. The following explains a portion of the emissions concern with FCC, why it is so important, and what is expected of the designer in the beginning stages. The material in this paper is not intended to replace any authorized publications in regards to regulatory emissions and FCC.

INTRODUCTION

Sharp's flat-panel displays are basically considered components. For this reason one cannot say that we can get specific approvals at this level. FCC applies to emissions at the system and peripherals level. Our products are designed with compliance in mind but one cannot expect every kind of measure to be taken at the component level. Sharp's manufacturing is reactive to customers' needs and justifiably most of them can achieve compliant system designs.

STATIC INTERFERENCE IN THE HOME AND OFFICE

FCC has two classifications: Class A or Class B. Class B applies to home or personal use and Class A applies to all others. Radio-frequency interference is the main problem with systems using high-frequency clocks. These signals interfere with neighboring receivers. The bulk of these receivers are found in the home in the form of AM/FM radios, televisions and some two-way and HAM radios. Wireless remote and cellular phones are abundant and can also be susceptible. Both classifications are used to distinguish acceptable signal levels for each environment. The acceptable levels in the home are more stringent. Interestingly enough with the advent of multimedia, the office will become more sensitized to the interference levels. Static interference comes in through the receivers antennae, referred to as radiated interference, or through the power lines as conducted interference.

The source of interference is typically the same for all environments. Nature is certainly a contributor to noise but typically thunderstorms are the most noticeable. Primarily the man-made aspect of interference is experienced and for that reason it is necessary for some regulation through the FCC. Any time electrical energy is present one can expect this interference in the form of electro-magnetic interference or EMI. Automobiles, power tools, appliances, transmitters, office equipment, test equipment, medical equipment, and computers to name a few. If you paint a picture of the modern version of these in your mind you can realize that almost all of these have some form of visual display for the user interaction.

DEFINITIONS

The Federal Communications Committee was created by Congress to regulate emissions and license broadcasting. There are a number of bureaus within the FCC. The Office of Engineering and Technology (OET) deals with authorizations and grants, while the Field Operations Bureau (FOB) enforces regulation. According to a 1987 document noted FCC/OET MP-4 the OET office is at:

Federal Communications Commission
Authorization and Evaluation Division
7435 Oakland Mills Road
Columbia, MD 21046

MP-4 happens to be on RF measurement procedures. Copies of those materials on general rules and regulation can be requested there. The regulation which applies to interference is Title 47 code of federal regulations (CFR) Parts 2 and 15, although there are 42 parts or sections. Part 2 deals with general rules. Part 15 is on RF devices. Each part is divided into subparts. Subpart J applies to all digital devices using 10 KHz or greater clocks which are not regulated within other rules.

Subpart A refers to:

- Class A and B distinctions
- Personal and business computer distinctions

Class A is 'A computing device that is marketed for use in a commercial, industrial or business environment; exclusive of a device which is marketed for use by the general public, or which is intended to be used in the home.' which requires verification. Verification involves the manufacturer insurance of compliance without any need to submit data or samples. They are required to have test data though on file at the manufacturers side. The limits are:

Class A Radiation Limits

FREQUENCY (MHz)	DISTANCE (m)	FIELD STRENGTH (µV/m)
30-88	30	30
88-216	30	50
216-1000	30	70

NOTE: Class A measurements can be made at any distance between 3 and 30 m. The test results can be scaled inversely with the distance. For example at 3 m the allowable field strength in the frequency range 30 to 88 Mhz is 300 µV/m.

Class A Conducted (Power Line) Limits

FREQUENCY (MHz)	MAXIMUM VOLTAGE (µV)
0.45-1.6	1000
1.6-30	3000

Class B is 'A computing device that is marketed for use in a residential environment notwithstanding use in commercial, business and industrial environment.' These are devices which require certification. Peripherals which fit the description for a Class B computing device also require certification. Certification involves submitting test configurations and data to the FCC by the applicant. This is a much more difficult process than Class A because of this and its more stringent signal limitations:

Class B Radiation Limits

FREQUENCY (MHz)	DISTANCE (m)	FIELD STRENGTH (µV/m)
30-88	3	100
88-216	3	150
216-1000	3	200

Class B Conducted (Power Line) Limits

From 0.45 to 30 MHz the maximum voltage fed back to the line at any frequency must be less than 250 µV.

There are conditions which help determine if the application is business or personal (Class A or B). For Class B all three of the following should apply:

1. If it's available through retail or mail order catalog to the general public (not niche catalogs that cater to specific commercial applications).
2. Advertisements directed at the general public via magazines or marketing brochures rather than specific commercial users.
3. Operates on battery power or house current.

One must demonstrate to the commission that because of price or performance the system could not be applicable in the home or for personal usage.

APPLICATIONS AND COMPLIANCE

As one can see, both radiated and conducted types of EMI are potentially disruptive to broadcast signals at the receiver. Compliance to FCC emissions can also benefit the end product by allowing immunity at internal signal lines to external noise. One now has to consider on how to comply to FCC limits. The limits described above are maximum limits. The designer and manufacturer must allow for some margin of manufacturing tolerances. Typically most will allow about 6 dB minimum below the given limits for both classifications. This is usually enough margin for most but one must take caution with ones own manufacturing tolerance capability. The equipment needed to do the testing is quite expensive. These will be described in more detail later. Most manufacturers contract out to what are called EMI test sites and labs. The availability of these test facilities depends on the location. They are not generally hard to find. It's best to use an FCC authorized site to allow for transferability of test data to the commission.

Flat panel displays affect system design at the video level when attempting to pass FCC. Typically the video controller generates clocks which range between 50 Hz and 20 MHz for monochrome LCD and EL displays. Generally, the video clocks encompass the higher part of that range (10 to 20 MHz). In color LCD displays, the frequency of video clocks is about 28 MHz at the high end. These are the areas where one must concentrate to alleviate 'hot spots' in the FCC range of frequencies. Most of the applications in monochrome are easily passed. It is in color displays where the designer is challenged in resolving for a compliant system.

Incompatible shielding practices can cause problems. If a system's main enclosure is shielded well and the display bezel is left unshielded, conducted emissions from the system can be radiated through the display housing. Refer to Figure 1.

Some typical measures one would take for attenuating EMI would be:

- Board Layout Practices – Here the video graphics control board is laid out with compliance in mind. Close attention to ground paths and plains is critical. A long ground path can vary in impedance at different frequencies. Additionally output impedance's of the video clock lines may require some damping by way of ferrite beads or capacitors to smooth out any spikes. Very sharp rise and fall times can cause amplified EMI 'hot spots.'
- Cabling – The shortest path to the display is recommended. Instances where this is not possible

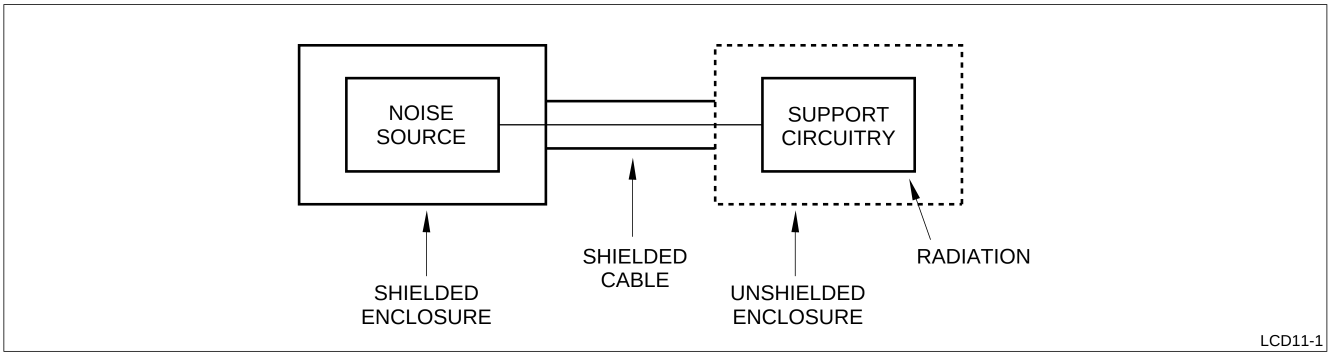

Figure 1. Incompatible Shielding

one must enhance shielding or experiment with different grounding points. Add ferrite cores to filter out noise. These can prove to be very effective counter measures.

- Metal Enclosures – Full metal enclosures or conformal coating of plastic enclosures are recommended for stubborn emissions.
- Separate Interconnect Boards – This facilitates flexibility in adding measures to reduce emissions without having to do new board layouts or bulky cabling.

TEST FACILITIES AND EQUIPMENT

There are two type of testing facilities. An open field test site is preferred for final determination of level compliance. These require an open field away from any power lines or metal structures. A baseline background noise is established to make any corrections to the data. In some cases the equipment under test (EUT) is laid out in the open on some wooden platform with appropriate power connections and monitoring cables. These are routed to a lab environment at some distance so as not to cause any skew in the testing. The platform is set 30 meters from dipole antenna for class A, 3 meters for class B.

There are five main items which are maximized for worst case readings.

1. The EUT must be rotated as in a turntable to maximize the signals received back at the lab area. Usually these tables are remotely controlled for rotation to allow expedience.
2. Cable placement is optimized for worst case.
3. Configuration of the system is optimized by attaching cables and or peripherals on all I/O connectors.
4. Worst case software is run to peak the overall speed of all the system clocks. At the display side a full screen of scrolling H’s is a good test.
5. Receiving antenna orientation horizontal, vertical, and height is adjusted for worst case.

An enclosed shielded lab environment can be used to do EMI testing but it’s only used for determining ‘hot spots.’ One should realize that frequency profiles in an enclosed lab environment can hide some unexpected problem areas. It’s advisable not to make any manufacturing decisions based on enclosed lab findings. The final decisions should always come from an open test site. One could be fighting an apparent problem area in an enclosed lab test and not know that in actuality the problem is non-existent in the real test. This could cost valuable engineering time for both the manufacturer and the components vendors.

Conducted tests are done on both the hot and neutral lines of the system power cord. Readings are taken separately for both. The center of the test equipment is a line impedance stabilizer network (LISN). This ‘box’ provides uniform impedance to the equipment under test (EUT). Signals are tapped off of this box on to a spectrum analyzer to measure the range of 450 KHz to 30 MHz. Class A measurements break it down in two ranges. For 450 to 1600 KHz the readings should not exceed 1000 µV. From 1600 KHz to 30 MHz it should not exceed 3000 µV. Much lower voltage levels are allowed for line interference in the home or Class B. Throughout the entire range the reading should not exceed 250 µV.

MANUFACTURING CHANGE EFFECTS

Whenever changes are made in the manufacturing of the system or its components several rules will apply.

For certified equipment such as for Class B one can refer to FCC article 2.1043. Simply, a change which has lower emissions requires little or no action by the manufacturer. On the other hand if one changes the product and it reduces the amount of margin (even if still under the FCC limits) this will require retesting and submittal of new test data. For this reason one must submit the worst case manufactured capability of the product at FCC initial submittal. This can help the compliance engineer when doing audits during the life of the product.

For verified equipment or Class A one can refer to the 'Public Notice of April 7,1982' document from FCC. In this case typically the manufacturer can simply retest and file his findings internally. Again no application is needed with the FCC.

LABELING FOR COMPLIANT SYSTEMS

Labeling is defined explicitly by the FCC. Specific wording must appear on the compliant system. FCC Class B labeling should appear such as:

FCC Class A labeling requirements should appear such as:

– Grantee Name Here –

FCC ID: XXXYYY1234

Certified to comply with Class B limits, Part 15 of FCC Rules. See instructions if interference to radio reception is suspected.

Made in . . .

In addition to labels one must have an insert to the systems instruction manual which has specific actions to be taken by the user to remedy the interference. Also precautions are given when changing out system components such as power cords or peripherals. One can obtain this wording directly from the FCC Part 15, subpart J Rules.

This equipment complies with the requirements in Part 15 of FCC Rules for a Class A computing device. Operation of this equipment in a residential area may cause unacceptable interference to radio and TV reception requiring the operator to take whatever steps are necessary to correct the interference.

CONCLUSIONS

FCC rules are extremely detailed and can suffer from interpretation. One would expect to see more claims with FCC in regards to testing and misuse of the rules. Surprisingly most of the claims are related to labeling of the products. In the history of emissions claims only during the hey day of CBs did the amount of claims rise. Notebook computers have been abundant and no news of increased claims have been apparent. This just shows that manufacturers have not had difficulty in complying specially with the use of flat panels rather than the obtrusive CRT.

REFERENCES

[1] *EMI for EDP, Telecom, and Medical Devices*, A Seminar, by Dash, Straus and Goodhue, Inc., Compliance Engineering

[2] *FCC Procedure for Measuring RF Emissions from Computing Devices*, FCC/OET MP-4 (1987)

[3] FCC, Code of Federal Regulations, Article 47, Parts 2 and 15 subpart J.

NOTES

LIFE SUPPORT POLICY

SHARP components should not be used in medical devices with life support functions or in safety equipment (or similiar applications where component failure would result in loss of life or physical harm) without the written approval of an officer of the Sharp Corporation.

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