REPORT 1209

MEASURES FOR THE AVOIDANCE OF POSSIBLE INTERFERENCE GENERATED BY DIGITAL TELEVISION STUDIO EQUIPMENT

(1990)

1. INTRODUCTION

With the advent of digital picture processing, the problems of spurious radiation from such apparatus has had to be considered. Equipment built to operate on the CCIR Recommendation 601 digital video standard utilizes a luminance sampling frequency of 13.5 MHz, the ninth harmonic of which coincides exactly with an international distress frequency, namely 121.5 MHz. In addition, 243 MHz, or the 18th harmonic of the luminance sampling frequency, is also reserved for international distress use.

The international distress frequencies, 121.5 MHz and 243 MHz are used by Emergency Location Transmitters (ELT) in the aeronautical service and Emergency Position Indicating Radio Beacons (EPIRB) in the marine service. The methods of operation are similar and an emergency is indicated by the radiation of a carrier with AM "chirp" modulation. The signals may be received on fixed receivers but are usually detected by aircraft or satellite receivers. Sophisticated processing is required to detect these signals reliably due to noise, interference and frequency variations due to misalignment and Doppler shifts over a bandwidth of 25 kHz. [Chung and Carter, 1987] outlines the processing involved in the SARSAT (Search And Rescue Satellite Aided Tracking) program of Canada, USA, France and USSR.

In view of the need to eliminate harmful interference, the design, construction and operation of digital equipment must take this into consideration, as a high priority. This Report describes electrical and mechanical measures, methods of measurement and some results of measurement.

2. Circuit Design Methods

Whenever feasible, the circuit board should be partitioned by logic speed, frequency and function. This technique reduces track lengths and helps to isolate high-frequency digital signals from analogue signals and also input and output lines. Impedance matching should be employed for high-speed logic devices. Balanced ECL circuits are frequently used.

The use of multi-layer printed circuit boards with power and ground distribution planes is recommended, as the planes act as feed-through capacitors at high frequencies. Analogue and digital power busses should be isolated. When the printed circuit board is being designed, the power distribution system should be considered first, followed by the signal distribution arrangements.

Decoupling capacitors with low effective series resistance and inductance should be placed close to IC power pins to reduce power supply radiating loops. Decoupling capacitors should also be employed at the point where the power supply enters the board. Surface mounted components should also be used where practical.

3. Electro-Magnetic Considerations

The following techniques may be employed for the minimisation of electro-magnetic radiation from equipment:

- use of connectors that are shielded and earthed to the equipment chassis.
- shielding and compartmentalising of components or sub-assemblies
- shielding and minimising the length of internal wiring.
- bringing earths and shields to a common point.
- use of multilayer boards with ground-planes for extender modules
- use of RF-screened chassis.

It has been reported that shielding is effective only if all inputs and outputs are filtered.

Electro-magnetic radiation can occur from ribbon cables. Possible means of minimising this radiation are by using "twist-n'-flat" and shielded cable, as well as by specially designed circular cables. Additional information on aspects of electro-magnetic shielding is contained in [Jerse and Terrien, 1986].

4. Measurement Methods

CISPR publications 16 and 22, on which the methods recommended by the standards associations of many administrations are based, give detailed specifications and procedures for measuring electromagnetic radiation. When measuring the radiation from a particular item of equipment, the real-life operational conditions of the equipment must be adhered to as far as possible. In particular, all external connections must be present.

5. Acceptable levels of radiation

CISPR Publication 22 recommends that the electro-magnetic radiation limits for Class A equipment (non-domestic low voltage equipment) should conform with the limits given in Table I.

TABLE I - Limits of radiated interference field strength at a test distance of 30m for Class A equipment

Frequency Range (MHz)	Quasi-peak limits dB(μV/m)
30 to 230	30
230 to 1000	37

Some administrations however recommend the limits given in Table II

TABLE II - Limits of spurious emissions (CSA Class A)
Maximum field-strength in dB(μV/m) at 30m

Frequency (MHz)	Maximum field-strength dB(μV/m) at 30m
30 to 88	30
88 to 216	34
216 to 1000	37

In [CCIR, 1986-1990 a] useful information is provided that may be used in making comparative judgements regarding the level of interference from digital equipment.

6. Measurements of radiated interference levels

Measurements of the levels of radiated signals at 121.5 MHz for a prototype digital PAL-RGB/YC_RC_B decoder based on Recommendation 601 have been conducted in Australia using a measurement technique conforming with CISPR publication 22. [CCIR, 1986-90 b] At a distance of 30m from the decoder field strength levels of up to 46 dB(μV/m) were measured. With cables removed levels of 37 dB(μV/m) were measured.

Similar measurements were carried out in the UK [CCIR, 1986-1990 c], again on experimental processing equipment conforming to Rec. 601, and adhering closely to the measurement technique outlined in BS 6527: 1984 (which is in accord with CISPR Rec. 22) in order to ensure repeatable results. The equipment under test was mounted on a remotely controlled turntable, and the measuring antenna was adjustable in height and polarisation so that worst case measurements could be obtained, field strength levels (referred to 30m) of up to 39 dB(μV/m) were measured. However, when the equipment was enclosed in a wire mesh cage a value of 24 dB(μV/m) (referred to 30m) was obtained.

These measurements on prototype equipment demonstrate that a potential problem exists. Careful attention needs to be paid to the electromagnetic compatibility of equipment based on Recommendation 601 in design, manufacture and use.

In Japan, measurements of the radiation from commercially produced digital video equipment having a sampling frequency of approximately 14.3 MHz have been conducted [CCIR, 1986-1990 d]. While this equipment does not conform to Recommendation 601 the levels of measured 9th harmonic (128.7 MHz) radiation may provide a useful guide to the levels that could be obtained from commercially produced equipment conforming with Recommendation 601. The level of 9th harmonic radiation measured was 22 dB(μV/m), referred to 30m.

Results reported in /CCIR, 1986-90e/ carried out at an experimental digital television studio in France gave mean field strengths which at 30 m would amount to between 29 dB (μ V/m) and 37.8 dB (μ V/m). If an attenuation of 20 dB to the concrete construction of the studio is taken into account, the resultant field strength would certainly be below the appropriate CISPR limit which is 30 dB (μ V/m) at 30 m.

REFERENCES

CHUNG, T. and CARTER, C.R. [1987]. Processing of real ELT signals for SARSAT. Canadian Electrical Engineering Journal, Vol. 12, No. 1;

JERSE, T. and TERRIEN, M. [1986]. A Designers Guide to Shielding. Hewlett Packard Publication.

CCIR Documents

[1986-90]: a. 11/81 (CCIR); b. 11/10 (Australia); c. IWP 11/7-143 (United Kingdom); d. IWP 11/7-157 (Japan); e. IWP 11/7-161 (EBU).