

Case study #	1.4
Title	Emission from telephone equipment affecting an amateur radio
Type of trouble	Acoustic noise.
Source of trouble	Host equipment of telephone system.
System affected	Customer's equipment and office equipment.
Location	Customer premises, Telecommunication centre.
Keywords	Emission, amateur radio, common mode choke, filtering.
Version date	2004-01-01

System configuration

Acoustic noise interference occurred in an amateur radio installed on the second floor of a building (see Figure 1.4-1). The building's first floor is an office and workshop and the second floor is a living space. The affected frequencies were 145.00 and 144.00 MHz. A lot of office equipment and manufacturing equipment was installed on the first floor. The distance between the amateur radio and the noise source (core equipment) was 10 m.

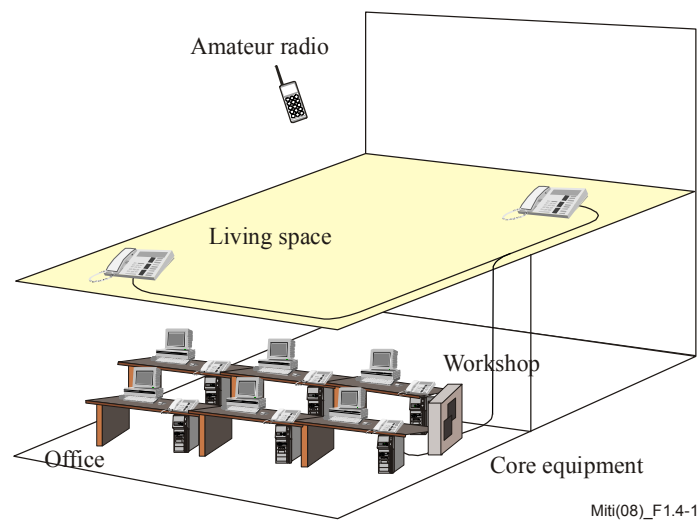


Figure 1.4-1 – System configuration

Measurement/Searching techniques/Experiment

- 1) Search technique (to find which equipment emitted the noise)

The emission source was searched for using a hand-held amateur radio tuned to the affected frequency. The affected area could be searched roughly. The electrical equipment acting as the emission source was determined by turning off the power of the suspected equipment. It was found that the emission source was the core equipment of the telephone system.
- 2) Mitigation trial
 - a) A ferrite core was installed in the power line and in the telephone line of the core equipment.
 - b) The core equipment was wrapped in aluminium foil.
 - c) An insulated conduction sheet was pasted onto the rear of the circuit board.

As a result, the acoustic noise affecting the amateur radio decreased slightly, but still remained.
- 3) Search technique 2 (to find the noise source)

When a noise is emitted, there must be both a noise source and a noise radiator. Both elements were searched for.

 - a) The system was measured in an anechoic chamber and the noise level was checked.
 - b) The noise source was searched for using a near-field magnetic probe and a spectrum analyser, as shown in Figure 1.4-2. In this case, a probe (Figure 1.4-3) was used. This probe had a coil consisting of several turns installed ahead of the coaxial cable. The coil was connected between the inner and outer conductors. Areas close to board components IC8 and Xtal4 had higher noise levels.
 - c) The noise level was checked by trial and error in an anechoic chamber when a mitigation device such as a capacitor or ferrite core was installed.

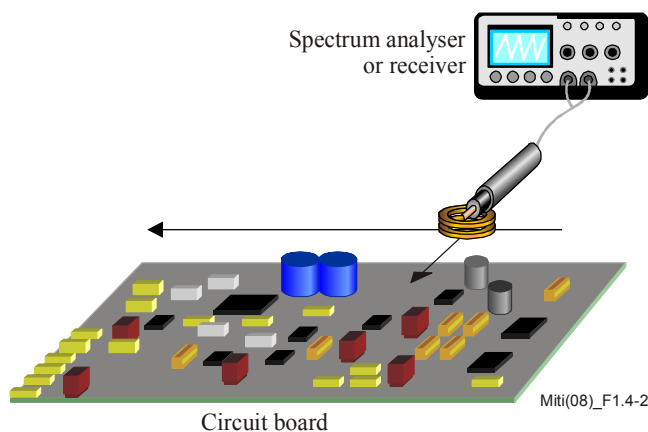


Figure 1.4-2 – Searching for the noise source

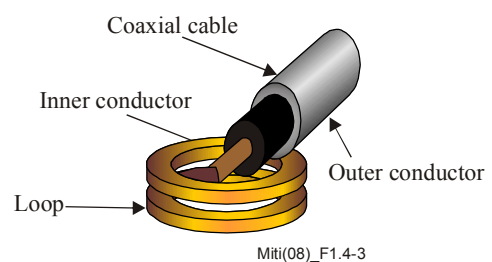


Figure 1.4-3 – Loop antenna

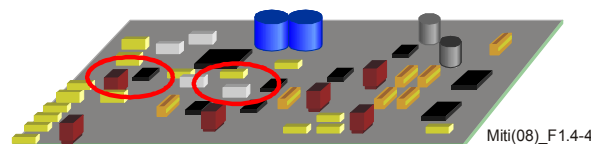


Figure 1.4-4 – Result of noise search

Mitigation method

The following definitive mitigation methods were applied:

- 1) An insulated conduction sheet was pasted onto the circuit board and a capacitor was put between the GND of the circuit and the sheet (Figure 1.4-5).
- 2) A ferrite bead was installed at the base of Xtal4 (Figure 1.4-6).
- 3) A capacitor was installed between VCC and GND of IC8 (Figure 1.4-7).
- 4) Ferrite cores were installed on all lines (Figure 1.4-8).

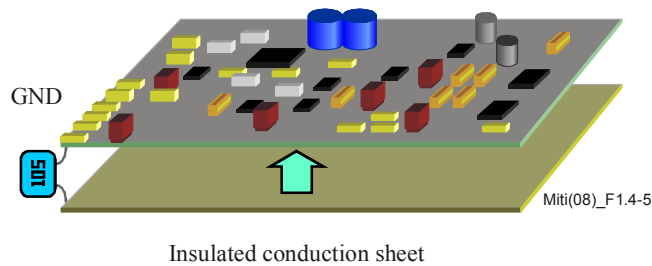


Figure 1.4-5 – Conduction sheet

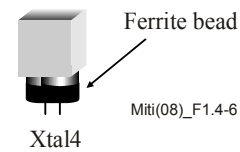


Figure 1.4-6 – Ferrite bead

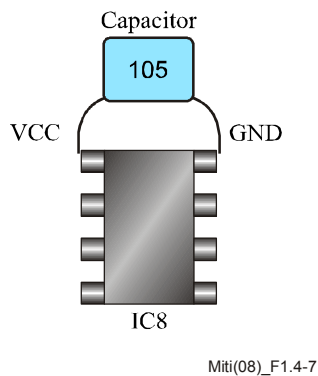


Figure 1.4-7 – Capacitor

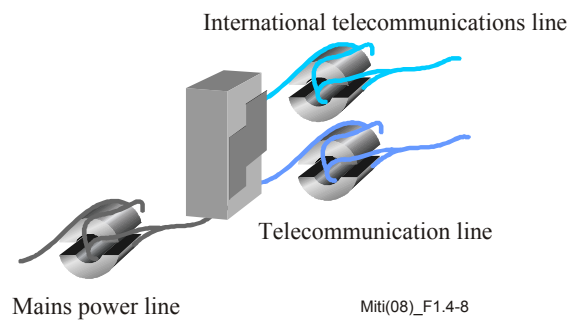


Figure 1.4-8 – Ferrite core

NOTE 1 – System integrity must be confirmed.

NOTE 2 – Changes to the system must be reported to the customer and are outside the guarantee in the future.