Case study #	1.2
Title	Acoustic noise troubles caused by switching noise of digital subscriber unit (DSU)
Type of trouble	Acoustic noise.
Source of trouble	DSU.
System affected	Customer's equipment.
Location	Customer premises.
Keywords	DSU, mutual coupling.
Version date	2004-01-01

System configuration

Acoustic noise trouble occurred at a customer's premises. The system configuration is shown in Figure 1.2-1. A remote terminal (RT) was used, as well as single mode fibres for the trunk lines. Metal lines were distributed using a metallic internal cable. Telephones, facsimile machines, and DSU were connected to the cable. There was no radio base station around the location. The electric field strength was not so high. After an ISDN service was introduced, the acoustic noise problem occurred. The line connected to the telephone was changed; however, the noise problem still continued.

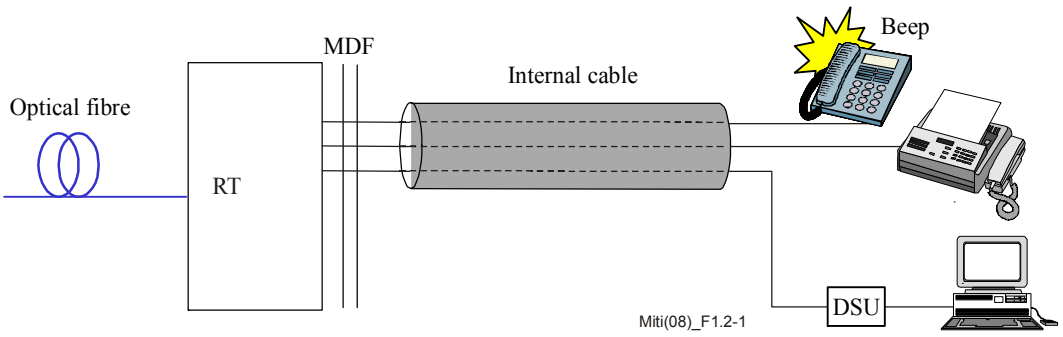

Figure 1.2-1 – System configuration

Measurement/Searching techniques/Experiment

To identify the noise sources, electric current wave shapes were measured using a current probe as shown in Figure 1.2-2. First of all, the current in the line connected to the telephone where the acoustic noise problems occurred was measured. The current level was not high but could cause malfunction of the telephone. However, the wave shape had little relation with the telephone because inverter noise spectrum was included in the wave shape. Next, the current on the line connected to the DSU was measured (see Figure 1.2-3). The current level was 240 mA_{p-p}, which is not a low level. As a result of the investigations, it was confirmed that the electric current noise originated at the DSU power source because the noise disappeared when the DSU was turned off. The noise current from the DSU travelled over the internal cable. In the cable, mutual coupling phenomena occurred. The noise current from the DSU induced noise current on the line connected to the telephone. The current caused malfunction of the telephone and the noise was detected in the telephone.

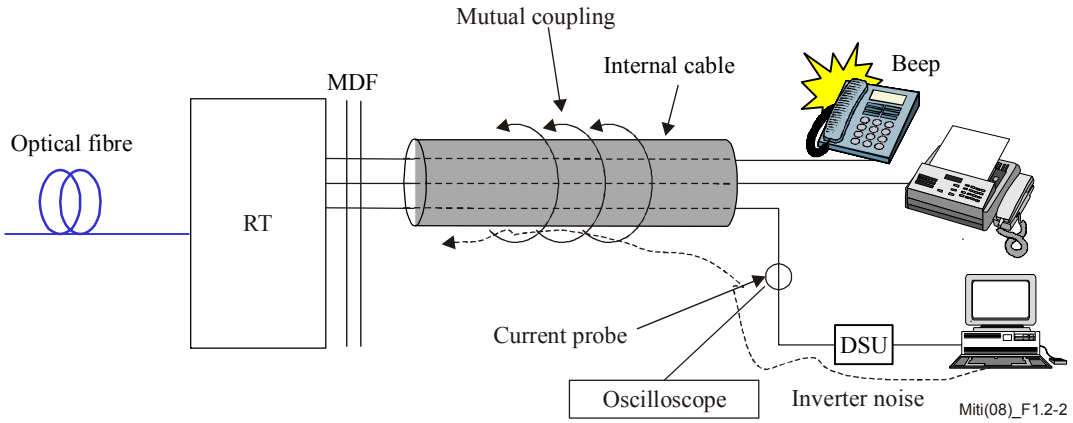

Figure 1.2-2 – Measurement of noise current on lines

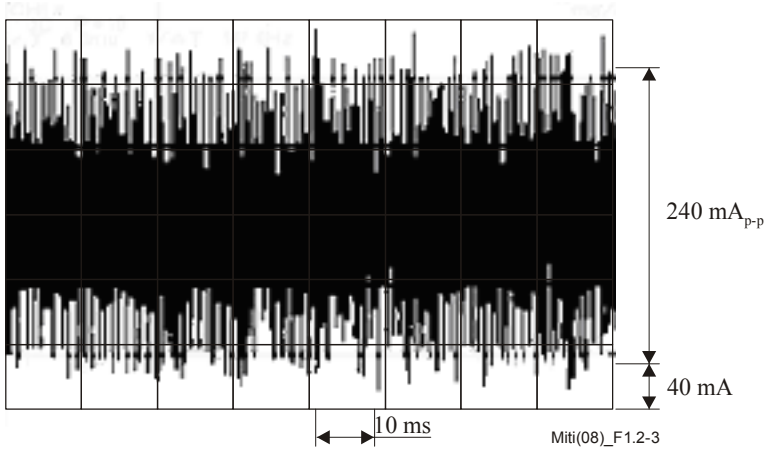

Figure 1.2-3 – Current wave shape in the line connected to the DSU

Mitigation method/Results/Conclusion

The centre frequency of the DSU switching noise was about 10 kHz; therefore, the common-mode filter (F2-40K) for mitigations shown in Figure 1.2-4 was selected. The central frequency of the filter was 40 kHz and it was effective for the switching noise of this case. By applying the filter, the current in the line connected to the DSU was reduced, as shown in Figure 1.2-5. The current level was reduced to less than 10 mA and the acoustic noise problem was solved.

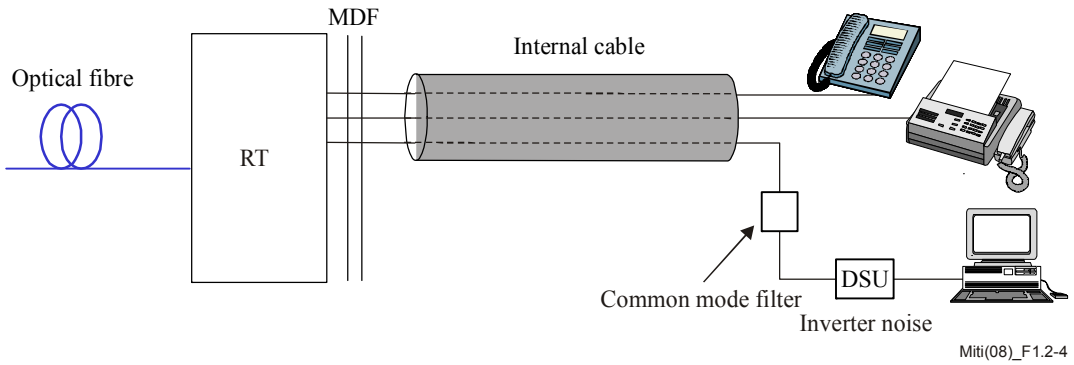

Figure 1.2-4 – Applied mitigation using common mode filter

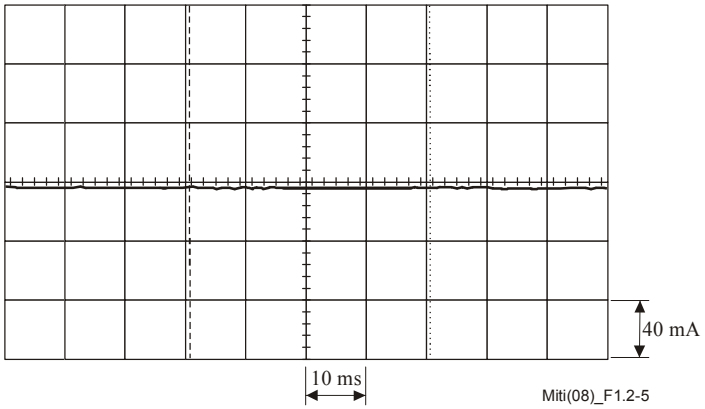

Figure 1.2-5 – Wave shape of the current in the line connected to the DSU, after the mitigation

References

Rec. ITU-T K.37; Annexes A and B.