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PRACTICAL INVESTIGATION INTO EMI FROM A LIFT MOTOR

PRAKTYCZNE BADANIA ZAKŁÓCEŃ ELEKTROMAGNETYCZNYCH SILNIKA WINDY OSOBOWEJ

Abstract: Electromagnetic Interference (EMI) consists of any unwanted spurious, conducted or radiated signals of electrical origin that can cause degradation in equipment performance. As a result, even though the electromagnetic compatibility (EMC) standard requirements have been met for an existing configuration, unwanted EMI may still cause the malfunction of an EMI victim, in this case a lift. This paper discusses an atypical case by referring to applicable standards and presents results, observations and recommendations.

Streszczenie: Na zakłócenia elektromagnetyczne składają się różne niepożądane sygnały pochodzenia elektrycznego które mogą powodować pogorszenie parametrów urządzeń technicznych.. W rezultacie, nawet jeśli są spełnione standardowe wymagania kompatybilności elektromagnetycznej dla danej konfiguracji, niepożądane zakłócenia mogą powodować różne perturbacje funkcjonowania urządzeń; w tym przypadku był to dźwig osobowy. W artykule omówiono nietypowy przypadek, ustosunkowano się do obowiązujących przepisów, podano szereg spostrzeżeń i zaleceń.

1. Introduction

The operation of the Radio Frequency Identification (RF ID) reader in a security gate at Mawson Centre building at Mawson Lakes Campus of the University of South Australia, was found to be subject to interference. The interference occurred whenever a nearby lift was descending either empty or with one passenger. The interference caused the security gate alarm to be activated and the glass sliding door to be locked immediately. This was an obvious nuisance to the building's users and posed a very interesting question why it occurred in light of the extensive EMC regulations in place prohibiting the cases as this from happening [1]. Moreover, as it was later discovered, the operation of audio-visual terminals (noise on the screen) in a lecture theatre adjacent to the lift was also affected by the same interference. In order to investigate compliance issues with CISPR (Comité International Spécial des Perturbations Radioélectriques) standards applicable to the investigation configuration, two tests needed to be performed: the radiated emission test and the conducted emission test. The EUTs (Equipment Under Test) were the passenger lift, the RF ID security gate, and the RF ID control unit. The worst case of EMI observed with an empty lift descending was singled out for further investigation.

2. General information on standards

Standards Australia is an independent body, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth Government, Standards Australia is recognised as Australia's leading national standards body [2]. It draws for application in Australia from the international standardisation documents such as the ones below.

The CISPR 22: 2002, "Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement", gives procedures for the measurement of the levels of spurious signals generated by the Information Technology Equipment (ITE) and limits are specified for the frequency range of 9 kHz to 400 GHz for both class A (domestic) and class B equipment (other than domestic). No measurements are required to be performed be performed at frequencies outside the limits.

The objective of this standard is to establish uniform requirements for the radio disturbance levels of the equipment, to limit levels of disturbance, to describe methods of measurement and to standardise operating conditions and interpretation of results [2].

The CISPR 14.1: 2003, "Electromagnetic Compatibility – Requirements for household appliances, electric tools and similar apparatus", applies to the conduction and the radiation of RF (Radio-Frequency) disturbances from appliances whose main functions are performed by motors and switching or regulating devices, unless the RF energy is intentionally generated or intended for illumination. The standard covers equipment such as: household electrical appliances, electrical tools, regulating controls using semiconductor devices, motor-driven electro-medical apparatus, electrial/electronic toys, automatic dispensing machines as well as movie or slide projectors. The disturbances are investigated in the frequency range of 148.5 kHz to 300 MHz [3].

3. Lift power consumption

The descending lift requires more power than the ascending lift due to the power required to raise the counter-balance. The power required for a descending lift depends on the weight of the passengers/goods in the lift. The more weight carried, the less power is required for the lift motor. As the motor's current magnitude and the resulting magnetic field depend on the power supplied to the motor, a hypothesis was developed that the main cause of the interference was the magnetic field. However, other possible cases needed to be tested before a final conclusion. The configuration of the system to be tested and the floor plan for tests are shown in Fig. 1 Fig. 2, respectively.

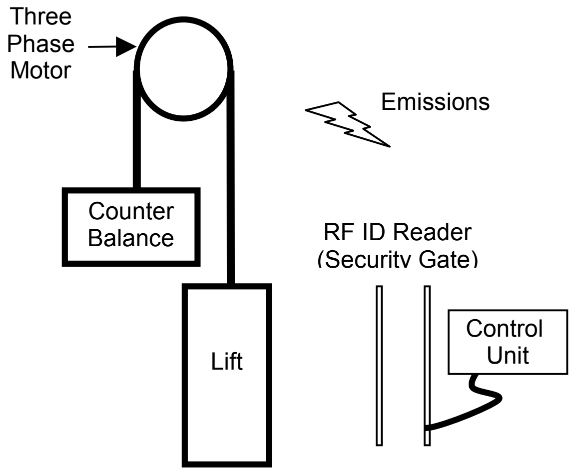

Figure 1. Diagram of the test objects

4. Radiated emission test

As the system under investigation could not be placed in a screened room as stipulated by CISPR 14, the military standard MIL-STD-461E [4] was invoked instead. The E-field emission test was performed by placing a Hewlett Packard 11955A biconical antenna (Fig. 3) 1 m from the lift doors to monitor the RF emissions generated by the lift. The results were subsequently displayed on the spectrum analyse, and recorded.

A magnetic field measuring loop RE101 coil [4] was used to detect the magnetic field emissions (H-field). The RE101 coil consisted of 36 turns AWG 7/41 litz copper wire on an insulated former with a diameter of 13.5 cm (Fig. 4).

The RE101 coil was placed at the distance of 2m from the security gate to obtain readings between 9 kHz and 150 kHz which is outside the range of CISPR 14 requirements (148.5 kHz to 300 MHz).

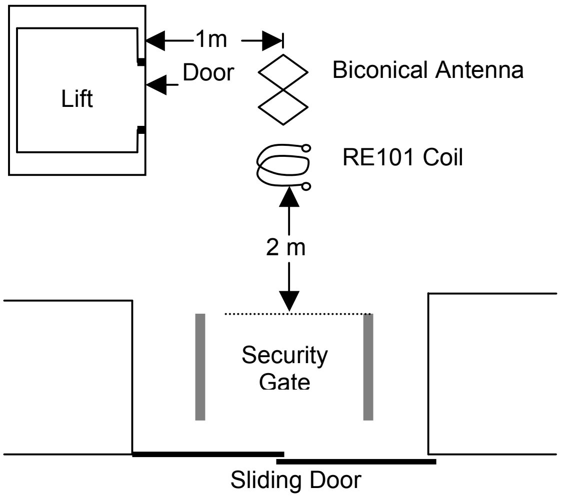

Figure 2. Sketch of floor plan for tests

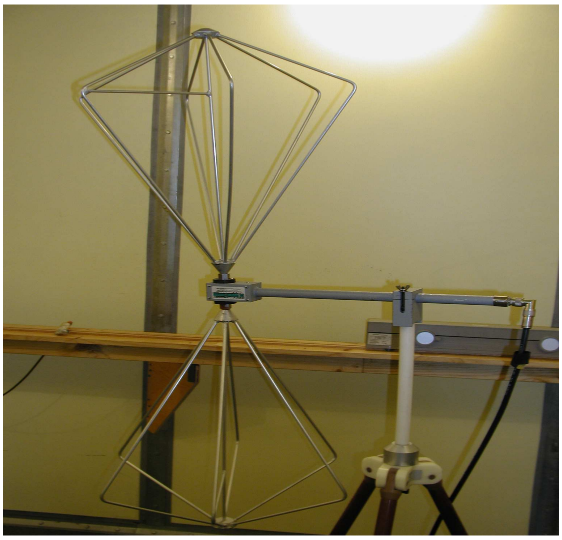

Figure 3. Biconical antenna for measuring E-field emissions

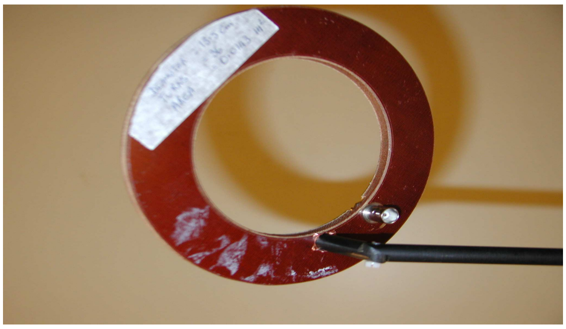

Figure 4. RE101 coil for measuring H-field emissions

5. Conducted emission test

Conducted tests using a voltage probe were performed on the earth, live and neutral power lines of the RF ID control unit, in accordance with CISPR22 directions.

An isolating transformer was connected between the power mains outlet and the spectrum analyser to prevent earth leakage when conducted emission test was performed on the active and neutral lines of the RF ID control unit.

6. Measurement results (radiated emissions)

Biconical antenna readings (radiated emissions) showed no significant E-field emission during the tests. However, the RE101 test spectrum (Fig. 5) showed an increase in the level of magnetic field above the ambient reading between 9 kHz and 100 kHz with a peak value of 66 dBpT (39.8 mGauss) at 16.51 kHz. Test results indicated by markers in Fig. 5 are presented in Table 1.

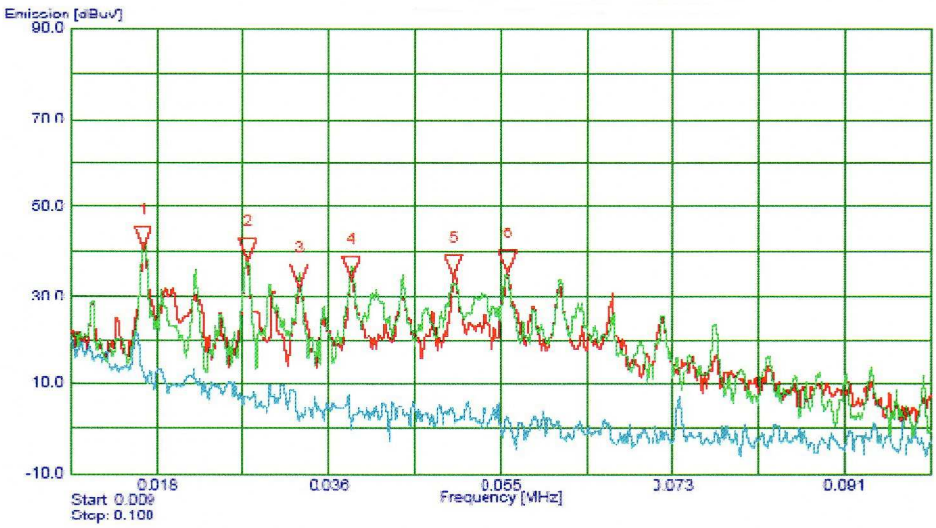

Figure 5. RE101magnetic field radiation test results between 9 kHz and 100 kHz

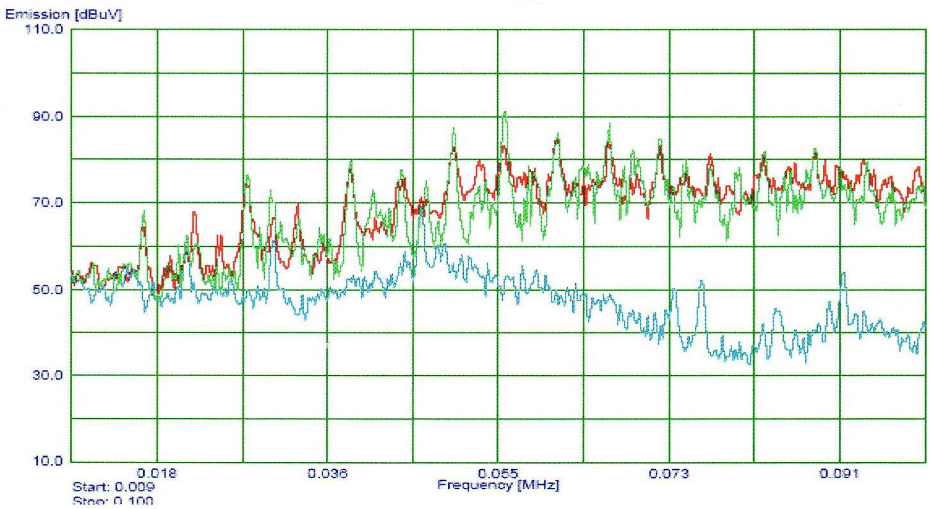

Figure 6. Conducted emissions on live power line at frequencies between 9 kHz and 100 kHz

Table 1. RE101 test results

Marker	Frequency (kHz)	Peak (dBpT)
1	16.51	40.7
2	27.65	37.9
3	33.11	32.0
4	38.58	33.7
5	49.50	34.3
6	55.18	35.2

7. Measurement results (conducted emissions)

The test did not indicate any significant changes in the EMI level during all the lift movement scenarios. Furthermore, there was no significant interference observed on earth and neutral power lines. There was some increase of the noise above the ambient in the live power line (Fig. 6 and Fig. 7). The maximum peak voltage of 91.2 dBμV was observed at 69.12 kHz.
Test results indicated by markers in Fig. 7 are presented in Table 2.

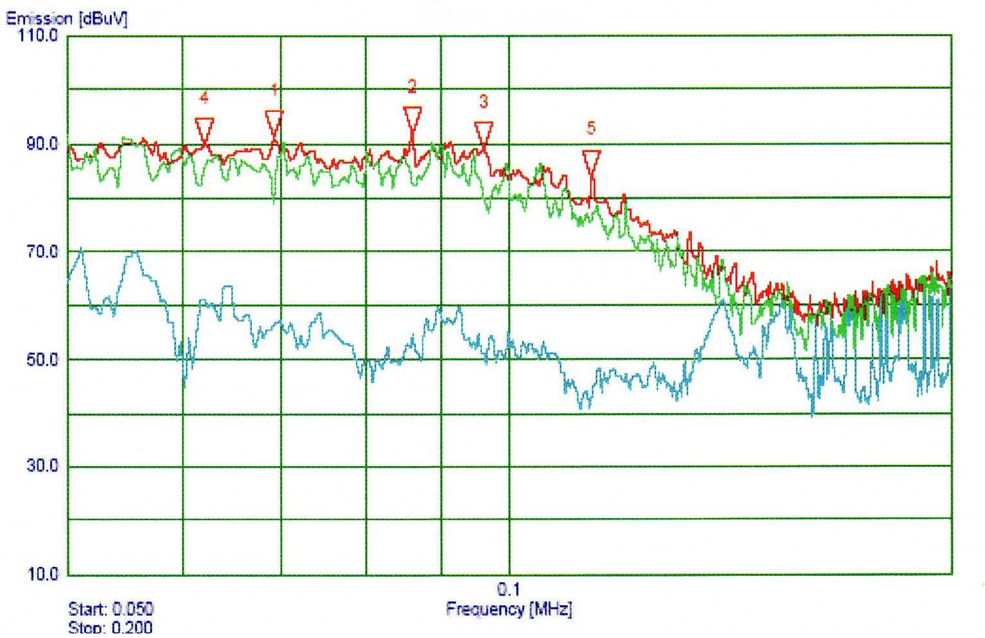

Figure .7 Conducted emissions on live power line at frequencies between 50 kHz and 200 kHz

Table 2. Conducted emissions test results

Marker	Frequency (kHz)	Peak (dBμV)
1	69.120	91.2
2	86.000	91.8
3	96.120	89.2
4	62.000	89.8
5	1.1375	84.0

8. Summary

Radiated emission tests were conducted by substituting the CISPR 14 by MIL-STD-461E in the frequency range between 9 kHz and 150 kHz. Conducted emissions were measured in compliance with CISPR 22 between 9 kHz and 200 kHz. There was no expectation of the presence of higher frequency emissions over the background noise as illustrated in Fig. 7.

Interestingly, the RF ID security system operated at approximately 2.5 kHz, which is outside the range stipulated by both CISPR 14 and CISPR 22.

9. Conclusions

It was found that the source of interference lied below 9 kHz: a frequency not covered by the existing standards. Although the whole system complied with the CISPR 14 and CISPR 22 standards, emissions were still the source of the interference.

For the conducted interference test, the high amount of current drawn by the lift when it was empty or with one passenger may induce noise in the data cable or supply cable leading to the RF ID control unit. These can also cause radiated interference to some component parts of the RF ID security system.

In conclusion, the test results indicate that even though the EMC standard requirements not mandatory in this case have been met for the existing configuration, undesired EMI caused the malfunction of the victim. This ambiguity points to the need for stricter requirements for testing in the existing standards to avoid cases illustrated to happen.

Initially neither the lift supplier nor the RF ID security system installer/producer wanted to take any responsibility for the malfunction of the security system. The lift producer obviously complied with the existing EMC standards. Eventually the RF ID producer made a concession and redesigned its system to work at 75 kHz and to meet the necessary EMC requirements. After that was not any mulfanction to the security gate and to the audio-video terminals in the building.

The case presented illustrates the conflict between an existing and a later installation in terms of compliance with EMC standards. The revised European Union Directive 2004/108/EC on EMC [5] gives precedence to pre-existing installations.

10. References

[1]. Cheang S.M., Liu M.Q.: *Report on Mawson Centre Lift Investigation*, Electrical and Information Engineering Project 2005, University of South Australia, 2005

[2]. Standards Australia/Standards New Zealand, CISPR 22: 2002, *Information Technology Equipment – Radio Disturbance Characteristics – Limits and methods of measurement*

[3]. Standards Australia/Standards New Zealand, CISPR 14.1:2003, *Electromagnetic Compatibility – Requirements for Household Appliances, Electric Tools and Similar Apparatus*

[4]. Department of Defence Interference Standard, MIL-STD-461E: 1999, *Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment*

[5] *Directive 2004/108/EC on EMC*, Approved by the European Parliment and the Council on 15 December 2004, published in the Official Journal of the European Union, L 390/24, 31 December 2004, to replace Directive 89/336/EEC from 20 July 2007.

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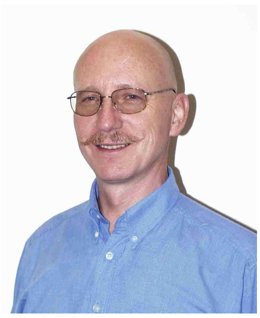

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