THE EFFECT OF CONSUMER ELECTRONICS ON AVALANCHE TRANSCEIVERS

Erwin Meister[1] ans Ilari Dammert [2]

[1] CCS Adaxys, Lachen, Switzerland.
[2] Mammut Sports Group, Seon, Switzerland

Every winter, the question how gadgets like Go Pros, GPS devices, smart phones, camera equipment, wrist watches, but as well professional equipment such as headlamps for organized rescues, interfere with an avalanche transceiver in SEND or SEARCH mode is raised.

The current avalanche transceiver technology is based on the concept of searching for buried subjects by following the flux lines of a 457kHz transmitter. Interference related complications in rescue have been reported and may be caused by portable electronic devices or metal objects such as carabineers, ice screws etc.

In order to systematically analyze how the transmit function may be compromised and the receive mode may suffer loss of range or show inappropriate distance/direction indications, a laboratory study has been carried out.

Based on measurements in an EMC-Laboratory [Electro-Magnetic-Compatibility], the study provides results about how different metal objects as well as active and passive devices influence the transmit [SEND] and receive function [SEARCH] of an avalanche transceiver. For devices which may be critical in rescue, such as a smart phone, the study evaluated the critical safety distances in order to allow the use of such devices on the accident site while a search is carried out.

The study provides for the different user groups of avalanche transceivers a better level of understanding concerning interference issues and recommendations how to practically avoid situations which may lead to problems during companion rescue or in an organized rescue mission.

KEYWORDS: Avalanche Rescue Transceiver, Electromagnetic Compatibility, Interference

1 INTRODUCTION

An avalanche transceiver is designed to search for buried subjects with a maximum range of approx. 60 meters (digital), using the internationally standardized frequency of 457kHz.

The rescuer with the receiving transceiver follows along the flux line pattern the electromagnetic field of the transmitter. The device of the buried subject transmits a 457kHz signal approx. once a second.

Corresponding author address: Erwin Meister,
CCS Adaxys, Alpenblickstrasse 26,
CH-8853 Lachen, Switzerland;
tel: +41 (0) 55 451 78 95;
email: erwin.meister@adaxys.com

ETS 300718 defines the legal and technical requirement for avalanche rescue devices and ensures compatibility between them.

In recent years, users of avalanche transceivers have started to carry and actively use a wide variety of consumer electronics in the mountains. It is important to understand that any kind of electronic devices emit Electromagnetic Interferences [EMI] and metallic objects affect magnetic circuits. Both effects have the potential to disturb the functionality of the transceiver in its "SEND" and "SEARCH" mode.

This raises the question of what kind of influence interfering objects such as consumer electronics and metallic objects have to a transceiver in transmit and receive mode.

The goal of this study is to answer this question, and to provide a better level of understanding concerning interference issues for the different user groups of avalanche transceivers. The conclusions include recommendations on how to practically avoid situations which may lead to problems during companion rescue or in an organized rescue mission.

2 BACKGROUND

Complex electronic devices consisting of a printed circuit board with various integrated switching circuits cause due to their switching processes in operation a perpetual magnetic field of different intensity. Hans Oested in the early 1819 for example already demonstrated such a phenomenon, when he observed that electric current could deflect a magnetic needle.

Based on this discovery it is obvious that any product which consumes electric power creates a perpetual magnetic field – even if this magnectic field is still small.

Instancing displays which are used in many devices are a special "source" of generating electromagnetic fields. To run a display needs on one hand electric power and furthermore creates constantly changing magnetic fields. As well electronic components such as charge pumps and processors are creating magnetic fields.

3 AVALANCHE TRANSCEIVER

Each transceiver consists of a transmitter and a receiver. To reach the goal of this study it is required to analyse both modes, "SEND" and "SEARCH" individually.

The aim of "SEND" mode is to transmit a magnetic field in compliance with EN 300 718.

The aim of "SEARCH" mode is to be able to detect even very weak signals from buried subjects far apart and to process the signal into an easy to interpret distance and direction indication to guide the rescuer.

4 METHODS

We applied quantitative laboratory measurements for both, "SEND" and "SEARCH" mode with a number of different beacons which were available on the market in the 2013/14 season.

In each test, interfering objects were positioned in different distances away from the searching or sending beacon.

The tests started at that distance where no influence to the sending or receiving beacon has been observed. Then the distance between the beacon and the interfering object was decreased in steps (e.g. 10cm) and the influence measured.

The first objects – different metallic items which are more or less common or useful for backcountry trips - had the potential to disturb the transmit mode of an avalanche transceiver [Tab. 1].

Metallic items influence magnetic fields and resonant circuits. Most products like electronic devices, shovels, beverage and food packaging, etc. contain metals, even if this is not always obvious for the user. For testing purposes, a standardized aluminum plate of 83x188x1 mm has been chosen. This dimension allowed that each tested beacon could be fully covered during the test.

The second object was to create interference to a receiving beacon. We decided to choose commonly used consumer electronics for this purpose [Tab. 2].

To exclude external interference during the measurements all tests were made in a shielded radio frequency chamber. A reference loop antenna was used to generate a reference 457kHz signal. The signal t was generated outside of the shielded chamber and supplied by an again shielded cable.

The signals measured during the tests were recorded by a PULS*EBarryvox* via its earphone jack connection. The amplitude of the 457kHz signal was equal to a signal which can be expected in a real avalanche scenario in 50m distance from a buried subject.

All measurements concerning SEARCH mode were performed in coaxial direction between the transceiver and the consumer electronics.

5 RESULTS

5.1"SEND" Mode

A range reduction has been observed for all tested beacons in relation to the distance between the aluminum plate and the transmitting beacon.

Influence of metal

For each examined transceiver, a reference measurement without any interference was made in a test distance of 30cm. In the next step of the measurement protocol, the previously described alloy plate was positioned as an interfering object in different distances to the transceiver.

In distances closer than 30mm between the transmitting device and the alloy board, an influence on the transmitter and the transmitted field strength was observed.

Range Reduction

When the aluminum plate was directly placed on the case of the transceiver (distance = 0), a significant reduction in amplitude of the transmitted signal was measured. At distances greater than 30mm, no range reductions were observed.

Objects which can affect the transmit signal

The following list gives an exemplary overview of objects that affect a beacon in "SEND" mode at a distance closer than 30mm:

Alloy bottle
Avalanche shovel
Metallic belt buckle
Carabineer; Ice screw, etc.
Beverage packaging
Candy packaging

Table 1: List of objects that were tested in "SEND" mode

5.2 "SEARCH" Mode

There was a significant loss of range in "SEARCH" mode over all tested beacons. The shorter the distance between the interfering objects and the receiving beacon, the greater was the loss of range.

In addition to the results stated about the influence of metallic objects in transmit mode, we also have to consider the following basic principles for a device in receive mode.

The goal of receive mode is to provide as much range as possible. To reach this goal the sensitivity of the receiver has to be as high as possible. The receiver electronics are therefore designed to amplify and process very weak signals.

When there are interfering signals within the frequency bandwidth of the receiver which are equal or greater in amplitude than 457kHz signal of the buried subject, this may lead to problems such as loss of effective range concerning signals of the buried subjects, random distance and direction indications as well as potential problems for the multiple burial algorithms.

It is important to note that all test objects in the following Table 2 as well as all beacons are in compliance with the essential requirements of electromagnetic compatibility [EMC].

Digital Cameras
Smart Phone
Watches

Table 2: List of objects that were tested in "SEACH" mode

The following figures should give a visual impression about a received 457kHz signal under different conditions.

Figure 1 and 2 show the internal electromagnetic noise of a PULS*EBarryvox* with and without a 457kHz signal from a buried subject.

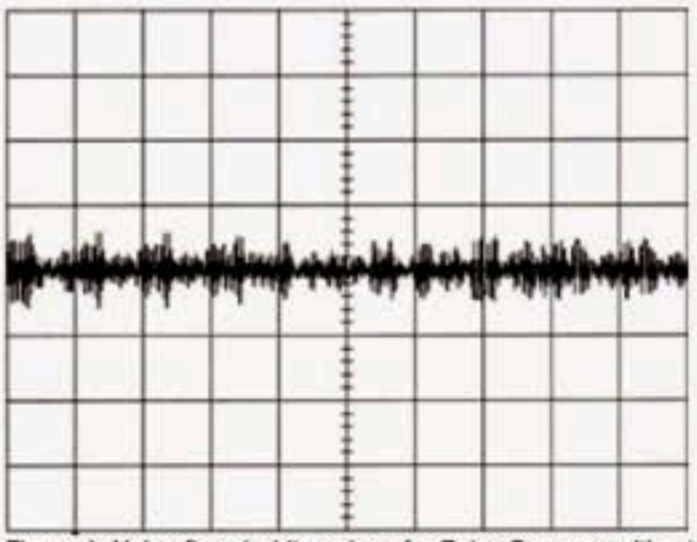

Figure 1: Noise floor / white noise of a Pulse Barryvox without any external interference or signal from a buried subject.

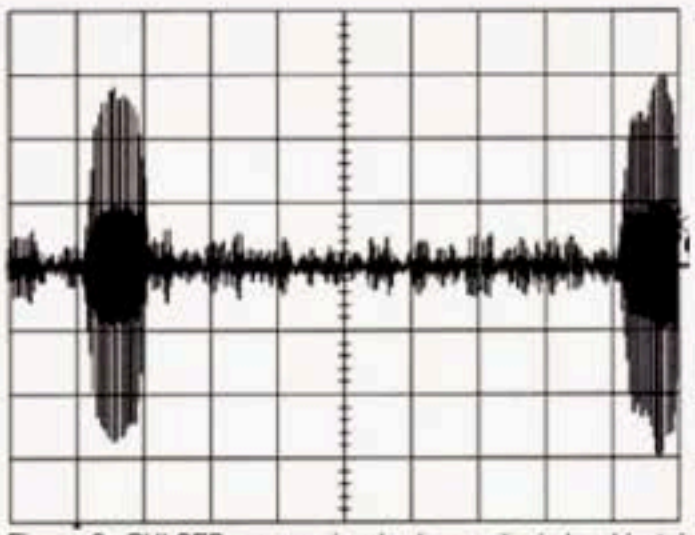

Figure 2: PULSEBarryvox signal when a buried subject is present, note that the amplitude of the noise between the "beep sounds" remain on an equally low level as shown in Figure 1. The difference between "signal" and "noise" is very distinct.

Figure 3 shows the influence from holding an interfering smart phone 36cm away from the receiving beacon.The noise level between the "beep sounds" dramatically increased in amplitude, making the difference between "signal" and "noise" much less distinct. Formely, this ratio is known as "signal to noice ratio" SNR, which is a critical value for the reliability of signal detection.

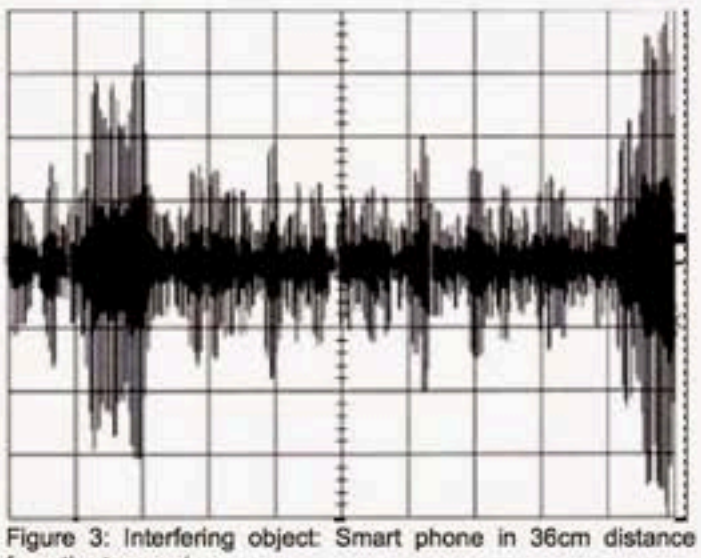

Figure 3: Interfering object: Smart phone in 36cm distance from the transceiver

Figure 4 and 5 show the influence from an interfering digital camera 18cm and 36cm away from the receiving beacon.

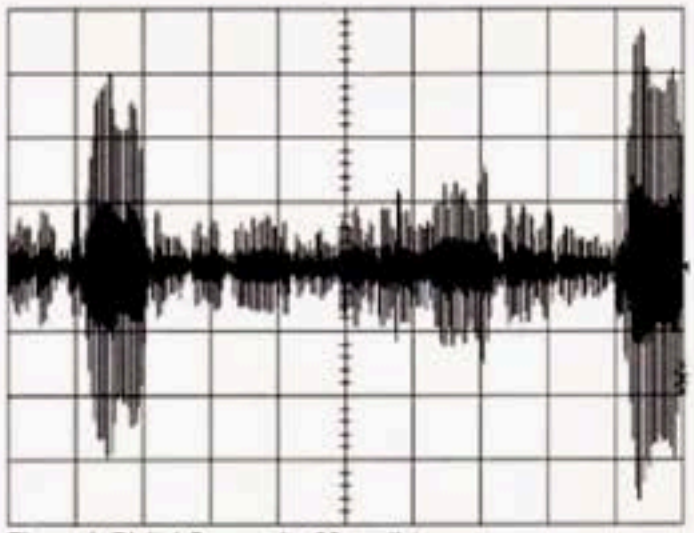

Figure 4: Digital Camera in 36cm distance.

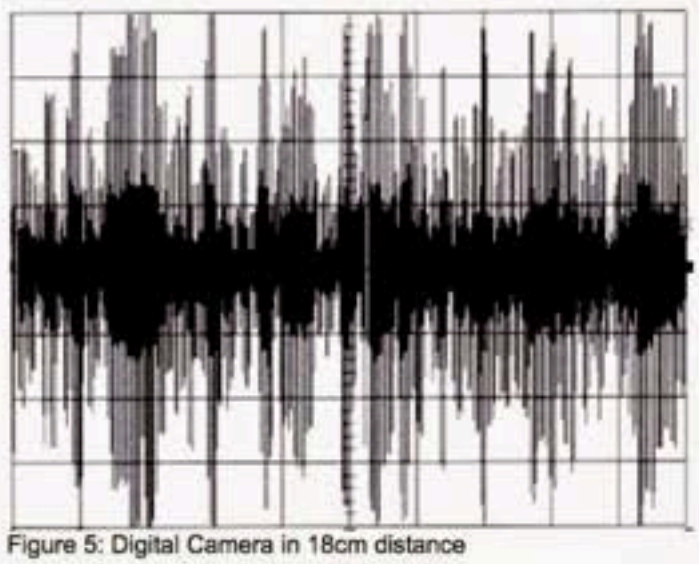

Figure 5: Digital Camera in 18cm distance

Figures 4 and 5 clearly visualize that the signal to noise ratio decreases the closer the interfering digital camera is held to the receiving beacon. In particular figure 5 shows that here is basically no more difference between the "real" signal from the buried subject and the interference caused by the camera.

Figures 3, 4 and 5 show how a smart phone or a digital camera in 18 and 36cm distance influence the received signal and how the interfering signal looks like compared to a signal transmitted by a buried subject in 50m distance from the rescuer. Many beacon manufacturers recommend a search strip width of 50m and are therefore capable to detect a transceiver signals from up to 60m away.

In 60m distance, the signal is again lower than in our test scenario with 50 meters. Accordingly, there is even less tolerance for interference in order to allow a reliable signal detection, which is required to guide the rescuer with distance and direction indications.

Influence of Consumer Electronic

The overview chart in figure 6 shows the possible influence of different interfering objects in this test.

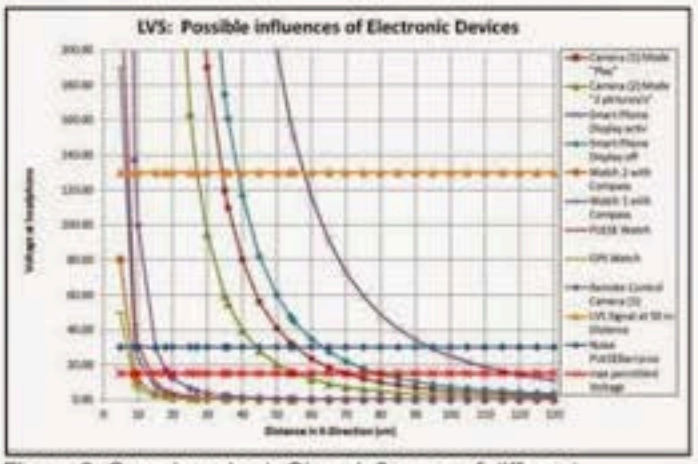

Figure 6: Overview chart: Given influence of different interfering objects

Based on the results of the tests, we defined a safety margin of 50% in order to achieve a SNR which allows reliable signal detection. In figure 6 the threshold in amplitude for interfering signals is illustrated as the red line "*max. permitted voltage*". As long as interfering signals stay in amplitude below the threshold value, we assume that the performance and reliability of "SEARCH" mode is not affected. Looking at fig. 6, every source of interference which still exceeds the red threshold value at distance of greater than 50cm therefore require special measures as outlined in the conclusions and recommendations such as for mobile phones.

The blue line in figure 6 named "*Noise Pulse Barryvox*" is equal to the described internal electromagnetic noise of the PULS*EBarryvox* as described in figure 1. In order to provide to the rescuer as much range as possible, the transceivers are designed to detect and analyze signals which exceed the internal noise in amplitude.

The following figures 7, 8 and 9 give a more detailed view about consumer electronics that could possibly create interference in close proximity to a beacon in „SEARCH" mode.

For example figure 7 shows a noticeable difference for smart phones with and without an active screen.

The graph for the active screen shows that the defined threshold value [red line] is already exceeded at 120cm. If the screen is inactive,

the amplitude of the interfering signal at 40cm is equal to the amplitude of the signal from the buried subject in 50m distance, and only at 80cm distance, the interference falls below the safety threshold. This clearly shows, why it is recommended to turn off mobile phones while searching.

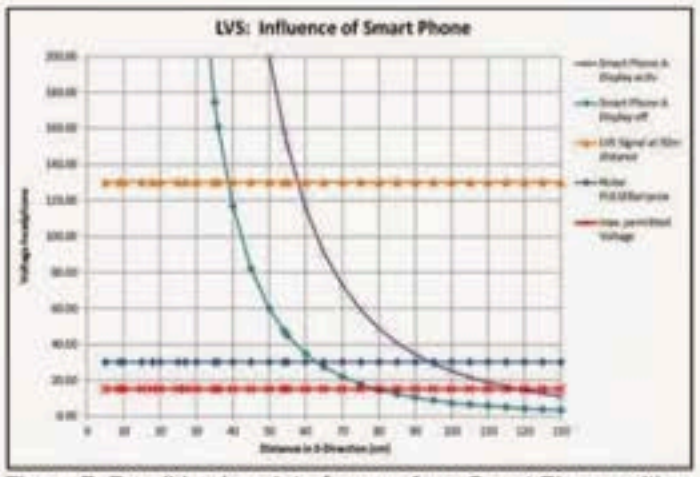

Figure 7: Possible given interference from Smart Phone, with and without an active display

Figure 8 shows the interference caused by a digital camera and its remote control in different operational states [play mode, recording 2 pictures/second].

One example out of figure 8: If a digital camera is mounted on the chest of a skier the receiving beacon must be held in at least 50cm distance, in order to avoid potential problems during the search. As it would be very challenging during a real rescue to comply to this, the recommendation clearly says that all electronic which are not vital during the search, have to be switched completely off.

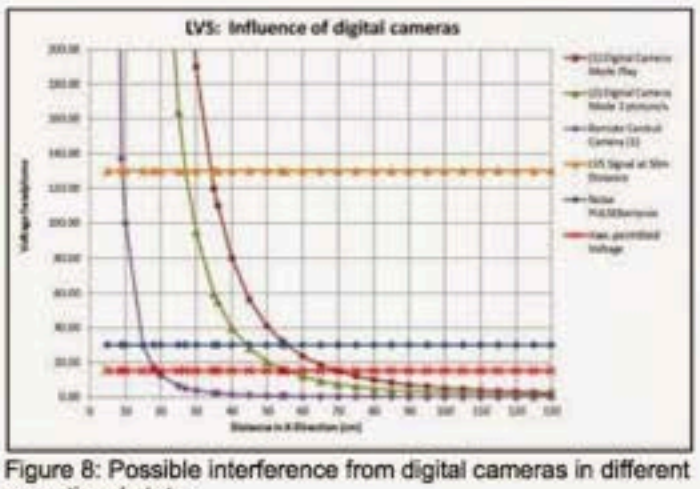

Figure 8: Possible interference from digital cameras in different operational states

Figure 9 shows different wrist watches and their potential interference if transceiver is held in the same hand during search.

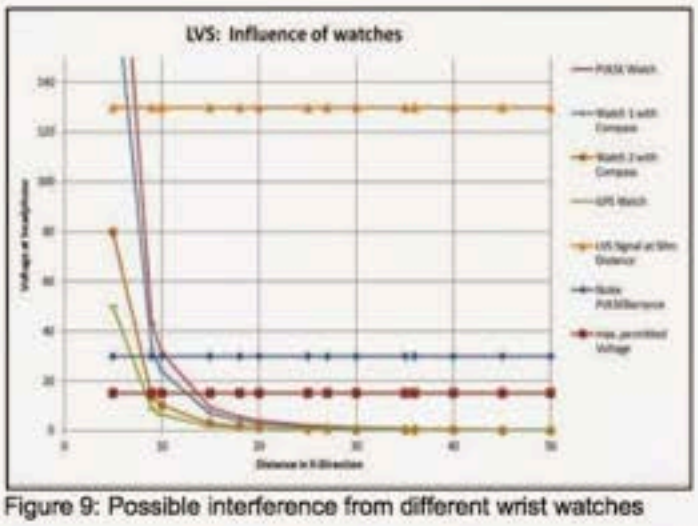

Figure 9: Possible interference from different wrist watches

Figure 9 shows that wrist watches have a significant influence in the distances closer than 10 to15cm from a beacon in "SEARCH" mode.

Practical implications of figure 9: If the rescuer wears a wrist watch during search he should be aware to hold the searching beacon in the opposite hand to avoid possible influence to "SEARCH" mode.

6 CONCLUSIONS

As a matter of principle, avoid having interfering objects (e.g. mobile phones, radios, headlamps), metallic items (pocket knives, magnetic buttons), or other transceivers close to an avalanche transceiver. Please keep as well in mind that several beacons contain a magnetic compass, mainly to speed up direction indications during search. As the compass is highly susceptible to any magnetic interference, you should not wear clothing with magnetic buttons!

Users of pacemakers are advised to carry the device in a secure pant pocket. Consult the manufacturer's instructions with regard to the impact on pacemakers.

„SEND" Mode

The results of the measurements show that in "SEND" mode influence has to be expected in distances closer than 30mm from the transceiver

Since it is hard to predict where the worn interfering objects or metallic items come to rest after an avalanche burial, we recommend to keep a minimum distance of 20cm in "SEND" mode to the beacon.

„SEARCH" Mode

Based on the results and great variety of potentially interfering objects, it is not possible to give one final recommendation in terms of minimum distance for "SEARCH" mode.

As a general recommendation for a search, hold the device at least a minimum of 50cm away from interfering objects and turn off any electronic devices, if possible. It is highly re-commended in this case to turn off mobile phones!

Finally, it is recommended that more testing will be done. There are many more potentially interfering objects that have to be tested with the currently available beacons as well as with new beacon generations in the future.

Conflict of interest

The first author of this paper is an employee of CCS Adaxys. and is involved in the development of avalanche transceivers.