Obsolescence and Analog Avalanche Transceivers: Ensuring Downward Compatibility

by

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Introduction

Older analog beacons are becoming increasingly susceptible to "frequency drift" with age, temperature and abuse. Often this drift becomes severe enough that the beacons do not comply with the latest European standard for transmit frequency. To extend their receive range, some newer digital transceivers are designed with narrow receiver bandwidth, which inhibits their ability to detect poor transmitters. To ensure downward compatibility—reliable performance between new and old technology—an international standard should be created for receiver bandwidth. Users should consider bandwidth when selecting new transceiver fleets. Those with analog fleets should institutionalize a regular inspection program—and eventual replacement with units containing crystal transmitters and wide receiver bandwidth.

Background

In 2001, the French avalanche research institute, ANENA (Association Nationale pour l'Étude de la Neige et des Avalanches), reported that one widely used model of analog transceiver (A1)* was failing to meet the European standards for transmit frequency at cold temperatures. The report suggested that some newer transceivers could experience compromised receive performance when used in conjunction with these transmitters, especially those with narrow receiver bandwidth. In 2004, Backcountry Access and Rescue Technology hired an independent lab, Apex Wireless, to determine the receiver bandwidth of the newest generation of avalanche beacons and their compatibility with these "drifted" transmitters, specifically A1.

Transmit Frequency

Since 1996, the worldwide standard for transmit frequency in avalanche transceivers has been 457,000 Hz (457 kHz). In 2001, the European Telecommunications Standards committee on avalanche transceivers changed the tolerance allowed under the ETS 300 718 standard from 457,000 +/- 100 Hz to 457,000 +/- 80 Hz.

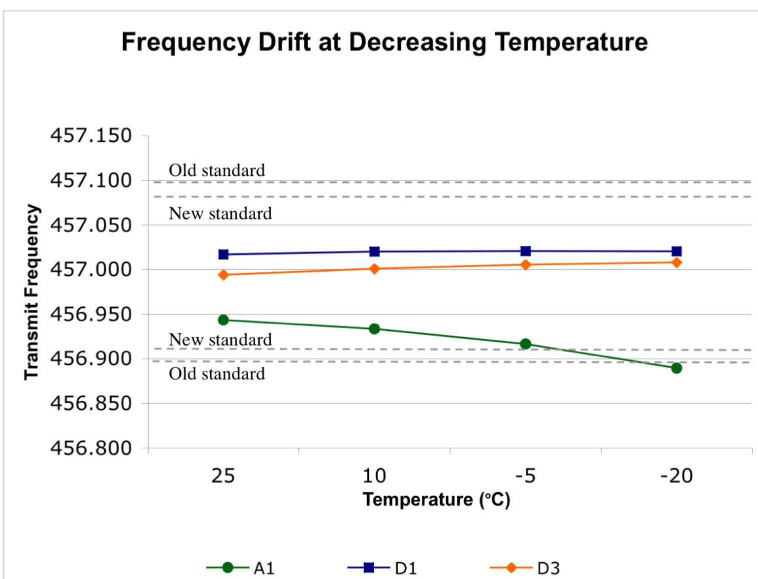

Figure 1:
The ANENA data shows that transceiver A1 often transmits outside the European standard, especially at low temperatures. D1 and D3 were well within the standards and less sensitive to temperature.

***LEGEND:**	**A1**: Ortovox F1	**D1**: Tracker DTS	**D2**: Ortovox M2
	D3: Mammut Barryvox	**D4**: Ortovox X1	**D5**: Pieps DSP

One reason for drift of transmitting frequency lies in hardware differences between beacons made now and those made previous to the onset of digital beacon technology. It is not directly related to analog versus digital technology. Instead, it merely depends on what components were used at the time of manufacture. Most older beacons used ceramic or X-cut crystal reference oscillators to create the 457 kHz signal. These are unreliable in producing a signal meeting the new transmit frequency standard and are susceptible to frequency drift induced by time, temperature, and trauma. The new generation of digital and analog/digital hybrid beacons generally use higher quality, higher cost oscillators made of AT-cut quartz crystal. This has proven to be more reliable for transmitting within the specifications (Fig. 1).

Receiver Bandwidth

Receiver bandwidth is a measure of a beacon's sensitivity to the transmit frequency it is receiving. Wide bandwidth means a beacon can receive a wider range of frequencies. Narrow bandwidth means a beacon's performance can be significantly compromised when receiving a poor signal. Compromised performance includes reduced receive range and/or inconsistent readings.

Receiver bandwidth is mainly defined by the center frequency and "steepness" of the filter used in signal processing. A steep filter might prevent "seeing" a poor signal. There is no specific European or North American standard for receiver bandwidth. However, ANENA states that all receivers should be equally sensitive to transmit frequencies that fall inside the (former) specification of 457 kHz +/- 100 Hz.

According to ANENA, only transceiver D1 meets its criterion of equal sensitivity within this critical bandwidth. The Apex tests revealed a wide range of bandwidths among the newer beacons (Fig. 2) and inconsistent performance by transceiver D5.

Downward Compatibility

The data from both Apex and ANENA suggest that compatibility is an issue when narrow-bandwidth receivers are used in conjunction with drifted transmitters. The receiving beacons can show decreased range, unreliable readings, and false detection of multiple signals.

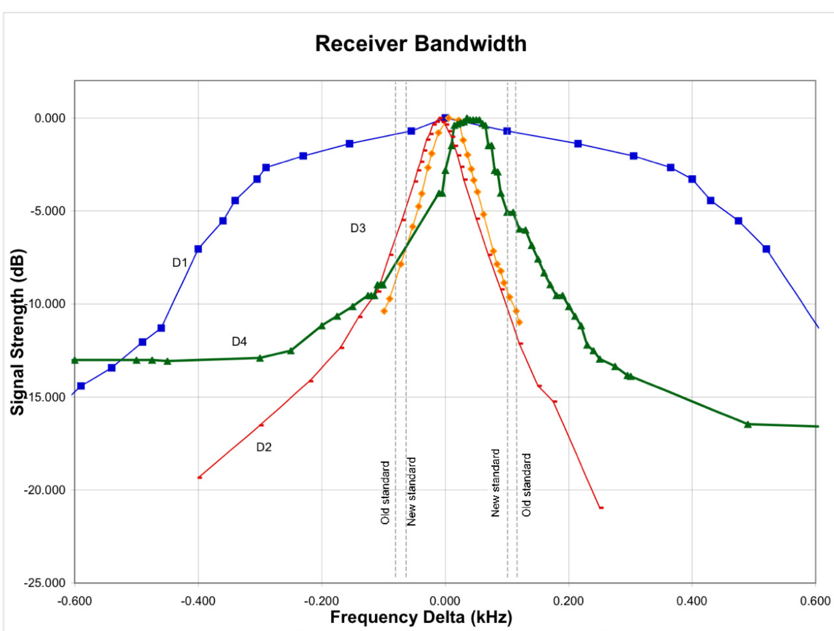

Figure 2:
The Apex data shows that transceiver D1 has the widest receiver bandwidth and the least sensitivity to frequency drift. D2, D3, and D4 show narrower bandwidths, steeper filters, and less compatibility with drifted transmitters.

D5 showed widely varying inconsistencies the farther the transmitter drifted from the center frequency, indicating multiple signals despite the existence of only one. As a result, Apex could not determine its bandwidth.

To determine the extent of this problem, the authors collected a sample of ten used A1 transceivers from various professional ski patrol and guiding organizations. Since the ANENA study just included new beacons—and therefore just analyzed the effects of temperature—the authors collected used beacons to help determine the effects of age and abuse. The authors then hired Apex to perform transmit frequency tests on these units at room temperature. The variation in frequency was significant. Two of the ten beacons were transmitting outside the +/- 80 Hz standard: one at –90 Hz and the other at +423 Hz. Considering the limited sample size, this calls into question the variation in transmit frequency among the approximate 300,000 other A1 transceivers currently in use worldwide.

The authors then performed field tests with the +423 Hz transmitter to determine the "worst-case" effect on receive range. The transmitter was oriented in-line with the receiving units, all with fully charged batteries. For digital beacons, maximum range was recorded when consistent distance and directional readings were displayed. For hybrid analog/digital beacons, maximum range was recorded when output from the speaker registered at 60 dB. Results indicated a significant variation in range: from approximately 35 to 0 meters. Transceiver D1 was the most compatible with the drifted transmitter; D5 was the least compatible.

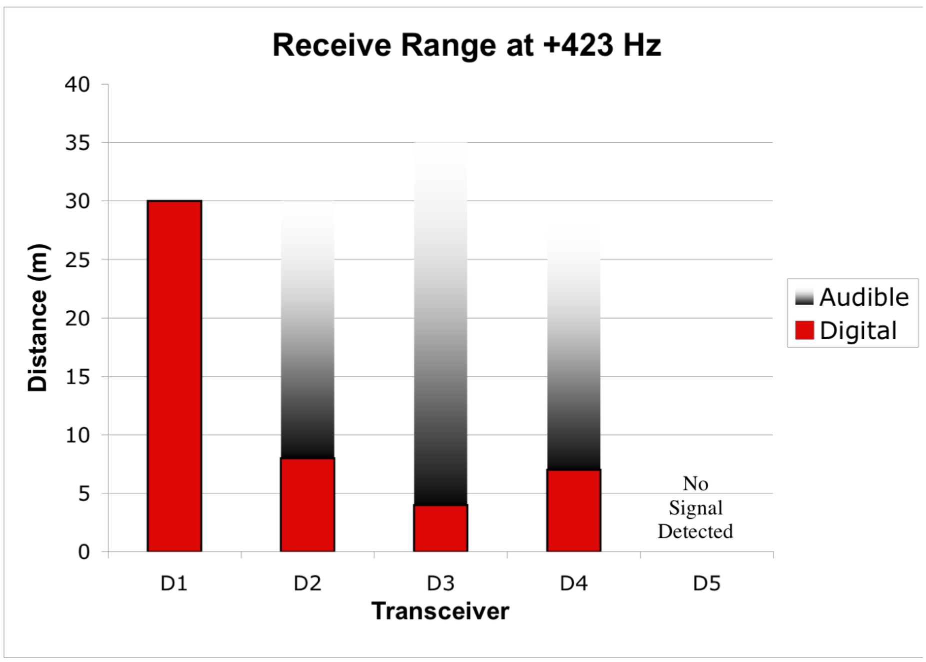

Figure 3:
In the receive range tests, D1 showed reliable distance readings and insignificant loss of receive range. D5 detected no signal at all. The hybrid analog/digital units (D2, D3, D4) showed decreased range and inaccurate readings. The gradient shown in the analog/audible phase indicates the relative strength of the audible signal.

Conclusion

While today's new beacons are adequate to accommodate the effects of poor initial transmit frequency and temperature-induced drift, some cannot accommodate the cumulative effects of time and trauma, two factors that will continue to exacerbate frequency drift problems with the aging of the world's analog beacon fleet.

The authors recommend that an international standard be created for receiver bandwidth. It should require equal sensitivity to signals within both the old and the new European standard on transmit frequency. It should also require the reliable detection of signals transmitting significantly outside this tolerance.

Users should strongly consider receiver bandwidth when selecting new transceiver fleets. Those with analog fleets should at least institutionalize a regular inspection program with the manufacturer. They should also consider eventually replacing those fleets with units containing high-quality crystal transmitters and wide receiver bandwidth.

REFERENCES

Johnson, Brian; Avalanche Beacon Frequency Characteristics, Apex Wireless Inc., Sept. 2004.
Sivardière, François; Transceiver Tests: Laboratory Measurements. *Neige et Avalanches*, ANENA, March 2001.

Bruce Edgerly is Vice President of Backcountry Access, Inc., in Boulder, CO, and John Hereford, is President of Rescue Technology, Inc., also in Boulder, CO. Their companies manufacture and distribute one of the beacons included in the tests. You can reach them at edge@bcaccess.com and herf@qwest.net. If you have a fleet of analog transceivers at least five years old, the authors are interested in testing their transmit frequency as part of this ongoing research.