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Today's Transceivers

User expectations, performance limitations and marketing messages

By Rob Whelan

I am always impressed with how emotionally attached we are to our avalanche beacons. This winter's debate over compatibility between Pulse and Tracker2 devices was a classic example of the passion these pieces of plastic can elicit. For me, this debate and others like it highlights a serious disconnect: what the user expects from the device; what the device can actually do; and the marketing message delivered to attract customers. Let's look at where this disconnect comes from.

It is always interesting to talk with the engineers who design these products. They are the ones who can tell you not just what the device can do, but also what its limitations are. Next are the sales reps. They will tell you all about the great new features and benefits of the device, but might not have the technical background to explain certain behaviors. The marketing message focuses on the strengths of the device, which are defined by the design choices of the engineers. In some companies, the engineers are at arnl's-length from the marketing group. In others, they are tightly integrated.

And then there are the users. They are informed by their peers, by what they read on the net, and to a large extent by us-the instructors and professionals who use these devices every day. While their expectations are influenced by the product's marketing message, users can be fiercely loyal to their brand or technique ("My favorite beacon is the one I have practiced with the most"-Peter Macpherson, Mountain Guide).

Let's start with some background. The first avalanche beacons were developed by Skadi in the late 60s. For the first 25 years of development, the signal from the device was optimized for transmission through snow (457 KHz signal propagates well through snow) and for interpretation by human hearing (long beep sound followed by a period of silence). In 1986, this frequency and the allowed pulse periods and pulse widths became an international standard. The standard has since been revised slightly (European Standard *EN 300718-2001,* lKAR 2001) but still allows for +- 80 Hz from the specified 457 frequency, pulse periods (duration between beep sounds) from 0.7 to 1.3 seconds and pulse widths (length of the beep sound) from 0.07 to 0.4 seconds (fig. 1).

Within this standard, beacon manufacturers have design options to improve the performance of their products. However, they are constrained by the concept of "downward compatibility." That is, the requirement for the receiving beacon to be able to process the incoming signal from any transmitter that meets the specification.

As early as 1998, some manufacturers were calling for a tighter specification to take advantage of the rapid improvement in digital signal processing technology (Hereford, 1998). A tighter spec would allow longer range, better signal separation for multiple burials, and overall more design options. However, it would also mean that current devices would no longer be compatible with the new specification-rendered obsolete, like the old 2275 Hz beacons after the frequency standardization in 1986.

In the absence of a new specification, the manufacturers have done their best to add new features to the digital devices using the specification originally designed for analog technology. The current spec allows for a wide range of design options, and different manufacturers have different philosophies when it comes to new features.

Some have opted for wide band receivers, which can receive older devices that may have fallen outside or at the edges of the specification. This approach has the advantage of great downward compatibility, but with the penalty of reduced range and increased noise. Others have optimized their design for pattern recognition to assist with marking multiple burials. This relies on precise timing of the transmitter, and also on the transmitter having relatively short pulse widths and a unique pulse period. The penalty here is reliance on the transmitting beacon to have tight tolerances, so downward compatibility suffers and user expectations for easy marking may not be met.

These competing design philosophies can result in unexpected performance during searches. Imagine that you are searching with a modem digital device that uses pattem recognition to solve multiple burial scenarios. If the transmitting devices do not have a precise pulse period, the pattern recognition may fail. In addition, if the transmitters have relatively long pulse widths, and they do not have a unique pulse period, there could be prolonged periods of signal overlap, and once again the pattern recognition may fail (Lund, 2008).

The new user of a modem avalanche beacon is blissfully unaware of these limitations, perhaps analogous to an individual with a new digital camera. The expectation, based on the marketing message, is that the camera should be able to "point and shoot" right out of the box. This gives the user the impression that the camera is "simple." In fact, the camera is using a powerful processor to handle a complex task. It manages focus, lighting, movement and a host of other inputs, and optimizes them for the best result. This is successful most of the time, but not always. Sometimes the user must provide some input to get a good result (tum on the flash, for instance).

In the case of an avalanche beacon, the user gets directions from the beacon, usually a distance and direction indication, and expects to be able to simply follow the direction indicator to the buried victim, and have an indication that they are in the right place to start probing. This is usually successful in a single burial search with a modem device, and is without a doubt a big improvement over analog single-antenna beacons.

From the engineer's point of view, the focus is to provide simple controls and a friendly interface. One of their big challenges is that the information from the transmitting beacon only updates about once a second. In the rush of a beacon search, a lot can happen in that one second. The user may be moving fast, or swinging the beacon back and forth. Often I hear about "slow processors" in some devices. These modem microcontrollers are not slow-all the signal processing and screen updating is done in the first 50 - 100 milliseconds following the arrival of the incoming pulse. For the remaining 900 ms, the processor is idling waiting for the next pulse.

What may be interpreted as a "slow" processor is often a result of the algorithm used to process and separate signals from the background noise. If the user is moving too fast, or swinging the beacon back and forth, it is hard for the algOrithnl to keep up Gust a<; with an analog device it is hard to determine the change in volume if the searcher is moving erratically). Under these conditions, the "point and shoot" method can fail and the user's expectations won't be met.

In the case of multiple burials, the search problem can become so complex that the simple point and shoot strategy can break down. If all the transmitters are "marking friendly," i.e. they have short, precisely timed pulse widths and a randomized pulse period, then marking features can work well. TIus makes it easy for the searcher. They simply perform a single-burial search and probe to confirm location. When it is time to keep searching, they mark the first burial and carry on to the next using the same strategy. This allows for one single-burial search after another. Simple.

In reality, there are numerous influences that can confound this search strategy. From the design perspective, the engineer has to communicate to the user that the situation is complex, and prompt the user to change to a backup strategy. This inevitably complicates the user interface. Thus we arrive at the trade-off. Do we want beacons that are simple to use under stress and accept that they will not be able to solve every situation? Or do we want to be able to solve every complex situation and accept that the user will need more training and practice? That is the design choice facing the engineers at this point. In the next issue of the CAA Journal Avalanche.ca, I'll look more in depth at the marking function on the various brands and how to optimize the performance of this important feature.

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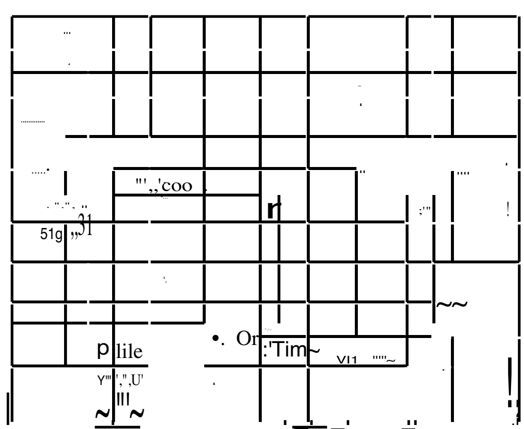
Figure 1



This is what the receiver "sees" after the incoming signal has been de-modulated. This signal has a relatively narrow pulse width, or "on-time" relative to the overall pulse period. High amplitude makes it easy to distinguish from background noise and other transmitters. Figure courtesy of Backcountry Access

BIO:

Rob Whelan has been working as a guide for CMH for the past 21 years. He has been involved in research and implementation of the annual beacon training program for the guiding team at CMH. Rob has background in electronics and software, and keeps current on the latest avalanche beacon technology as it evolves. Rob lives near Nelson, Be.