Overview of Avalanche Beacons, Prepared by Jonathan S. Shefftz, Northfield Mountain Nordic Ski Patro *(JShefftz@NERandoRace.com)*					
T y p e **Dual-Frequency** *(i.e., transmits on only 457Khz, searches for both 457Khz and older 2.275Khz)*	**Current-Standard Avalanche Beacons (i.e., 457Khz only)**				
	Single Antenna		**Multiple Antennas**		
			Dual Antenna	**Triple Antenna**	
	Mainly Accoustical Signal	Digital Processing & Display		Relatively Basic Features	With Marking/Masking
S u m m a r y The American Avalanche Association declared dual-frequency beacons obsolete in June 2001 -- retire any such beacon immediately (with the exception of use as a target beacon for practice).	The first avalanche beacons relied entirely on the user's hearing the transmitting beacon's accoustical signal. The more recent models of the analog single-antenna beacons below also have LED lights to provide a visual indicator of signal strength.	Single-antenna beacons with digital processsing add a numerical and/or graphical readout of signal strength (expressed in highly approximate terms of distance to the transmitting beacon).	A second antenna allows for directional indicators to follow the flux line (whereas a single-antenna beacon even with digital processing helps the searcher to know if the flux line is being followed yet does not indicate which direction to follow to continue staying on the flux line).	A third antenna eliminates spikes and nulls in the final pinpoint search phase.	Additional processing/controls attempt to isolate the different signals in a multiple burial, and then allow the searcher to mark/mask a found beacon so that the signal from an already found beacon will not complicate the search for any other beacon(s).
M o d e l s Ortovox F2	Barryvox VS 68	ARVA 9000	ARVA A.D.vanced	Backcountry Access Tracker2	Barryvox Pulse
Pieps 2	Barryvox VS 2000	ARVA Evolution	ARVA Evolution+	Ortovox D3	Ortovox S1
Ramer	Barryvox VS 2000 Pro	Ortovox M1	Backcountry Access DTS Tracker	Ortovox Patroller	Pieps DSP
	Ortovox F1	Ortovox M2	Barryvox Opto 3000	Ortovox X1	Pieps DSP Advanced
	Ortovox F1 Focus	Pieps Freeride			
	Pieps Optifinder				
	Pieps Opti 4				
	SOS F1ND				
	SOS SOS-SB				

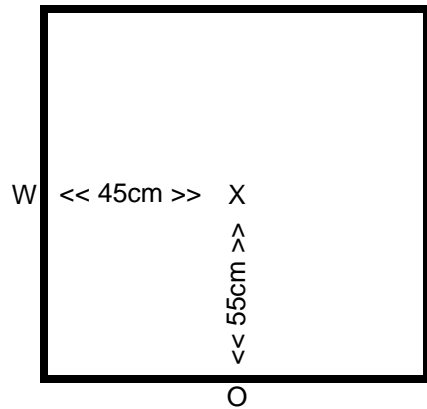| updated:	Subjective Recommendations for Digital Beacons, Prepared by Jonathan S. Shefftz, Northfield Mountain Nordic Ski Patrol											
01-Sep-2007	Good choices are in regular typeface.				Better choices are in bold typeface					[Inapproropiate choices for stated priorities are in italics with brackets.]		
	ARVA / Wasatch Ski Distribution LLC		BCA		Barryvox/Mammut - Climb High		Ortovox / Ortovox USA				Pieps / Liberty Mountain	
If you want:	Evolution+	ADvanced	Tracker DTS	Tracker2	Opto 3000	Pulse	M2	X1 / Patroller	D3	S1	Freeride	DSP/Advanced
-- a simple user interface.	Besides indicator for multiple burial, as simple as a beacon user interface can possibly be.	[Additional functionality / controls always have the potential to create confusion.]	Besides button for Special mode, as simple as a beacon user interface can possibly be.	Besides button for Special mode and indicator for multiple burial, as simple as a beacon user interface can possibly be.	[Additional functionality / controls always have the potential to create confusion.]	[Full-text screen conveys additional information and soft keys allow for numerous functions, but has the potential to create confusion.]	[Somewhat "busy" screen, plus user must adjust sensitivity control.]	As simple as a beacon user interface can possibly be.	Besides indicator for multiple burial, as simple as a beacon user interface can possibly be.	[Additional functionality / controls always have the potential to create confusion.]	?	[Additional functionality / controls always have the potential to create confusion.]
-- long range for initial signal acquisition.	[Typical shortened range for all-digital design.]	[Typical shortened range for all-digital design -- analog mode provides only a very small boost.]	[Typical shortened range for all-digital design.]	[Typical shortened range for all-digital design.]	Initial analog accoustical signal helps to boost range.	Initial analog accoustical signal helps to boost range.	Long range, but analog accoustical signal only.	Long range, but initially analog accoustical signal only.	[Typical shortened range for all-digital design.]	Range results for pre-production units sounds promising?	?	Long range with full digital distance & directional indicators.
-- ease of use for single burial.	Just follow the directional indicators and distance readout.	Follow the directional indicators and distance readout, but advanced features could cause confusion.	Just follow the directional indicators and distance readout.	Just follow the directional indicators and distance readout.	Just follow the directional indicators and distance readout; can be set up to lock out advanced functions.	Distance readout with 360-degree rotating arrow eliminates being off by 180 degrees, but can be slow to update.	[Requires much more skill & user input.]	[Only a small portion of the search phase entails directional indicators and distance readout.]	Just follow the directional indicators and distance readout.	Employs radically new graphical approach with unclear ease of use for newcomers.	[Single antenna, so no ability to display directional indicators.]	Follow the directional indicators and distance readout, but advanced features could cause confusion.
-- functions specifically designed for multiple burials.	Indicator light, option to scan # of beacons within different radii and narrow search angle.	Indicator light, manual switchover option into full analog mode, options to scan # of beacons within different radii and narrow search angle.	[Special mode to narrow search angle and unlock focus on previously found beacon.]	Indicator light plus Special mode to narrow search angle and unlocks focus on strongest signal.	Indicator light, automatic switchover into analog accoustical signal, and manual switchover option into full analog mode.	Lists different burials with respective distances and directions coupled with masking / marking function.	[No special features for multis, other than ability to hear multiple signals.]	[No special features for multis.]	[No special features for multis other than indicator.]	Graphically displays different burials with respective distances and directions coupled with masking / marking function.	[No special features for multis other than indicator.]	Displays symbols for multiple burials combined with masking / marking function, and option to scan # of beacons within different radii.
-- precision for the final pinpoint search phase.	[Suffers from spikes & nulls.]	[Suffers from spikes & nulls.]	[Small box size, but suffers from spikes & nulls.]	Third antenna to eliminate spikes & nulls coupled with small box size.	[Okay box size, but suffers from spikes & nulls.]	Third antenna to eliminate spikes & nulls coupled with small box size and programmable options.	[Large box size, and suffers from spikes & nulls.]	Third attenna to eliminate spikes & nulls active only within 2m, and box size is large.	Third antenna to eliminate spikes & nulls active only within 2m, and box size is large.	Third antenna to eliminate spikes & nulls and very promising graphical approach pending software updates.	[Suffers from spikes & nulls.]	Third antenna to eliminate spikes & nulls coupled with okay box size.
-- to use your old analog skills.	[No analog mode.]	Allows manual switchover into full analog mode complete with sensitivity control.	[No analog mode.]	[No analog mode.]	Allows manual switchover into full analog mode complete with sensitivity control.	Allows manual switchover into full analog mode complete with sensitivity control.	Essentially a digital display and processing to assist with analog accoustical searching.	Portions of the search phase use analog accoustical signal, but switchover points are automated, and no sensitivity control.	[No analog mode.]	[No analog mode.]	With only a single antenna, must entail some use of analog skills?	[No analog mode.]

01-Sep-2007	Objective Comparison of Digital Beacons, Prepared by Jonathan S. Shefftz, Northfield Mountain Nordic Ski Patrol											
Company/ Distributor & Model	ARVA / Wasatch Ski Distribution LLC		BCA		Barryvox/Mammut - Climb High		Ortovox / Ortovox USA				Pieps / Liberty Mountain	
	Evolution+	A.D.vanced	Tracker DTS	Tracker2	Opto 3000	Pulse	M2	X1 / Patroller	D3	S1	Freeride	DSP/Advanced
Nationality:	France		U.S.		Switzerland		Germany				Austria	
Typical Retail:	$290	$340	$290	$335	$300	$400	$280	$300	$300	~$600	$200	$380/$465
	Note that weights below are for beacons with batteries and full harness system; figures in italics rely on secondary sources and may not be comparable.											
Weight oz	10.1	12.4	13.1	10.9	9.2	11.6	10.9	9.5	11.5	13.4	6.0	10.4
g	285	355	370	309	260	330	310	270	325	380	168	295
Batteries:	4 AAA	4 AAA	3 AAA	3 AAA	3 AAA	3 AAA	2 AA	2 AA	2 AA	3 AAA	1 AA	3 AAA
Transmit Hours:	250	250	250	[info pending]	200	200	300	300	300	250	[info pending]	200
Antennas:	2	2	2	3	2	3	1	3	3	3	1	3
Switchover Procedure to Search:	Pull out sliding switch at top of beacon.		Hold down centrally located button ~2 seconds.	Pull out sliding switch at bottom of beacon.	Press centrally located button 3x.	Press down and simultaneously slide over switch on top edge of beacon.	Depress buckle sides to partially release harness (or can operate without harness).	Slide over release switch and simultaneously turn knob near bottom of beacon.		Open flip-phone-style clam shell.	[info pending]	Press down release button and simultaneously slide up long switch.
	Distances below (worst/best alignment from single range test) are meant to be roughly indicative as to when various features are activited; all information for ARVA beacons based on secondary sources.											
Initial Signal Acquisition:	Digital audio, LCD distance readout, and LCD directional indicators (1 of 5).	Analog audio at ~?/?m [pending upcoming test]..	Digital audio, LED distance readout, and LED directional indicators (1 of 5) at ~26/48m.	Digital audio, LED distance readout, and LED directional indicators (1 of 5) at ~?/?m.	Analog audio at ~50/66m.	Analog audio at ~46/61m.	Analog audio at ~41/78m.	Analog audio at ~55/80m.	Digital audio, LED distance readout, and directional indicators (1 of 3) at ~27/48m.	Digital audio, LCD display with cross-hair over beacon symbol and distance readout at ~?/?m.	[info pending]	Digital audio, LCD distance readout, and LCD arrows (1 or 2 of 5) at ~47/66m.
Secondary Search Mode/Display:	Continue with digital audio, LCD distance readout, and LCD directional indicators (1 of 5).	Digital audio, LCD distance readout, and LED directional indicators (1 of 5) at ~?/?m [pending upcoming test].	Continue with digital audio, LED distance readout, and LED directional indicators (1 of 5).	Continue with digital audio, LED distance readout, and LED directional indicators (1 of 5).	Programmable audio (digital, analog, or none), LCD distance readout, and LCD directional indicators (1 of 5).	Analog audio, LCD distance readout, and single LCD 360-degree rotating arrow at ~44/52m.	Analog audio, LCD distance readout, LCD stacked bar for alignment with flux line, and LCD indicator for suggested sensitivity control at ~30/48m.	Analog audio and LED distance readout at ~23/37m; then, digital audio, LED distance readout, and directional indicators (1 of 3) at ~4/11m.	Continue with digital audio, LED distance readout, and directional indicators (1 of 3).	Continue with digital audio and LCD display with cross-hair over beacon symbol and distance readout.	[info pending]	Continue with digital audio, LCD distance readout, and LCD arrows (1 or 2 of 5).
	Distances below are simply the digital readouts from each beacon's display.											
Pinpoint Search Mode/Display (i.e., differences from secondary):	Distance readout down to 0.0m and directional indicators down to 2.0m.		Directional indicators and distance readout down to 0.1m.	Directional indicators and distance readout down to 0.1m.	Distance readout down to 0.3m and arrows programmable down to 3.0 or 0.3m.	Audio programmable digital or analog within 3.0m, distance readout down to 0.0m, and arrows programmable down to 3.0 or 0.3m.	Distance readout down to 0.2m.	Distance readout down to 0.2m and directional indicators down to 2m (at which point third antenna becomes active).		Descending circle graphic (with distance readout and arrows, pointing either inward or outward) on LCD display within 3m.	[info pending]	Distance readout down to 0.1m and arrows down to 2.0m.
	Distances below represent the length of a constant minimum distance readout (and hence uncertainty range) when pinpointing along a line, assuming horizontal beacon burial just barely below the surface.											
	(Note that distance readout for X1 steps down to 0.2m minimum only when almost at the transmitting beacon; length for the more reliable 0.3m readout is similar to the D3's 0.2m readout.)											
	(Also, figures for DSP reflect 0.3m readout, since although the display can step down all the way to 0.1m, the actual reading almost always stops at 0.3m, even when immediately adjacent to the transmitting beacon.)											
Pinpoint Line (cm):	[not tested]		24	[pending testing]	54	14	144	10/164 (see note)	160	[pending testing]		60
	Box size equals the product of optimal and worst alignment distances from center of transmitting beacon at which minimum distance readout is reached. Note that all beacons have a similarly small box size for a beacon burial of >~70cm.											
Box Size (m²):	[not tested]		0.04	(See optional actions below.)	0.19	0.02	1.15	0.03/2.49 (see note)	2.27			0.34
Multiple-Burial Indicators and/or Actions (besides multiple signals being received):	Indicator on LCD screen for multiple burials. (Also see optional actions below.)		(See optional actions below.)	LED light indicates multiple burials. (Also see optional actions below.)	Symbol indicates multiple beacons and automatically shifts to analog accoustical signal.	Soft keys to scroll through list of multiple beacons with distance readouts (plus heart symbols for other Pulse beacons that detect minute movements) then mask each found beacon.			LED light indicates multiple burials.	Displays up to 4 beacons with distance readouts and relative locations on LCD cross-hair display, then mask each found beacon (which then shows another beacon if more than 4).	Indicator for multiple burials.	Displays up to three burial symbols, with "…" added for more than three, then mask each found beacon.
Optional Search Actions and Other Features:	Can scan 9 concentric radii (progressively), displaying distance range for each radius and directional indicator(s) for beacon(s) scanned in each radius. Also can narrow search angle (e.g., in attempt to exclude found beacon).	Can scan 9 concentric radii (manually selectable), displaying distance range for each radius & directional indicator(s) for beacon(s) scanned in each radius. Also can narrow search angle (e.g., in attempt to exclude found beacon). Can switch into full analog mode w/ sensitivity control & LCD distance readout.	"Special Mode" narrows search angle (e.g., in attempt to exclude found beacon) and simultaneously overrides any lock onto the strongest signal.	"Special Mode" narrows search angle (e.g., in attempt to exclude found beacon) and simultaneously overrides any lock onto the strongest signal.	Programmable to allow switch into full analog mode with sensitivity control.	Can switch into more traditional "back-up" mode (i.e., distance readout, rotating arrow, muliple-burial indicator) programmable to add analog sensitivity control and suggested volume along with option to shut down LCD display and use only one antenna; numerous other programmable options/parameters.				Analog mode upon battery strength <20%; compass, clinometer, thermometer.		Can scan to show # of beacons within 5/20/50m (though erases any previous masking of found beacons); can test other beacons' frequency drift; attempts to shift frequency pattern to avoid being in sync w/ other nearby transmitting beacons; Advanced version has compass, altimeter, thermometer (all for navigation only).
Emergency Revert to Transmit:	Push down protruding switch at top of beacon.		5-minute auto revert (upon lack of action) selectable at startup (i.e., setting not saved); otherwise, press centrally located button.	5-minute auto revert (upon lack of action) selectable at startup (i.e., setting not saved); otherwise, push in protruding switch at bottom of beacon.	8-minute auto revert (upon lack of action) default, programmable to 4 minutes or no auto revert; otherwise, hold down centrally located button ~2 seconds.	8-minute auto revert (upon lack of action and movement), programmable to 4 minutes or no auto revert; otherwise, push in protruding part of sliding switch on top edge of beacon.	Push in protruding prongs or reinsert part of harness.	Release sliding switch.		30/90/120-second or none programmable auto revert (upon lack of action and movement); also can close clam shell.	[pending testing]	Push down protruding part of sliding switch.
Version Changes:	Older version had LED (instead of current LCD) directional indicators; almost identically named "Evolution" model has single-antenna beacon in old 9000 case (with digital audio and distance, somewhat similar to Ortovox M1/M2).	Versions before 2006 lacked ability to divide up search areas for multi-burials, but software can be updated.	New harness and button design in Fall 2004; 2006-07 was final season; much earlier versions had all-elastic harness and default setting for automatic revert to transmit.	New for Fall 2007; also has faster processing than original Tracker.	Earlier versions distributed by "RED" (in a blue case) had slower processing.	New for Fall 2006; current software is version 2.00 and can be updated for future revisions.	Predecessor M1 had slower pulse rate and earlier M1 versions had a more complicated display.	Earlier version had slower signal processing and only 2 antennas. Patroller is identical to the current X1.	New for Fall 2006.	New for Fall 2007 (for regular production & retail sales); can be updated for future software revisions.	New for Fall 2007.	Earlier versions had black harness (instead of current silver); Fall 2007 software will be version 5.0 and can be updated for future versions.

Illustration of "Box Size" Test & Calculations

 X = Transmitting beacon
 O = Point at which minimum distance readout appears with Optimal flux line alignment
 W = Point at which minimum distance readout appears with Worst flux line alignment

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┌──────────────────────────┐
│                          │
│                          │
│                          │
W   << 45cm >>   X          │
│               ^          │
│               ^          │
│          << 55cm >>      │
│               ^          │
│               ^          │
└──────────────────────────┘
            O
```

Box Size = {2 x W } x {2 x O}
           = {2 x 45 } x {2 x 55}
           = 90 x 110
           = 9900 cm2
           = 0.99 m2

Note that this test was inspired mainly by a NYT avalanche beacon review that commented (negatively) on the box size for a particular beacon. In reality, this test is likely to matter only when the beacon is buried very close to the surface yet the victim's body is somehow still entirely below the surface. Hence, although the results are presented, a gray background color is used.

<u>bio, short:</u>

Jonathan S. Shefftz patrols at Northfield Mountain in western Massachusetts, where the avalanche danger is currently (really, really very) low. When he is not praying for snow, he works as a financial economics consultant and has been qualified as an expert witness in Administrative Court and U.S. District Court. He can be reached at jshefftz@post.harvard.edu for corrections, questions, suggested addendums, and/or hints for more effective snow dances.

<u>bio, extended:</u>

Jonathan S. Shefftz patrols at Northfield Mountain in western Massachusetts,	www.NEEnergyInc.com/Northfield/CCski.asp
where the avalanche danger is currently (really, really very) low.	www.nmnsp.org
He is an apprentice avalanche instructor for the National Ski Patrol Eastern Division,	www.NSPEast.org/html/amn.htm
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When he is not praying for snow, he "enjoys" the occassional rando race,	www.NERandoRace.com
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having been qualified as an expert witness in Administrative Court and U.S. District Court.	www.nafe.net/LER/l6_2_3.pdf