DHV-Safety tests LTF A- and B- Paragliders, Part 9

This report extends the work publicised initially in DHV Info 174 which can also be found under www.dhv.de. Details on how we have classified the gliders, the relevance of different manoeuvres to accident statistics, German airworthiness requirements (LTF certification) and other information can be found there.

The DHV safety and technical department tested the following gliders in the 9th round of its ongoing safety test program:

Glider	LTF Test number	Weight range	DHV Safety Class
LTF A			
U-Turn Emotion 3 S/M	EAPR-GS-0352/15	80-95 kg	*Overall: 2* Asymmetric Collapse 2 Front Collapse 2 Spiral Dive 2
LTF B			
U-Turn Infinity 4 M	EAPR-GS-0177/14	70-105 kg	*Overall: 4* Asymmetric Collapse 4 Front Collapse 4 Spiral Dive 3
Airdesign Rise 2M	EAPR-GS-0175/14	85-105 kg	*Overall: 5* Asymmetric Collapse 5 Front Collapse 4 Spiral Dive 3
Nova Mentor 4 M	DHV GS-01-2116-14	90-110 kg	*Overall: 5* Asymmetric Collapse 4 Front Collapse 5 Spiral Dive 3
Advance IOTA 28	EAPR-GS-328/14	90-115 kg	*Overall: 5* Asymmetric Collapse 5 Front Collapse 3 Spiral Dive 5

DHV safety tests are designed to test the passive safety of paragliders when subjected to extreme test manoeuvres. Tests are generally conducted in still air. In particular, asymmetric collapses are performed at maximum folding angles with resulting maximum area deformations but still within the marked collapse field valid for LTF tests. Front collapses are performed with the goal of achieving the maximum possible deformation. All these tests are designed to reveal design weaknesses under worst-case scenarios: i.e. when a pilot finds him/her-self in extreme turbulence and then remains passive.
It is important to note that alongside the reactions to massive collapses, other parameters are also important when trying to classify the the passive safety of a paraglider, for example collapse resistance, canopy feedback and controllability. As it is difficult to define, compare and measure these qualities, the conclusions reached in these tests are based on glider reactions to extreme manoeuvres and instability. Real life collapses may well exhibit completely different recovery reactions, depending on constructions and designs, and may result in a glider behaving more dynamically or benignly. A realistic judgement of personal piloting skills and flying conditions are the major safety factors when flying paragliders, independent of a gliders safety class rating. In order to understand how a glider is rated, it is important to read the entire report and not concentrate on the summary numbers at the end. The test protocol provides a detailed analysis of glider behaviour, commented on from the test pilots, and should be read to help understand why a particular rating has been awarded.

Test manoeuvres / recovery from instability

All test manoeuvres were filmed with on-board GoPro cameras, ground cameras and documented with the DHV's data loggers. Test manoeuvres were performed by the DHV test pilots Simon Winkler and Jürgen Kraus at the top third of the weight range.

Note: U-Turn's Emotion 3 M was rated Safety Class 3 at the top end of its weight range for the spiral dive manoeuvre. Test flights conducted at 90 – 95 kg were all rated safety class 2. U-Turn have reacted by reducing the weight range for the glider and re-classifying it at the EAPR Test center. It's new product name is now Emotion 3 S/M, and this is rated Safety Class 2.

Asymmetric Collapses

In this test series, only one LTF-A glider was present, the U-Turn Emotion 3 S/M. The glider is difficult to collapse massively – maximum force with both hands was required from the test pilots. Once a steeply folded collapse with large deformation area has been achieved, reactions from the glider just remain within the criteria for a Safety class 2 rating. The glider turns quickly to the collapsed side but following this the rate of turn slows rapidly. Dives forward of up to 60° were recorded. The entire course change was usually under 135°. Re-inflation of the collapsed side was soft.

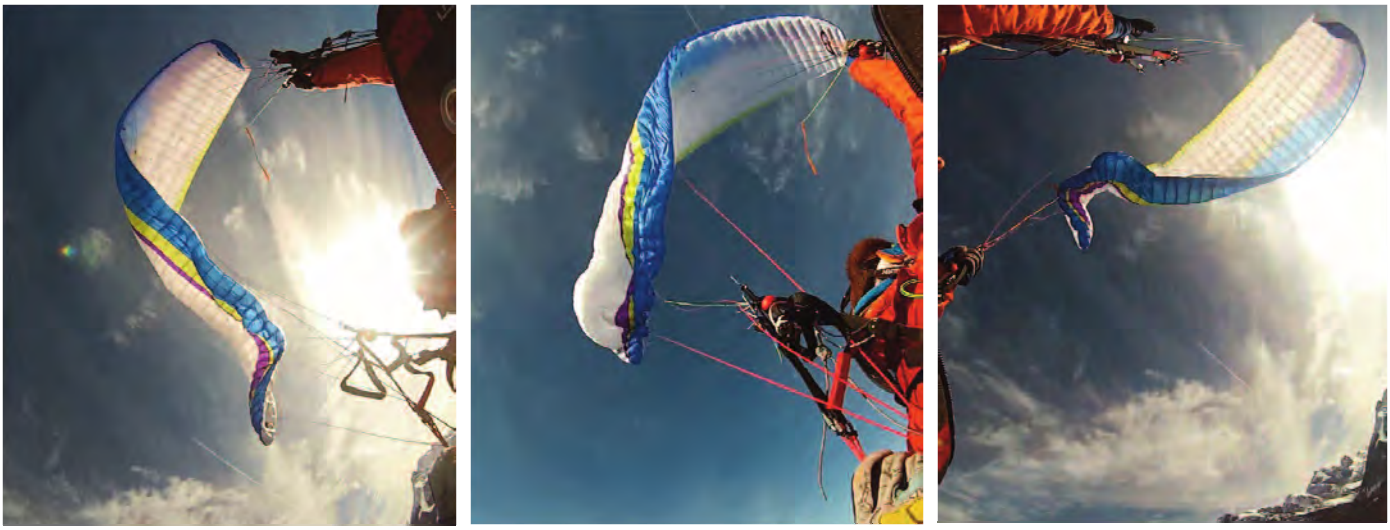
U-Turn Emotion 3: Both hands were required to produce high area steeply folded collapses. Recovery reactions were benign.

U-Turn's Infinity 4 generally collapses with a high deformation area and at a steep folding angle. Collapse resistance is relatively high, meaning the canopy remains inflated for longer during the manoeuvre, and then abruptly folds down. Resulting glider reactions were then correspondingly dynamic. In spite of the collapse characteristics, recoveries were soft and not impulsive. When smaller collapses were induced, reactions were more benign. After the collapse, the canopy slows markedly before diving forward. Dive angles are very similar, both when fully accelerated or when flown at trim speed. Course change on recovery was different from case to case – on some occasions 120-180°, on others 180-360°. On two collapses the leading edge caught up in the lines, delaying recovery further, but recovery was easy with simple brake appliance.

U-Turn Infinity 4: Steep folding angles are accompanied by high area collapses and dynamic recovery reactions. Reactions to smaller collapses are more benign.

U-Turn Infinity 4: The picture shows how the leading edge may get caught in the lines after a collapse, at a point just behind the nylon rods. This sort of cravat is easy to recover from by applying gentle brake and does not result in continued rotation.

Airdesign Rise 2: reactions to asymmetric collapses are very dependent on the collapse angle. Flatter collapses provoke normal reactions for a glider at the top end of the LTF-B category: the canopy pitches markedly forward but course changes of only 180° to 270° result after this. The opposite wing tip tends to roll in a little on a collapse, which helps dampen roll and pitch movements. Collapses at steeper angles are difficult to produce, but when provoked are answered by very marked forward pitching and rapid course changes. On occasion, large opposing collapses occurred with moderately dynamic course changes. On two occasions the canopy opened impulsively during forward pitching, which resulted in another collapse on the same side but without increased dynamics. Even though the glider has the highest aspect ratio of all tested here, no tendencies for cravatting were noted.



Airdesign Rise 2: different collapse angles produce different reactions. In comparison with the Infinity 4, steep angled collapses are difficult to induce on the Rise 2.

Nova's Mentor 4 is easy to collapse in the defined measurement field. The glider demonstrated reactions appropriate for the safety class 4 classification. Compared to other gliders in the test, this canopy collapses softly. Steep angled collapses are difficult to produce. After collapsing, the glider pitches forward to the limit of the safety class 4 category and then turns up to 270°. The canopy recovers softly, cell-by-cell, after maximum 180°. When collapsed steeply, small collapses on the opposite wing tip result, which tend to help reduce the overall dynamics of recovery. Massive steep collapses at the upper limit of the measurement field produced the most violent reactions: marked forward pitching followed by large opposing collapses and course changes of up to 90° on the opposite side. This behaviour is on the limit to the safety class 5

category. No cravats occurred during testing, but this alone is no guarantee that this will always be the case during flying.

Collapse angle tests on the Mentor 4 M: Shallow angled collapses in the measurement field (left) provoke reactions conform to the LTF-B classification. Steeper collapse angles (mid-left) produce increased dynamics, marked forward pitching and on occasion large opposing collapses (mid-right and right) – borderline to safety class 5.

Advance's Iota has the highest dynamics of the gliders tested here. Collpapses to the maximum of the test field are easy to induce, and produce marked backward pitching followed by a moderately fast dive forward. Reactions to collapses did not follow a clear pattern, on occasion the glider opened softly, cell-by-cell, but usually openings were fast and impulsive. On impulsive recovery during the dive forward, the glider collapses again on the opposite side which can result in a total collapse of the entire canopy. This behaviour was also noted for collapses in the middle of the measurement field. Following this, the glider quickly self-recovered without any tendencies to cravat. Opposing collapses also occurred to a maximum of 40%, which did cravat and result in course changes of more than 90° to the opposite side.

High area collapses at steep collapse angles (left) often opened impulsively during forward diving (middle). This increases the acceleration during forward pitching and results in a complete collapse of the leading edge (right). Recovery from this was fast, did not cravat and required no pilot input.

Advance Iota: the picture shows the slight cravat after an opposing collapse. The leading edge gets caught in the lines at a point at the end of the nylon rods. The cravat is simple to recover from with a little brake input, but sufficient to cause a rapid turn if left unattended.

Asymmetric Collapses							
Glider	**Height-loss in m**	**Pitch-angle in °**	**Pitch change rate in °/sec**	**G-Force in G**	**Course-change angle in °**	**V/sink maximum in m/s**	**Notes**
LTF A							
U-Turn Emotion 3 S/M	30-39 m	45°-60°	70°	2,5 G	90°-180°	10-14 m/s	Low area collapses produce low forward pitching and low height loss. High area collapses result in borderline behaviour for safety class 2, with height losses of 35 m, maximum pitch angles of 60° and total course change of 180°.
LTF B							
U-Turn Infinity 4 M	50-59 m	60-75°, mostly 70°	100°	2,7 G	270°-360°, mostly 270°	14-18 m/s	High area, steep angled collapses with dynamic canopy reactions. Slight tendency to cravat on collapsed wing tip. Course changes indifferent.
Airdesign Rise 2	50-59 m	60-75°, mostly 70°	140°	2,9 G	180-270° mostly 200°	10-14 m/s	Strong tendency for opposing collapses when tested at upper limit of measurement field. Large forward pitching, low course changes. Glider is usually recovered within 200°.
Nova Mentor 4 M	30-39m	60-75°, mostly 70°	145°	2.7 G	270°-360°, mostly 270°	10-14 m/s	Collapses and recoveries are generally soft. High area / steep angled collapses are difficult to produce. Maximum possible collapses result in marked forward pitching and are generally accompanied with collapses on the opposite wingtip. On occasion the opposing collapses can be large and generate course changes of up to 90°. Recovery often delayed, cell-by-cell with course change up to 360°.
Advance Iota 28	50-59 m	75-90°, mostly 80°	105°	2,9 G	180-270°	18-22 m/s	Marked forward pitching at moderate dive forward speeds. Generally impulsive re-inflation of collapsed wing with resulting complete collapse. Opposing collapses with course changes of >90° also occurred during testing.

Front collapses

In recent safety tests many gliders have demonstrated weaknesses with regard to front collapse behaviour. In this series, none of the gliders exhibited horseshoeing, but rather a different phenomena: short deep stall phase during recovery. After the canopy has almost completely re-inflated, the middle stalls once again causing the canopy to back-fly somewhat. In some cases this resulted in marked pitching backwards which can again create new problems when the glider dives forward on recovery.
Nova's Mentor 4 exhibited this behaviour most markedly. Interestingly, to produce front stalls on the glider the A-risers need to be pulled symmetrically to the middle. No general behaviour characteristics could be determined for recovery; on occasion the canopy opened nicely from the middle, on occasion recovery was delayed by a short deep stall phase.
U-Turn's Infinity 4 also exhibited deep stall behaviour after a front collapse, followed by severe forward pitching. Again, behaviuor to front collapses was indifferent; on occasion the canopy recovered progressively cell-for-cell from the middle, at other times the wingtips would re-inflate first or the entire leading edge impulsively at once. On one instance the canopy entered a stable front horseshoe, but this could not be reproduced.
The **Iota** from **Advance** re-inflates from the middle, but pitches forward markedly. On one occasion the glider entered a short deep stall phase similar to the **Mentor 4**.
Airdesign's Rise 2 reacts typically for it's class. Recovery is delayed and height loss increased only when the glider is flown at the lower take-off weight limit. Re-inflation is progressive from the midpoint outwards.
U-Turn's Emotion 3 reacted very benignly to front collapses. The collapsed area is not as large as with other gliders in this test.

U-Turn Infinity 4: trim speed moderate area collapse The glider entered a short deep stall phase on recovery particularly in this configuration. On recovery the glider stalls again over the entire leading edge and back-flies (see wind indicator on left riser). The following dive forward ought to be actively blocked via appropriate brake input.

U-Turn Infinity 4: 100% front collapses were possible both at trim and top speed. The greater the collapsed area, the more the canopy tends to re-inflate impulsively. On massive symmetric front collapses (left) the gliders wingtips often re-inflate first (middle) which lead once to a stable front horseshoe (right). Recovering from the horseshoe was simple via symmetric brake input. If the glider re-inflates impulsively behind the pilot, then the resulting dive forward needs to be actively blocked via appropriate brake input.

Airdesign Rise 2: Massive collapses were difficult to induce. Generally the glider collapses at about 60% area. On massive collapses at the lower end of the weight range (left) recovery was slightly delayed (right), but the the glider self re-inflated progressively from the middle.

Nova Mentor 4: Again, massive collapses were difficult to induce, the canopy generally collapses at about 60% area. At the lower end of the weight range the canopy enters a short deep stall on recovery, but the folded wingtips help reduce forward dive dynamics.

Advance Iota: behaviour is normal for the gliders classification. At the lower end of the weight range recovery is slightly delayed. Re-inflation is progressive from the canopy mid-point outwards, and recovery rapid with marked forward pitching.

Front Collapse						
Glider	**Height-loss in m**	**Pitch-back angle in °**	**Pitch forward angle in °**	**Rotation, G-Force in G**	**V/sink maximum in m/s**	**Notes**
LTF A						
U-Turn Emotion 3 S/M						
40% collapse	25 m	-30°	-20°	No	<10 m/s	
Maximum collapse presented by construction	30-39 m	30-45°	30-45°	No	10-15 m/s	Only low area collapses were possible to induce. Re-inflation generally rapid, on occasion progressive from canopy mid-point.
LTF B						
U-Turn Infinity 4 M						
40% collapse	30-39 m	30-45°	45-60°	No	<10 m/s	
Maximum collapse presented by construction	40-49 m	45-60°	45-60°	No	10-15 m/s	Indifferent behaviour: on occasion normal re-inflation from canopy mid-point, on occasion impulsive over entire span. At lower end of weight range, tendency to enter deep stall on recovery.
Airdesign Rise 2						
40% collapse	30-39 m	-30°	30-45°	No	<10 m/s	No problems.
Maximum collapse presented by construction	40-49 m, >50 m	30-45°	30-45°	No	10-15 m/s	At lower end of weight range re-inflation can be delayed and height loss increased. At the top end of the weight range, re-inflation is optimal and progressive from canopy mid-point.
Nova Mentor 4 M						
40% collapse	40-49 m	-30°	45-60°	No	10-14 m/s	
Maximum collapse presented by construction	>50 m	30-45°	45-60°	No	10-14 m/s	Special technique required to induce collapse. Re-inflation on occasion from canopy mid-point. Occasional delayed recovery with deep stall phase.
Advance Iota 28						
40% collapse	40-49 m	45-60°	-30°	No	10-14 m/s	
Maximum collapse presented by construction	40-49 m	45-60°	45-60°	No	10-14 m/s	Generally rapid re-inflation with marked speed recovery. Deep stall phase at lower end of weight range.

Spiral dives

U-Turn's Emotion 3 has very agile handling characteristics and can easily be brought into a spiral dive. For its class, G-forces during the manoeuvre are over average. If the pilot is passive an tips his/her upper body to the outer side while in the spiral, than exiting is without delay, usually within 180°. Should the pilot remain neutral in the harness, then the glider will turn for up to 360° on exiting before recovering completely. Incorrect harness setup can enhance this effect! Generally the agile steering characteristics and low pitch and roll damping of this glider set it aside from other LTF-A gliders. This should be noted when the glider is used by beginners and novice pilots.
The **Infinity 4** from **U-Turn** requires a little time to enter a spiral properly. On exiting after releasing the inside brake, the glider first accelerates and sink velocities increase by 2-6 m/s. Full recovery to straight flight was then usually within the next 360°, on occasion 720°.
Airdesign's Rise 2 reacts in accordance with its LTF classification when spirals are flown as set down in certification regulations and pilots allow their bodyweight to tip the harness to the outer side. In a neutral pilot position the glider turns for longer and indicates tendencies to remain in a stable spiral dive.
The outer wing tip of **Nova's Mentor 4** tends to deform when the inner brake is released in a spiral, which prevents further acceleration and aids a rapid recovery. If the wing tip remains inflated then the glider continues to turn for more than 360°. Neutral pilot position also delays recovery to normal flight as with the **Rise 2** and an active recovery is recommended.
Advance's Iota behaves quite differently: independent of pilot position, the glider remains in a stable spiral dive when the brakes are released and accelerates to a maximum sink velocity of nearly 25 m/s. Exiting is relatively easy via brake input on the outer wing tip. G-forces of nearly 5 G were measured, and were the highest recorded in this test series.

Spiral dives							
Glider	**Vsink after 360°, 720°, max.**	**G-Force after 360°, 720°, max.**	**Height loss after 360°, 720°, max.**	**Height loss from brake release to regaining normal flight**		**Action after brake release**	**Notes**
LTF A							
U-Turn Emotion 3 M	6 m/s 14 m/s 19 m/s	2,0 G 3,4 G 4 G	25 m 60 m	60 m		Short acceleration from 16 to 19 m/s for <180°, then exit and self recovery within the next 180°	Agile steering characteristics enable rapid spiral entry. Exit within 180° with passive piloting. Neutral pilot positions increase exiting to within 360°
LTF B							
U-Turn Infinity 4 M	5 m/s 12 m/s 20 m/s	1,9 G 3 G 4 G	25 m 70 m	70 m		Acceleration from 14 to 17 m/s for 180°. Then exit and self recovery within the next 180°	Easy entry. Spiral dives are easy to control. On inner brake release the sink velocity increases by 2-6 m/s. Self exiting and recovery after 360°, on occasion up to 720° where maximum sink rates of 20 m/s were reached.
Airdesign Rise 2 M	8 m/s 14 m/s 20 m/s	2,2 G 3,8 G 4,3 G	30 m 75 m	90 m		Acceleration from 14 to 20 m/s within the next 180°. Then deceleration, exit and self recovery within	Spiral dives are easy to control with passive piloting where weight shifting to the inside of the spiral is not

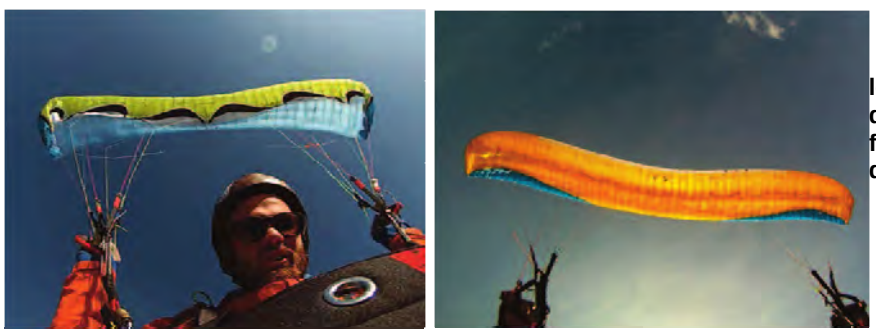
						the next 540°	performed (conform to LTF testing regulations). Tendency to remain in stable spiral dive should pilot weightshift to inside or remain neutral.
Nova Mentor 4 M	8 m/s 14 m/s 18 m/s	2,6 G 3,5 G 3,7 G	35 m 75 m	50 m		Outer wing tip deflates and reduces sink velocity. Exiting within 360°. Should the outer wing tip remain inflated, exiting is delayed to 540°	Glider enters a spiral dive rapidly. Sink velocities are average. On brake release the outer wingtip generally deflates, and exiting is radpid with no increase in sink velocity. Should the outer wing tip remain inflated, then exiting requires up to a further 360°. Active exiting is recommended.
Advance Iota 28	7 m/s 11 m/s 25 m/s	3 G 3,5 G 4,8 G	30 m 60 m	Pilot action required		Inner wing tip deflates and glider accelerates from 14 to 25 m/s within 360°, and then remains in a stable spiral dive at 20 m/s sink velocity.	Glider accelerates on brake release and remains in stable spiral dive irrespective of pilot position. Exiting is simple but requires strong input on the outer brake.

B-Stall

None of the test pilots found any safety relevant problems with B-stalls on the tested gliders. The canopies of **U-Turn's Infinity 4** and **Advance's Iota** did tend to bend a little, and ought to be observed during the manoeuvre. Both **Airdesign's Rise 2** and **U-Turn's Infinity 4** have a relatively high initiation resistance.

B-Stall				
LTF A				
Glider	**Sink rate in stable B-stall. Deformation tendencies Rotation**	**Pitch back on entry / pitch forward on exit**	**Height loss on exit**	**Notes**
U-Turn Emotion 3 S/M	9,5 m/s no no	15°-30° -15°	-30 m	Very stable sink phase, low pitching back and forward.
LTF B				
U-Turn Infinity 4	9,5 m/s slight no	15°-30° 15°-30°	-30 m	High initiation resistance. Tendency to front horseshoe for very large B-stalls. Observation recommended
Airdesign Rise 2	9 m/s no no	45-60° 15-30°	-40 m	Stable sink phase, moderate pitching back and low pitching forward. High initiation resistance.
Nova Mentor 4	9 m/s no no	15-30° 15-30°	-40 m	Stable sink phase, moderate pitching back and forward.
Advance Iota	7 m/s no no	15-30° 15-30°	-40 m	Simple, slight tendency to front horseshoe. Observation recommended.

above: Emotion 3, Rise 2 and Mentor 4: B-stall manoeuvre presents no problems.

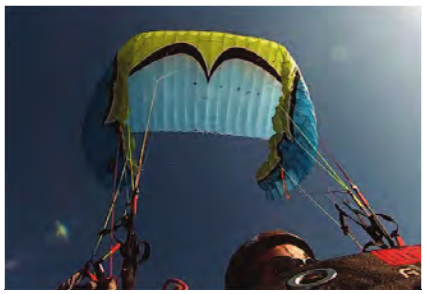


left: Infinity 4 and Iota: slight deformation tendencies. A complete front horseshoe did not occur during testing.

Big Ears

This manoeuvre could be performed easily and effectively on all gliders tested here. Slight wingtip flapping was present, particularly on Airdesign's Rise 2 but this was not a problem for the manoeuvre. Large wing tip folds are possible on Nova's Mentor 4, which then require active recovery via appropriate pilot input.

Big Ears					
Glider	**Entry**	**Exit**	**Vsink (trim) Vsink (full)**	**Speed difference trim - full**	**Notes**
LTF A					
U-Turn Emotion 3	Easy	Automatic, slightly delayed	3 m/s 3,5 m/s	Approx.0-3 km/h less than trim speed Approx. 3-5 km/h more than trim speed	Wingtips flap slightly at trim speed, flapping decreases at full speed
LTF B					
U-Turn Infinity 4	Easy	Automatic, delayed	3,5 m/s 4,5 m/s	Approx.3-5 km/h less than trim speed Approx. 3-5 km/h more than trim speed	Problem free.
Airdesign Rise 2	Easy	Automatic, rapid	3 m/s 3,5 m/s	Approx.3-5 km/h less than trim speed Approx. 0-3 km/h more than trim speed	Slight wingtip flapping
Nova Mentor 4	Easy	Markedly delayed / must be actively recovered from through pilot action	4 m/s 4,5 m/s	Approx.0-3 km/h less than trim speed Approx. 3-5 km/h more than trim speed	Large wing tip folds possible. On occasion no automatic recovery.
Advance Iota	Easy	Automatic, rapid	3 m/s 4 m/s	Approx.3-5 km/h less than trim speed Approx. 0-3 km/h more than trim speed	Problem free


Above: Emotion 3, Infinity 4 and Iota: problem free big ears


Large wingtip folds possible on the Mentor 4 (left). Pilot action required to recover. The wingtips on Airdesign's Rise 2 (right) tended to flap a little.