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Zodiac's zenith

Now featuring one of the most modern light aircraft engines on the market, the latest Zodiac not only has power to spare, but remains something of a bargain

Words Dave Unwin Photos Jim Lawrence



As the propeller blades dissolved into a shimmering blur, the exhaust sounded a pleasingly crisp bark of power. Flying is a visceral experience – the sight, feel and even the smell of an aircraft all combine to make aviation the immersive experience that it is, and sound plays an important part too. I've always admired the Rotax 912 series: its undoubted efficiency, excellent reliability and good power-to-weight ratio have ensured that it has been for many

years the undisputed world champion of ultralight engines. However, while low noise is one of its virtues, the sound it puts out has never really appealed. In contrast, the eager growl of the ULPower 350iS tucked under the latest Zodiac's cowling definitely grabs one's attention. And of course, the fact that this engine produces thirty per cent more power than a 912S is no bad thing either!

The impressive exhaust note hadn't come as a total surprise. Even from the other side of the taxiway, I could clearly see that 'Four

Zulu Zulu' was very different from any other Zodiac that I'd flown. Not only did it seem slightly taller, but the bulged cheeks of the cowling hinted that a more powerful engine lurked within. I've always been a firm believer in the old maxim "never fly a new type of engine in a new type of airframe" and, as the ULPower 350iS is one of the newest engines in the GA market, I was pleased to see it was housed in a fully developed light sport aircraft (LSA) with real pedigree; the Zenith Zodiac. 



Line began in 1984

Designed by Chris Heintz, the Zodiac 601 first flew as a Lycoming-powered VLA (European Very Light Aircraft) in 1984. Since then it has been continually refined and improved, and is currently available in a number of variants, powered by both air-cooled and liquid-cooled engines and with differing maximum weights. The 650 is the latest and largest Zodiac to come from the Zenith Aircraft factory, and is specifically aimed at the burgeoning LSA market.

As you'd imagine, the type has evolved considerably over the last 28 years and there are a significant number of differences between an early 601 and the current 650B; the most significant one being the engine, so let's start at the spinner. As mentioned earlier, the original aircraft was powered by a 116hp Lycoming O-235 and over the years probably a dozen different engine types have been tried, with different cylinder configurations, drive arrangements and cooling systems. With the ULPower engine the wheel has (sort of) turned full circle, as – just like the O-235 – it is a direct-drive, air-cooled flat-four. However, that's where the similarities end. The 350iS is more powerful, yet smaller and lighter. It has electronically controlled multi-point fuel injection and ignition, as a 21st Century engine should. It is quite tightly cowled and, as there is only a small hatch for access to the oil dipstick, a more detailed pre-flight

inspection requires the cowling to be removed, although this didn't appear to be too onerous. It is fed from an integral welded aluminium fuel tank in each wing, with a combined capacity of 91 litres, and turns a two-blade, ground-adjustable Whirlwind prop.

Below the engine bay is the rugged-looking nosewheel leg. Far too many modern VLAs feature nosewheel legs that look a touch on the flimsy side (and indeed often are), but the Zodiac's is pretty robust. I was already getting the impression that Zenith Aircraft is aiming the 650 at the training market, and a good trainer needs a strong undercarriage. The direct-linkage steerable nosewheel uses a bungee for shock-absorption, while the main undercarriage is a sturdy single-piece cantilever with aluminium spring legs bolted directly to the underside of the fuselage. Although this system is simple, robust and practically maintenance-free, it's been my experience that the damping qualities of a leaf-spring undercarriage aren't always entirely satisfactory. Of course, this may encourage students to make better landings.

All three wheels are closely spatted and use the same 500 x 5 size tyre, but 600 x 6 tyres are an option. There are actually too many options to list, although one I'd certainly exercise were I in the market is to configure the aircraft as a taildragger. The wing is thinner than early Zodiacs' and uses

a Riblett GA 35-A-415 aerofoil with a small amount of dihedral. It features a straight leading edge and a slight taper along the trailing edge while the wingtips, in common with many other Heintz designs, are of the Hoerner type and feature position and strobe lights. The wing and fuselage skins are 6061-T6 aluminium. Electrically-actuated flaps cover just over half of the trailing edge and are infinitely variable between 0 and 20°. Taxi and landing lights are located just inboard of the port tip, but the feature I most liked is that the 650 has wingroot lockers. (I know that the Fastback and Sportcruiser both have them, but credit where credit's due – the Zodiac had them first.) Up to 11.3kg can be carried in each.

Unusual tail surface

Another fascinating facet of the Zodiac is its rudder. Although the empennage, fixed tailplane and cable-operated elevators are entirely conventional in appearance and construction, the sweptback vertical surface is rather unusual as it is of the all-flying type. Many WWI fighters had this kind of rudder, possibly because control was then of more importance than stability. However, very few GA aircraft use this arrangement (my own VP-1 being a notable exception) probably because designers now feel that stability is more important than control.

The theory behind the all-flying rudder is that it promotes clean airflow across 



Left: ULPower 350iS delivers lots of extra oomph
Opposite & below: big canopy offers excellent access
and pilot view, Y-shaped stick is shared by occupants



both sides of the flying surface, which has the net effect of less flow separation (and consequently less induced drag) on the low-pressure side whenever the rudder is applied.

I'm not entirely sure about this – although it does make sense – but what is undeniable is that, as it is slightly smaller than a conventional fin and separate rudder, it is lighter, while being a single piece it is easier to make. Furthermore, this arrangement does offer more control authority. Not only as the moving part is bigger than a separate rudder, but it's also an asymmetrical aerofoil. And plenty of directional control is always appreciated when taking off or landing in a strong crosswind.

Access to the cockpit is good – sturdy steps aft of the trailing edge, a wide wingroot walkway and an expansive canopy well supported by gas struts make ingress and egress easy. Upon settling onto the comfortable semi-reclined seat, the immediate impression is of spaciousness; thanks to the 1.11m-wide cabin and generously sized bay behind the seats, which can take up to 18.1kg of baggage.

With my straps snug – only a three-point harness I'm afraid – and the seat adjusted to suit the fixed pedals, I studied the layout of the instruments and controls. By now, you'll be starting to appreciate that the Zodiac does have some unusual and interesting features, and the next one to catch my eye was the Y-shaped centre-stick. This clever design is an elegant and lightweight way of providing a stick for both pilot and passenger, although a pair of more conventional sticks is an option. The test aircraft only had the PTT built into the P1's sticktop, with a rocker switch for the electric pitch trim and the toggle switch for the flaps located on the left side of the cockpit, next to the plunger-type throttle. In common with many of the LSAs I flew during my time in Florida, the 650's instruments are entirely digital and consist of dual Dynon Skyview PFDs – a ten-inch model on the left and the seven-inch version on the right. Apart from the flap and trim switches, all of the switches and circuit breakers are in the centre of the panel – the toggle switch in the centre console below the combined rotary ignition/start switch is the fuel selector switch. The injected engine requires return lines back to the fuel tanks, and the electric pump manages this easily. Note that on the test aircraft the P2/instructor's side had neither throttle nor brakes.

My impressions of the cockpit were generally favourable. The controls are nicely laid out and easy both to see and to reach (for example, the fuel cock is located in clear view on a small console that extends downwards from the base of the instrument panel). However, although I approved of the



location of the flap switch (next to the throttle) I didn't like the type (it's a simple toggle switch). The flap and trim positions are shown on the Skyview.

Headroom and climb performance to spare

With Zenith's Roger Dubbert in the other seat I lowered the canopy and locked it into place. One of the things I didn't like about the 601 was that the canopy latches were a bit fiddly, but the 650 uses a much better single-latch system. With the canopy down it seemed to me that there's a bit more headroom than in earlier Zodiacs, but what really struck me was the sheer size of the big bubble – it provides a full 360° field-of-view above the wing. However, a direct-vision panel wouldn't go amiss.

The engine start was simple and straightforward, as you'd imagine of a modern motor fitted with electronic control. There's no primer or mixture, and the dual ignition system is electronic. Turn the key and it starts, just like a car. The electronic control unit also greatly reduces pilot workload in flight, as there's no mixture to adjust nor (of course) carb heat to apply. Taxying out towards the active runway,

I spotted several show goers stop and stare, intrigued by the eager growl of the air-cooled engine. The 650 is a very easy machine to taxi – unusually for an aircraft in this class the nosewheel steers through the rudder pedals and this, combined with the relatively wide track undercarriage and toe-operated hydraulic disc brakes, makes the ground-handling characteristics excellent.

As we had a considerably better power-to-weight ratio than the CT-LS camera ship, I elected to give it a generous head start, and waited until it was airborne before rolling out onto the runway. Thus far I'd been reasonably happy with the latest Zodiac, but it was only as the throttle hit the stop that I went from liking the 650 to loving it. It surged down the runway with the airspeed tape increasing at an impressive rate and at 40kt I rotated and we were airborne after a ground roll of barely 70m. The initial climb rate was around 1,200fpm at 70kt, but the view over the nose really was poor as the climb angle is so steep. Consequently I trimmed forward for 80kt, which still gave us a healthy 1,000fpm. Despite the fact that we'd given the CT-LS a good lead, we soon began to overhaul it both horizontally and

Left: all-metal construction makes for angular, if nonetheless pleasing lines **Below:** muscular cowl shape reflects the 130 horses under the hood



No more wheezing slowly up to altitude... this thing climbs like it means it!

vertically – so I pulled off a big handful of power to avoid overshooting and then eased into position. Sliding smoothly into formation I noticed how ‘normal’ the unusual Y-stick felt. Although it’d been about eight years since I’d last flown a Zodiac, after only five minutes it felt like I’d flown one yesterday. Formation flying in the Zodiac is a lot of fun – and, take it from me, this isn’t always the case. In fact sometimes it’s bloody hard work! The combination of simply superb visibility, crisp controls and a powerful responsive engine make the 650 a fine formation machine. After a couple of photographic circuits at Placid Lakes we parted company with the CT-LS, and commenced a climb to altitude to investigate the stall characteristics. Once again, I really liked the great rate of climb provided by the

130hp engine, and I think instructors will too. No more wheezing slowly up to altitude as if you’re riding an asthmatic albatross, this thing climbs like it means it!

Harmony and handling

I began my assessment of the handling with a series of increasingly steep turns. The skies over central Florida are quite busy, and once again I was grateful for the exceptional field-of-view provided by the huge canopy. There are simply no blind spots above the wing, which makes keeping a good look-out easy. Control harmony was good, and it seemed to me that all three primary controls were light and well balanced. It was interesting to note that the all-flying rudder is not as sensitive as you might imagine, and is actually quite nicely harmonised with the ailerons and elevator.

Another aspect of the envelope that I was particularly keen to evaluate was the stick-free stability. The first Zodiac I flew was a 601XL about ten years ago, and my single biggest criticism was that the aircraft was slightly unstable in pitch. On this occasion, an examination of its stick-free stability soon revealed it to be neutral laterally and

positive longitudinally and directionally.

Moving on to slow flight and stalls revealed the 650 to be, as Roger described it, a “good honest airplane”. With full flap and no power it never really stalls, but just sort of mushes with a high sink rate. There is still plenty of roll authority as the ailerons continue to work post-stall. Roger encouraged me to try a departure stall, so with ten degrees of flap and full power I kept hauling the nose up and up... and up! The airframe was shaking like a dog drying itself off, but the wing just didn’t want to stop flying. I have no idea what the speed was when the wing finally quit. At such high angles of attack, the IAS is only really an approximation due to position error – but I can safely say it was extremely slow. There is no artificial stall warning system fitted.

A look at the cruise performance revealed that although the extra horses have greatly improved the take-off and climb performance, the 130hp 650B isn’t that much faster than a 100hp 601X – which is only what you might expect. Indeed, as the airframes are essentially the same, it’s an excellent example of the square-cube law. ➔



Basically, the power needed to push an object through a fluid increases as the cube of the velocity. This means that although a 100hp aircraft may be able to fly at 100kt, for the same aircraft to do 200kt it'll need 800hp. At 5,000ft and 2,800rpm the 650's TAS is around 126kt, but the motor is burning about 28lit/hr. A more comfortable rpm is 2,500, which gives a TAS of approximately 110kt, while the fuel flow drops to a much more respectable 19lit/hr. With full tanks, this makes the still-air range 450nm, with at least 30 minutes reserve.

All that was required now was to try a few circuits. These were very straightforward. As mentioned previously, the field-of-view is exceptional, while the flaps are efficient and the small changes in pitch easily trimmed out. I used 50kt, although with a bit more time on type I think that another five could be safely shaved off, particularly in light winds. And if you did suddenly find yourself getting slow, you've got 130 eager horses waiting to give you a pull!

Interestingly, the energy-absorbing qualities of the leaf-spring undercarriage are actually very good, and certainly superior to some other aircraft fitted with a similar system that I have flown. I asked Sebastian Heintz about this, and he explained that Zenith use cold-formed 6061-T6 aluminium for the leaf-spring; which provides better damping than 2024.

Good value for the money

Overall, I was very favourably impressed by the 650B. The handling is good and the field-of-view superb. It can carry a decent payload a fair distance over a good range, while the cockpit features comfortable seats

and good heating and ventilation (although I think that a concertina-type sunshade might be useful in the summer). There's plenty of room for baggage behind the seats, while I really do like the wing lockers.

There are a couple of tweaks I'd recommend, such as a better flap switch and a DV panel, but these minor issues could easily be addressed while building the aircraft. And while we're talking about construction, I have to say that I suspect that it would probably prove to be one of the easier kitplanes to build. Two types of kit and a ready-to-fly version are available; the 49 percent kit and the QB or quick-build. Irrespective of which version you choose, the builder's manual is nothing short of exceptional, with clear, concise, unambiguous instructions supported by easily-understood diagrams and a video. The builder is also supplied with actual blueprints of the entire aircraft and not just assembly instructions.

Zenith kits have always had a good reputation, in fact Chris Heintz and a dedicated team actually built an entire aircraft during Sun 'N' Fun one year, with Chris flying the completed machine on the last day of the show. Building an aircraft during the course of an event is quite an impressive feat – and as far as I'm aware no one else has succeeded in doing so.

In fact, now I think about it – I liked the CH650 a lot. Although it may not be as plush as the Bristell Fastback, Renegade Falcon or Tecnam P2008, on the other hand it is only two-thirds of the price. Indeed, it offers exceptional value for money.

However, what I really liked about the 650 is the take off performance. Most GA

SPECIFICATION

ZENITH ZODIAC CH650B

DIMENSIONS

Wing span	8.23m
Length	6.10m
Height	1.98m

WEIGHTS AND LOADINGS

Empty weight	315kg
Max all-up weight	600kg
Useful load	285kg
Fuel capacity	91 lit
Baggage capacity	40kg

PERFORMANCE

VNE	139kt
Cruise	138kt
Stall	38kt
Climb rate	1,200fpm
Service ceiling	12,000ft

ENGINE

130hp ULPower 350iS air-cooled flat-four driving a two-blade, ground-adjustable, composite Whirlwind propeller

MANUFACTURER

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aircraft can be landed in a much shorter distance than they need to take off (interestingly the converse is true for most jets), and this can lead to awkward, embarrassing and even dangerous situations. However, this does not hold true for the 650. Basically, if you can get in, you can get back out again! ■