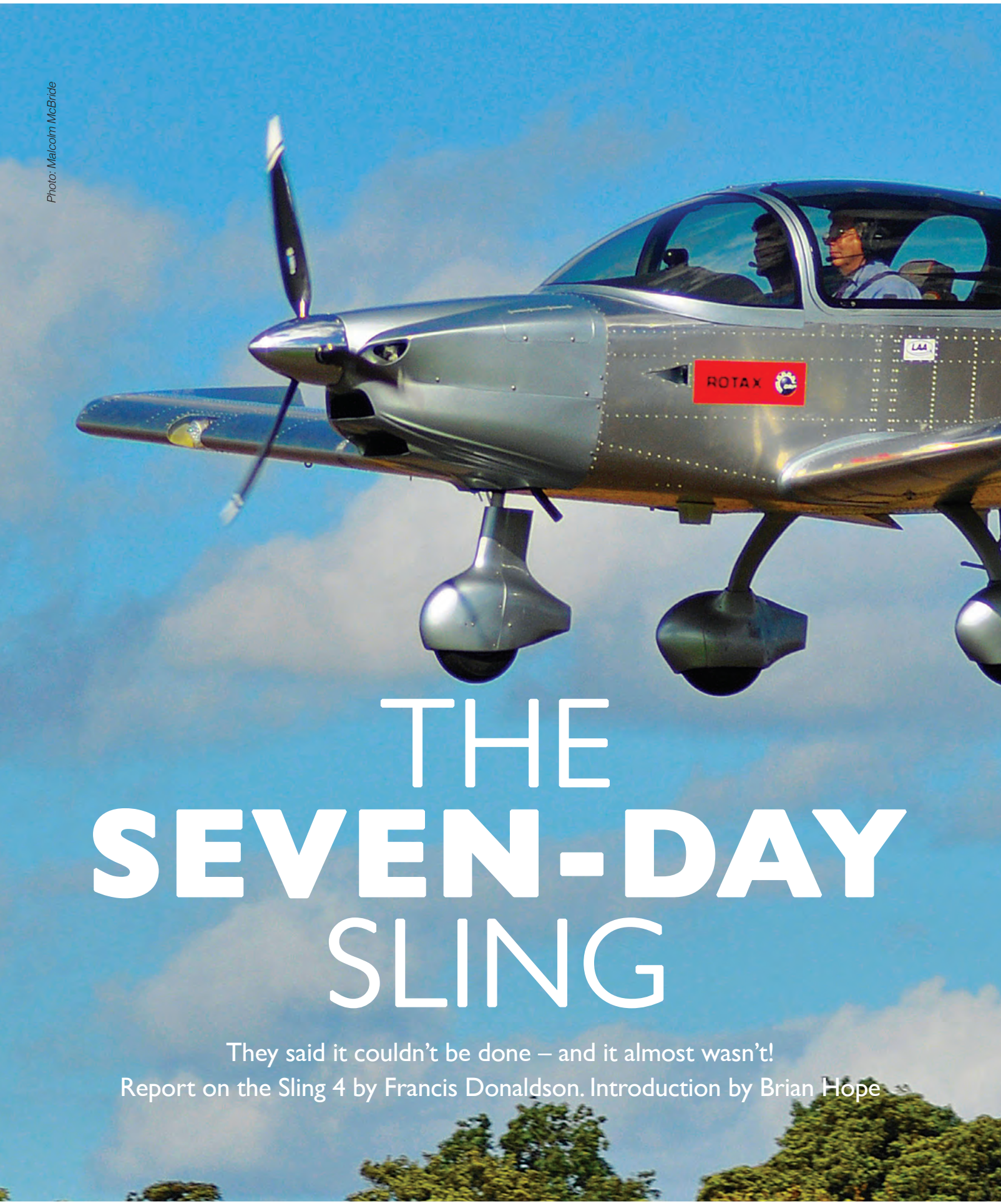

Photo: Malcolm McBride

THE SEVEN-DAY SLING

They said it couldn't be done – and it almost wasn't!
Report on the Sling 4 by Francis Donaldson. Introduction by Brian Hope

Twenty-past-five on Sunday afternoon, 4 September 2016: an unpainted but nonetheless attractive light aircraft joined the tail-end of the queue of departing aircraft from Sywell, the last stragglers heading for home after a truly fun weekend at the Rally. Lining up on 21 hard, with the remnants of a tricky crosswind from the right that had taunted pilots all day, the aircraft climbed purposely into the air and carried out two circuits before making a textbook landing. The Sling 4 had flown!

Seven days earlier it had been hundreds of individual components and thousands of rivets in a pile of wooden crates that had been shipped all the way from South Africa. The seven-day Build a Sling Challenge had been achieved, The Airplane Factory (TAF) and a handful of UK volunteer amateur builders which included the aircraft's owner, Lucien D'Sa, had assembled a flat-pack kit aircraft in just one week. Seeing it fly as the Rally infrastructure was starting to be dismantled was the perfect ending to a perfect Rally.

This incredible journey had started in December, when Steve Slater suggested to fellow Rally Committee members that building a complete kit aircraft at the Rally might be good way to promote amateur aircraft building and form a centrepiece to our 70th Anniversary Rally.

Fate then took a hand because in the February magazine Francis Donaldson wrote about those aircraft that were being considered for LAA approval, including TAF's Sling 2 and 4, and in the same issue we mentioned that a seven-day build challenge was a possibility for the Rally. LAA member Tim Hardy emailed copies of both articles to Mike Dawson at TAF and the rest, as they say, is history. Conference calls between the UK and South Africa laid down the plan – the LAA would facilitate TAF building a Sling 4 at the Rally by providing suitable accommodation for the build and the usual LAA build support and Inspection, and they would undertake the build using a team of five TAF employees and five amateur UK builders. I couldn't believe that it had all come together so easily!

The Sling family of two and four seaters is not yet well-known in the UK, or Europe for that matter, but they have built a solid reputation in South Africa and are now spreading their wings in the US and Australasia. The Airplane Factory have certainly been enthusiastic to promote the reliability and usability of the Sling 2 and 4, including three around the world flights, one of which ›

included a 27-hour flight from Cabo Frio Airport, Brazil to Cape Town Airport, South Africa, a distance of 6,222km (3,865 miles)!

I'll let Francis continue the story from an LAA Engineering perspective.

Francis Donaldson: My first contact with the Sling 4 came when James Pitman, Sling's Director-Corporate and his similarly youthful MD brother Andrew, passed through Turweston in the summer of 2013 enroute from Oshkosh back to their base near Johannesburg, giving me a chance to look their aeroplane over, get a basic idea of its layout and structure and advise on the steps that would be needed to put the design through the LAA type acceptance process. There had been little publicity about the type up to that point, in the northern hemisphere at least, so as we regard ourselves as pretty well informed on such developments it seemed quite strange to be looking at what was clearly a mature product yet knowing almost nothing of its history or pedigree.

DESIGN AND CONSTRUCTION

Of all-aluminium alloy construction, despite its roots being in a two-seat model, the Sling 4 appeared to be generously proportioned in the areas of its flying surfaces and its moment arms, and with enough dihedral for positive lateral stability. The wingspan has been stretched by 800mm compared to the two seater, and the rear fuselage by 450mm to accommodate the second row of seats in place of the two-seater's baggage bay. Unlike some of the competition, the Sling 4 seemed to offer a very adequate cockpit for four adults.

The airframe structure is conventional riveted aluminium except for the cabin top which, like the Vans RV10, is an inset fibreglass moulding which provides the framing for the twin top-hinged gull wing doors and fixed windscreen, whilst also, strongly bonded and riveted in place, contributing to the overall strength of the monocoque fuselage and providing a dependable turn-over structure.

Although this fleeting encounter gave us a chance to meet the two highly charged brothers and hammer out the way forward for an approvals process, unfortunately there was no opportunity to fly in the aircraft at that time because it had arrived already loaded to the gunwales with fuel ready for the next leg of the trip. With a special long distance tank, the aircraft had an endurance over 20 hours and James did not think that the performance of the aircraft at way over the normal max gross weight would do the Sling justice. With a final volley of good wishes the two went on their way, promising that a paperwork package would follow in due course.

The Sling team were quick to forward two thick volumes of compliance documentation, consisting of a compliance checklist against the FAR-23 design code, and a report summarising and justifying a small number of non-compliances with the code.

The supporting reports took the form of a loads report, which presented the aerodynamic and other loads acting on the aircraft in flight and in taking off and landing, and no less than 77 load test reports that testified and illustrated how a sacrificial Sling airframe had withstood these loads when tested in their factory using a typical armoury of sand bags, hydraulic rams and so on. Flight test reports showed how the Sling team had checked the flight handling against the requirements and built up a complimentary picture of how the type behaves in its natural environment. A detailed build manual, pilot's operating handbook and pilot's checklist completed the package.

SEVEN-DAY GREEN LIGHT

When the idea of a seven-day build at the Sywell Rally first cropped up, as a demonstration not only of the Sling but of the potential with modern kitplane pre-fabrication, we in the Engineering Department were naturally more than a little wary, particularly as

The Airplane Factory's approval submission was first class and included a great deal of evidence of load testing of a sacrificial airframe. Photo: TAF

James Pitman, right, talks LAA's Francis Donaldson through the controls of the Sling 4, ready for his flight test. Photo: Malcolm McBride

Mike Blythe, third from right, discusses applying the starboard wing skins with the wing build team. Photo: TAF

this would be the first of its type in the UK and we hadn't even had a taster to the type's flying characteristics yet.

On top of that, astonishingly, the starting point wasn't even going to be a quick-build kit in the normal sense of the word, where a lot of assembly work had already been done. This was to be starting from a flat-pack with only the instrument panel pre-assembled and pre-wired to save time at Sywell. The last thing we wanted was to portray to the world at large an image of a kitplane being thrown together to a gash standard or with big build problems to overcome, or issues with gaining type approval at the end.

But, after having reviewed this very substantial and thoroughly competent body of compliance paperwork, and in light of the aeroplane's sensible layout and proportions and its history as a well-established factory built and kitplane in South Africa, we decided that it would be a reasonable proposition. The project planning went ahead, marked at intervals by skype calls between Johannesburg and Turweston to settle such matters as the build tent, the build team, tools and equipment, accommodation and refreshment.

Clearly the build couldn't be completed in just the three days of the Rally, so arrangements were made for the tent to be erected on site early. Work started on the preceding Sunday on an otherwise bare airfield and continued through the week as all the other Rally marquees and fandango took shape around them, the team no doubt inspired by the sound of a pair of Spitfires offering once-in-a-lifetime joyrides from a patch of turf alongside.

Having already satisfied ourselves with the main aspects of the design of the Sling 4 from the original visit and from slogging through the proffered paperwork, we found that seeing the project coming together at Sywell provided our design team with a unique opportunity to check the quality of the kit and the detail design features while still fully exposed as the aircraft took shape.

Andy Draper, our Design Engineer at LAA Engineering, kindly volunteered to be the LAA inspector on the project, looking after build quality, conformity and airworthiness matters. This turned out to be particularly advantageous because from his days with the Europa company, Andy has a huge amount of experience in manufacturing kits, and quickly achieved a very good rapport with the Sling team who clearly appreciated that Andy was not going to be fobbed off on technical matters. My role was to deal with the kit quality and design investigation aspects and to manage the flight testing side.

FINAL SIZE PRE-DRILLING

I was particularly interested to see how the Sling's mostly final-size pre-drilled parts would fit together, as I know from past experience how very difficult this is to make work on sheet aluminium aircraft. It's not too difficult to achieve repeatability with flat sheet parts but to get the holes in the right place on pressed sheet metal parts, such as ribs and fuselage frames, is another thing altogether – small changes in the pressing process, or switching to replacement press tools, can very easily result in the pre-drilled holes in pressed flanges moving enough to prevent the parts fitting together properly. At best, misfitting parts can cause inbuilt stresses, or show up as unsightly ripples in skins that, to those in the know, show up like a sore thumb.

Van's aircraft were the first to achieve enough of a level of confidence in their CNC-machined parts to allow final size pre-drilling of a sheet aluminium kitplane, rather than pilot-sized holes or even the traditional approach of pre-drilling one part only and drilling through into the other on assembly. The proof of the pudding is in the eating, and the final-sized pre-drilling of the seven-day Sling 4 seemed to be faultless – everything lined up, and this is very important to the kitplane builder.

Even though it might seem like a trivial thing to open up a pilot-sized hole to final size with a quick zip of the drill, not having to do this means there's no swarf introduced between matching parts and therefore no need to dismantle, de-burr, or blow away the swarf before riveting, and so saves a great deal of time in the assembly process. It was this, more than anything else, which made it possible to build the aircraft in seven days. It says a lot for the relatively young Sling company that they have managed to achieve this level of success in their production engineering, even more so as although designed entirely using CAD, the Sling aircraft do not benefit from the latest state-of-the-art Catia CAD software.

Despite all this refinement, inevitably the build process was not without one or two snags. We had to insist on a handful of the many thousands of hand-pulled rivets being replaced.

One wing had to be re-worked slightly after a short run of blind rivets forced the free end of one the laminations of a spar cap away from its neighbour rather than holding them together.

And the composite canopy frame had to be re-fitted because due to a misunderstanding, the adhesive bonding it in place started to set before it had been settled exactly into its correct position.

On the design side, we debated over whether a few self-locking nuts should be replaced by castle nuts and split pins, and grumbled about a couple of through-bolts in a flap driveshaft that had been hand-drilled out of 'square'. We weren't entirely happy with the way the auto-pilot pitch servo was mounted either - despite seeming rigid at first sight, the mounting flexed noticeably when the system was tested on the ground.

The aircraft was cordoned off for its final inspection, which was carried out at Sunday lunchtime while the last few jobs were still being finished off in the cockpit. A minor crisis arose when the carefully pre-prepared fireproof identification plate was found to be absent from the cockpit, and the entire team searched the tent's every nook and cranny until the errant plate turned up – in the owner's pocket!

Engine in, cowling on, where's that Airmaster prop? Photo: Ed Hicks

A COMPARISON OF THE SLING 4 WITH OTHER LAA FOUR-SEATERS
(MANUFACTURERS' FIGURES)

	Sling 4	Pioneer 400	Jabiru J430	Van's RV-10	Jodel 1050
Wingspan	32ft 8in	28ft 10in	31ft 0in	31ft 9in	28ft 7in
Length	23ft 5in	23ft 0in	21ft 6in	24ft 5in	21ft 4in
Wing area	134 sq ft	120.6 sq ft	100.5 sq ft	148 sq ft	146.4 sq ft
Max gross weight	2028 lb	1650 lb	1540 lb	2700 lb	1720lb
Empty weight	1036 lb	840 lb	770 lb	1630 lb	970 lb
Useful load	992 lb	810 lb	770 lb	1070 lb	750 lb
Engine	Rotax 914	Rotax 912S/ 914	Jabiru 3300	Lycoming O-540	Continental 0-200
Max power	115bhp	100/115bhp	120bhp	260bhp	98bhp
Wing loading	15.1 lb/sq ft	13.7 lb/sq ft	15.3 lb/sq ft	18.6 lb/sq ft	11.7 lb/sq ft
Cruise speed	120kt	119kt	120kt	175kt	113kt
Stall speed	42kt	44kt	45kt	55kt	48kt
Fuel capacity	182 litres	80 litres	140 litres	227 litres	150 litres

Team members put in long hours and their work was closely inspected by the LAA as they went along, resulting in a few rejected parts. Photo: Ed Hicks

The crowd swelled visibly as the time for 'roll out' drew near, especially as the size of the tent made it obvious that even by the surreptitious removal of a couple of hefty stanchions from the tent's frame, there would not be enough room for the Sling to exit square–on.

Finally, the build inspection was completed and the various forms signed. The call went out for extra volunteers and on James' instruction, willing hands lifted and dragged the Sling diagonally out into the sunlight, everyone breathing a sigh of collective relief as its tail surfaces escaped the threatening clutches of the tent's roof structure.

First sight of the aircraft outside the confines of tent showed it to be a handsome creation, despite the bare aluminium external finish. The sheet metal fuselage is made up of single-curvature panels, but the shape is more sophisticated than it first appears. The fuselage is wider at shoulder level than at the bottom. According to designer Mike Blyth, this tweak to the geometry cuts down on frontal area while preserving shoulder room for the occupants. I found it also helped dispel the boxy look common among four-seaters, without the expense of Beagle Pup or Saratoga-style compound curved skins, or the ARV's superplastic aluminium cockpit tub.

FIRST ENGINE RUNS

The newly-born Sling was wheeled out into the airside area for the first start-up of its Rotax 914 engine, which was faultless, and led several to remark on how quiet the turbo-charged flat-four sounded in this all-metal airframe. James taxied away from the crowd to do the high-power runs, and to test the steering and brakes.

Perhaps unrealistically optimistic, we had expected him to leave the aircraft airside in readiness for the first flight but should not have been surprised to see the Sling being brought back to the tent for some snags to be fixed. After all, what are tests for if not to find what doesn't work? In this case it was the electrics that were having the team scratch their heads – the pitch-change function of the expensive three-blade Airmaster variable pitch propeller was somehow not working, and the engine's CHT's were not registering on the panel.

The prop problem turned out to be due to a dud circuit breaker, but fortunately there was a spare on the panel of suitable current rating, so the prop feed wire could simply be transferred across. While the team sorted out these problems the application for the permission to test fly was prepared and, snags sorted, signed up and handed over to Fiona Storer, our Engineering Administrator, to carry out the regular checks and to log the application onto the LAA database using the wi-fi in the Aviator Hotel. Then, as the shadows started to lengthen outside and the crowd waited patiently, I was able to carry out my share of the checks and finally complete and sign up the flight test authorising paperwork and airworthiness approval note which I had prepared the previous morning at Turweston.

The first flight was a complete success. A large group of onlookers, volunteer builders and Sling crew made their way to the runway's edge to cheer as James lifted the seven-day Sling into the air. After a single large circuit James made a celebratory pass along the runway (at a sensible height) and waggled the wings in salute before returning to a silky smooth landing, belying the crosswind that was still making itself felt on Sywell's tarmac.

The Sling came to Turweston during the following week for various tweaks to be done and to set up the auto-pilot, before getting cracking with the formal flight test program. One of the underbelly aerials was found to be vibrating in flight, which was easily cured with a local skin stiffener angle.

Carrying out the standard flight test schedule for variable pitch propellers, we found that the fine pitch stop had been set rather finer than we like to see. With the prop switched to 'manual' and motored to the fine pitch stop, it allowed the revs to exceed the max permitted figure if 100% power was used while climbing at the normal climb speed. Of course, with the system operating normally in 'auto' mode, the constant-speed system would coarsen the prop pitch to prevent this but LAA's policy is that as the reliability of the pitch-change system on the non-certified Airmaster prop has not been proven to meet any formal reliability standards, it should be set up so that the propeller pitch can 'freeze' at any achievable setting without compromising flight safety.

Testing the auto-pilot, the airspeeds that were reached while using the auto height change function were slightly outside of the limits specified on the LAA test sheet, suggesting that the system gain needs to be turned down slightly so that the height changes happen at a shallower angle over a longer period of time.

CG CONSIDERATIONS

One of the inevitable problems with a four-seat aircraft is the big change in loaded centre of gravity position between flight with the front pair of seats occupied and when fully loaded with the rear seats occupied and baggage even further aft. This problem is exaggerated in four-seaters of low mass such as the Jabiru J430, Pioneer 400, MCR4S and even the RV10.

To cope with the wider cg range needed for a four-seater, they typically have to have a more powerful tail than a two-seater of similar size – either through an increase in tail area, in tail moment arm, or both. Even so, the handling in pitch is often markedly different between light and fully loaded, so it was important to check how the Sling would behave at both extremes of the cg range. Because of this, with four-seaters it is generally even more important than in a two-seater that the empty cg is in the optimum position, to make sure that when loaded it can make the best possible use of the loaded cg range available.

On G-LDSA, the empty cg was slightly forward of the ideal point, so a few kilograms of ballast were fitted in the rear fuselage to bring the cg back a tad – this will probably be able to be removed, or at least reduced, once the aeroplane is re-weighed after painting.

As the Sling's fuel tanks are in the leading edge bays of the wing, and the front seats are almost exactly coincident with the empty cg, the maximum forward cg position on the Sling (19% SMC) is achieved with the front seats loaded and full fuel. To load the aircraft to the maximum gross weight and the aft cg limit (31% SMC) we loaded full plastic water carriers weighing 78kg and some additional folded lead sheet totalling 12kg onto the rear seats, together with 14kg in the rear baggage bay, and flew with a reduced fuel load.

Of course, the payload is an important feature of an aircraft like this – several people at Sywell asked if the Sling 4 is indeed a genuine four-seater or a 2+2. G-LDSA is configured with a very comprehensive instrument

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James Pitman of TAF takes the Sling 4 for its maiden flight, which went smoothly despite a testing crosswind. Photo: Brian Hunter

Many hands make light work, or at least fit the wing. Looking like an aeroplane at this point but still so much to do. Photo: TAF

This was not the quick-build kit – the Sling was put together from flat-packed pre-cut and pre-drilled sheets. Photo: Ed Hicks

fit and 'the works' in terms of options, and in its unpainted condition weighed 502kg. With a maximum gross weight of 920kg this leaves a payload of 418kg for passengers, baggage and fuel meaning that weight-wise, four 77kg crew can carry 100kg of fuel and baggage. Care is needed however, because the aeroplane rapidly approaches the aft cg limit when weight goes into the rear seats so, particularly so when carrying minimum fuel, in practice the rear seat weight has to be somewhat restricted to stay within the aft cg limit. This is very much a point to be watched whenever the fourth seat is occupied.

FLYING THE SLING

My impression of flying the seven-day Sling was that it was a sophisticated and very well sorted design that handles in an exemplary fashion. On climbing in I was struck by the height of the cockpit sill, but once seated, the relatively high seating position meant that the cockpit doors stretched well down to elbow level, conferring an excellent view forwards over the nose and forward-and-down past the wing leading edge – an important feature for eyeball navigation as well as contributing greatly an overall pleasurable flying experience – no-one likes to fly along looking through a letter-box slot.

The gull wing doors closed easily and latched positively, both front and rear latches engaging simultaneously and both having their workings reassuringly on view so that there could be no mistaking they're being properly secured. The harness is a car-like lap and diagonal arrangement with an inertia reel at floor level – again, just like a car - and this and the very neat high quality upholstery contributed to what was undoubtedly a very comfortable cockpit indeed. The single central throttle for the turbocharged Rotax 914 engine has a neat détente arrangement to act as the 'gate' delineating 100% power, so that a ›

That's a very smart panel with a lot of kit! Carbon fibre panel finish sets off the avionics very nicely. Photo: Malcolm McBride

Mass recharge point for the team's power tools! Photo: Ed Hicks

separate movement was needed to go all the way to 115% power. Despite the high seating position, I had ample head room (I am 6ft 1in) and the cockpit felt airy and modern.

In flight, despite some reservations on James' part, my tests showed that longitudinal static stability and the dynamic stability (the stick-force per g) were well within an acceptable range at the aft limit and conversely at the other extreme cg condition. With the addition of a very small extension to the elevator trim tab, it was possible to trim the aircraft out in the critical situation of forward cg, full flap and power off in the approach configuration. The stall characteristics were extremely well mannered, the aircraft tending to spontaneously roll back to wings-level from turning stalls either way. In wings-level stalls the Sling eventually rocked its wings a number of times before finally letting go, the stick generally by that time hard on the back stop. Altogether, this is a very easy to fly aeroplane which cruises comfortably at over 110 knots.

There's more to go with the type acceptance program yet, including a fatigue life to be agreed, but so far all the signs are good and we look forward to seeing the Sling 4 again when it has been painted and the last few adjustments made. Having seen the process throughout and flown their creation, a hearty congratulation to the seven-day Sling team and the many volunteers for achieving such a very satisfactory outcome! ■

SLING 4 SPECIFICATIONS

DIMENSIONS

Wingspan: 32ft 8in (9.965m)
Length: 23ft 5in (7.1m)
Height: 8ft (2.45m)
Cabin width: 43.8in (1.11m)
Standard empty weight 1036lb (470kg)
Max useful load: 992lb (450kg)
Max weight: 2028lb (920kg)
Engine: Rotax 914UL 115hp (84.5kW)
Max continuous: 100hp (73.5kW)

WEIGHTS AND PERFORMANCE

(Vne): 135kias (161mph)
75% cruise @ 6000ft amsl: 120kias (138mph)
Stall speed - clean 47kcas (54mph)
Stall speed - full flaps 42kcas (48mph)
Rate of climb - sea level 750fpm
Maximum operating altitude 15,000ft
Range @ 75% power 780nm (1450km)
45min Reserve
Kit manufacturer: The Airplane Factory, South Africa
www.airplanefactory.co.za

THE BUILD TEAM

THE SLING BUILDERS had a lot of fun at the Rally and very quickly gelled into a team as they worked, ate and stayed at the same hotel together. I asked Mike Blyth and James Pitman how the experience had been for them and their co-workers from South Africa. Here's what they said:

What a pleasure and a privilege for The Airplane Factory of South Africa to be able to participate in the LAA's 70th year celebrations. We were overcome by the reception we received not only from the LAA, but also from Sywell Aerodrome, the show organisers, exhibitors, helpers and the public. Three of the team of five builders from the factory in Johannesburg had never before visited England, and one had never left the borders of South Africa. For us to be able to travel to the source of the industrial revolution, to a country with such a history of aviation and technology contribution, and to participate in such an inspirational activity as helping to assemble one of our aircraft in 7 days (8, as it turned out!), was a lifetime highlight.

One of the missions of The Airplane Factory is to bring safe, high quality, accessible and truly useful aircraft to the world. The LAA seven-day build couldn't have been a more perfect public exhibition of how, with energy, enthusiasm and (considerable) discipline, aviation is within reach of many. The build team represented a perfect mixture of personalities and skills - four members with substantial aircraft assembly experience, four amateurs with an established interest and four absolute beginners. Often it was the beginners who made the difference!

To be given the opportunity to fly our seven-day wonder in the closing hours of the show, and then to have her put through her flight test paces with Francis Donaldson and Andy Draper of the LAA only days later was, we realise, a rare privilege. We hope and expect that the Sling 4 will prove its own justification for the special accelerated treatment she received.

Notwithstanding the accelerated nature of the build and test flying, we were most impressed to witness how comprehensive an analytical, inspection and flight testing program is applied to all new permit to fly aircraft introduced to the UK. We're also delighted to report that in the two weeks since the build potential customers from at least two other European countries now maintain confidently that, "If the requirements of the UK LAA are met, there'll be no problem with our regulators!".

To crown the entire experience, fate provided an almost perfect day on the Sunday following her first flight, and it was possible to fly G-LDSA from Fair Oaks to Land's End and back to Bournemouth so that her owner, builder Lucien d'Sa could become familiar with his new baby. In Bournemouth she is now in the process of receiving the lick of paint she requires to properly finish her off.

Thank you to the LAA, the team and all others who provided support for a great and memorable experience.

– The Airplane Factory Team.

Without doubt, building any aeroplane in just seven days is a challenge; building a flat-pack, all metal machine is even more so. This build was an extraordinary achievement and speaks volumes for the design and how today's state-of-the-art technology has been incorporated into production of the kit. Congratulations to all concerned. Check out the video at *https://vimeo.com/183910026*

Well done to the Sling team of factory workers and UK volunteers! Photo: TAF