The BMW R1100RS Motorcycle Engine

The BMW engine, nestled in the cowl of a CH601 UL, sportin' a light-weight WoodComp www.woodcomp.cz ground adjustable propeller.

By Kuba Mysluk, Konstancin, Poland
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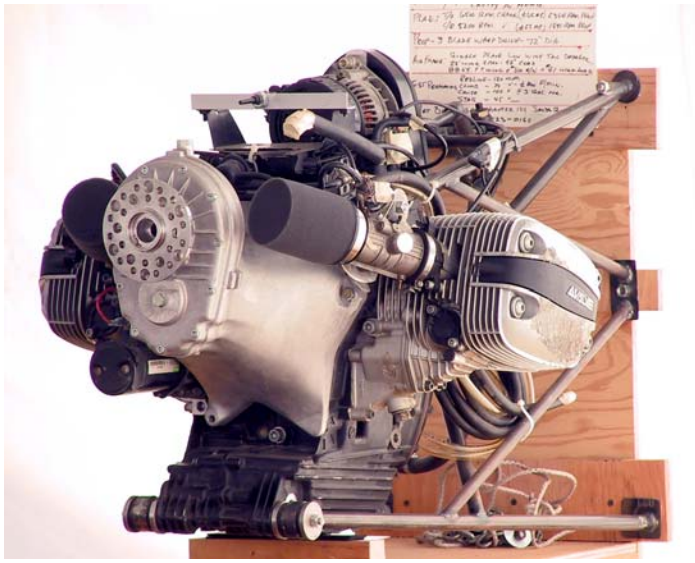
Do you think that the FAA or other regulatory agencies throughout the world are difficult to deal with? Try building and flying your own plane behind the Iron Curtain. This is how 39 year old Kuba began his aviation obsession. Now living in Konstancin, near Warsaw, Poland, Kuba has built 300+ hrs flying European "Microlights", mainly powered by automobile and motorcycle conversions. From East Germany's Trabant (an atrocious little boxy 2-door automobile, featuring a two-cylinder two-stroke 600cc engine) to West Germany's BMW pride.

Kuba currently owns two planes: Czech's "Tulak" with his own 1800cc VW conversion installed and a motor-glider. But, (as Kuba puts it) "to stupid Polish regulations" all his flying has to be done in the nearby, aviation friendly Czech Republic.

While living behind the Iron Curtain, Kuba broke the law by building a motor-glider. His first flights were also illegal, being flown from an illegal airfield. This could make for an interesting movie. Now that the wall is down, Kuba is free to build his own machines, using almost every engine available (except, as he puts it, "to expensive Rotaxes"). With no available technical support from the manufacturer, all design work is seat-of-the-pants and truly experimental. Considering liquefied petroleum gas (LPG)? He's familiar with it. How about Diesel? That's old news. Kuba is now embarking on refining the BMW motorcycle engine, more specifically the 1150cc version.

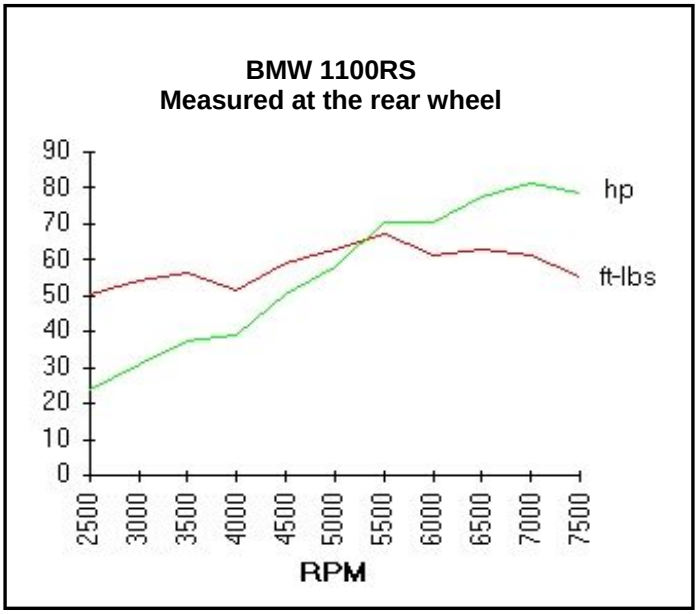
English is certainly not Kuba's native language but that's how he submitted this article. I've done my best to tweak it for him with out losing his voice. I hope you enjoy reading this article as much as I enjoy bringing it to you.
~ Pat

Are you searching for a new 100 HP engine for your experimental aircraft or future design? Then please read this article based on my personal experience with the BMW R1100RS motorcycle engine, as installed in the Zenair Zodiac CH601 UL. The particular plane I have experience with flew more than 1000 hours in 2003 with most of that flight time being logged as training flights at a local flight training school. Approximately 4,500 landings were logged, so in my estimation, this was a real test of the engine.



The above engine was displayed in the engine forum tent at Copperstate 2003. It's the product of Art Luther and he was kind enough to speak on the engine. Although this is not the same exact series of 1100cc BMW you are reading about, the redrive is the same.

Please note that this article describes the negative experiences (problems) encountered, none of which would cause us to quit using this engine. Be assured that any and all future projects of ours will utilize this great BMW engine. One issue more: All the opinions expressed are my own; I don't have any connection to "BMW", or the engine's conversion company "Take Off GmbH", www.takeoff-ul.de or any other company or business invested with BMW. I do not guarantee your results will be as good as ours and always remember, this is not an aircraft engine. Please also keep in mind as you read this, we are not engineers nor professional aviation mechanics. We are a bunch of enthusiasts and our testing is less than scientific. Please regard all these writings as those of an informed, experienced, amateurs.



BMW R1100RS

This is a two cylinder, 1100cc "boxer", 4-stroke, fuel injected engine with a single electronic ignition system. Power is rated at 100 hp @ 7500 rpm. The alternator is rated at 600 W (40-50 amps), and there are several reduction drives available: 2.46:1, 2.75:1, 3.05:1, 3.46:1. The weight is approximately 76 kg (168 pounds), dry, without the exhaust system

The engine we flew was converted by "Take Off GmbH" of Germany and used a reduction drive with a ratio of 3.05:1. In my opinion, 2.75:1 would probably work best, but we are going to check 2.45:1 The engine is equipped with a type of centrifugal clutch (It's an odd sight to see the prop spinning from the wind with the engine off.) This clutch allows the engine to run more smoothly and can also save the crankshaft in the event of a prop strike. We love this feature because our students must make hundreds of simulated forced landings -this is really good thing if you mustn't turn engine off for this.

COST

A new, aero-converted engine with reduction drive can cost about 7500-8500 EURO (around $9-10,000 USD) Used engines can be secured and used as a starting point. The cost of a low time engine (about 40,000km or about 25,000 miles) if purchased with out the computer and the injection system, can run as high as 1,500 EURO or $1,800 USD. 5,500 EURO ($6,500 USD) can get you a good used and very complete engine. The reduction drive can set you back another 2,000 EURO ($2,500 USD). It all depends on the source, but you can find engines from a wrecked bike for the salvage price.

PERFORMANCE

The CH601 UL is typical all-metal Microlight. Due to its "school" function, the prop was set for best take-off and climb performance. With two persons on board, we saw a typical 5 meters per second vertical speed (1,000 FPM) and achieved 140km/h (70MPH) economy cruise. The fuel consumption at this setting is about 10-12 liters per hour (2.6-3.17 US gallons) of typical 95 octane automobile fuel. *Editor's note: With a "standard" BSFC, 2.6 GPH works out to be around 38 horsepower.*

The flight parameters for a "cruise" prop depends on the propeller manufacturer. When we set to approximately 20º-21º @75% power, we saw a 170 km/h (105 MPH) cruise, and 220 km/h (135 MPH) as max horizontal top speed.
Here are a few examples of typical engine speeds:
Engine Idle, prop not spinning - 1,200RPM
Centrifugal clutch engaged - 2,200 RPM
Cruise - 4,800-5200 RPM
Redline -7,200 RPM (depends on prop)

MY OWN OPINION

Excellent, brilliant engine, but at this time, the reduction drive leaves a bit to be desired. The reduction drive looks like it was designed for a pusher application. We are in the process of manufacturing our own redrive and it MAY be ready by the time you read this article.

With a new clutch and redrive there were no problems for the first 400 hours with the plane doing 99% take-off and landing exercises (patterns or circuits if you prefer). The engine manual supplied by "Take Off GmbH" states that the clutch is good for 400 hours and at exactly 400 hours, we encountered vibrations just before the clutch broke. The vibration was minimal at idle (1,200 RPM) and between 3,000-3,500 RPM. We replaced the clutch but after the next 250 hours, problems begin again. We fixed it a few times with these same results; due to vibrations we had a broken flywheel.

The flywheel is stamped steel, about 5 mm thick with a steel ring gear held in place with rivets. All damage was similar, just loose rivets. When we modified it to accept solid screws instead of rivets, the steel cracked. The boxers typically have a big and fast changes in a moment of inertia (torque) which simply destroyed our flywheel. The solution was a 3.90 kg flywheel. The original was only 1.90 kg, too light-weight and weak in my opinion. Once installed, the new flywheel made the engine run a bit smoother and seemed to solve our problem; the

vibration was gone. Looking at the engine as installed in the motorcycle, the flywheel is very heavy. We chose to emulate that and do away with the light-weight flywheel supplied with the PSRU.

As a result of the vibrations, we also suffered a crack in the aluminum engine case. A little welding proved to be only a temporary cure, as the alloy has a silicon content, which we don't have the technology to deal with properly. I think we had these cracks after first 400 hours.

I'd like to say a bit about vibrations in other BMW1100s engines. We had numerous early BMW conversions in Poland but, due to vibrations, we had few unexpected engine failures. As a result of this the engine doesn't have a good reputation here. We are confident that the true source of many of the problems encountered to date was brought about by the flywheel; it was just too weak. One of my other Czech friends has a CH701 with BMW1100 and he had forced landing. As he told me, it was just a huge vibration without reason, and as a result, the engine threw a prop blade. When we examined the engine we found a destroyed PSRU damper bushing.

BACK TO OUR BMW

One dumb problem was in the alternator. The original German design has a generator fan which works "opposite" to the airflow. Due this bad design, we have to change the alternator drive belt every 60 hours! The alternator belt was destroyed a few times by the elevated temperature of the alternator pulley. The pulley was just too hot and when the engine was not running, the belt's rubber was damaged. We fixed the fan, of course, at the same time we fixed the flywheel situation. During the following 300 hours we never suffered a single belt breakage. We're not certain, but potentially the vibrations were as harmful to the belt as the hot pulley.

We did not have any problems with the basic engine, just the PSRU. Cylinders, crank, bearings, valves, pistons and rings were all within specification after 1,000 hours. No problems with the fuel injection or electronic ignition. We had zero unexpected engine stops! The engine starts right up without any problems, hot or cold.

INDUCTION AND ATTENTION TO DETAIL

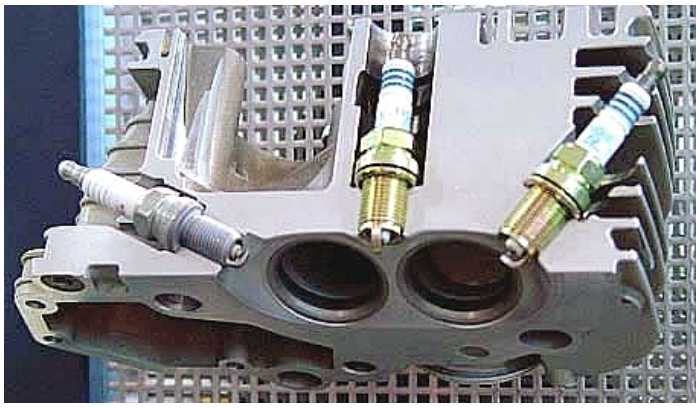
One of the many things I like about this engine is the electronic fuel injection. One reason for this is that the system (like most fuel injection systems) is not as susceptible to induction icing as a standard carburetor is. There's no reason to fear the complications of the computer either, as any BMW bike serviceman can help you with any of the engine settings. The most difficult part to get set up properly is with throttle synchronization. You need to be very careful when tuning the throttle bodies and injectors; using a good flow indicator as guessing just won't cut it here.

Next issue: Spark plugs. They must be within specification. This engine does not like "hotter" or "colder" plugs.

Another area to pay close attention to is that the Lambda sensor (O2 sensor) must be torqued in place exactly as specified. Strange, but the BMW engines didn't work smoothly when it was a little bit under torqued.

Careful attention must be paid to the electrical wiring. This engine will stop if there are any interruptions in the system. We had situation where a mechanic replaced the battery. By mistake, he didn't secure the connections tight and correctly. As a result, the engine didn't run smoothly due to cable vibrations on connector. In our next CH 601 we will have a small dedicated back-up battery for computer unit.

Still another tip: in this engine you must have about 5 liters of volume between injection unit and the air filter. The huge stock composite tubes, running from the air-filter to the throttle-body, will become useful here.



This cutaway of the 1100 head (displayed on the Take Off GmbH website) shows 3 plugs. The 10mm plug on the left is the "traditional" location for a secondary plug. The center plug is the factory location, and the one on the right is an optional 3rd plug location for triple redundancy.

A FEW WORDS ON SINGLE IGNITION

Two ignition systems doesn't always mean better, especially if the heads are not designed for it. I know of another airplane, a very nice Czech EUROSTAR (a Czech version of Pottier P220) that has a BMW 1100. We have this one in our school to field test the new engine/ airframe combination. The manufacturer, Evektor, http://www.evektor.cz used only a Rotax 912 in the past. In the test pilot's opinion, this plane is flying 20-40 km/h faster than similar configuration with the 100hp Rotax 912. "Evektor" built and installed a double ignition for the BMW with the following results:

1. We've had problems with starting a cold engine. There is second set of spark plugs which share the same coil with the original set. This, in my opinion, weakens the spark. With the starter engaged (while cranking the engine), the available voltage to the coil is reduced, making for an even weaker spark. To me (and again, this is just my opinion) it just doesn't make sense to say you have a dual ignition system when you only have dual plugs. At a minimum you should have a second set of coils to fire

the second set of plugs if you want closer to a “true” dual (redundant) system.

2. The sparkplugs are small 10mm, and the second was installed on the “side” of combustion chamber (see the “peanut plug”, photo on the previous page). As a result, we had two "flame fronts” colliding as the fuel ignited. Usually they would meet each other in an incorrect place and the result would be a burnt or “holed” piston. We had a forced landing on the EUROSTAR due this fact.

Engine specifications	
Model	BMW R1100RS
Year	1993-2001
Engine type	Two cylinder boxer
Stroke	4
Displacement	1085.00 CC (66.21 cubic inches)
Power	90.00 HP (65.7 kW) @ 7250 RPM
Torque	95.00 Nm (9.7 kgf-m or 70.1 ft-lb) @ 5500 RPM
Bore x stroke	99.0 x 70.5 mm (3.9 x 2.8 inches)
Valves per cylinder	4
Intake / Outlet dia	34mm / 29mm
Cooling system	Air
Compression Ratio	10.7:1
Valve control	OHV, using chain drive, cup tappets, push rod and rocker arm
Induction system	Electronic injection, Bosch Motronic MA 2.2
Engine lubrication	Wet sump
Ignition	Electronic ignition; Bosch Motronic MA 2.2
Starter	Electric, 1.1 kw
Spark plugs	Bosch FR6 DTC

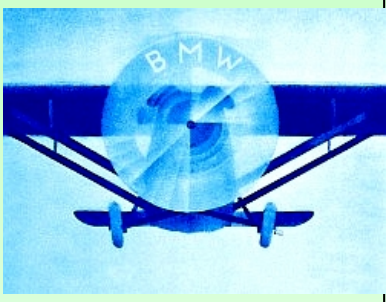
ENGINE MAINTENANCE

After the first 10 hours: Change the oil and filter. Check the valve lash Every 100 hours: Change the oil and filter, sparkplugs and check valve lash. The valves are hydraulic, but check them anyhow. Every 400 hours: Change shock absorbers (neoprene bushings), damper and clutch. 500-800 hours: Basic examination.

That's end for now. If anyone is interested any added details more - I'm still present on Yahoo AirVW group or please ask me directly at kuba_mysluk@yahoo.co.uk

Kuba Mysluk

Do you think BMW only ever made fine sports cars and high-end motorcycles? Here’s some history and background on BMW:



The inspiration for the BMW Roundel came from BMW's aircraft legacy.

Bayerische Motoren Werke AG (BMW), German manufacturer of automobiles, motorcycles and aircraft engines. Based in Munich, Germany, the company is the leading auto exporter in Europe. The English translation of the company's name is Bavarian Motor Works.

The company traces its origins to 1913, when a Bavarian named Karl Rapp began an aircraft-engine shop in Munich named Rapp Motoren Werke. In 1917 Rapp resigned and the company, led by Austrian engineer Franz-Josef Popp, changed its name to Bayerische Motoren Werke. That same year chief engineer Max Friz designed the company's first aircraft engine, the six-cylinder Type IIIa, which created strong demand for BMW engines. When the 1919 Treaty of Versailles prohibited German companies from producing aircraft and aircraft engines, BMW switched to making air brakes for railway cars. In 1923 Friz developed the company's first motorcycle, the R32, a model that held world speed records for motorcycles during most of the 1930s.

In 1928 the company entered the automobile business by acquiring Fahrzeugwerke Eisenach (Eisenach Vehicle Factory), a maker of small cars based in Eisenach, Germany. In the 1930s BMW began producing a line of larger touring cars and sports cars, introducing its highly successful model-the 328 sports car-in 1936.

After World War II ended in 1945, Allied forces dismantled the company's main factories. BMW made kitchen and garden equipment before introducing a new, inexpensive motorcycle to the German market in 1948. The company's return to auto production in the 1950s resulted in poor sales. In the 1960s the company turned its fortunes around by focusing on sports sedans and compact touring cars, and it began to compete with Mercedes-Benz in the luxury-car markets of Europe and the United States. BMW's U.S. sales peaked in 1986 but then dropped steeply, partly due to competition from two new luxury cars-Lexus, made by Toyota Motor Corporation, and Infiniti, made by Nissan Motor Co., Ltd. The 1989 collapse of the Berlin Wall led to a boom in car sales in Europe, and in 1992 BMW outsold Mercedes-Benz in Europe for the first time.

In 1990 BMW formed a joint venture with the British aerospace company Rolls-Royce PLC to produce aircraft engines for business jets. In 1992 BMW broke ground for a major automobile plant in Spartanburg, South Carolina, its first automobile plant in the United States. In 1994 BMW acquired 80 percent of the Rover Group-a British manufacturer of small cars, luxury cars, and Land Rover sport-utility vehicles-from British Aerospace PLC. The $1.2 billion acquisition brought the company into new markets.

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