Case study: Automotive

Salakazi Racing (Finland)

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Renishaw encoders ride on a controlled explosion

Background:

Finnish Salakazi Racing has equipped its KTM super-twin powered dragster with a new automatic clutch that uses magnetic rotary position encoders.

Challenge:

The clutch, as the main mechanism for transferring power from the engine to the road, endures extreme temperatures and high rotary speeds. Encoders need to be robust and capable of operating in this harsh environment.

Solution:

The RLS RM22 magnetic encoder is immune to dirt and debris — with ingress protection of IP68. The compact RM22 encoder can also handle high operating speeds and temperatures up to 125 ˚C.

The data that the encoder provides is critically important and enables the clutch to be preset before each race.

The RM22 features a non-contact, two-part design, eliminating bearings or seals and allowing for rapid, easy installation and removal.

The KTM dragster, built by Salakazi Racing, completes the quarter mile in 6.7 seconds

With almost 1500 horsepower from just 1995 cc, the KTM Dragster does the quarter mile in 6.7 seconds at a terminal velocity of 316 kmh. In Stanley Kubrick's classic film Dr. Strangelove, Slim Pickens was dropped from the aeroplane riding a bomb. If he'd been riding a motorcycle, then he would certainly have been astride a KTM Nitro Methane fuelled dragster built by Finland-based Salakazi Racing. Helping tame the KTM's (barely) controlled explosion is a brace of "bomb proof" Renishaw RM22 compact, high-speed rotary magnetic encoders.

Take a 360 kg motorcycle with an absurd power output, a fearless, Finnish gentleman with a reputation for breaking speed records and things happen fast.

Within a split second, the engine screams to 7,500 rpm. Before the spectator has a chance to comprehend what has transpired, the race is over and bike and rider are a quarter mile down the track, braking frantically. In motor racing terms, it doesn't get much simpler. The objective is to traverse the straight line from A to B as quickly as possible.

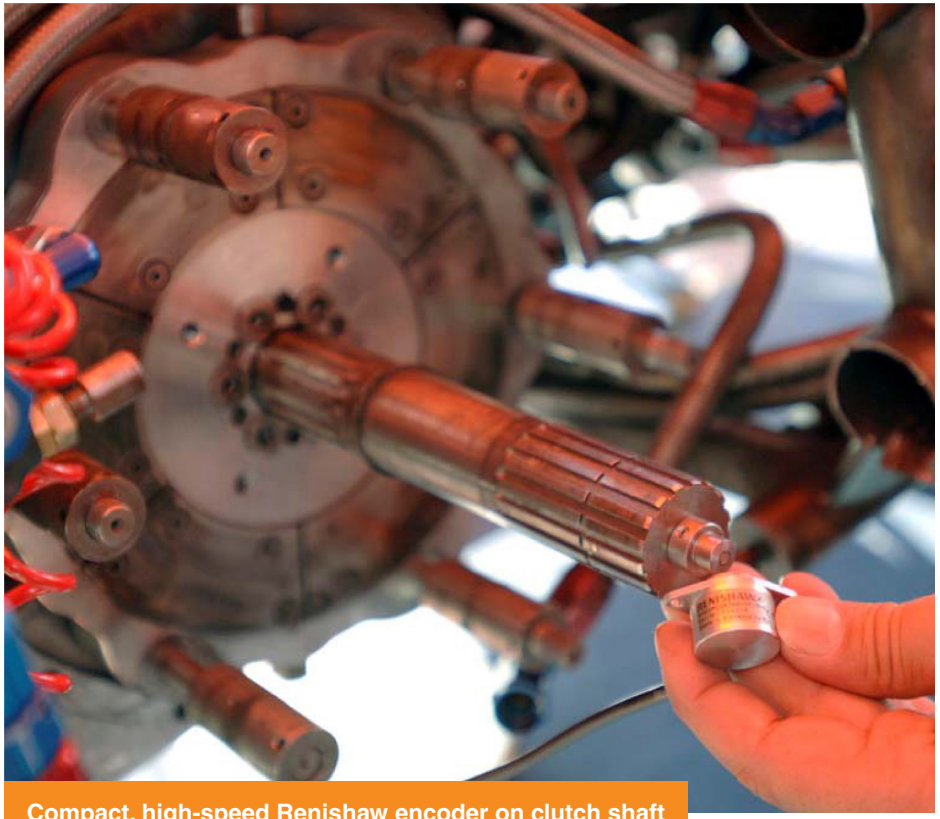
Jaska Salakari — the first Finn to break the seven-second barrier for the quarter mile -- pilots the fastest Super-Twin Top Fuel bike in Europe and owns Salakazi Racing. Since 2000, his speed-obsessed six-man team, a combination of full and part-timers, has been running a KTM Super twin powered Dragster of their own design and construction.

In drag racing, reaction times are measured in milliseconds and races are never won with a wildly spinning rear wheel. All the horsepower in the world is useless unless effectively translated into rapid forward motion. For the pilot (or is that 'passenger'?) — there's little or no time to think, let alone engage and slip a normal clutch. It's impossible for the rider to accurately determine the rate of engagement needed to provide optimal traction.

Salakazi Racing has equipped its KTM dragster with an automatic Prowork three disc, four-stage clutch fitted with a Prowork digital controller. The controller engages the clutch — according to how it has been pre-programmed — when the rider snaps open the throttle. That's where rotary position encoders suited to high rotary speeds of up to 30,000 rpm come into play. One of the tiny but critical devices monitors the position of the crankshaft in the engine, while the other measures the clutch speed.

Exploding limits

The RM22 magnetic encoder from RLS d.o.o., a Renishaw associate company, is designed for trouble-free performance in the harshest environments but the Salakazi Racing Team has chosen one of the toughest of places to locate any piece of electronic equipment.



Compact, high-speed Renishaw encoder on clutch shaft

"The Renishaw encoder isn't interactively controlling the clutch whilst underway, but the data it provides us with beforehand is critically important. We couldn't obtain it — and couldn't preset the clutch — any other way.

We need to read the clutch speed even before the rear tyre completes the first full rotation, to make decisions for engaging the clutch, and the acceleration doesn't happen smoothly. This problem has now been solved and proper filtration has been done to program code. Next season, the Renishaw encoders will also be used to control the ignition advance and, in a couple of years, we are going to use the encoders to adjust cams."

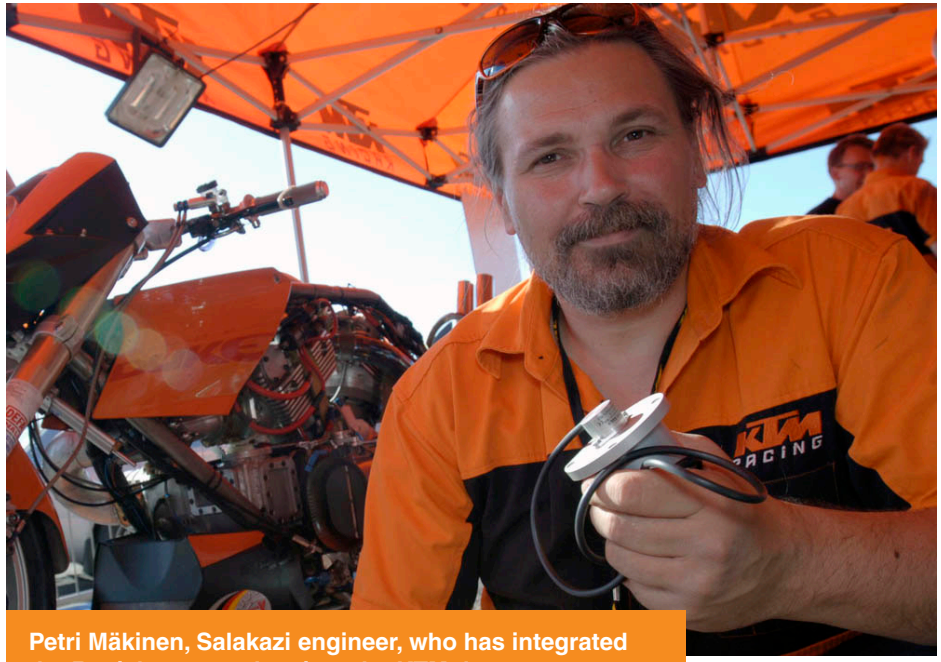
Pointing to the end of the crankshaft on a partially disassembled engine Mäkinen smiles mischievously and says, “This is where we put the Renishaw magnetic actuator. We’ve located it directly on the end of the shaft. The encoder body is on the other side, in the clutch housing. I honestly think that only a space rocket would be a tougher environment for the encoder.”

The RM22 is designed and manufactured by Renishaw’s Slovenia-based associate company, and is immune to dirt and debris according to the IP68 standard. However, with a maximum operating temperature specified as 125 ˚C , Mäkinen elaborates on how the encoder survives the very high temperature inside the clutch. The secret, he says, is placing the encoder in the heavy, machined aluminium housing.

“With a diameter of only 22 mm it was possible to locate the encoder in the clutch housing itself, without compromising the strength of the piece. Clutches can explode,” he says, as an aside. “I’ve seen this happen a few times, so the clutch housing plays an important role in rider safety. If the encoder were bigger we’d have to re-engineer the solution.”

The RM22 features a non-contact, two-part design, eliminating bearings or seals and allowing for rapid, easy installation and removal.

“After each race our mechanics cool the clutch and quickly remove the housing and the encoder,” says Mäkinen. “The heavy aluminium body shields the encoder from the heat during the race. Before it ever gets a chance to heat up beyond specs, we’ve already got it back to the pit garage and removed it.”



Petri Mäkinen, Salakazi engineer, who has integrated the Renishaw encoders into the KTM dragster

Preparing the KTM dragster for a run - it is programmed for optimum performance before every run

Salakazi Racing (Finland)

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Getting the power down

By comparing these values, clutch slippage, traction and road conditions can be determined with high precision. This data is highly coveted by the team and allows the technicians to properly adjust the first stage counterweights in the clutch before the race.

Track and bike conditions vary for every meeting, but the vital data collected and compiled by the Renishaw encoder after every run makes it possible to program the controller for as close to optimum clutch engagement as possible. This provides maximum speed and acceleration with minimal wheel spin during the first few fractions of a second.

Petri Mäkinen — Salakazi Racing's self-confessed "technology guru" — is quick to point out that the Renishaw enabled solution is not the same as a traction control system. Primarily, he says, because the clutch is tuned by set values programmed into the controller before the race before the clock even starts.

"The Renishaw encoder isn't interactively controlling the clutch whilst underway," he explains, "but the data it provides us with beforehand is critically important. We couldn't obtain it — and couldn't preset the clutch — any other way.

We need to read the clutch speed even before the rear tyre completes the first full rotation, to make decisions for engaging the clutch, and the acceleration doesn't happen smoothly. This problem has now been solved and proper filtration has been done to program code. Next season, the Renishaw encoders will also be used to control the ignition advance and, in a couple of years, we are going to use the encoders to adjust the cams."

Mäkinen uses the data to put the maximum engine power on the road and propel Salakari to speeds in excess of 300 km/h in less time than it takes to read this paragraph. If past performance is anything to go by, it seems to be working.

Reliable operation, race after race

Once integrated into a complex machine such as a dragster motorcycle, any part or component is only as good as it is reliable. Mäkinen is emphatic in his praise for the Renishaw RM22 encoder, a diminutive but vital component, which has proved itself way beyond its published specification.

"Given the conditions, the reliability of the Renishaw encoders is amazing. Without them, we could do nothing more than estimate vital engine and track information," he says. "But guessing isn't good enough if you want to break records."

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