KTM FREERIDE E

TWIST - AND FLY!

Taking KTM's electric motocrosser for a spin

BY ALAN CATHCART
PHOTOGRAPHY BY HEIKO MANDL

Trust KTM to make saving the planet fun, as well as virtuous. While other manufacturers of electric motorcycles focus on E-biking's environmental benefits in providing personal transportation, KTM had a different agenda. For when the Austrian dirt bike kings started work in 2008 on developing the Freeride E, their in would be fun to sample.

"It's getting more and more difficult to ride motorcycles off-road, especially in Europe and the USA," says Harald Ploeckinger, Chief Operating Officer of KTM and the man with the overall responsibility for making things hum at KTM. For 15 years a key Rotax executive, amongst Harald's many tasks is overall responsibility for engine development and series production for KTM's sport motorcycle division. Thus the Freeride E electric bike project is his baby.

"One of the major issues is noise," he said. "We felt that by developing a product which doesn't emit any noise or noxious gasses, this might allow us to bring motorcycling closer to urban areas, to attract those people to off-road riding who'd hesitate to load a bike into a truck or trailer, and then drive for hours to find somewhere they can use it."

To the point that municipalities could establish off-road motorcycle parks in city confines, just like artificial ski slopes, or rock climbing faces?

"Yes, on the outskirts of a city that's convenient to reach," says

KTM's electric off-roader – the Freeride E.

Ploeckinger. "Somewhere that could allow people to sample our sport who didn't yet have the chance to get familiar with it because of the distances to be covered to do so. I think it's a way to demonstrate to people that off-road riding is so much fun – Austria is a great country to ski in, so why can't we use the same areas to have fun on two wheels? With the Freeride E we have no emissions, and almost no noise except for the chain – in fact, the sound of skis cutting through packed snow is probably louder."

I had the chance to put the pre-production prototype Freeride E to the test the same week it made its public debut at the EICMA show in Milan, by riding it around KTM's specially built E-bike test track constructed outside its satellite engine factory and WP suspension plant less than two miles from its Mattighofen headquarters. In doing so it answered the question of how well KTM's R&D e-team (headed by ex-Toyota Formula 1 engineer Hannes Proschek) has succeeded in meeting that objective. But first, what were KTM's dynamic objectives in developing the bike?

"We started out by determining which gasoline-engined traditional product it should be comparable to in terms of performance," said Ploeckinger. "We set a maximum weight target of 100 kg [220 pounds], and decided the benchmark performance should be the same as or better than a 125cc two-stroke. But this was also clear to us that it should be a KTM - so no compromises, even if we have a different propulsion system. In terms of battery duration, we looked for the classic 40-minute moto plus two laps timeframe. Then we contacted the Austrian Institute of Technology/ AIT research institute in Vienna, who are well-known specialists in electric drive and battery technology, and they agreed to col-

KTM FREERIDE E

The author hadn't been on a dirt bike in years, but adapted easily to the beginner friendly Freeride.

laborate with us. The project has been partially funded by the Austrian government as experimental development, though this only happened well into the project - when we thought we might as well apply for this. It's not often that the applicant presents a running prototype for such a project, as we did in demonstrating it publicly. I've never before in my career had such a wave of requests to test ride the bike afterwards - it was more like a tsunami."

The first step for KTM was to determine the overall strategy for its first electric bike's engine package, and Ploeckinger & Co. quickly settled on a 300V high-voltage motor developed by their German engine suppliers PERM - already well known for its high power, high-efficiency, but very slim, brushless electric engines. Such a compact design complimented the projected architecture of the bike, and exactly matched the 125cc two-stroke dynamics wanted by KTM, using lithium-ion batteries that were also a key element in the weight issue, and in energy capacity.

"The high-voltage system lets you downsize everything," says Hannes Proschek, the head of the R&D team. "In electricity, power is the multiple of current times voltage, so the higher the voltage, the lower the current - and the lower the current, the smaller the components we can use. This was a key element in making the bike compact and light, while maintaining the same or higher levels of performance."

The resultant brushless, synchronous motor, with the permanent magnets sitting inside a narrow disc armature, is extremely slim and compact, while capable of producing 22kW (30 hp) at 6000 rpm, and a maximum 42Nm of torque at 500rpm. That indeed delivers equivalent performance to a 125cc two-stroke, but with around twice the torque.

It's powered by an easy-to-remove 2.1kWh lithium-ion battery pack, which I timed Hannes Proschek in taking one minute

and 38 seconds to detach for recharging by unbolting the four thick bolts attaching it to the top of the motor – though, of course, it can also be topped up. Claimed complete recharging time is 1.5 hours, including balancing, using KTM's own charger that is capable of delivering this high power.

"We're basically limited by how much juice we can take out of the plug – it's not the battery that limits us, it's the socket," says Proschek, who claims that within 45 minutes of charging time, 80 percent of the charge is already restored.

This makes it feasible for a Freeride customer to have two batteries that he/she can run in tandem, if stamina and inclination coincide – one in the bike powering it, the other charging up ready for a swap over every 45 minutes (no word yet on the price of spare batteries).

KTM has opted for the commonplace cylindrical lithium-ion 18650 laptop batteries, even though the flat-sided architecture of the next-generation lithium polymer cell batteries now available from South Korea permits much denser packaging - a key issue on the Freeride E.

"We considered using these so-called coffee pack cells, but we had to think about how we can pack them, and get a really good quality product at the end of the day, especially when they're heating up and getting warm under load," says Ploeckinger. "But we decided maybe it's too early, so let's use standard cells - but develop our own battery management system as part of the battery package. The controller controls the engine, and communicates to the battery, but to manage the cells you need to have this BMS – especially in terms of balancing the charge. So we did this."

Balancing means accounting for the energy differences between the 360 individual cylindrical cells in the KTM battery pack – because by nature of the chemistry it can happen after a few recharging cycles that one of the cells has more charge than another one. But the lowest one will determine when you have to shut off the battery, because there's a lower voltage threshold, so it's important to try to equalize the charge, in order to make full use of the storage capacity available.

Japan's Panasonic supplies the cells to KTM's battery suppliers in Poland, WAN Technik, and their specification guarantees a minimum lifetime of 1000 cycles, so KTM expects to easily achieve the specified 500 cycles likely to represent the expected lifetime of such an off-road motorcycle. With the battery pack weighing 55 pounds the sturdy handle needed to lift it out for recharging – and the engine 22 pounds, the

The Freeride E looks good.

The Bubba Scrub... or the Electric Slide?

resultant power-and-fuel package is nearly identical in weight to that of a 125cc two-stroke motor and a full tank of fuel (not forgetting the actual tank itself) combined.

While it's true that on an E-bike this doesn't get any lighter as the fuel gets used up, the constant weight means that the 49/51 percent overall weight distribution of the Freeride's 209-pound weight that's near-ideal for off-road use, remains the same at all times.

However, in addition to the motor and battery, the key element in the trio of ingredients delivering motive E-power is the electronic controller. With nothing available off the shelf, unlike with the motor, KTM had to search for a partner to deliver a purpose-built product, and program it. They found one in British specialists TT Electronics, which conveniently already had an Austrian office in nearby Salzburg. Together they engineered the power section of the controller, both high and low voltage boards, and the packaging for all this to suit the bike's very compact layout.

"The key points on the controller were the performance range and packaging size, and the requirements for water tightness and protection against dust, vibration and shocks in off-road riding," says Proschek. "It represented quite a challenge in developing a suitable product, because electricity, water and dust don't go so well together."

Consequently, the complete electric system is dust and waterproof, so cleaning with a pressure washer is not a problem.

Indeed, fitting an electrical power source to an off-road motorcycle that's inevitably going to be crashed more than a laptop or a car, inevitably raises questions about safety - sure, an electric road vehicle runs the risk of having a collision, but not hitting stones and rocks after falling on its side as a matter of course. How's that addressed on the Freeride E, where with 300V going into a single plug-in connector on a detachable battery pack, safety is very much an issue if someone isn't to become very dead, very suddenly.

"The battery is housed in a particularly solid aluminum casing, and is very well protected from external ruptures, shocks or penetrations," says Hannes. "Also, the chassis itself has the frame wrapped around the battery, and this gives added protection. For sure, you don't want to penetrate a cell if you crash, as this can create a fire. But we believe our protective system actually makes the Freeride E safer from fire risk than a traditional bike with liquid gasoline aboard."

KTM did consider fitting supplementary cooling fans, as much to cool the battery pack as the controller, both of which get warm, but they managed to avoid the extra weight and complication of this by employing sheets of heat-transfer material.

However, the protection provided by the Freeride E's composite chassis may be considered secondary to its role in making it handle, and here KTM took advantage of the fact there's no fat two-stroke exhaust to have to package. Thus they downsized the bike's dimensions to their 85cc entry-level motocrossers as part of the crucial weight-saving campaign to offset the weight of the battery. At the same time they were able to make it more agile and controllable, especially with the idea of it being a starter bike for beginners.

The chrome-moly steel frame spars that wrap around the battery pack are bolted into the forged aluminum rear uprights comprising the pivot for the forged aluminum swingarm, with a high-strength fiber-reinforced plastic subframe carrying the seat, clothed in particularly alluring Kiska Design styling.

All the running gear comes from the 85cc KTM, including a 43mm WP upside-down fork that offers almost 10 inches of travel up front, matched to the WP shock with PDS progressive-rate link giving 10.2 inches of suspension movement. Both have compression and rebound adjustability.

Chassis geometry is quite sharp, with a 23-degree head angle combined with a 55.8 inch wheelbase, and the pair of lightweight Giant wheels are the standard 21 inch and 18 inch sizes for a full-size dirt bike, shod with 80/100 Metzeler rubber up front and a 110/90-18 rear. The wave disc brakes are different from the 85cc bike's, though, with a four-piston caliper and 260mm disc handling stopping duties up front, and a 250mm disc and two-piston caliper in the rear The brakes are from Formula – a company already well known in the mountain bike arena, here entering the motorcycle sector for the first time on KTM's E-bike.

The Freeride has the power of a 125 in what is basically the chassis of an 85cc motocrosser.

It's worth noting that the rear brake is operated by a lever positioned bicycle-like on the left grip of the taper-section 28/22mm aluminium handlebar, though KTM intends to offer a foot-pedal option for those finding it hard to re-program their instincts accordingly. As a part-time off-roader who always considered his best dirt bike days were definitely behind him, I had no instincts to re-program, making me instantly welcome the increased controllability provided by the hand rear brake.

KTM FREERIDE E

(Far left) The powerplant is small.

(Left) The battery compartment.

The battery level indicator is right where you can see.

Slinging a leg over the 35.8-inch high seat delivered a totally comfortable, mega-controllable riding stance that's not excessively tall, and with reasonably low footpegs should make the Freeride E suit most statures. It also should give a sense of confidence to beginner riders – or comeback kings, like me.

To obtain forward motion, you must first flick on the kill switch on the right handlebar – there's no ignition key – then wait while the system boots up, as monitored via the battery interface module located behind the triple clamp, which basically acts as an information center. This has a row of LEDs around the central display, which light up when you flick the killswitch. If all the green ones are lit, the battery is fully charged, then as the charge diminishes the lights do too, until the yellow one lights up with 20 percent remaining, and the red at 10 percent.

Twist and go... the current Freeride has both front and rear brakes controlled via levers on the bars.

There's also a diagnostic function in case there are any problems with the power supply, helping you to locate if the problem is with the controller or the battery. If one or more green LEDs are illuminated, you're good to go, so thumb the starter button mounted beneath the killswitch. Then twist the throttle – and fly.

Additionally, there are three central red windows numbered 1-2-3, which on the final production bike will light up to indicate the riding map selected – 3 will be beginner level, with very soft throttle mapping and limited power delivery and road speed; 2 intermediate; and 1 maximum power. KTM hadn't yet installed the 2/3 programs yet, so I was riding full-on on 1, but even on this KTM has programmed the controller to deliver a more progressive initial throttle response. With maximum torque available from an electric motor at 1 rpm, there's lots of potential to flip you over backwards if you simply wind the throttle hard open. So, KTM has softened this electronically via the controller, with maximum torque now delivered at 500 rpm, then holding flat to the theoretical 6600 rpm digital limiter - theoretical, because

with direct drive and no gearbox, you'll need a long straight piece of road to reach this.

Selecting options 2/3 on the mapping also extends battery duration, says Proschek – as will the style of riding employed.

"At the moment, to find any weak points, we're focusing on mapping for wide open throttle on full power, even though the target was not to create something to compete with racing motocross bikes" he states. "Taking away power is easy, but whereas an expert test rider can exhaust the battery in 20 minutes, what I've done is to simulate trail riding, going into forests on single trails, but not pushing or going at enduro racing speed. Riding comfortably and easily, apart from seeing a lot of deer without frightening them, I proved you could do this for up to one and a half hours on a single charge. The idea was to make sure that an amateur can ride 45 minutes hard on a single charge, since after that time he's normally shattered, and wants to get off and have a drink. So this was the target, and it's what we have achieved with this bike."

That sounds promising in terms of range – but with deer so disinterested in e-bikes, no wonder KTM has apparently attracted keen interest in the Freeride R from the hunting community. Kiska Design will be presumably tasked with producing an optional gunsling for the E-bike…

With the Freeride E all lit up, riding it is both extremely simple and totally addictive. I can honestly say that my hour or so aboard it until the power started to fall off (see, not an expert!) was the best 60 minutes of off-road riding I've ever enjoyed. And enjoyment is the key word, even when I got over-confident and crashed it trying to get too hard on the power too soon for the available grip from the Metzeler rear tire.

Well, I had to test how good the battery's crash protection really was, didn't I? Dusting myself off and hopping back on again proved the Freeride E stood up well to being decked at speed, while delivering immediate, controllable but also powerful acceleration without having to fiddle with a clutch lever. And you have a lot of punch from low rpm – enough to get serious air over a jump.

While at low speeds the manueverability of the bike is very good, so slim and well balanced it feels more like a trials bike than a performance off-roader, when you need power and especially torque it's immediately available at the twist of the wrist. So to climb an almost 10-foot high ramp with a 70 percent vertical approach needs only a 16-foot run-up from a standing start – amazing!

Yet carving ever tighter turns around an intricate network of ruts and roots is equally feasible, and fun – such technically difficult sections are much easier to ride with the E-bike, because the low-down torque of the electric motor is really beneficial, and you never notice you don't have a clutch. That's because you soon develop an alternative technique of using the rear brake lever that replaces it as a way of slowing as needed when you back off the throttle, while you stand on the footpegs and balance the bike almost at rest without having to worry about releasing the clutch or shifting gear.

Whatever the case, even a born-again novice off-roader like myself feels in charge of the Freeride E at all times, and that's one of the things that makes riding it so satisfying. That, and its feeling of robustness coupled with light yet precise steer-

A complete recharge of the batteries takes 1.5 hours, according to KTM.

ing, and agility – the WP suspension ate up substantial ridges and hardened ruts at speed, giving added confidence.

Even without the E-power, it's a good off-road package – but the twist 'n go power delivery is the icing on the cake. Maybe the biggest surprise was how easy the Freeride E was to back out of a dead end that I ran myself into while exploring the outer reaches of KTM's E-Park. Hop off, pull the bike back and wind it on forwards on the throttle, back and forth until you've turned it around, all without worrying about stalling it or having it run away from you because you didn't slip the clutch enough. With the e-bike turned around and pointed where you want to go, just hop back aboard again, twist – and go. Big fun.

Okay – so where do I sign up for a long-term dose of E-biking the KTM way, Herr Ploeckinger?

"We plan in July or August of 2012 to build 500 pre-production bikes, then gather feedback from non-professional riders after they've run the bike in different conditions and in different climates, from Spain to Sweden," he said. "We plan to learn as much as we can from this, because we don't want to have a new technology that creates problems for the customers, but to develop it properly under all conditions. And then towards the end of next year we will start production of the Freeride E at a price below or comparable to what you see already with a four-stroke Enduro - so it has to be below 10,000 ($13,500), including battery."

KTM plans to offer two E-variants up front, first in Europe, followed soon after by the USA and Australia - a 100 percent motocrosser like the one tested, as well as a street-legal EXC Enduro with lights and indicators. But they're also planning a Supermoto version with road tires and street suspension – an E-Duke.

"To launch an electric off-roader, as I see it, is like climbing Mt. Everest, and if you were to take it to the road, it's only a little smaller a challenge," says Ploeckinger. "The battery pack is scalable, as a combination of parallel and sequenced cells, and as long as you don't change the voltage you can use the same controller and motor, so we're looking towards urban mobility concepts, as well. But we wanted to start out by offering something to those customers who want to ride off-road but not in competition - nothing extreme, just to have fun on the bike. I compare riding the Freeride E to cross-country skiing, where you use a different set of skis than when you go alpine skiing downhill. Each is fun – just one is more extreme than the other."

So KTM isn't targeting the Freeride E at anything more than simply having fun, either in your backyard if it's big enough, or somewhere else comparatively close at hand, on a nearby trail or open space. There's no noise to annoy the neighbors, and zero maintenance beyond remembering to plug it in after the ride - plus you can simply hose it off with a pressure washer to clean it since it's fully waterproofed.

Trust KTM to raise the e-bike epiphany to a level where riding one delivers comparable performance and equivalent fun to conventional bikes – yet while planting a minimal carbon footprint as you do so. **CN**