

Engineering Analysis Report: Electric Fat Tire Bike

Of E-Grizzly and E-Cherokee Electric Fat Tire Bicycle
 both the 1000 watt and 1250 watt
 by Xtreme Fat Tire Bikes

A) Prepared by Robert Van Der Plas, PE
 Mechanical Engineer
 California Professional Engineer License No. 19522

B) Revised by Bob Beacon, genius in mechanical designs, automotive design, and robotic design. He used the watts equation $\text{amp} \times \text{volts} = \text{watts}$ and reviewed the controller whereas Robert did not.

C) Also reviewed and approved by Thomas Coghill, BS in physics and is now being reviewed and approved a by a third party engineer

1. Introduction

This report is condensed from the engineering analysis report for products submitted by Thomas Coghill Jr. of Xtreme Fat Tire Bikes (see Reference 8 below). The current report addresses only the essential elements relating to the E-Grizzly and E-Cherokee electric fat tire bicycle. The only difference is E-Grizzly is matte black with yellow rims and E-Cherokee is painted camouflage.

2. Summary of conclusions

E-Grizzly electric fat tire bike tested for this report has a significant advantage over other electric fat-tire bikes on the market today due to its use of a hub motor in the front wheel. Other available electric fat-tire bikes have the motor mounted either in the rear wheel or the bottom bracket.

Only the front hub system offers the advantage of allowing the rider to balance torque over both wheels (the riders effort on the rear wheel combined with the electric motor on the front wheel). This feature can prevent the bike either skidding out of control when traction of the driving wheel is lost or getting 'bogged down' in e.g. soft sand.

In addition, the tires on the E-Grizzly were larger than on any other electric fat-tire bikes thereby offering slight advantages in efficiency, comfort, and traction.

3. Items received for analysis

This information was rewritten by Thomas Coghill Jr., BS in physics and is now being analyzed by a third-party engineering firm which will be published soon.

3.1 Hardware Summary

Item	Qty.	Description	Comments
1	1	E-Grizzly electric bike	Fat-tire electric assist bike with 48 V front-hub motor

3.2 Documentation Summary

Item	Description	Reference/Comments
1	Fat Tire Bikes: E-Grizzly & E-Cherokee	Manufacturer's description of item 1 in table 1.1 above
2	Abstract "Performance Differences [...] 26 & 29 inch-wheel bikes [...]"	Journal of Sports Science 2015 Dec 3 : 1-7. By Steiner, T., Muller, B., Maier, T., and Wehrin, J.P,
3	Patent "Energy Coil System for Vehicles"	Patent US 8,632,087 B2 Jan 21, 2014 for bicycle with front hub with kinetic energy storage device
4	Catalogue Images of fat-tire bike rims	Shows use of non-balance cut-outs in commercially available fat-tire rims from several manufacturers

4. Summary of work performed for this report

4.1 Documentation provided (per table 3.2 above) was read, analyzed, and referenced to the hardware items provided per table 3.1 above

4.3 Where appropriate, engineering theory was used to predict suitability in use of the assembled bicycle and its individual components

5. Evaluation of item 1: E-Grizzly bicycle

The E-Grizzly is a fat tire bike with electric assist by means of a 48v 500 w labeled front hub motor made by Bafang (also known as 8-Fun) a well-established China based manufacturer or electric motors for bicycles use and a 48 V Li-ion battery with a rated capacity of 11.6 Ah (calculated energy content: 48v X 11.6 Ah = 557 Wh) specification data as observed on the bicycle provided are summarized as follows:

6) Controller and Output: The controller mounted on the E-bike Xtreme stated as a 1000 Watt System has a controller mounted behind the seat post tube which is rated minimum 10 amps maximum 20 amps. Therefore, using calculations which can be found on any internet or electronics book, the equation for watts is:

$$\text{Amps} \times \text{Volts} = \text{Watts}$$

So, for the controller with a minimum of 10 amps (each bike has three power levels)

- At low (level 1) your output is 10 amps X 48 volts = 480 watts
- At medium (Level 2) your output is 15 amps X 48 volts = 720 watts
- At Max output (level 3) you have 20 amps x 48 volts = 960 watts which Xtreme rounded up

And states as 1000 Watts

Xtreme also has another system which it states is 1250 watts. The motor is labeled 750 watts. Its controller has a minimum of 12 amps and a max of 26 amps. It also has 3 levels. Using the same accurate calculation. *(This can all be researched online if one needs additional proof.)*

- At low (level 1) you have 12 amps x 48 volts = 576 watts
- At medium (Level 2) you have 18.5 amps x 48 volts = 888 watts
- At max power (level 3) you have 26 amps x 48 volts = 1248 watts

Frame and associated parts	Fat-tire bike specific welded aluminum alloy frame, frame number J51206451; 120 mm bottom bracket; 135 mm front hub spacing; 190 mm rear hub spacing; plastic platform pedals; 27mm diameter seatpost; padded plastic seat; 28" wide 32 mm diameter handlebars
Dimensions	Wheel base: 1,105 mm (43.5") Center of front wheel to bottom bracket: 635 mm (25.0") Bottom bracket to center of rear wheel: 482 mm (19.0") Bottom bracket height (with currently installed tires): 317 mm (12.5") Seat height range (center of bottom bracket to top seat): 635-900 mm (25"-35.5") Q-Factor (distance between pedal attachment points on left and right cranks): 228 mm(9.0")
Wheels	29" x 4.8" Xtreme Warrior fat tires on 559 mm BSD, 106 mm (4.2") Outside width rims with 36 spokes front and rear; rims with circumferentially symmetrical weight-reduction cutouts; inner tubes with Schrader valves; rated tire pressure: 30 psi maximum; measured un-loaded outside tire diameter 754 mm (29.7") with tire at 15 psi
Gearing	Shimano Alivio rear derailleur with 11-32 tooth rear sprocket 8-speed cassette and 38-tooth single front chainring (no front derailleur)
Brakes	Avid BB-series mechanical (i.e. cable operated) disk brakes with HS-series rotors front and rear
Electric Motor	Bafang front hub motor, marked BPM 48v 500w 26 (17) 1601165029-6; With 36 spoke holes; installed with torque-arm in the form of a retainer plate held on to an eyelet mounted on the fork-end (or front dropout) on one side only
Battery	Li-ion 48v, 11.6 Ah (557 Wh); weight 3.25 kg (7.25 lbs)
Electric Motor Controls	Handlebar-mounted thumb throttle control; handlebar-mounted output-control 3-level selector switch; handlebar-stem-mounted display panel; battery-management system in battery mount; motor control circuitry mounted at back of seat tube.
Weight of complete bike	26.3kg (57.9 lbs) without battery; 29.55 kg (65.15 lbs) with battery
Controller	See #6

Most obvious characteristics that distinguish the E-Grizzly bicycle from most other bikes are the extremely large fat tires and the front-hub mounted electric motor and these features we discussed in the following sections 6 and 7 respectively.

7. Tire Size and Pressure

Fat-tire bikes also known simply as "fat bikes" have been introduced by a number of manufacturers and dealers since about the year 2010 and are particularly recommended for use on soft surfaces most typically sand or snow. They form a subcategory of the mountain bike, characterized by the size of their tire; whereas conventional mountain bikes typically have 2.12" wide tires, fat-tire bikes have tires that are at least 3.0" wide

For a thorough analysis of the advantages of large-diameter tires please refer to referenced item 8 from which this paper is condensed.

The E-Grizzly bike came equipped with tires that were marked 29" by 4.8" (26 x 4) and were mounted on 559 mm BSD rims (i.e. on rims with the BSD not typically associated with 29" tires but with those normally associated with 26" tires.

This should result in an outside wheel diameter of $559 + 224 = 803$ mm (31.6'). Due to the fact that the center of a rim is deeper than the bead seat diameter and tires are not perfectly round in cross-section, the actual outside diameter as measured, with the tire inflated to 15 psi, was 754 mm (29.7") which is about the same as for 3" wide tire mounted on the 622 mm BSD rims used for nominal 29" tires

8. Electric Assist

The E-Grizzly Fat Tire bicycle is equipped with a Bafang 48 volt, electric front-hub motor marked at 500 watts and a front hub market at 750 watts, and a down tube mounted 48 volt, 557 Wh battery with the auxiliary components listed in the table on page 3. Unlike some other electric-assist bikes (especially those legal for road use in Japan and Europe) on which the electric output is activated only as an assist to pedaling, this electric motor can be used as sole propulsion and its output can be controlled by the rider with or without simultaneous pedaling input. Thus, in effect, this bike is not a bicycle with electric assist but rather an electric bicycle with pedal assist.

The amount of electric power can be controlled by means of the control switch (levels 1 2 or 3) and by means of the thumb throttle lever (see # 6)

The level of electric output required of any electric vehicle depends largely on the speed, steepness of terrain, headwind, and tire rolling resistance. At a leisurely pace of 16 km/h (10 mph) on a level road, the required output to propel a bicycle of this kind can be calculated to approximately be a 100w (0.13 hp). In theory with a fully charged battery (557 watts), this level of output should be adequate for continuous riding during 5 1/2 hours, covering a distance of 88 km (55 miles). In practice, power surges such as acceleration from stops, overtaking, and hill climbing will cut into that range significantly probably reducing the range to about 44 km (27 miles). Tested in real world conditions, at the bikes full power and speed, distance is 25 miles.

The above would apply only to use on a smooth road, which for the use of the E-Grizzly is generally less prevalent than its intended special use on soft and/or very rough surfaces where power consumption is significantly higher. In such more demanding terrain (and also at higher speeds) that range will be further reduced especially when uphill riding and frequent stop-and-go are involved.

There are three categories of electric motors for electric-assist bicycles:

Front-wheel-drive, rear wheel drive, and center drive.

Each of these three types is more suitable for certain types of use. For the kind of use typical of fat tire bikes, the front wheel drive offers the advantage over the other forms in that it makes it possible to operate the bike with power to both the front wheel (with the electric motor) and the rear wheel (by pedaling). For a bicycle, two-wheel drive has the same advantages that all-wheel drive has in cars: the machine can be ridden and controlled even when one of the wheels slips or gets "bogged down" e.g. in soft sand or snow, and this tester was able to successfully negotiate soft sand using this technique.

Due to the high torque rating of the motor when driving, as well as due to the effect of strong braking when applying the front disc brake, there is a risk on this kind of arrangement of the front wheel either coming out of the fork or twisting within the fork. To combat this danger, the E-Grizzly is

equipped with a retainer plate attached to an eyelet on the forks dropout. [This device was installed on only one side though it is potentially possible to install such a device on both sides of the wheel]. In combination with adequately tightened axle bolts, this device effectively keeps the front wheel in place under all foreseeable circumstances.

9. Conclusions

The E-Grizzly electric fat-tire bicycle is an excellent product, with significant advantages on a variety of surfaces over other electric-assist fat-tire bikes due to its use of a front hub motor (instead of the conventional arrangements in which the rear wheel is driven both by the electric motor and the rider when pedaling) allowing the rider to add rear-wheel input when needed, plus its additional power and torque. This bike has been tested on every terrain from hunting, through mud, snow, and sand and in extreme woods and trails.

Reference Notes:

A. Observations about tire rolling resistance, including the effects of wheel diameter, tire width, road surface, and tire flexibility, can be found in the following sources:

1. Van der Plas, Robert & Stuart Baird, Bicycle Technology. San Francisco: Cycle Publishing, 2010.
2. Van der Plas, Robert. "Rolling Resistance of Bicycle Tires." Bike Tech, April 1983.
3. Olsen, John. "A Tale of Two Tires, Part II. The Mountain Bike Tire." Bike Tech, June 1988.
4. Berto, Frank. "Testing Bicycle Tires." Bike Tech, October 1988.

B. Observations regarding the specific benefits of increased wheel size and tire width can be found in the following sources:

5. Pinkerton, John, Alberto E. Minetti & Paola Zamparo. "From Bipedalism to "Bicyclism: Evolution in Energetics and Biomechanics of History Bicycles." Cycle History 12: Proceedings of the 12th International Cycling History Conference. San Francisco: Cycle Publishing, 2002.
6. Steiner, Thomas, Beat Muller, Thomas Maier & Jan-Peter Wehrlin. "Performance Differences when using 26- and 29-inch wheel bikes in Swiss National Team Cross-Country Mountain Bikers." Journal of Sports Sciences, 2015.
7. "Could Wider Tires Make You Faster?" Mountain Bike Action, October 2016.

C. Source of the present report:

8. Van der Plas, Robert. "Engineering Analysis Report for Produce Submitted by Thomas Coghill Jr. of Xtreme Fat Tire Bikes LLC." Updated release, 31 October 2016.



CERTIFICATE

**The farthest distance cycled in 12
hours on a mountain bike is 260
km (161.56 miles) by Mike
Unklesbay (USA) in Daytona
Beach, Florida, USA on 29 April
2014**



OFFICIALLY AMAZING

© Guinness World Records Limited. This certificate does not necessarily denote an affiliation with any product or trademark owned by Guinness World Records Limited and may not be reproduced without prior written permission of Guinness World Records Limited.

GUINNESSWORLDRECORDS.COM



CERTIFICATE

The farthest distance cycled in 24 hours on a mountain bike is 456.06 km (283.38 miles), achieved by Mike Unklesbay (USA) in Daytona Beach, Florida, USA, on 30 April 2014



OFFICIALLY AMAZING

© GUINNESS WORLD RECORDS LIMITED 2014. THIS CERTIFICATE DOES NOT REPRESENT OR IMPLY ANY WARRANTY OR ENDORSEMENT BY GUINNESS WORLD RECORDS LIMITED AND MUST NOT BE REPRODUCED WITHOUT PRIOR WRITTEN PERMISSION OF GUINNESS WORLD RECORDS LIMITED.

GUINNESSWORLDRECORDS.COM