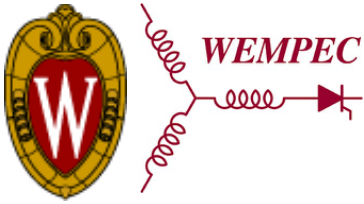


International Future Energy Challenge - 2019

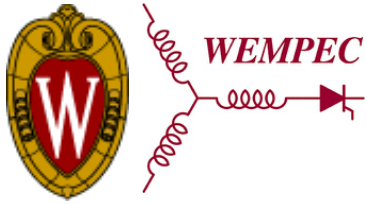


Host: University of Wisconsin-Madison



Leadership

- Steering Committee Chair
Qiang Li, Virginia Tech, USA (Chair)
- General Chair
Giri Venkataramanan, UW-Madison,
- General Co-chair
Kyle Hanson, UW-Madison, USA
- Publicity Chair
Bulent Sarlioglu, UW-Madison, USA
- Finance Chair
Ching-Jan Chen, National Taiwan University, Taiwan

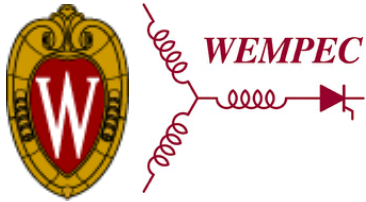


Topic

Motor drive for an electric bicycle

- Global E-bikes market
 - ~\$16 Billion in 2016
- Projection
 - ~\$25 Billion by 2025
- Growth \$1 billion/year

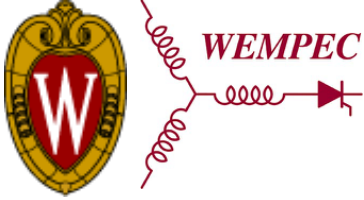
Attractive power electronics application topic visible to general public



Support

Motor drive for an electric bicycle

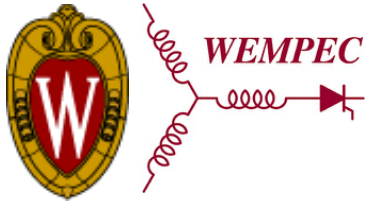
- UW-Madison
 - Wisconsin Electric Machines and Power Electronics Consortium (~90 industrial sponsors)
 - 5 tenure/track + 3 emeritus faculty
 - 3 staff members
 - ~60 graduate students
 - Test facilities and laboratories



Madison scene

Motor drive for an electric bicycle

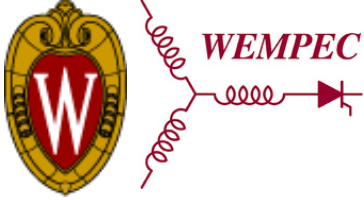
- Among “best places on earth to bike”
- Head Quarters
 - Schwinn, Mongoose, Cannondale,...
 - Trek
 - Planet Bike
- Large enthusiastic bicycle culture
- Network of paved bike-paths, bike-share locations
- E-bike retail stores



Approach

Motor drive for an electric bicycle

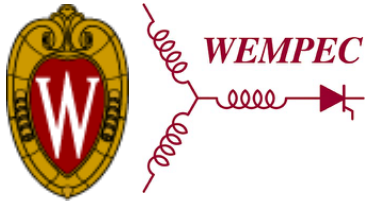
- Commercial off-the-shelf Hub-mounted motor and battery
- Power converter and drive design challenge
- Target power density and temperature rise
- Performance criteria



Main specifications

Motor drive for an electric bicycle

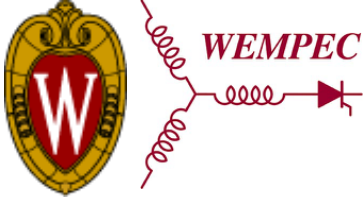
- Input: 48Vdc nominal
- 9Ah Lead acid battery pack
- Output: 3-phase BLDC motor drive
- Vout: 36V; Pout: 500W; variable speed.
- Internal temperature rise $< 40^{\circ}\text{C}$ @ 25°C Ambient.
- Case temperature $< 48^{\circ}\text{C}$



Final competition

Motor drive for an electric bicycle

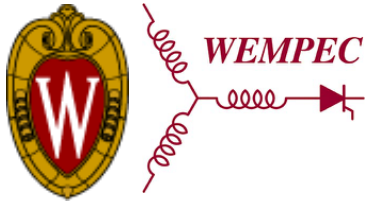
- Design presentations
- Laboratory testing
- Public outdoor event
- Various prize categories
- Opportunity for various local prizes (sponsorships)



Laboratory Evaluations

Motor drive for an electric bicycle

- Specially designed dynamometer
- Battery emulator
 - Repeatable and uniform parameters
- Operating endurance test
- Peak load test
- Energy consumption test (specified drive cycle)



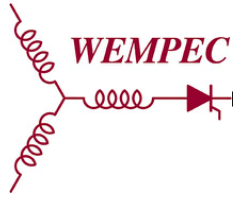
Schedule

Motor drive for an electric bicycle

- Information Session at ECCE 2018
September 25, 2018
- Letter of Intent Deadline
November 2, 2018
- Proposal Deadline
November 16, 2018
- Notification of Acceptance
December 21, 2018
- Workshop at APEC 2019
March 17, 2019
- Notification of Finalists
April 15, 2019
- Final Competition
July 29-31, 2019



WEMPEC

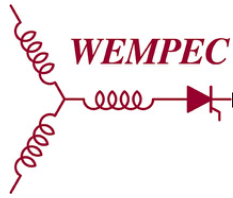


Technical Specifications

- 48V 9AH Lead Acid battery
- 3-phase brushless motor
- Trapezoidal back emf
- Integrated Hall-effect sensors
- 36V L-N fundamental RMS value
- 0-300Hz frequency
- 3-wire motor



WEMPEC

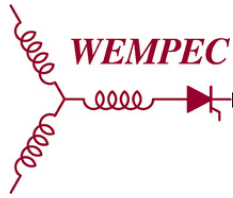


Technical Specifications

- Gear-box removed for dynamometer testing
- Battery negative referenced 5V control power for sensor, throttle, and on-off enable
- Control throttle 1~4V : 0-10A dc current
- Speed, torque, power control

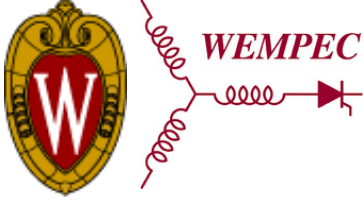


WEMPEC



Technical Specifications

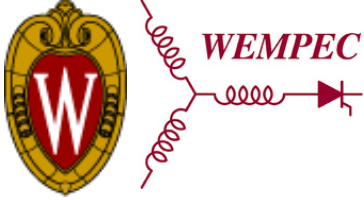
- Dynamometer motor connected to nominal identically rated machine as generator
- Generator output rectified and fed to electronic load with 5 settings
- Throttle input at 5 settings (12 sec each)
- Input power and output power measured to estimate efficiency



Test conditions

Motor drive for an electric bicycle

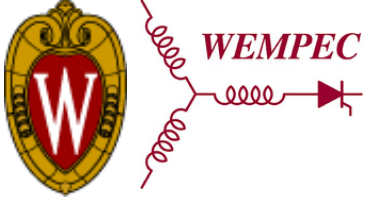
- Battery emulator
- Temperature rise at inverter switch case
- Temperature of housing
- Overload protection
- Under-voltage protection
- No-load acceleration test
- Full-load acceleration test



Field (optional) tests

Motor drive for an electric bicycle

- Install tested prototype on stock bike with fully charged battery and specified motor on wheel
- Maneuverability test on circuit course
- Range test on laps
- Relay race speed test with team members
- **Grand prize**



See you all in Madison



IFEC 2019