

# Technical White Paper on Electric Standup Paddleboards

Daniel A. Mahar, P.E., Firefly SUP Drives, LLC

December 5, 2021

Electric standup paddleboards (eSUPs) were introduced in the early 2010s with the advent of lithium batteries. This relatively new sport continues to evolve as companies strive to make products that excite and engage consumers. Today, eSUP products can be classified into three unique categories; 1. integrated drives, 2. fin-mounted drives, and 3. forward-mounted drives. Both fin-mounted and forward-mounted drives are motor systems that attach to a regular standup paddleboard converting it to an eSUP. In contrast, integrated drives are built into a dedicated eSUP board. Each design has distinct performance characteristics, and it is important for buyers to understand the advantages and disadvantages of each before deciding on a purchase.

Integrated drives are paddleboards that have the motor and battery system integrated into the body of the board. Integrated drives use either an internal impeller or small propeller located inside a chamber of the board to convert battery power into propulsion. These propulsion systems are commonly referred to as jet drives. Jet drives have the advantage of being located in the midsection of the board keeping the board balanced. They also have the advantage of leaving the fin in place to provide stability and hydrodynamic lift during turns. This results in a board that maneuvers well on the water.

Boards with integrated drives tend to be expensive and have limited speed or range. These disadvantages are attributed to jet drives being inefficient at converting battery power to propulsion, and the need to keep the board under a practical lifting weight of 50 pounds. The inefficiency of jet drives is due to drag induced by forcing water through restricted channels. Consequently, jet drives are only 25% to 50% efficient at converting battery power into propulsion when compared to fin-mounted and forward-mounted drives that use propellers for propulsion. To address this challenge boards with integrated drives are designed to operate at slower speeds or with shorter run times.

The second category of eSUPs are boards with fin-mounted drives. These are by far the most common drives on the market for two reasons. They use an efficient propeller for propulsion, and they are easy to install. To install the customer removes the fin and replaces the fin with a motor/propeller unit. The battery is placed on the tail of the board with a power cable running over the rail to the motor. Although fin-mounted drives have obvious marketing advantages with their ease of installation, they suffer from inferior portability at the beach, are difficult to operate, and have poor handling characteristics on the water. These disadvantages are a result of having the battery and control system behind the rider and the fin absent. A fin-mounted drive adds about 10 pounds of swing weight to the tail of the board negatively impacting how the board handles during turns and maneuvers. Board handling is also compromised with removal of the fin which makes turns using the paddle difficult. Further disadvantages include the battery being a tripping hazard on the deck, the need for a leash between the rider and battery as a safety shutoff device, and difficulty reaching battery on/off controls and charge level readouts.

The third category of eSUPs are boards with forward-mounted drives. Boards with forward-mounted drives have all the advantages of both integrated and fin-mounted drives without the disadvantages. Like a fin-mounted drive, a forward-mounted drive uses an efficient propeller to generate propulsion.

Like an integrated drive, a forward-mounted drive is located in the board's midsection keeping the board balanced while leaving the fin in place for stability and carving turns. Combining these advantages results in an eSUP with good speed and range, and a board that maneuvers exceptionally well on the water. Unlike most fin-mounted drives, boards with forward-mounted drives do not require an auto-shutdown leash between the rider and battery because the risk of hitting the propeller is mitigated by having the propeller forward of the rider.

There are two additional features offered by Firefly's forward-mounted drives that are not available on integrated or fin-mounted drives. First, forward-mounted drives are attached using a quick connect coupling system with vibration dampening. This provides fast connect/disconnect portability at the beach and a dampening mechanism that reduces noise and vibration associated with the motor. The second feature is an adjustable angle of attack device. This provides adjustment of the motor angle so that it propels the board in a straightforward direction, or slightly to port or starboard. This allows the rider to customize their riding/paddling style based on preferences and conditions.

Firefly SUP Drives is the exclusive purveyor of forward-mounted drives. Their products include a custom paddleboard designed to maximize forward-mounted drive experience, and a QuickPlate product allowing customers to self-install a forward-mounted drive on their paddleboard. Firefly products are easy to operate and have excellent maneuverability on the water making them the clear choice for customers demanding best-in-class performance.