

GA급 eCTOL 전기 항공기에서 병렬 배터리 구성을 통한 전압 강하 완화와 이륙 출력 여유에 미치는 영향

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Voltage Sag Mitigation through Parallel Battery Configuration and Its Effect on Takeoff Power Margin in GA-Class eCTOL Electric Aircraft

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Abstract : This paper investigates the effect of battery parallel configuration on voltage sag, available power, and takeoff safety margin in GA-class eCTOL (electric Conventional Takeoff and Landing) aircraft. High-current discharge experiments were conducted on a 22 Ah large-format pouch cell in 1S1P (209 A, 9.5C) and 1S4P (836 A total; 209 A per cell, 9.5C) configurations, yielding a measured DC internal resistance of $R_{\text{cell}} = 0.756 \text{ m}\Omega/\text{cell}$ at 25°C. This experimentally validated resistance is applied to a 156S battery pack architecture — derived from a prior GA-class electric aircraft development program — operating at a rated system power of 65 kW. Analysis shows that increasing the parallel count from 1P to 9P reduces voltage sag from 13.98 V to 1.55 V and recovers $\alpha = +1,400 \text{ W}$ (+2.15% of rated power). Applied to a representative 650 kg MTOW eCTOL aircraft, this translates to a takeoff climb gradient improvement of +0.53 percentage points, corresponding to a ~20% enhancement in FAR Part 23 safety margin. The same analysis applied to a 300 kW-class eVTOL shows negligible impact (<0.1%), confirming that the effect is specific to weight-constrained eCTOL platforms where high per-cell C-rates make voltage sag a dominant loss mechanism.

Key Words : eCTOL, Parallel Battery Configuration, Voltage Sag, Internal Resistance, Takeoff Power Margin, Climb Gradient, Electric Aviation

Acknowledgement : This study was conducted as part of the eVTOL system development program at V-SPACE Co., Ltd. The authors would like to express their sincere gratitude to all researchers and collaborators who contributed to the aircraft design, flight testing, and data analysis.

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