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Thermal performance maps for forced air cooling of ruggedized electronics enclosures

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Based on standard commercial form factors, this study explores chassis-level air cooling limits for ruggedized military electronics constrained by pressure drop requirements and fin manufacturing capabilities. Numeric and analytic models are developed and used to define a methodology for optimizing the geometry of longitudinal plate fins included in the side wall ducts to maximize the amount of heat that can be dissipated from an air-cooled chassis. The results of these analyses are presented in the form of a performance map intended to be used by a thermal design engineer to identify a particular fin manufacturing process well-suited for a specified set of mass flow/pressure drop and heat transfer boundary requirements. Analysis results demonstrate that if isothermal boundaries can be achieved, the heat transfer capacity of the chassis will increase relative to isoflux boundary condition assumptions. As a means to this end, the incorporation of heat pipes into the chassis wall is explored to enhance heat spreading and approach the isothermal limits of heat dissipation in the airflow ducts.