Performance assessment of commercial CIGS PV panels under stratospheric conditions

M. Guillouche, C. Alusse, V. Dupré T. Jean, B. Marchadour, L. Bigeard, J. Maillard, E. Biscay, P. Briand, R. Lebruman, L. Le Meur, G. Ferrand, R. Dumas, T. Lepetit

Nantes Université, Polytech Nantes, F-44300, France

This abstract presents the results of the Polyspace project, conducted by students from Polytech Nantes. The goal of this project was to characterize two commercial photovoltaic panels, provided by Solar Cloth, by recording current-voltage (I-V) curves during the ascent of an autonomous atmospheric balloon. The design and implementation of the flight system, including the helium balloon, were outside the project's scope, as these components were supplied by Planète Sciences in collaboration with CNES. This study enabled the assessment of the panels' performance under extreme conditions: altitudes up to 28,000 meters and temperatures as low as -56 °C.

The I-V curves were measured using a MOSFET (IRLZ44) operating in its ohmic region to simulate a variable resistor. By adjusting the gate-source voltage (V_{gs}), a controlled current was drawn from the panel. The transistor was driven by a PWM signal filtered by an RC circuit, and the output voltage was measured via a voltage divider connected to an Arduino. Current was determined by measuring the voltage drop across a shunt resistor, amplified by an operational amplifier. This setup allowed the coverage of the full current range needed to plot the I-V curve.

The evolution of the I-V curves shows a significant improvement in panel performance with increasing altitude, with peak performance observed between 12,000 and 20,000 meters. In this altitude range, the panel achieved an experimental maximum power output of 5.5 W, to be compared to the 6.5W theoretical output power and the 3.8W output power measured at ground level. This improvement is attributed to higher irradiance above the clouds, which increases the short-circuit current (Isc), and more importantly, to the drop in temperature — down to -56 °C — which significantly increases the open-circuit voltage (Voc).

Figure 1: photography of the final gondola

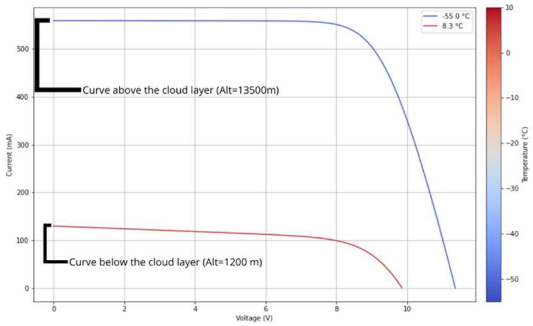

Figure 2: I-V characteristics of solar panel measured at two altitudes