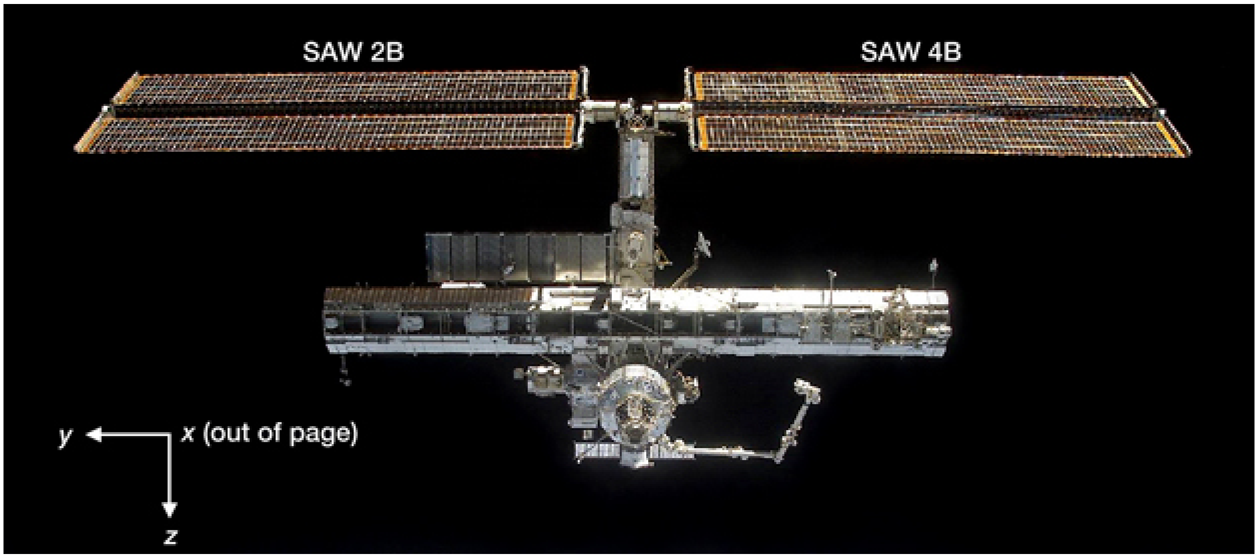
International Space Station Solar Array Wing On-Orbit Electrical Performance Degradation Measured



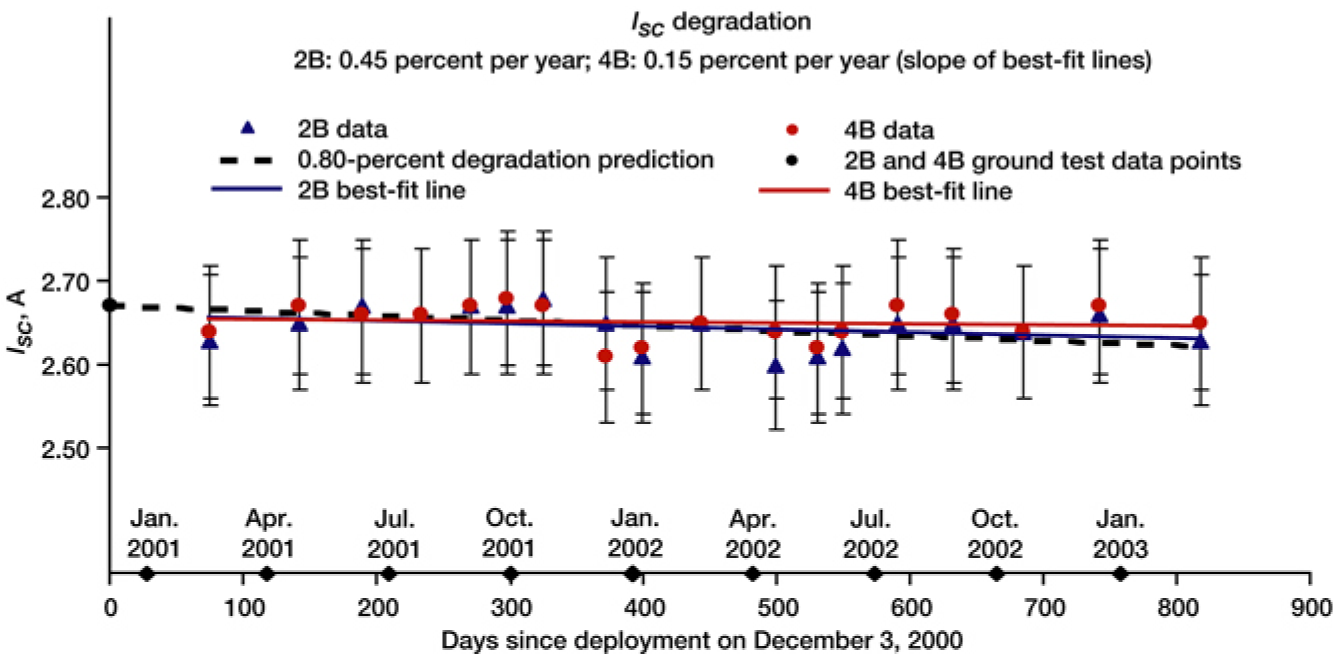
International Space Station showing coordinated system and solar array wing (SAW) nomenclature.

The port-side photovoltaic power module (P6) was activated on the International Space Station in December 2000. P6 provides electrical power to channels 2B and 4B to operate ISS power loads. A P6 is shown in the preceding photograph. This article highlights the work done at the NASA Glenn Research Center to calculate the on-orbit degradation of the P6 solar array wings (SAWs) using on-orbit data from December 2000 to February 2003.

During early ISS operations, the 82 strings of photovoltaic cells that make up a SAW can provide much more power than is necessary to meet the demand. To deal with excess power, a sequential shunt unit successively shunts the current from the strings. This shunt current was the parameter chosen for the SAW performance degradation study for the following reasons: (1) it is based on a direct shunt current measurement in the sequential shunt unit, (2) the shunt current has a low temperature dependence that reduces the data correction error from using a computationally derived array temperature, and (3) the SSU shunt current is essentially the same as the SAW short-circuit current on a per-string basis.

The major part of the analysis involved normalizing the shunt current to the reference conditions of equinox solar insolation, 28 °C operating temperature, no albedo current production, and no current loss from the shadowing of solar cells. This normalization allowed data from different dates and orbital conditions to be usefully compared with each other. Normalizing factors were calculated using the computer code SPACE (System Power Analysis for Capability Evaluation). The Glenn-developed SPACE code models the International Space Station's electric power system, and its accuracy has been validated with on-orbit data. For each shunt current data point, SPACE was used to correct for conditions that affect shunt current. These conditions can change on an orbit-to-orbit basis, such as solar insolation, or change within a given orbit, such as array temperature and Earth albedo.

After the shunt current was normalized, the shunt current per string of photo-voltaic cells, equal to the string short-circuit current I_{sc}, was averaged over an orbit Sun period. This average value of I_{sc} was used for comparison over time. The process was repeated for several orbits over the time span of the analysis. A value for the percentage degradation per year can be calculated from the slope of a best fit line through the I_{sc} data points as shown in the following graph. The calculated I_{sc} degradation rates were 0.45 percent per year for SAW 2B and 0.15 percent per year for SAW 4B. This amount of degradation is much lower than the estimated data analysis uncertainty, ±3.2 percent, and is lower than the 0.8-percent-per-year I_{sc} degradation predicted by SPACE. Thus, we concluded that there has been no appreciable SAW I_{sc} degradation in the first 26 months of on-orbit operation. Glenn plans to continue monitoring degradation of P6 SAW currents as well as that of future photovoltaic power modules.



Measured on-orbit degradation of SAW string short-circuit current, I_{sc}.

Bibliography

Kerslake, Thomas W.; and Gustafson, Eric D.: On-Orbit Performance Degradation of the International Space Station P6 Photovoltaic Arrays. NASA/TM-2003-212513 (AIAA Paper 2003-5999), 2003. http://gltrs.grc.nasa.gov/cgi-bin/GLTRS/browse.pl?/2003/TM-2003-212513.html

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