

FISCE Calibration Test Report

1. Introduction

This test was performed to calibrate the FISCE instruments on FIREBIRD-II Flight Units 3 and 4, on the ground, before launch.

2. Test Setup

This testing was performed outdoors, on July 19, 2014. All FU3 data was taken in the lot on the East Side of the EPS building, between 1845UTC (12:45 local) and 1915 UTC (13:15 local). All FU4 data was taken in near the main entrance of the EPS building between 2055UTC (14:55 local) and 2125 UTC (15:20 local).

Figure 1 shows the test setup used. The each flight unit was mounted to the white SPACEBUOY rotational test jig, using an aluminum adapter plate and 1.5U CubeSat mount. All sides of the CubeSat mount were covered with alumiLOY and Kapton tape, to reduce contamination during transportation and setup. During the actual test, the alumiLOY cover was removed from only the Y- (FISCE) side of the flight unit. After testing was complete, the Y- side was re-covered with alumiLOY and the flight unit was transported back to the clean bench and gently wiped down with ethanol and ChemWipes.

As shown in Figure 1, the mounting hardware on the adapter plate was used to align the Y- side of the flight unit towards the sun. This alignment will be referred to as normal or 0° . Data was taken at a total of five different angles, from 0° to 60° . For each angle the flight unit was rotated around the axis indicated in the figure, and the protractor built into the rotational test jig was used to measure the offset from 0° .

Commands and telemetry were sent to and from the flight unit through a USB GSE cable connected to a laptop running InControl. At each of the five test angles, the flight unit was manually commanded to initiate a photodiode test, with sample period of 1 second, followed by an IV curve test.

At each test angle, the current solar irradiance was measured using the AMPROBE Solar-100 Solar Power Meter.



Figure 1: Test Setup and Sun Alignment

3. Results

Solar Irradiance

Table 1 shows the solar irradiance at the time of each test, for each flight unit. Note that during FU4's test, the solar irradiance is consistently 4-5% higher than during FU3's tests.

Table 1: Solar Irradiance Differences

Angle from Normal	FU3 Solar Irradiance [W/m ²]	FU4 Solar Irradiance [W/m ²]	Difference (%)
0	1315	1377	5%
10	1330	1382	4%
20	1330	1386	4%
40	1314	1365	4%
60	1309	1381	5%

Photodiode Calibration

Figure 2 shows the results of the photodiode tests performed at each angle on each flight unit. During each photodiode test 20 ADC samples are taken, each 1 second apart. The figure shows the average of these 20 samples, for each angle and flight unit.

The difference between flight units is approximately 6% between 0° and 20°, and can be attributed to the difference in solar irradiance at the time of the tests.

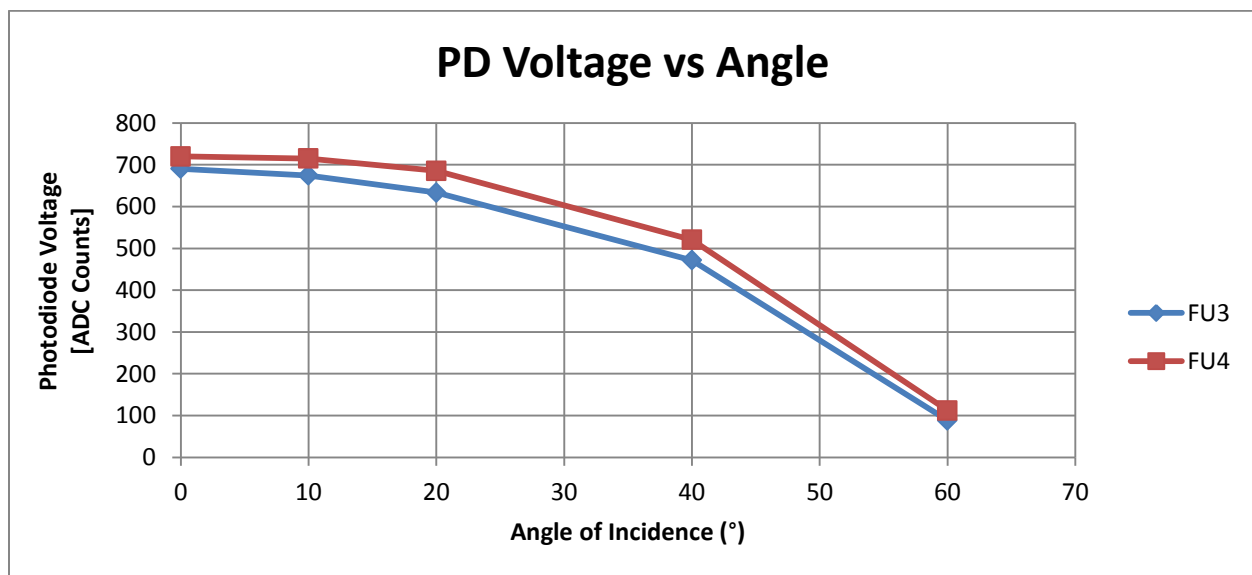


Figure 2: Photodiode Voltage vs Angle

DAC Calibration

Figure 3 shows a comparison between the raw DAC setting and the panel current during the IV curve tests. The data for this figure was taken from the 0° IV curve tests on each flight unit.

The figure shows that a given DAC setting will result in the same current flow through the load FET between flight units. Additionally, the figure shows that DAC setting relates linearly to the load current, as designed.

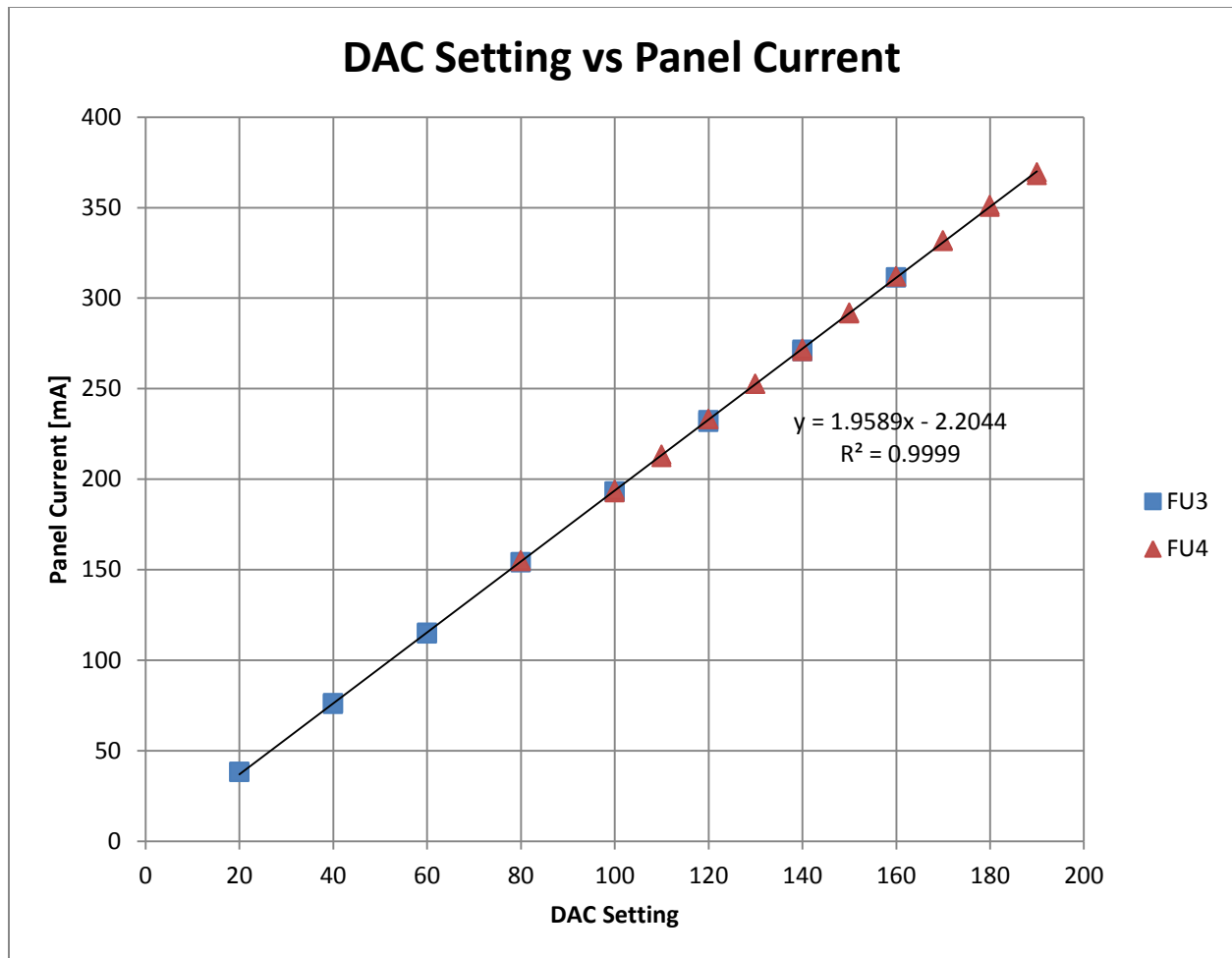


Figure 3: DAC Setting vs Panel Current

IV Curve Calibration

Figures 4 through 7 show the resulting IV curves for both flight units, in terms of both voltage vs current and power vs current.

Both the short-circuit current and peak-power observed on FU3 are 10% lower than that of FU4, this is attributed to the reduced solar irradiance during testing of FU3.

FU3 was tested at 0° two additional times, with different DAC settings to increase resolution around the peak power point. During these two additional test the solar irradiance was further reduced to 1262 W/m².

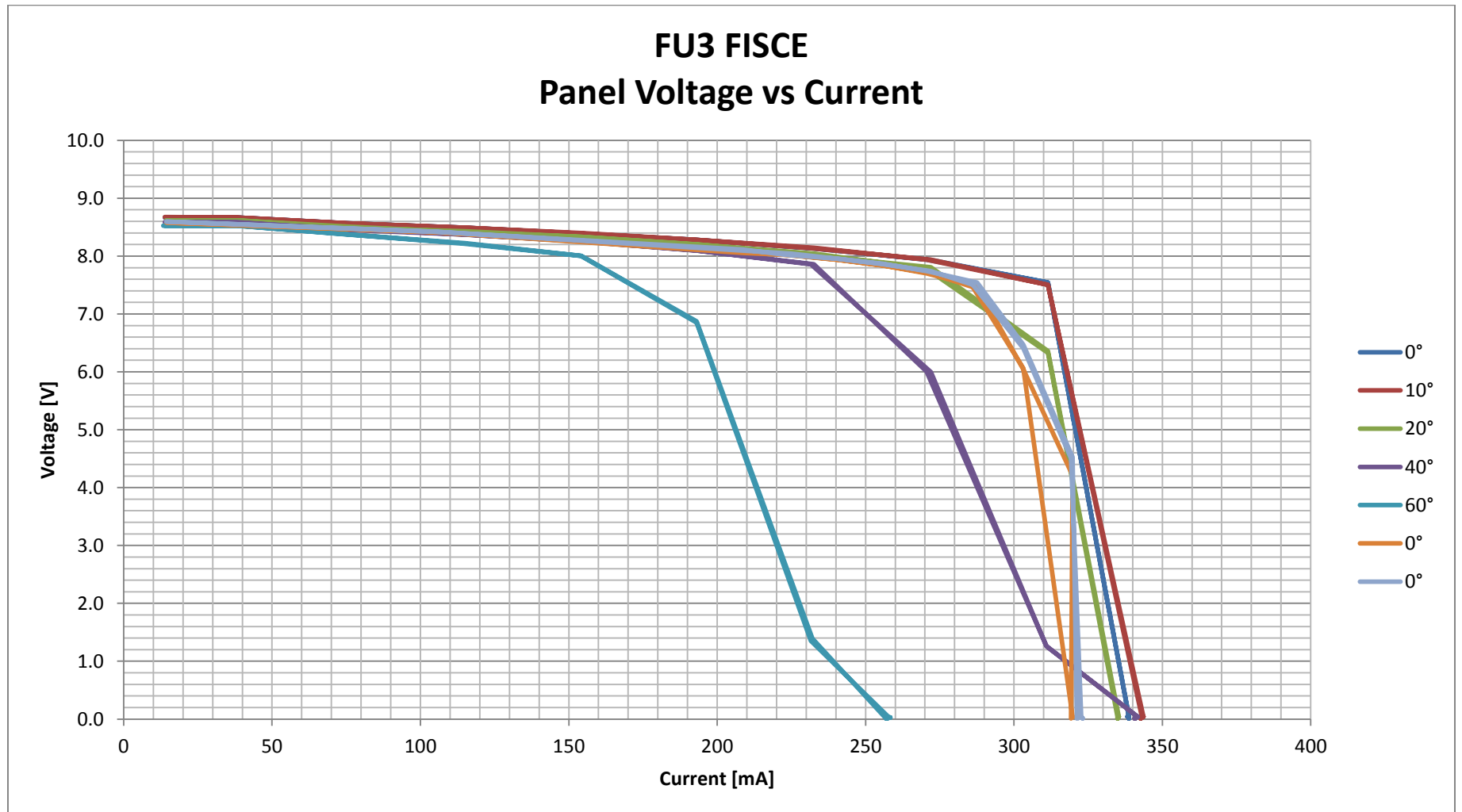


Figure 4: FU3 FISCE Panel Voltage vs Current

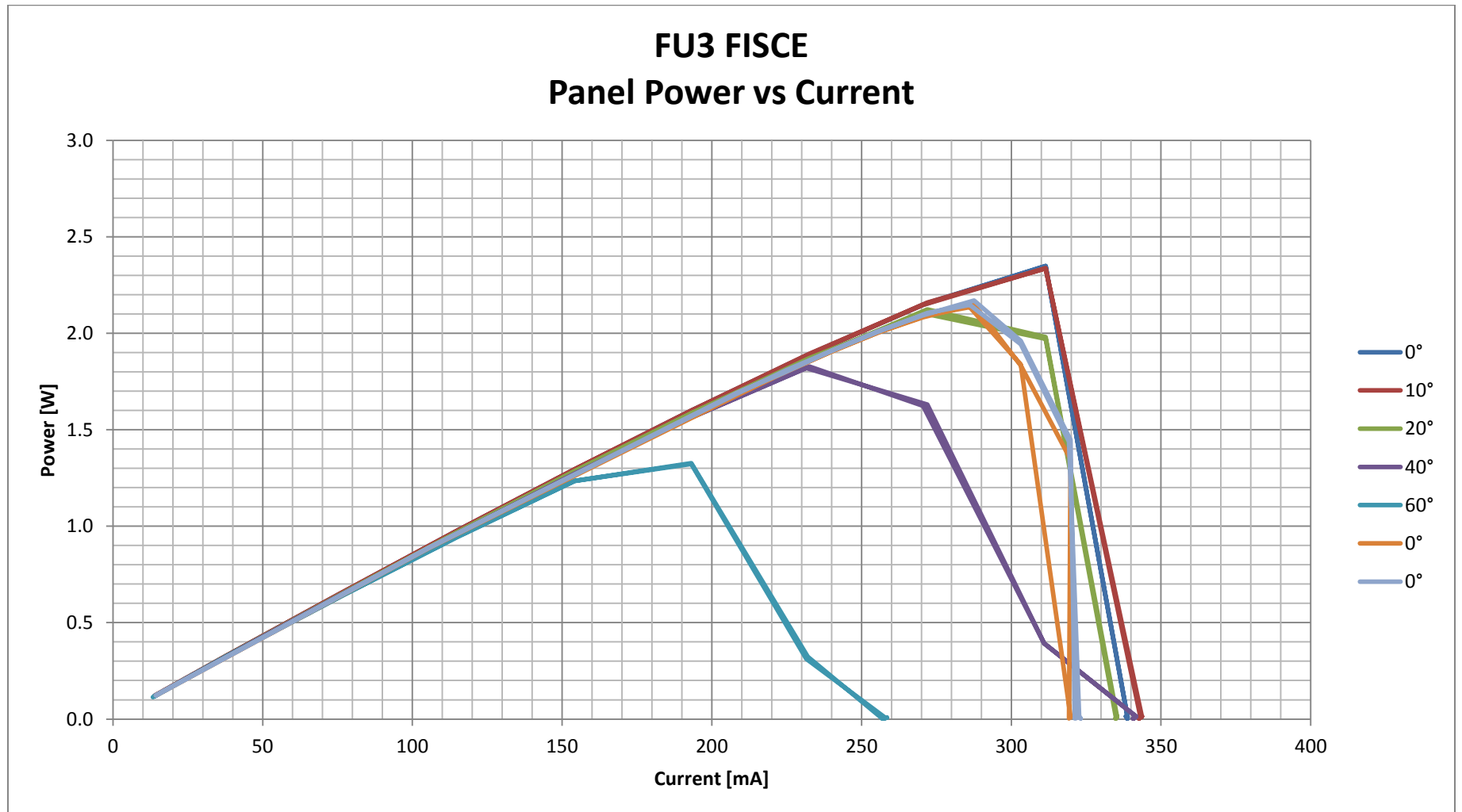


Figure 5: FU3 FISCE Panel Power vs Current

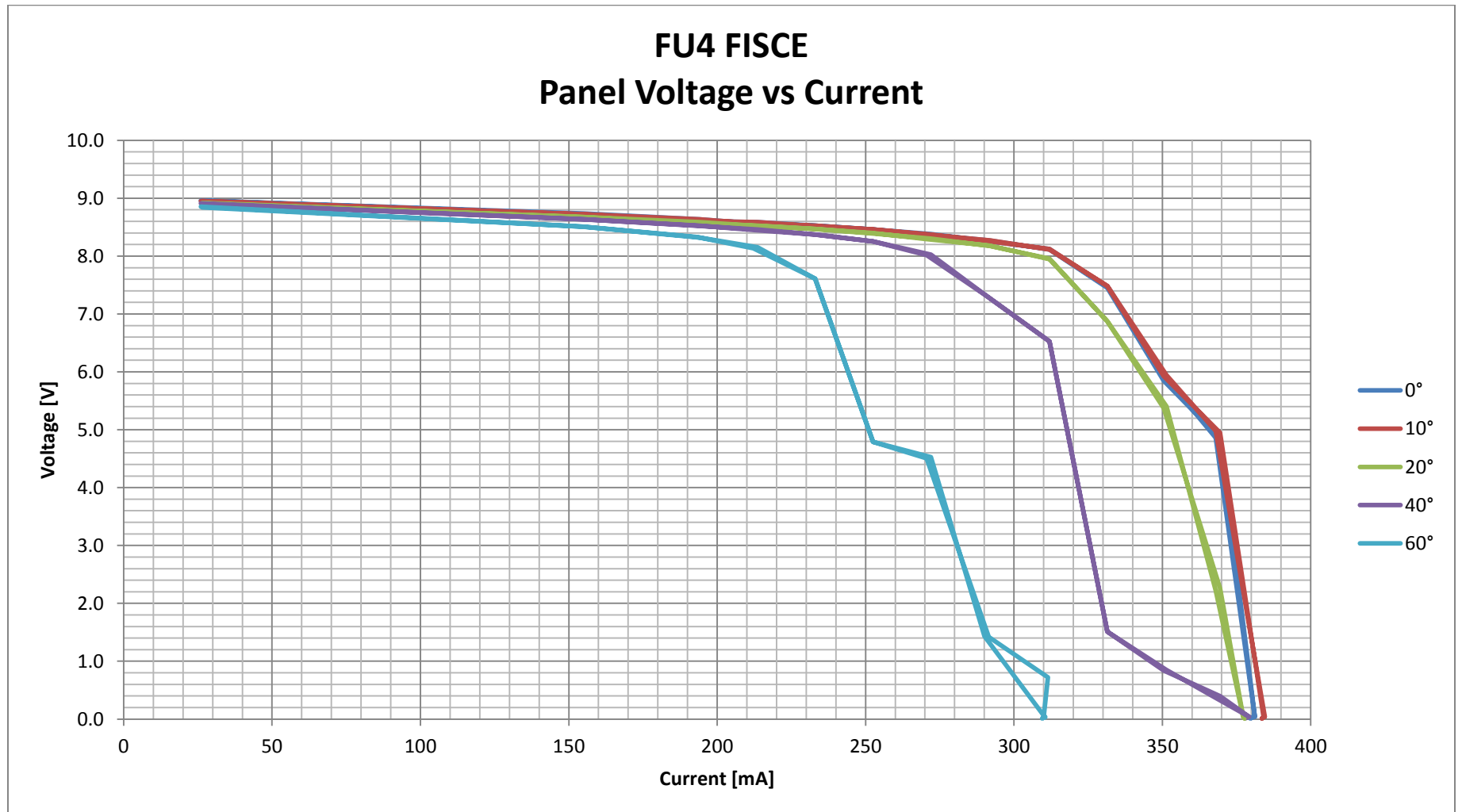


Figure 6: FU4 FISCE Panel Voltage vs Current

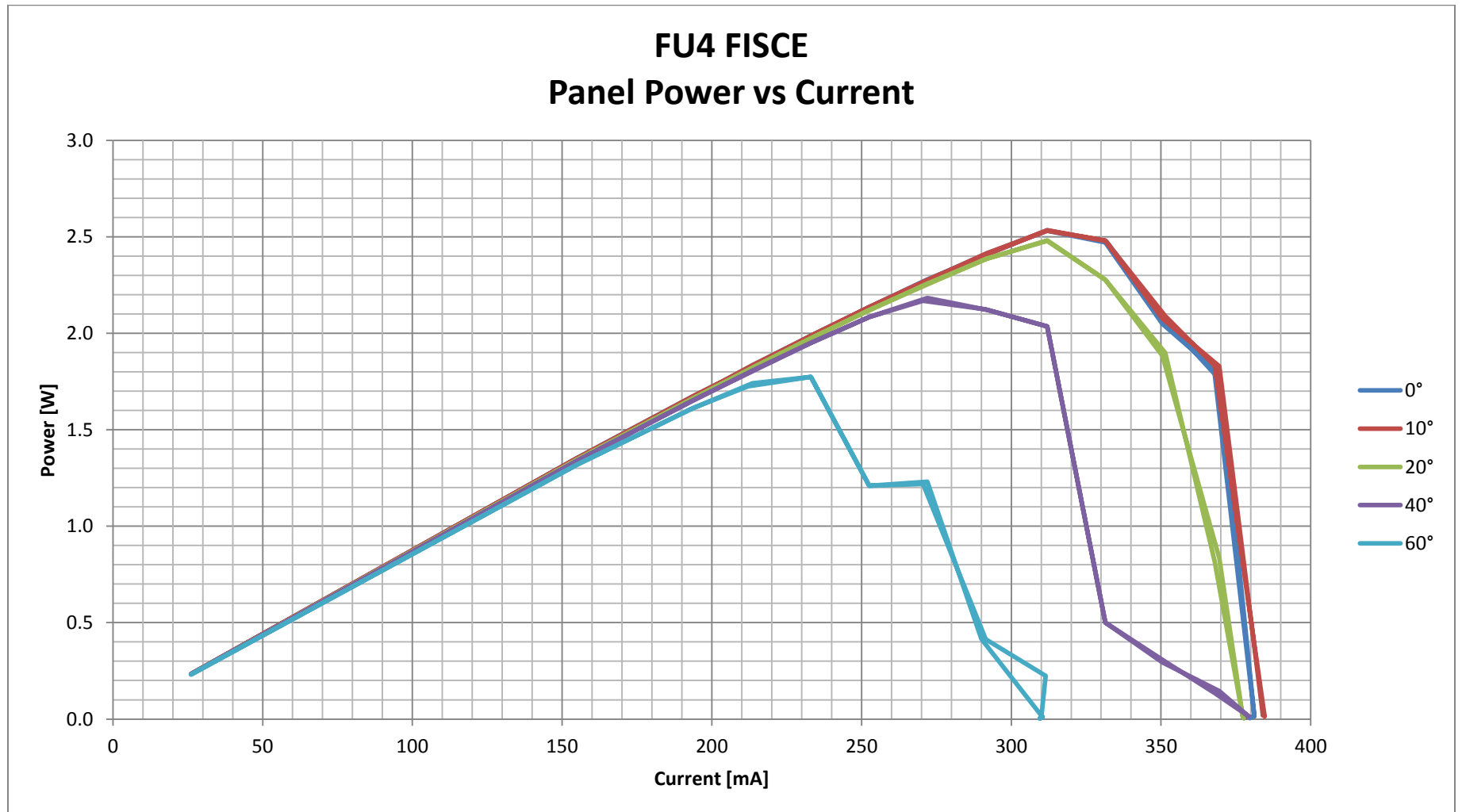


Figure 7: FU4 FISCE Panel Power vs Current

4. Conclusions

As a result of this testing, two things may be determined. First, the photodiode ADC channel value to be used as a threshold to trigger IV curve tests on orbit and second, the 15 DAC settings to be used on orbit.

As seen in the IV curve data for both units there is a negligible measureable difference between IV curves taken at 0° and 10°. However at 20°, the curve begins to shift down in current. This confirms that the original goal of taking IV curves with 15° of normal is acceptable. Based on the photodiode calibration data, it is recommended to use a value of **710 as the threshold for an IV curve** measurement. This will correspond to an angle of approximately 12°. This threshold may be revised on orbit as data is received.

The first and last of the 15 DAC settings will be placed at open circuit and short circuit. As shown in the IV curve data the power vs current remains fairly linear from open circuit up to 250 mA. Therefore only two samples shall be placed in this region, one at 125 mA, and the other at 250 mA. The remaining 11 sample points will be placed evenly between 250 mA and 415 mA which is 9% more than the measure short circuit current of 381 mA. These sample points and the corresponding DAC settings are shown below in Table 2. These values may be revised on orbit as data is received.

Table 2: Recommended DAC Settings

	Panel Current [mA]	DAC Setting
1	0	0
2	125	66
3	250	130
4	265	137
5	280	145
6	295	153
7	310	160
8	325	168
9	340	176
10	355	183
11	370	191
12	385	199
13	400	206
14	415	214
15	497	255

Figure 8 and Figure 9 shows an IV curve taken with FU3 on July 22, 2014 using the recommended settings from Table 1. At the time the data was taken, the solar irradiance was 1360 W/m^2 . As intended, the majority of the points are centered at the peak power point of 2.6 W at 327 mA, with a resolution of 15 mA between data points.

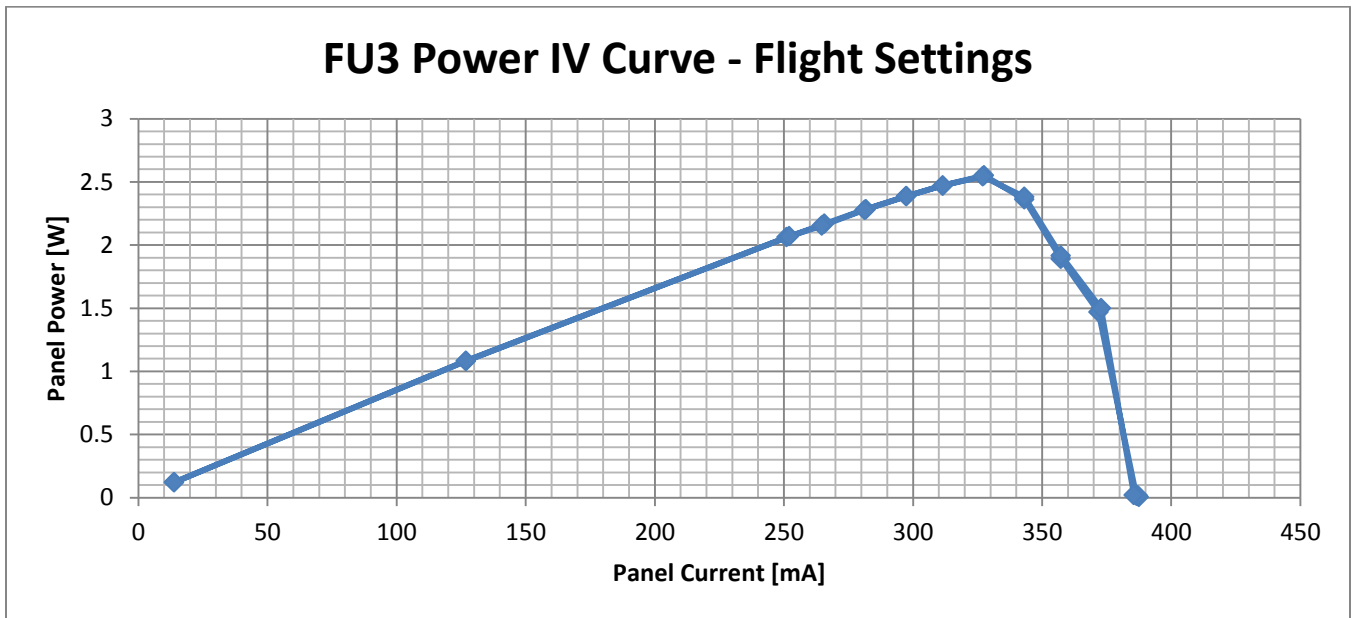


Figure 8: Flight IV Curve Settings

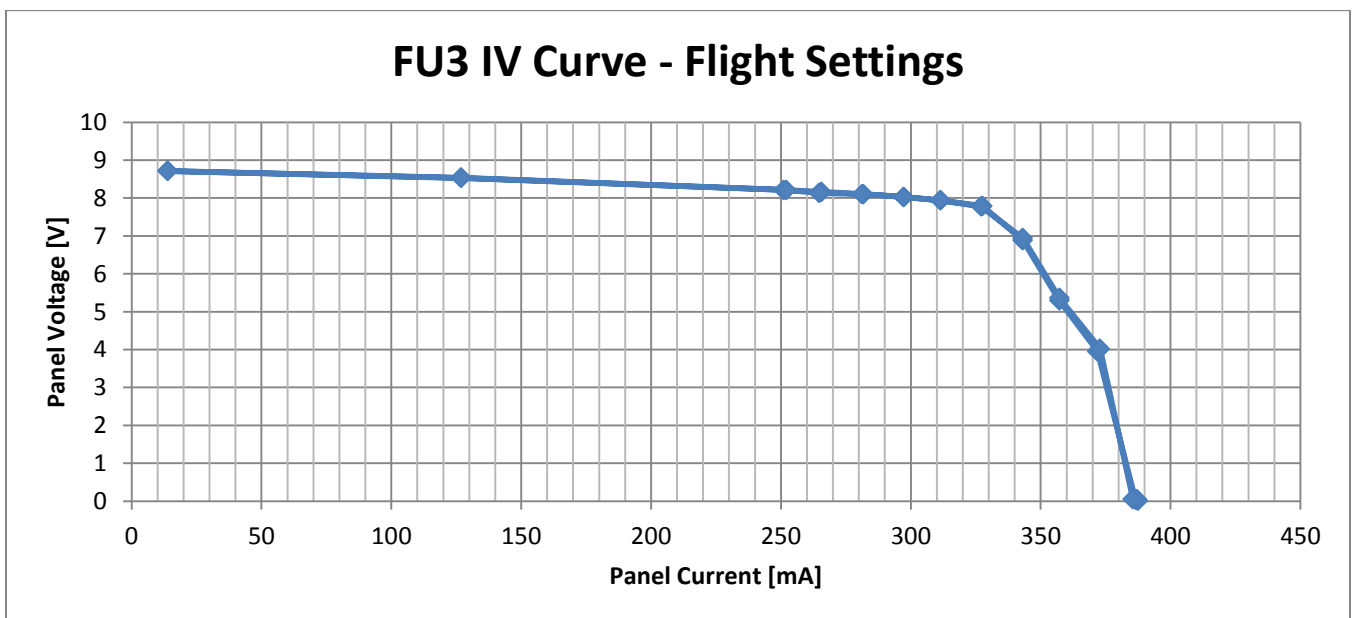


Figure 9: Flight IV Curve Settings