Effect of High Optical Power on ISC RFPDs
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1. Overview

Not much is known about sustained high optical power laser beams on the ISC RFPDs. Some characterization was done on the LSC RFPD (C30642) diode element at optical powers up to ~100mW, but we need data on sustained illumination at up to 1 watt (1064nm) as may be encountered inside HAM1 during times when the IFO is not locked.

A setup was created in the 40m lab where a portion of the PSL beam was diverted and used as an optical input to an RFPD under test. A wave plate was used to control power giving us a range of a few mW up to ~1.7 W. An optical power meter was used to measure the light level, and an RFPD was instrumented so that we could monitor several critical voltages. The beam spot size (at 13.5% of the profile amplitude) was measured to be 0.98mm in X and Y using a beam scan.

2. LSC Detector Results

Three voltages were recorded on LSC diode S1300528 in hopes of understanding the effect of high optical levels on the LSC detector components. Referring to the diagram below, the bias voltage, the voltage at the photodetector anode, and the output voltage of the transimpedance amplifier were recorded. The diode retaining ring (used to hold the diode element in place and to ensure good thermal coupling to the detector body) temperature was also measured by use of a non-contact thermal probe.

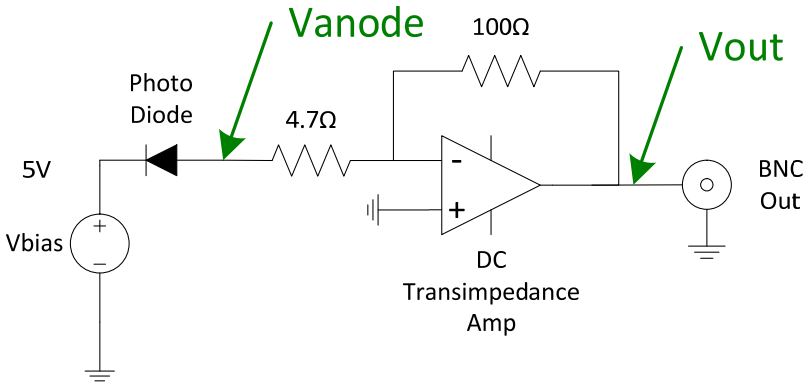

Figure 1

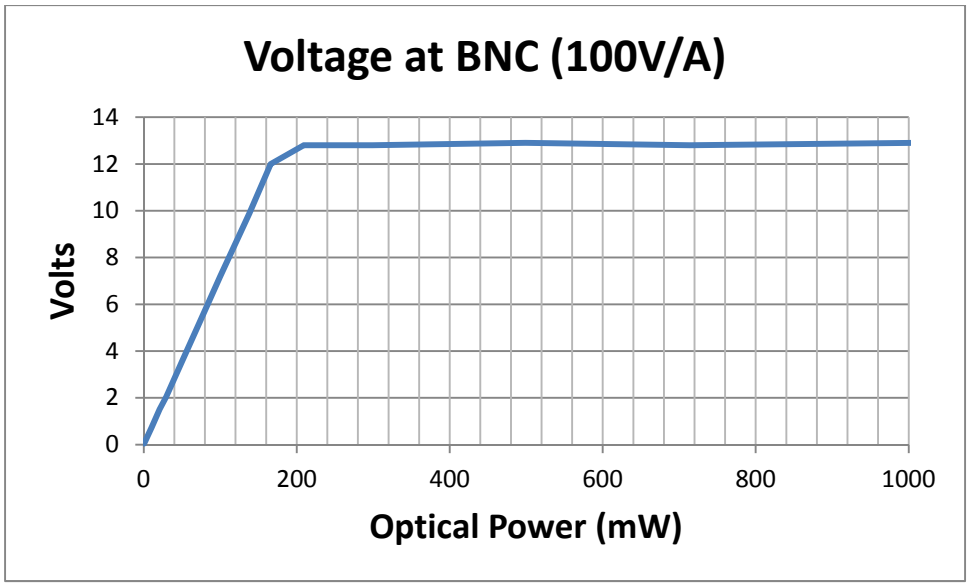

Figure 2

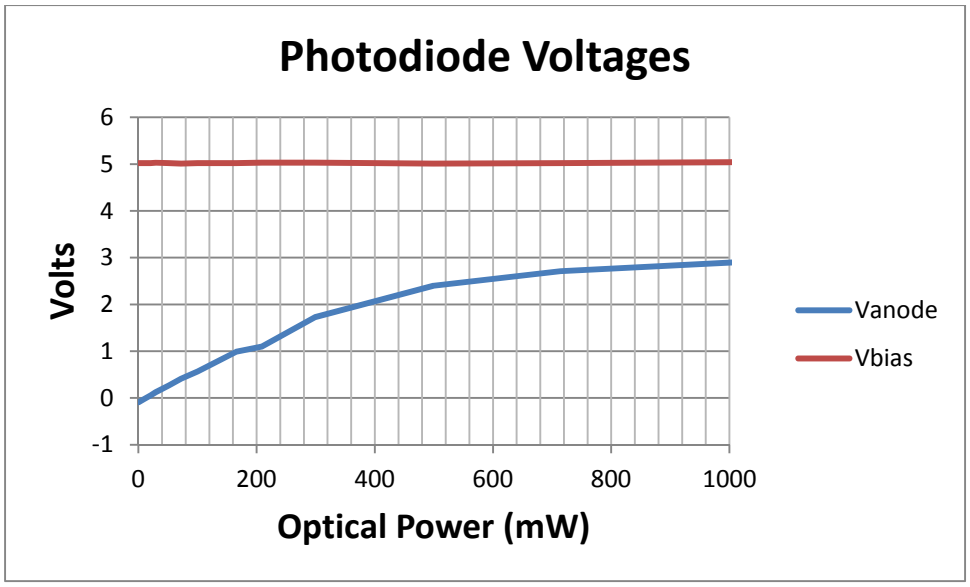

Figure 3

3. **LSC Detector Raw Data**

Optical Power Input (mW)	Voltage at BNC (100V/A)	Vbias (V)	Vanode (mV)	Vanode (V)
0.5	0.045	5.02	-93	-0.093
10.2	0.734	5.02	-20	-0.02
20.8	1.51	5.02	55	0.055
29.4	2.04	5.03	125	0.125
51.3	3.65	5.02	265	0.265
72.3	5.17	5.01	410	0.41
100	7.2	5.02	567	0.567
138	9.89	5.02	807	0.807
166	12	5.02	989	0.989
209	12.8	5.03	1100	1.1
299	12.8	5.03	1730	1.73
499	12.9	5.01	2400	2.4
714	12.8	5.02	2710	2.71
1010	12.9	5.04	2900	2.9

Table 1

4. **WFS Detector Results**

Similar to the LSC detector, the aLIGO WFS was also exposed to optical power levels up to 1 watt at 1064 nm

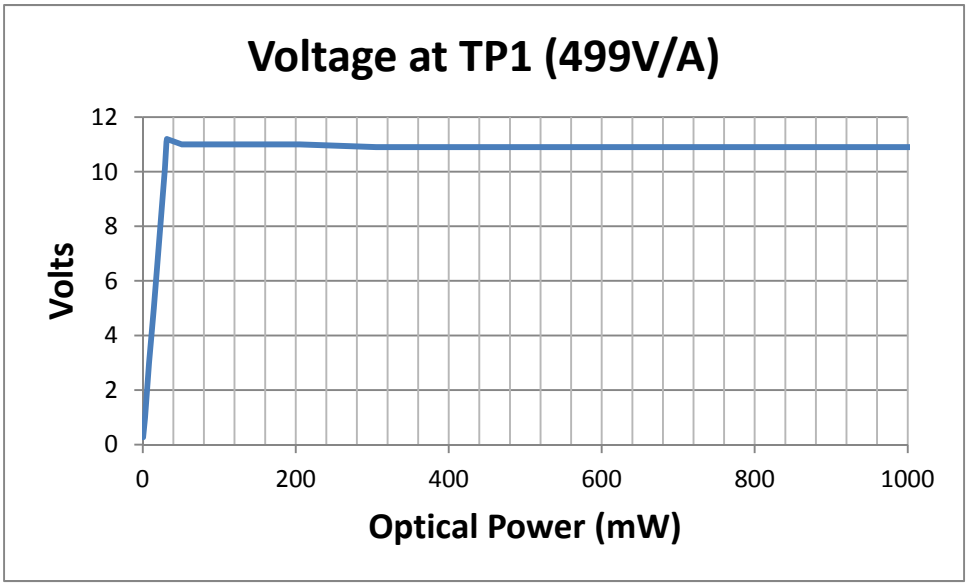

Figure 4

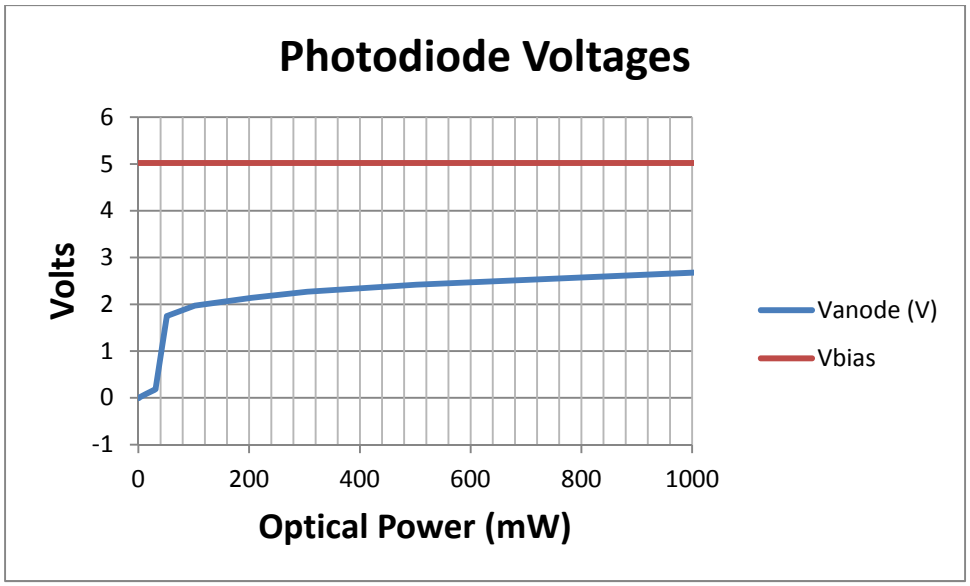

Figure 5

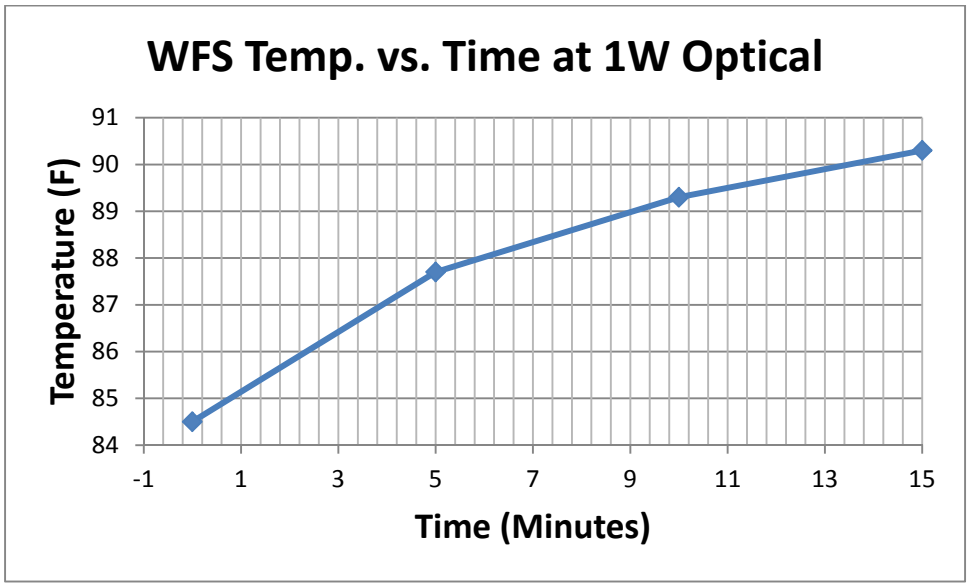

Figure 6 Diode retaining ring temperature vs time.

5. **WFS Detector Raw Data**

Optical Power Input (mW)	Voltage at TP1 (499V/A)	Vbias (V) TP8	Vanode (mV)	Vanode (V)
0.5	0.27	5.02	-6	-0.006
2.9	0.982	5.02	15.9	0.0159
8.3	2.99	5.02	50	0.05
14.5	5	5.02	87	0.087
29	10.1	5.02	173	0.173
31	11.1	5.02	190	0.19
31.6	11.2	5.02	244	0.244
51.3	11	5.02	1750	1.75
102	11	5.02	1970	1.97
205	11	5.02	2140	2.14
305	10.9	5.02	2270	2.27
502	10.9	5.02	2420	2.42
1010	10.9	5.02	2680	2.68

6. **Conclusion**

The RFPD element of both and LSC and WFS style RFPD was exposed to 1 watt of optical power for a period of 15 minutes each. The temperature of the retaining ring increased by less than 10 degrees C for both units. The thermal resistance of the diode element to case for the LSC diode is 20 C/W. After the test was concluded, a visual inspection of the diode elements did not reveal any damage.

The DC photocurrent read-back circuitry saturated at approximately 200mW for the LSC detector and 32mW for the WFS detector of incident light, but no lasting effects were noted in the circuit response or dark noise.