LadyBug Power Monitor - Attenuators
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1 Introduction

This document shows reference values and rough measurements of the attenuators attached to the LadyBug power sensors placed at the Gregorian Dome (GD) and Carriage House (CH). These attenuators are connected to the directional couplers attached to the waveguide. We are considering the following attenuation values for the directional couplers, GD: $46.7dB$ (measured at AO, Aug 2004) and CH: $50.00dB$ (reference value).

2 Previous Measurements

The attenuators were measured individually, except one, before installing the boxes at the platform during Summer 2010. Each attenuator has a label attached to it, and shows the values shown in Figures 1 and 2. There is not label for the $30dB$ attenuator for the Carriage House, but we expect an attenuation close to this value. According to these numbers, we expect total attenuation of $43.00dB$ and $39.95dB$ for GD and CH, respectively.

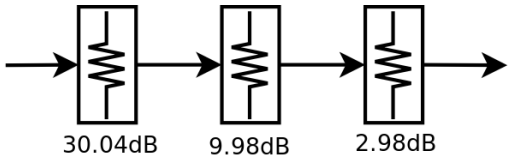

Figure 1: Gregorian Dome Attenuators.

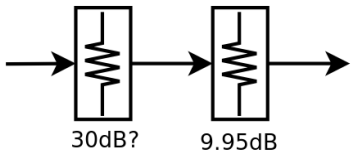

Figure 2: Carriage House Attenuators.

3 Total Attenuation

We measured (3 Feb, 2012, 4:00pm) the total attenuation of the circuits of Figures 1 and 2, applying a $430MHz$ at $10.47dBm$ signal and taking the measurements at the end of the attenuators. All these measurements were taken with the Rohde & Schwarz FSH6 Handheld Spectrum Analyzer with the R&S FSH-Z1 Power Sensor accessory.

We got $-32.65dBm$ at the end of the GD attenuators, so it give us $43.12dB$ attenuation, pretty close to the $43.00dB$ of the previous section. If we add this to the directional coupler attenuation, we will get $89.82dB$ total. We are correcting in the LabVIEW application (datalogger) for $89.80dB$.

We measured $-29.54dBm$ for CH, that give us $40.01dB$ total attenuation. Pretty close to the $39.95dB$ reference value. The measurement, plus the directional coupler reference value, gives $90.01dB$ total attenuation. We are using $90.02dB$ in the LabVIEW application.

4 Datalogger Power Measurements

The LabVIEW application shows the peak power in kiloWatts (kW). This is the default configuration, but different units can be selected (e.g. dBm).

We applied a known signal ($430MHz$ @ $5.06dBm$) to the combination of attenuators (except directional coupler) and LadyBug sensors. We measured the peak power in kW using the LabVIEW application, and calculated the equivalent power value in dBm applied to first attenuator. We expect these results close to $5.06dBm$ (R&S FSH6 measurement). The measurements were taken on Feb 6, 2012 around 11:00am.

We measured $0.1646kW$ for GD, this is equivalent to $52.16dBm$[1]. We are adding $89.80dB$ in LabVIEW, so this is $-37.64dBm$ at the sensor. We measured $43.12dB$ for the three attenuators, therefore it is $5.48dBm$ at the first attenuator ($30.04dB$). This value is pretty close to the expected $5.06dBm$.

We did the same procedure for the CH box. The LabVIEW display showed $0.3412kW$, it is $55.33dBm$. We are correcting for $90.02dB$ in LabVIEW, so at the sensor we have $-34.69dBm$. Adding the attenuators measurement, $40.01dB$, we have $5.32dBm$ at the first attenuator ($30dB$). This is also very close to the applied power.

5 Conclusion

There is a slightly difference between the previous measurements of the attenuators in 2010, and the total attenuation measured during this exercise. We got $0.12dB$ and $0.06dB$ difference for GD and CH, respectively.

The total attenuation values - including directional couplers - used in LabVIEW, match with the measurements and reference values cited in this document. The difference between these values is $0.02dB$ and $0.01dB$ for GD and CH, respectively.

We got differences in the last measurements - calculated

[1] $P_{dBm} = 10log_{10}(P_{mW}/1mW)$

power at the first attenuator - of $0.42dB$ and $0.26dB$ for GD and CH, respectively. This is not a dramatic difference, but it is required a calibration procedure in order to reduce the uncertainty. This could be caused by differences between instrument readings (offsets?, calibration?), and connectors coupling.

Just for information purposes, on Jan 2010 we compared the LadyBug sensors available at AO with one of our Agilent E4418B power meters. You can see the results in Table 1. The sensors installed at the platform are the LB480A (pulse profiling sensors); GD: S/N 98415; CH: S/N 97404.

Source (dBm)	LadyBug Sensors (dBm)				Ref. (dBm)
Agilent N5181A	LB479A		LB480A		Agilent E4418B
Serial Number	97400	97401	97404	98415	
-60.00	-60.18	-60.23	-60.50	-59.95	-60.30
-30.00	-30.05	-30.04	-30.10	-30.00	-29.96
-10.00	-10.05	-9.94	-9.98	-9.91	-10.00
-6.00	-6.06	-5.97	-6.00	-5.93	-6.03
-3.00	-3.04	-2.95	-2.99	-2.93	-3.02
0.00	-0.07	0.04	0.00	0.06	-0.04
3.00	2.99	3.09	3.06	3.13	2.98
6.00	6.08	6.16	6.15	6.21	5.98
10.00	9.94	10.03	10.05	10.12	9.99

Table 1: LadyBug Sensors comparison, Jan 20, 2010.

We used the Agilent N5181A to generate a $430MHz$ at different power levels from $-60dBm$ to $10dBm$. The LadyBug sensor limits are from $-60dBm$ to $20dBm$. All the measurements were taken with 100 averages in all the instruments.

Figure 3 shows the linear regression between the LB480A sensors and the Agilent E4418B power meter. Both sensors show a good correlations along the scale, and just $0.12dB$ and $0.06dB$ offset for GD and CH, respectively. It should be noted that we do not know anything about the calibration status if the E4418B.

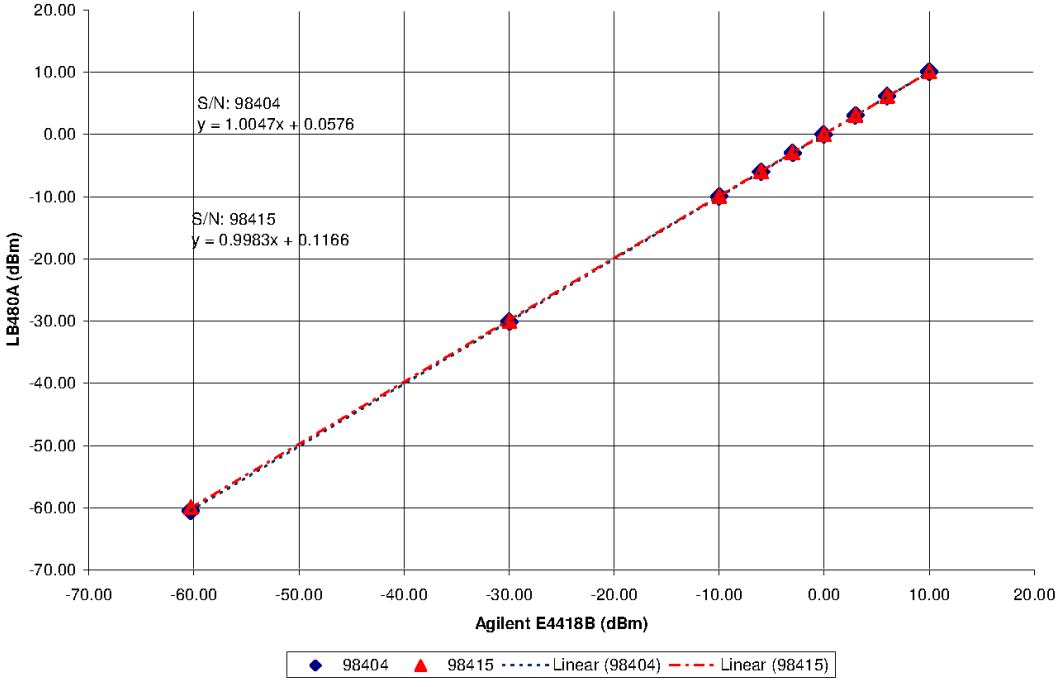

Figure 3: LadyBug Sensors plot.