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LIGO-E1200732-v1 *LIGO* 07/30/12

Dual PD Amp Circuit Board Data Summary and Information

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# Introduction

This document contains information about the Dual PD Amp circuit board proto-type that was put together by Alexa. Ultimately, five of these boards will be made and placed inside the ALS Fiber Distribution box (<wiki>).

\*\*IMPORTANT:

1. I switched the 33pF capacitors to 27pF capacitors so that the cut-off points at the transfer functions were all around 6KHz.
2. Eight 10K resistors need to be switched from 1206 to 0805 size resistors (green color).
3. C4 was left out it since it did not improve the noise significantly.
4. Switched U5A to OP284 (ADA4075 kept over heating).
5. I would recommend collecting shot noise data with a better source.

# Data

1. **Transfer Function:**

*Board Side B:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DO** | **D1** | **kHz (knee)** | **~ Max dB** | **.78D file** |
| 0 | 0 | 6.71 | 6 | SRS001 |
| 1 | 0 | 5.98 | 16 | SRS002 |
| 1 | 1 | 5.98 | 26 | SRS012 |
| 0 | 1 | 5.98 | 36 | SRS011 |

*Board Side A:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DO** | **D1** | **kHz (knee)** | **~ Max dB** | **.78D file** |
| 0 | 0 | 6.71 | 6 | SRS005 |
| 1 | 0 | 5.98 | 16 | SRS006 |
| 1 | 1 | 5.98 | 26 | SRS010 |
| 0 | 1 | 5.98 | 36 | SRS009 |

Note: All files are saved under Transfer Function folder (there are more than those listed due to retake of some measurements). The matlab file is called TF.m. The following command line was used to convert floppy disk files into .mat files: /Omat /Cx,mag,p /UdB,deg /”File location”\\*.78D.

1. **Electronic Noise Signal:**

*Board Side B:*

|  |  |  |  |
| --- | --- | --- | --- |
| **DO** | **D1** | **Freq Span** | **.78D file** |
| 0 | 0 | 102.4kHz | SRS047 |
| 0 | 0 | 12.8kHz | SRS048 |
| 0 | 0 | 1.6kHz | SRS049 |
| 0 | 0 | 200Hz | SRS050 |
| 1 | 0 | 102.4kHz | SRS051 |
| 1 | 0 | 200Hz | SRS052 |
| 1 | 1 | 102.4kHz | SRS053 |
| 1 | 1 | 200Hz | SRS054 |
| 0 | 1 | 102.4kHz | SRS055 |
| 0 | 1 | 12.8kHz | SRS056 |
| 0 | 1 | 1.6kHz | SRS057 |
| 0 | 1 | 200Hz | SRS058 |

Electric shot noise for all gains settings is approximately 60nVrms/√Hz (noise is dominated by U3).

*Board Side A (with ADA4075 op amp--faulty):*

|  |  |  |  |
| --- | --- | --- | --- |
| **DO** | **D1** | **Freq Span** | **.78D file** |
| 0 | 0 | 102.4kHz | SRS035 |
| 0 | 0 | 12.8kHz | SRS036 |
| 0 | 0 | 1.6kHz | SRS037 |
| 0 | 0 | 200Hz | SRS038 |
| 1 | 0 | 102.4kHz | SRS039 |
| 1 | 0 | 200Hz | SRS040 |
| 1 | 1 | 102.4kHz | SRS041 |
| 1 | 1 | 200Hz | SRS042 |
| 0 | 1 | 102.4kHz | SRS043 |
| 0 | 1 | 12.8kHz | SRS044 |
| 0 | 1 | 1.6kHz | SRS045 |
| 0 | 1 | 200Hz | SRS046 |

Electric shot noise for all gains settings is approximately 100nVrms/√Hz.

*Board Side A (with OP284 op amp):*

|  |  |  |  |
| --- | --- | --- | --- |
| **DO** | **D1** | **Freq Span** | **.78D file** |
| 0 | 0 | 102.4kHz | SRS084 |
| 0 | 0 | 12.8kHz | SRS085 |
| 0 | 0 | 1.6kHz | SRS086 |
| 0 | 0 | 200Hz | SRS087 |
| 1 | 0 | 102.4kHz | SRS088 |
| 1 | 0 | 200Hz | SRS089 |
| 1 | 1 | 102.4kHz | SRS090 |
| 1 | 1 | 200Hz | SRS091 |
| 0 | 1 | 102.4kHz | SRS092 |
| 0 | 1 | 12.8kHz | SRS093 |
| 0 | 1 | 1.6kHz | SRS094 |
| 0 | 1 | 200Hz | SRS095 |

Electric shot noise for all gains settings is approximately 60nVrms/√Hz (noise is dominated by U3).

Note: All files are saved under Noise Signal folder (there are more than those listed due to retake of some measurements). The matlab file is called NS.m. The following command line was used to convert floppy disk files into .mat files: /Omat /Cx,mag /Urms /”File location”\\*.78D.

1. **Shot Noise:**

*Board Side B:*

|  |  |  |  |
| --- | --- | --- | --- |
| **DO** | **D1** | **Freq Span** | **.78D file** |
| 0 | 0 | 102.4kHz | SRS062 |
| 0 | 0 | 12.8kHz | SRS063 |
| 0 | 0 | 1.6kHz | SRS065 |
| 0 | 0 | 200Hz | SRS066 |
| 1 | 0 | 102.4kHz | SRS077 |
| 1 | 0 | 12.8kHz | SRS078 |
| 1 | 0 | 200Hz | SRS068 \*not at 10V see SN.m |
| 1 | 1 | 102.4kHz | SRS070 |
| 1 | 1 | 12.8kHz | SRS071 |
| 1 | 1 | 200Hz | SRS072 |
| 0 | 1 | 102.4kHz | SRS073 |
| 0 | 1 | 12.8kHz | SRS074 |
| 0 | 1 | 1.6kHz | SRS075 |
| 0 | 1 | 200Hz | SRS076 |

With LED OFF: SRS061 (equivalents to electronic noise)

*Board Side A:*

|  |  |  |  |
| --- | --- | --- | --- |
| **DO** | **D1** | **Freq Span** | **.78D file** |
| 0 | 0 | 102.4kHz | SRS096 |
| 0 | 0 | 12.8kHz | SRS097 |
| 0 | 0 | 1.6kHz | SRS098 |
| 0 | 0 | 200Hz | SRS099 |
| 1 | 0 | 102.4kHz | SRS100 |
| 1 | 0 | 12.8kHz | SRS101 |
| 1 | 0 | 200Hz | SRS102 |
| 1 | 1 | 102.4kHz | SRS103 |
| 1 | 1 | 12.8kHz | SRS104 |
| 1 | 1 | 200Hz | SRS105 |
| 0 | 1 | 102.4kHz | SRS106 |
| 0 | 1 | 12.8kHz | SRS107 |
| 0 | 1 | 1.6kHz | SRS108 |
| 0 | 1 | 200Hz | SRS109 |

Note: All files are saved under Shot Noise folder (there are more than those listed due to retake of some measurements). The matlab file is called SN.m. The following command line was used to convert floppy disk files into .mat files: /Omat /Cx,mag /Urms /”File location”\\*.78D.

One can calculate the expected shot noise through the circuit board for each gain setting. Let V be the output voltage. For my calculations, I set V =10Volts. Let R be the resistance for each specific gain. There will be a gain of 2 from op-amp U5. Then one can calculate the voltage density (Vrms/√Hz) via equations: and , where I is the current and q is the charge of an electron. Here are my results:



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DO** | **D1** | **R(kΩ)** | **V** | **(nVrms**√**Hz)** |
| 0 | 0 | 1x2 | 10 | 80 |
| 1 | 0 | 3.16x2 | 10 | 142 |
| 1 | 1 | 10x2 | 10 | 253 |
| 0 | 1 | 31.6x2 | 10 | 449 |

1. **Optical Transfer Function.**

Using the Oz Optics laser (6), I first had to examine the modulated signal and see if it was really flat up to 100kHz. Taking, the transfer function, one can see there is a pole at 2kHz approximately.

*Modulated Laser:*

|  |  |
| --- | --- |
| **Freq. Span** | **.78D** |
| 102.4kHz | SRS110 |

*Board Side B:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DO** | **D1** | **kHz (knee)** | **~ Max dB** | **.78D file** |
| 0 | 0 | 2 | 2 | SRS111 |
| 1 | 0 | 2 | 12 | SRS112 |
| 1 | 1 | 2 | 22 | SRS113 |
| 0 | 1 | 2 | 32 | SRS114 |

*Board Side A:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DO** | **D1** | **kHz (knee)** | **~ Max dB** | **.78D file** |
| 0 | 0 | 2 | 6 | SRS115 |
| 1 | 0 | 2 | 16 | SRS116 |
| 1 | 1 | 2 | 26 | SRS117 |
| 0 | 1 | 2 | 36 | SRS118 |

Note: All files are saved under Optical Transfer Function folder. The matlab file is called OTF.m. The following command line was used to convert floppy disk files into .mat files: /Omat /Cx,mag,p /UdB,deg /”File location”\\*.78D.

Matlab script normalizes the TF from the laser and subtracts it out from the optical TF.

1. **Optical Transfer Function with 100ft cable.**

*Board Side B:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DO** | **D1** | **kHz (knee)** | **~ Max dB** | **.78D file** |
| 0 | 0 | 2 | 2 | SRS119 |
| 1 | 0 | 2 | 12 | SRS120 |
| 1 | 1 | 2 | 22 | SRS121 |
| 0 | 1 | 2 | 32 | SRS122 |

*Board Side A:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DO** | **D1** | **kHz (knee)** | **~ Max dB** | **.78D file** |
| 0 | 0 | 2 | 6 | SRS123 |
| 1 | 0 | 2 | 16 | SRS124 |
| 1 | 1 | 2 | 26 | SRS125 |
| 0 | 1 | 2 | 36 | SRS126 |

Note: All files are saved under Long Cable 🡪 Optical Transfer Function folder. The matlab file is called LCOTF.m. The following command line was used to convert floppy disk files into .mat files: /Omat /Cx,mag,p /UdB,deg /”File location”\\*.78D.

The results were very similar to those of the short cable.

1. **Shot Noise with 100ft cable (and LED as before).**

*Board Side B:*

|  |  |  |  |
| --- | --- | --- | --- |
| **DO** | **D1** | **Freq Span** | **.78D file** |
| 0 | 0 | 102.4kHz | SRS127 |
| 0 | 0 | 12.8kHz | SRS128 |
| 0 | 0 | 1.6kHz | SRS129 |
| 0 | 0 | 200Hz | SRS130 |
| 1 | 0 | 102.4kHz | SRS131 |
| 1 | 0 | 12.8kHz | SRS132 |
| 1 | 0 | 200Hz | SRS133 |
| 1 | 1 | 102.4kHz | SRS134 |
| 1 | 1 | 12.8kHz | SRS135 |
| 1 | 1 | 200Hz | SRS136 |
| 0 | 1 | 102.4kHz | SRS137 |
| 0 | 1 | 12.8kHz | SRS138 |
| 0 | 1 | 1.6kHz | SRS139 |
| 0 | 1 | 200Hz | SRS140 |

*Board Side A:*

|  |  |  |  |
| --- | --- | --- | --- |
| **DO** | **D1** | **Freq Span** | **.78D file** |
| 0 | 0 | 102.4kHz | SRS141 |
| 0 | 0 | 12.8kHz | SRS142 |
| 0 | 0 | 1.6kHz | SRS143 |
| 0 | 0 | 200Hz | SRS144 |
| 1 | 0 | 102.4kHz | SRS145 |
| 1 | 0 | 12.8kHz | SRS146 |
| 1 | 0 | 200Hz | SRS148 |
| 1 | 1 | 102.4kHz | SRS149 |
| 1 | 1 | 12.8kHz | SRS150 |
| 1 | 1 | 200Hz | 123 |
| 0 | 1 | 102.4kHz | SRS003 |
| 0 | 1 | 12.8kHz | SRS004 |
| 0 | 1 | 1.6kHz | SRS007 |
| 0 | 1 | 200Hz | SRS008 |

Note: All files are saved under Long Cable 🡪 Shot Noise folder (there are more than those listed due to retake of some measurements). The matlab file is called LCSN.m. The following command line was used to convert floppy disk files into .mat files: /Omat /Cx,mag /Urms /”File location”\\*.78D.