Light Preamp Performance Comparisons

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Following the construction of a number of different preamp designs, Justin VK7TW setup a photon test range behind his radio shack under the house. This enabled comparative signal to noise testing across a range of audio frequencies with all the preamps constructed by Justin and Rex.

Photon Test Range:
This area is a 4.5metre long by 0.75metre wide area that is fully shielded from all outside and inside light sources providing a dark test range. The idea came from Clint KA7EOI and his comparison tests between his preamp designs and the VK7MJ designed preamp which can be found at: http://ka7oei.com/optical_comms/optical_rx1.html

The transmission source is a single 3mm red diffuse lens LED running approximately 250uA current being fed via a two transistor audio preamp. Some initial testing was undertaken using a variety of PC sound card audio generator software packages and it was found that these did not output a consistent amplitude signal once they reach approximately 3-4 kHz with the amplitude dropping considerable at the higher audio frequencies and a range of digital processing spikes on the waveforms. The authors settled on using a Sabtronics function generator outputting square waves from a frequency of 270Hz through to 5kHz in the following steps: 270, 500, 1000, 1500, 2000, 2500, 3000, 4000 and 5000 hertz. This function generator gave a consistent amplitude waveform across the spectrum being used. Using Mike, VK7MJ's calibrated optical power meter the LED outputs –36.8dBW/m^2 at a distance of 21cm with no variability across the frequency range used.

The preamps are clamped at the end of the test range within alignment lines at the same level as the transmitting LED with shielded leads from the transmitter and receiver running from the test range into the shack computer and function generator.

The program used to measure the signal to noise levels was Spectran (http://digilander.libero.it/i2phd/spectran.html) PC sound card spectral analysis software. This software was configured with a 64 point moving average at a bandwidth of 1.3Hz and a sample rate of 11025Hertz. The averaging allows an accurate estimate of the noise level and the 1.3Hz bandwidth provides a measurable signal across all preamps.

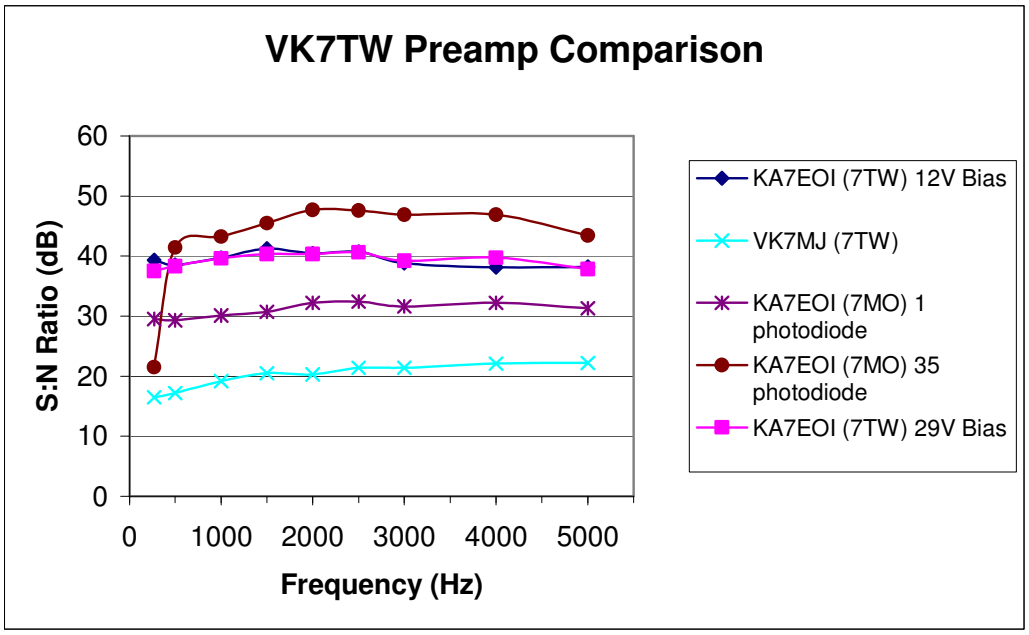
Preamp Testing:

The preamps tested on 25 October 2007 were:

1. VK7MJ design built by VK7TW using a BPW34
2. KA7EOI design built by VK7TW using 12V of reverse bias on the BPW34
3. KA7EOI design built by VK7TW using 29V of reverse bias on the BPW34
4. KA7EOI design built by VK7MO using one photodiode
5. KA7EOI design built by VK7MO using 35 photodiodes

Signal to Noise results from the testing:

HZ	VK7MJ (7TW)	KA7EOI (7TW) 12V Bias	KA7EOI (7TW) 29V Bias	KA7EOI (7MO) 1 photodiode	KA7EOI (7MO) 35 photodiode
270	16.5	39.3	37.5	29.5	21.5
500	17.2	38.5	38.3	29.3	41.4
1000	19.2	39.7	39.6	30.1	43.2
1500	20.5	41.2	40.3	30.7	45.5
2000	20.3	40.4	40.3	32.2	47.7
2500	21.4	40.7	40.6	32.4	47.6
3000	21.4	38.8	39.2	31.6	46.9
4000	22.1	38.1	39.7	32.2	46.9
5000	22.2	38.2	37.8	31.3	43.4



On 18 November 2007 a comparative field test was undertaken between the VK7MO built 35 photodiode array using the KA7EOI design behind a 320x400mm Fresnel lens and the VK7TW built one photodiode KA7EOI design in the focal point of a 320mm mirror dish via cloud bounce on a 27km path between VK7MO and VK7DY's QTHs. More information can be found at: http://reast.asn.au/optical/Field_Comparisons_VK7MO_VK7TW_VK7DY_20071118.pdf

Following azimuth and elevation alignment peaking on both receivers we got a consistent 9dB difference between the two receivers using WSJT JT65A weaksignal mode.

Conclusions:

Using the VK7MJ preamp built by VK7TW as the reference preamp the following are the measured increases in preamp performance:

- VK7MJ and KA7EOI (12V) built by VK7TW = +19.3dB
- VK7MJ and KA7EOI (29V) built by VK7TW = +19.2dB
- VK7MJ and KA7EOI one photodiode built by VK7MO = +10.9dB
- VK7MJ and KA7EOI 35 photodiode built by VK7MO = +24.8dB[1]

- The difference between the two KA7EOI one photodiode preamps is put down to VK7TW mounting the photodiode and FET in full free air and using LM833 low noise op amps in his design. This has resulted in an +8.2dB increase in preamp performance.

- All preamps gave relatively flat response with the significant drop on the 35 photodiode preamp being attributed to a 300Hz highpass filter to try and cut down the third harmonic of the 100Hz light pollution.

- The 35 photodiode array gives on average a 24.8dB higher signal than the VK7MJ design and on average a 5.5dB higher signal than the KA7EOI preamp built by VK7TW.

- No discernable difference across the spectrum between the 12v and 29v reverse biased photodiodes. KA7EOI's results show that there is a 1-3dB increase in the signal level at the higher frequencies (3, 4 & 5kHz) with higher reverse bias with a BPW34 photodiode. We have not been able to reproduce this.

[1] Removing the 270Hz result from the average results in an extra 2.2dB.