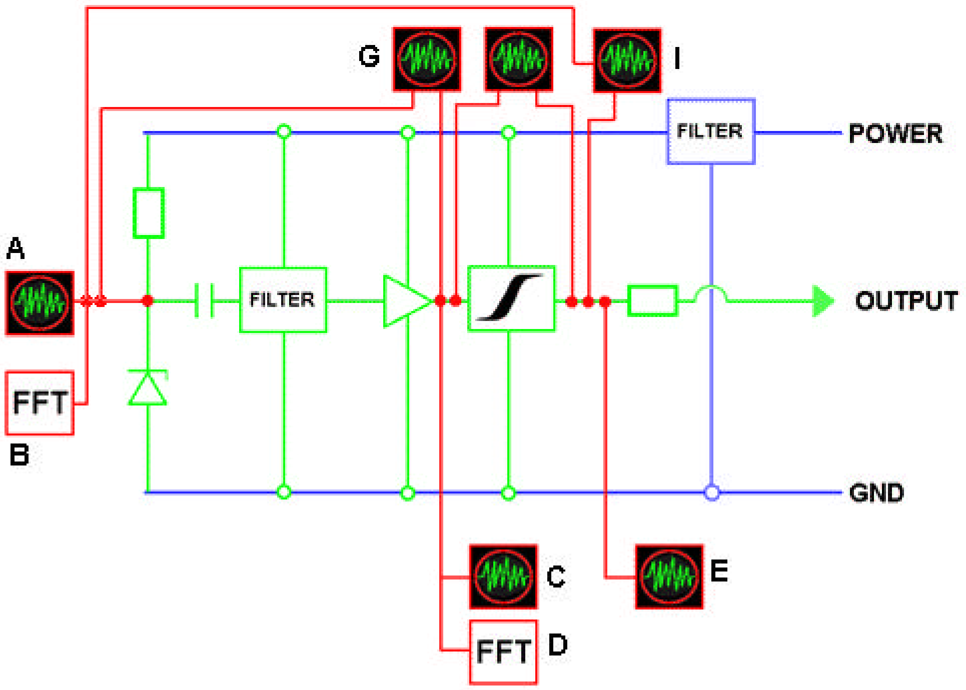
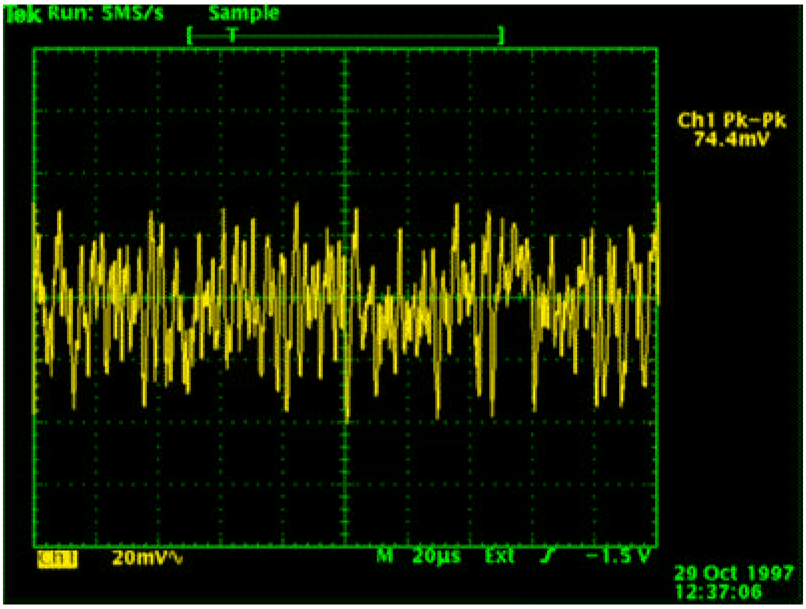
Electrical Measurements of the SG100 circuit

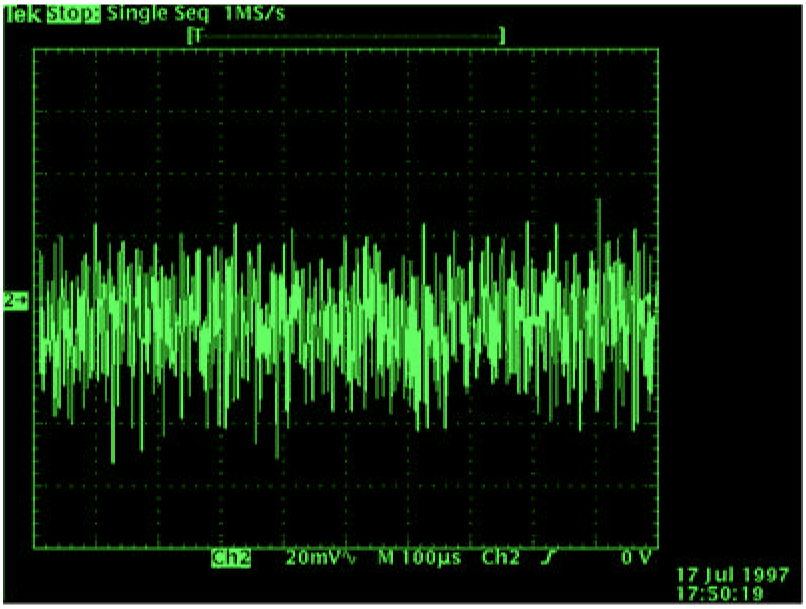
A schematic diagram of the SG100 circuit is displayed below. To the left we find the diode where the noise originates. To the right is the SG100 output. You may click on the oscilloscope icons to obtain a graph of the signal. Power spectra of the frequencies of the signal may be obtained by the FFT icons.



A.)

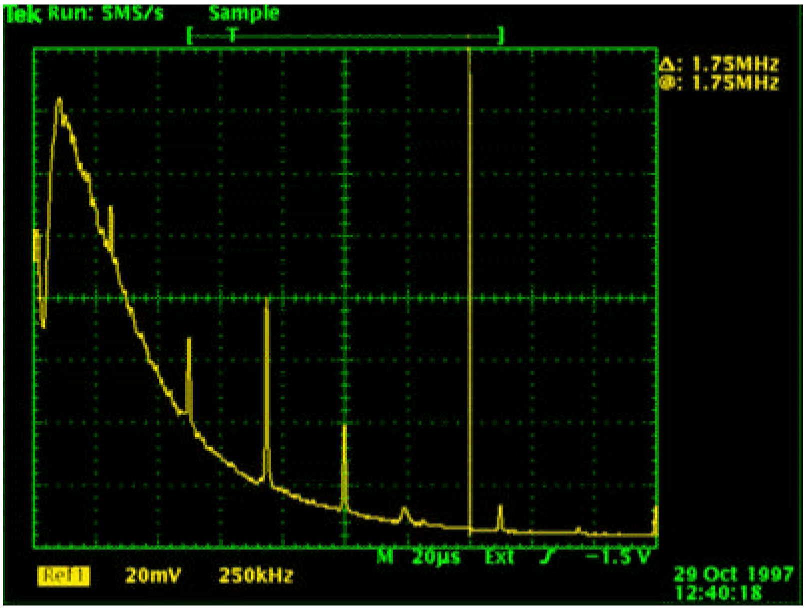


This is a measurement of the analog noise from the Zeener diode. At 20 us/div we have two bits/div at 100,000 baud. The picture displays two bytes.



In this picture we have a time-scale of 100us/div. The picture displays the raw noise of ten consecutive bytes (at 100,000 baud).

B.)
This is the spectrum of the noise obtained from the diode.
The picture display the average power for each frequency in the output.



Note that a linear scale for both frequency and power has been used. The frequency scale is 250 kHz/div or 2.5MHz for the whole picture. The 0 kHz point is at the left side of the picture and the 2.5 MHz point is at the right side.

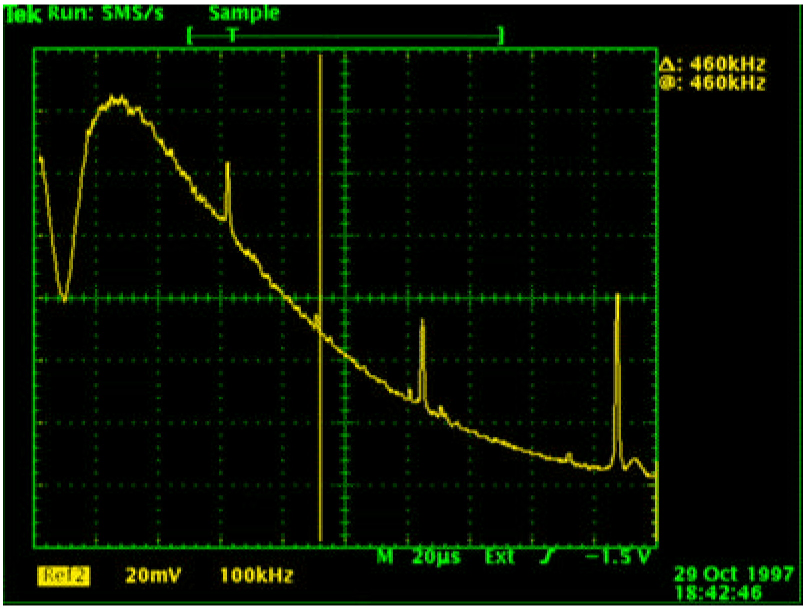
On the vertical scale we have a linear relative scale of the strength of each frequency component. The 0-level has been adjusted to the bottom of the picture.

For a noisy diode we expect one or several bands of frequencys with high output. A non-random signal would consist of one or several narrow "peaks".

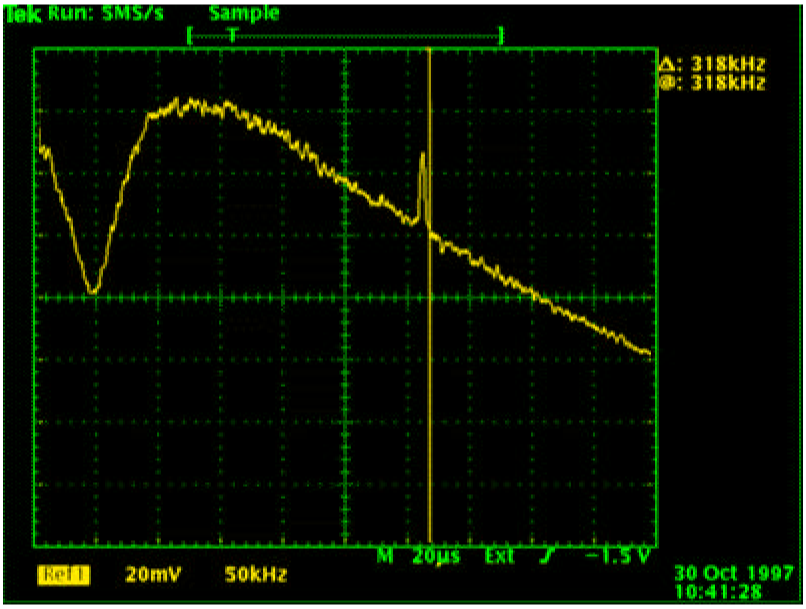
We see that we have high frequency response from 0 kHz up to (about) 630kHz. The bandwidth is (630-0)=630 kHz.

We cannot display frequency components higher than half the sampling rate. For 5 MS/s (Mega Samples/second) the maximum frequency is 2.5 MHz, as displayed in the figure. On the right side of the vertical line (at 1.75 MHz) the frequency output is very low. This is because the diode do not output any signals of these frequencys. The curve do not reach absolute zero due to round-off errors (in the sampling, etc).

We see a number of strong, very narrow, peaks. These are AM signals from broadcast radio. The radio signals is picked up in the measurement system and in the long cable from the oscilloscope to the SG100. The SG100 don´t have any shielding mounted either, during testing. It is not suprising that some disturbances are picked up in this measurement because the signal is very weak, and high amplification has to be used.

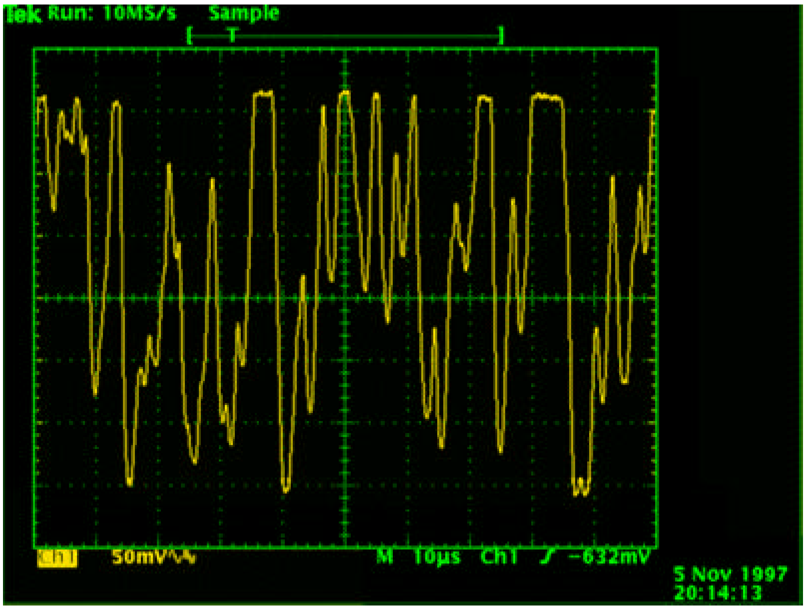


This picture is the same measurement as the one above, but with 100kHz/div. We have 1.0MHz on the whole picture. Wee see that the diode actually outputs strong signals, of all possible frequencys, up to 800kHz.

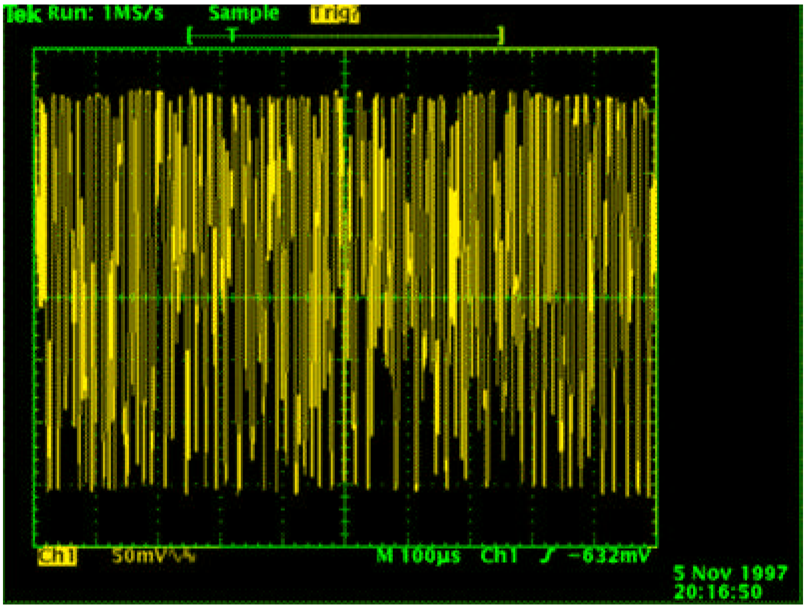


Here is the lower 500 kHz of the random signal of the diode. It is clear that, if proper amplification is used, we may actually sample the signal much faster than 100kHz. The measurement line is positioned at 318kHz, just right of one of the external signals, picked up by the measurement system. The frequency of this peak is about 312 kHz.

C.)



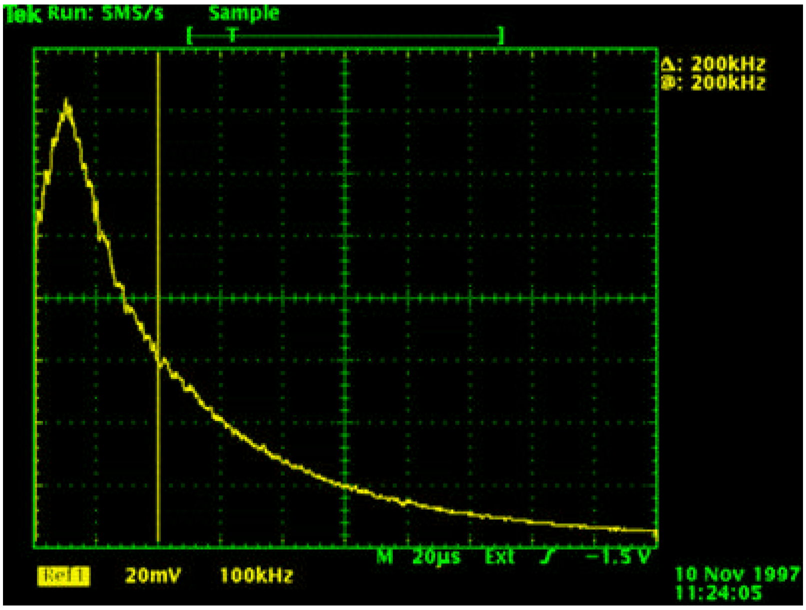
This is a picture of the output from the analog amplifier, before the signal is sampled. The time-scale is one bit/div (or one byte on picture) for the 100,000 baudrate. The output impedance is 100kOhms, at the point of measurement, and a special low capacitance probe has been used. The vertical scale is approximately 2V/div.



This is a picture of the output from the analog amplifier, before the signal is sampled. The time-scale is one byte/div (or ten bytes on picture) for the 100,000 baudrate.

D.)

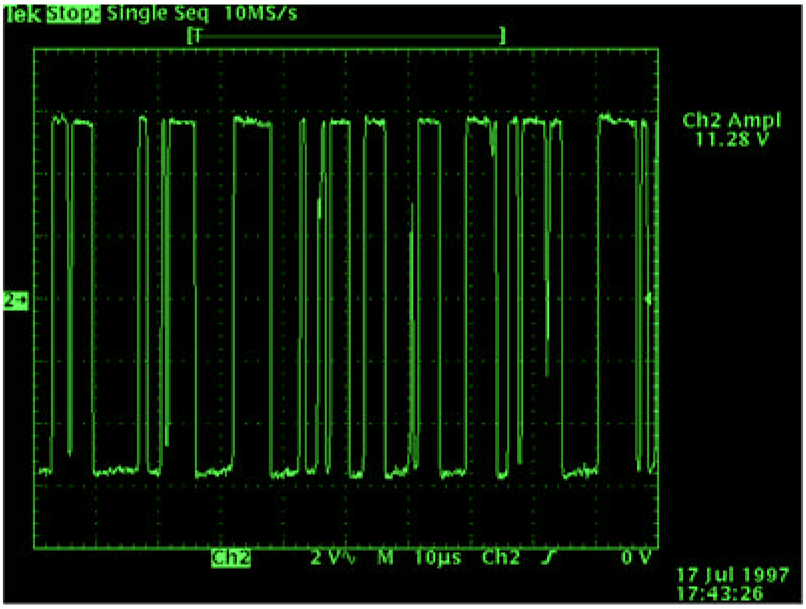
This is the spectrum of the noise obtained from the analog amplifier. The picture display the average power for each frequency in the output.



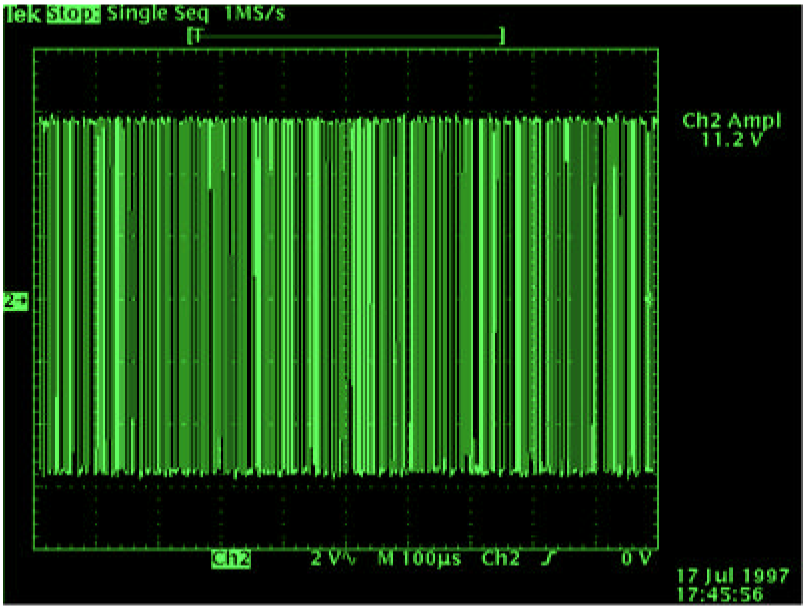
A filter (see diagram) has reduced frequencies above 100kHz, to reduce the possibility of jamming, and also to reduce the information rate of the output. It is possible, if the output looks too "noisy", that the UART of the computer refuses to read the noisy signal.

The vertical scale of picture is 1.0MHz (whole picture). The yellow line is positioned at 200 kHz.

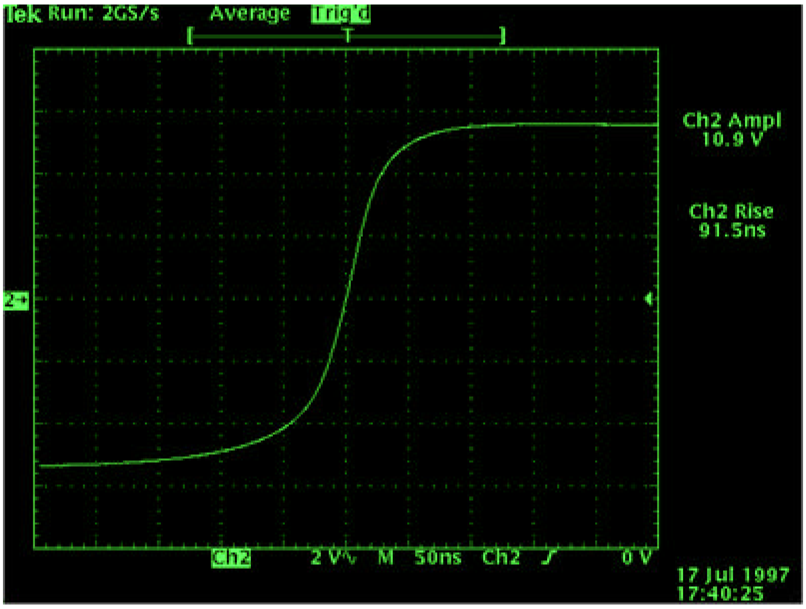
E.)



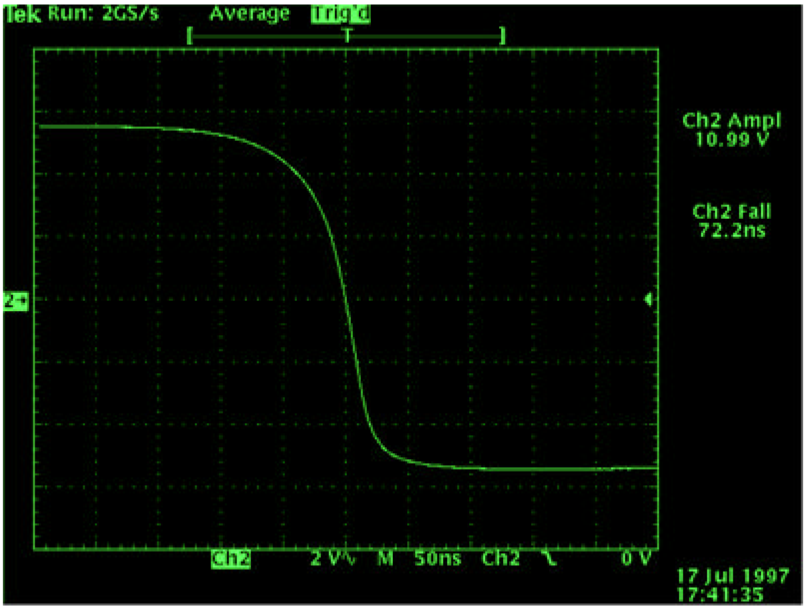
This is the output from the analog to digital converter. This picture also displays the output from the SG100 generator as observed from the computer. The UART in the computer reads the signal and assign "1" and "0" according to some (averaging) method. The time-scale is one bit/div at the maximum 100,000 baud speed.



Output from the SG100 generator with a time scale of 100us/div or one byte/div. We see the stream of ten bytes.



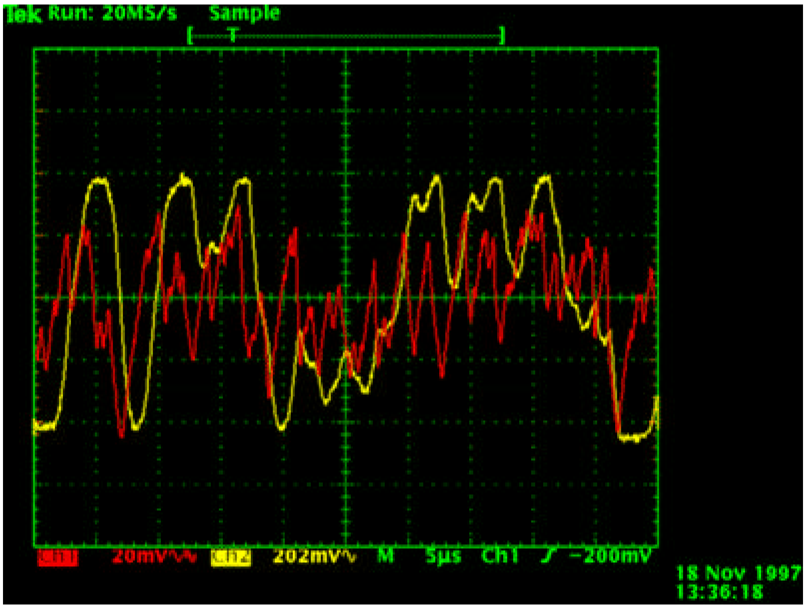
Detailed picture of the low-high transition of the digital signal. Note that no load is connected, which would make the transition much slower. It is clear that the output amplifier is very quick. Any transition time, up to 1000ns, would be acceptable.



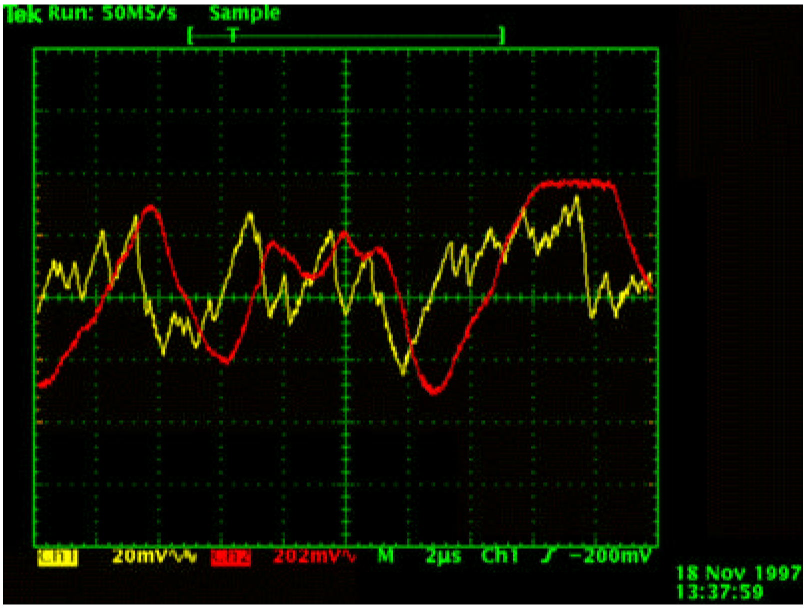
Detailed picture of the high-low transition.

G.)

This picture show a simultaneous measurement of the signal before and after the analog amplifier. The input signal, from the diode, is displayed in red colour and the output from the analog amplifier is yellow.



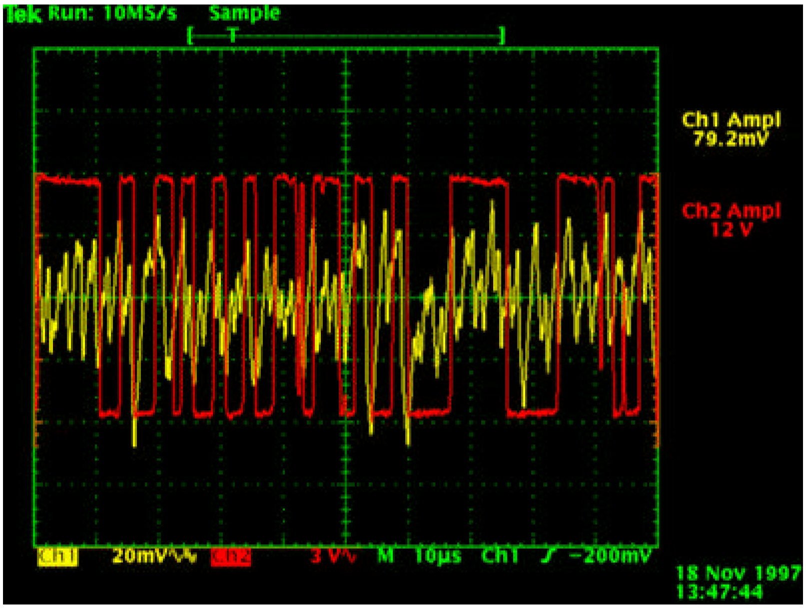
The amplitude of the input is about 0.06V (3 div). The scale of the output is about 2.9V/div (the amplitude of the analog amplifier is about 12V). The horizontal scale is 5µs/div. The picture displays 5 bits at 100,000 baud.



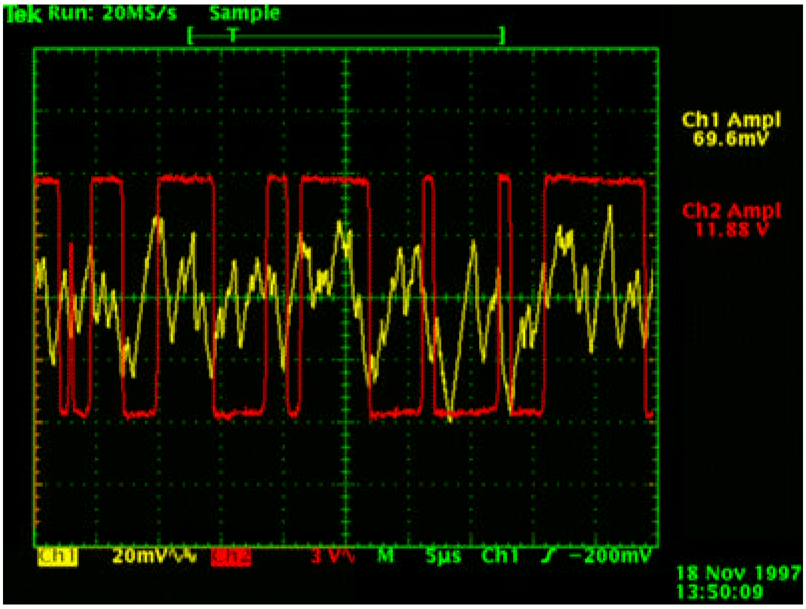
This picture have a time scale of 2µs/div. The picture displays 2 bits at the 100,000 baudrate.

I.)

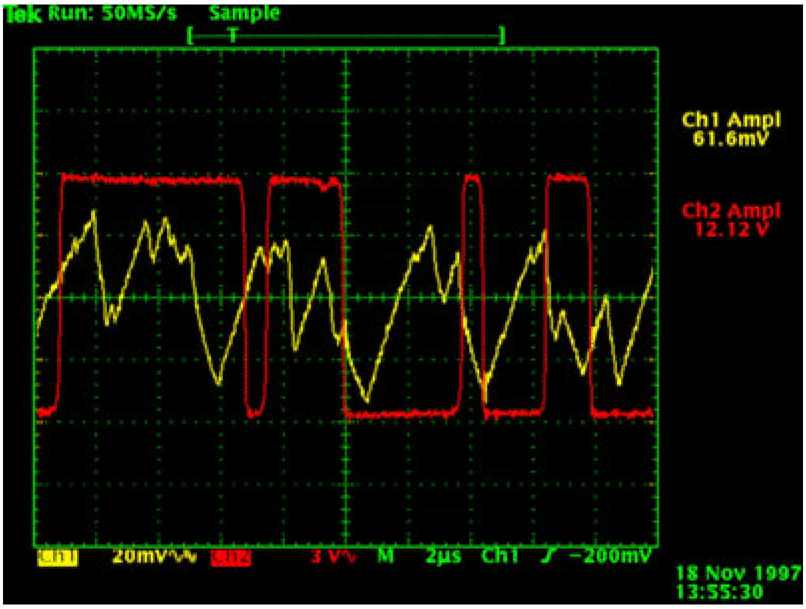
This picture show simultaneous measurements of the signal before and after processing in the analog amplifier and the analog to digital converter. The input signal, from the diode, is displayed in red colour and the output from the SG100 is yellow.



The vertical scale for the noise input (yellow) is 20mV/div, and 3V/div for the (red) output. The time scale is 10µs/div. The picture displays 10 bits of noise at 100,000 baud.



Measurement with a time scale of 5µs/div. The picture displays 5 bits of noise at 100,000 baud. Otherwise same measurement as above.



Measurement with a time scale of 2µs/div. The picture displays 2 bits of noise at 100,000 baud. Otherwise same measurement as above.

The time-delay of the amplifier and analog to digital converter may be estimated, from the picture above, to about 1 µs.