January 8, 2017

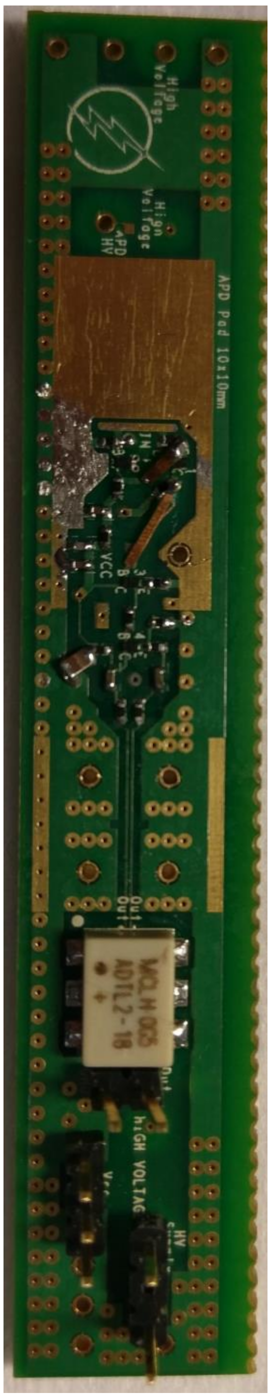
PENN Fast Amp for CMS Detector at CERN

Mitch Newcomer, Emmanuel Morales

University of Pennsylvania, HEP

BFR2

Top view of the board:



Notes

- The long strip of copper is connecting a 200 ohm resistor to the base of the third transistor. This was done to reduce stray capacitance at the collector of the second transistor by placing the 200 ohm closer to the second transistor instead.
- The short copper strip is connecting two 1pF capacitors (2pF) from the base of the second transistor to the collector of the first transistor (input transistor).
- Oscillations observed at the board's output can be eliminated by increasing the board's voltage (Vcc).

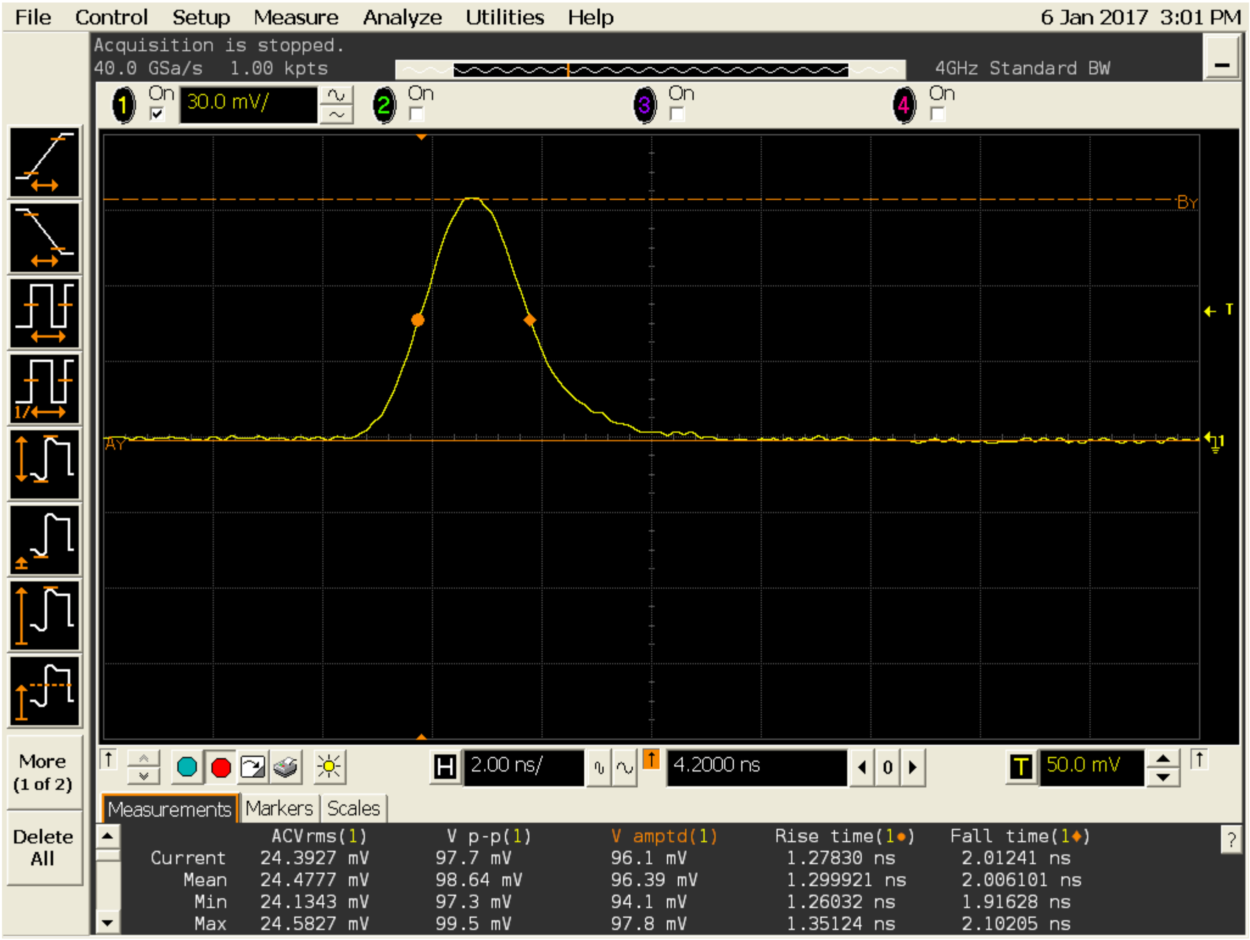
Connections

The output of the board is a two pin connector where the bottom pin is ground and the top pin is the signal out. The board's power is delivered by a three pin connector where the middle pin is Vcc and the adjacent pins are ground. For the detector's power, there is a two pin connector the size of a three pin where the leftmost pin (see image below) sets the high voltage for the detector at the other end of the board. The rightmost pin connects to the high voltage return, and is separated from the board's ground reference by a 10k ohm resistor.

LeCroy Pulser Tests

The charge being input into the board was calculated to be 120fC, and has a 1ns rise edge with a 1ns fall edge. The signal coming from the pulser goes through a 0.1uF capacitor and then a 1k ohm resistor before going into the input node. On the following images, the first two show what the output signal looks like without detector capacitance, and the rest of the images were taken after adding a 22pF capacitor from the input node to ground to simulate detector capacitance.

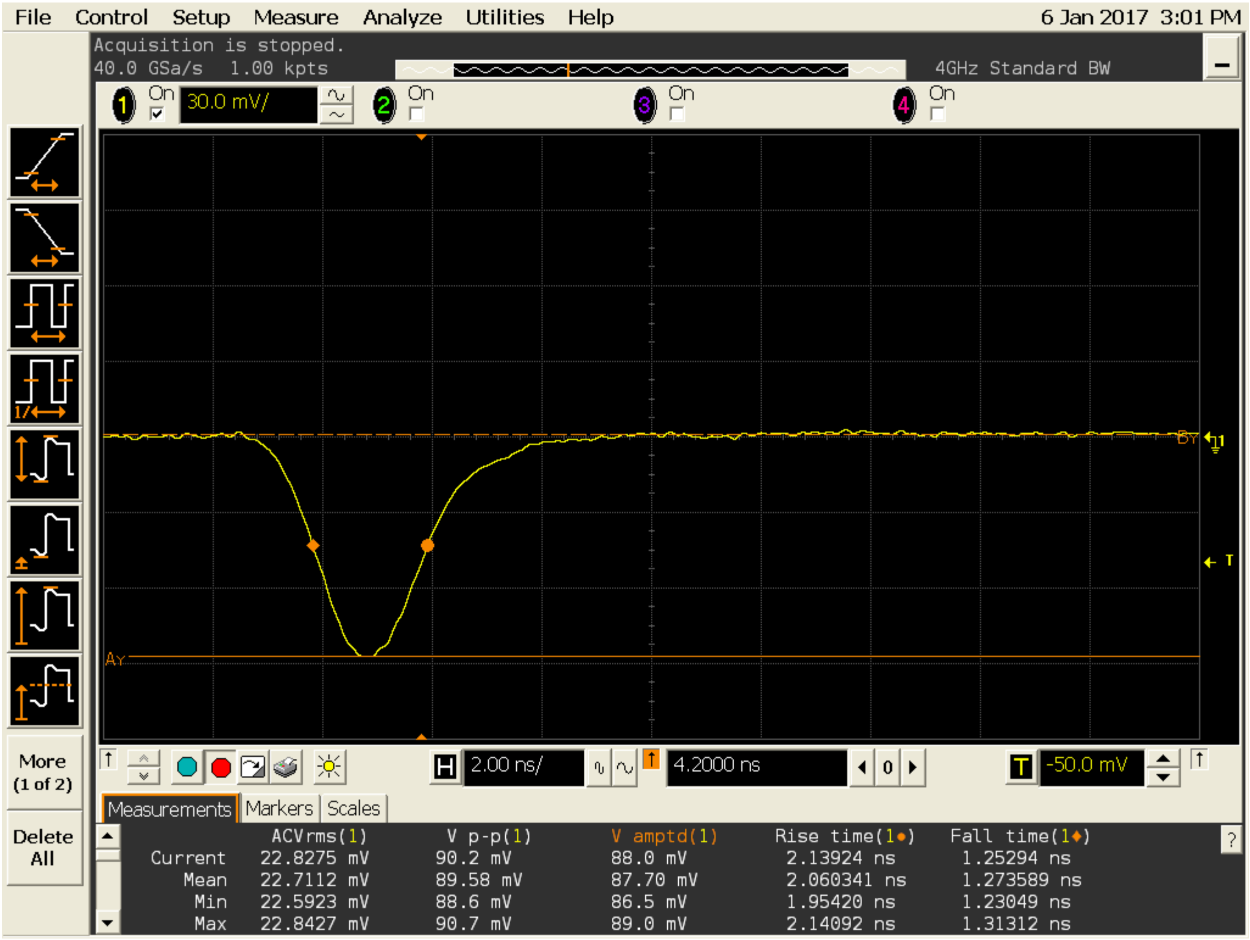
Sample 1: No Detector Capacitance



- V_{cc}: 3.8V
- $V_{amplitude}$: 96.1mV
- $T_{leading\ edge}$: 1.28ns

Increasing Vcc above 3.8V didn't change the behavior of the output signal.

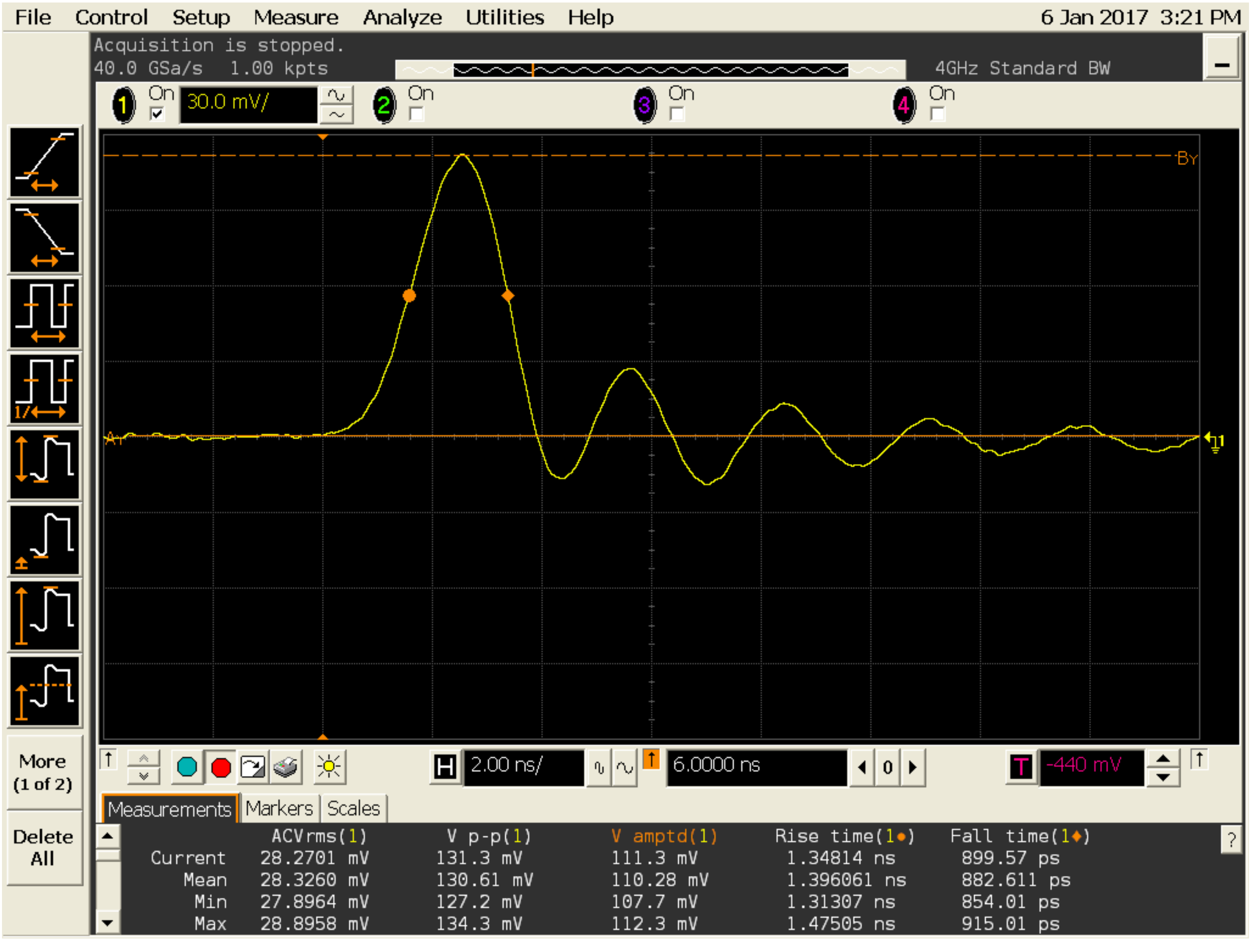
Sample 2: No Detector Capacitance



- V_{cc}: 3.8V
- $V_{amplitude}$: 88.0mV
- $T_{leading\ edge}$: 1.25ns

Increasing Vcc above 3.8V didn't change the behavior of the output signal.

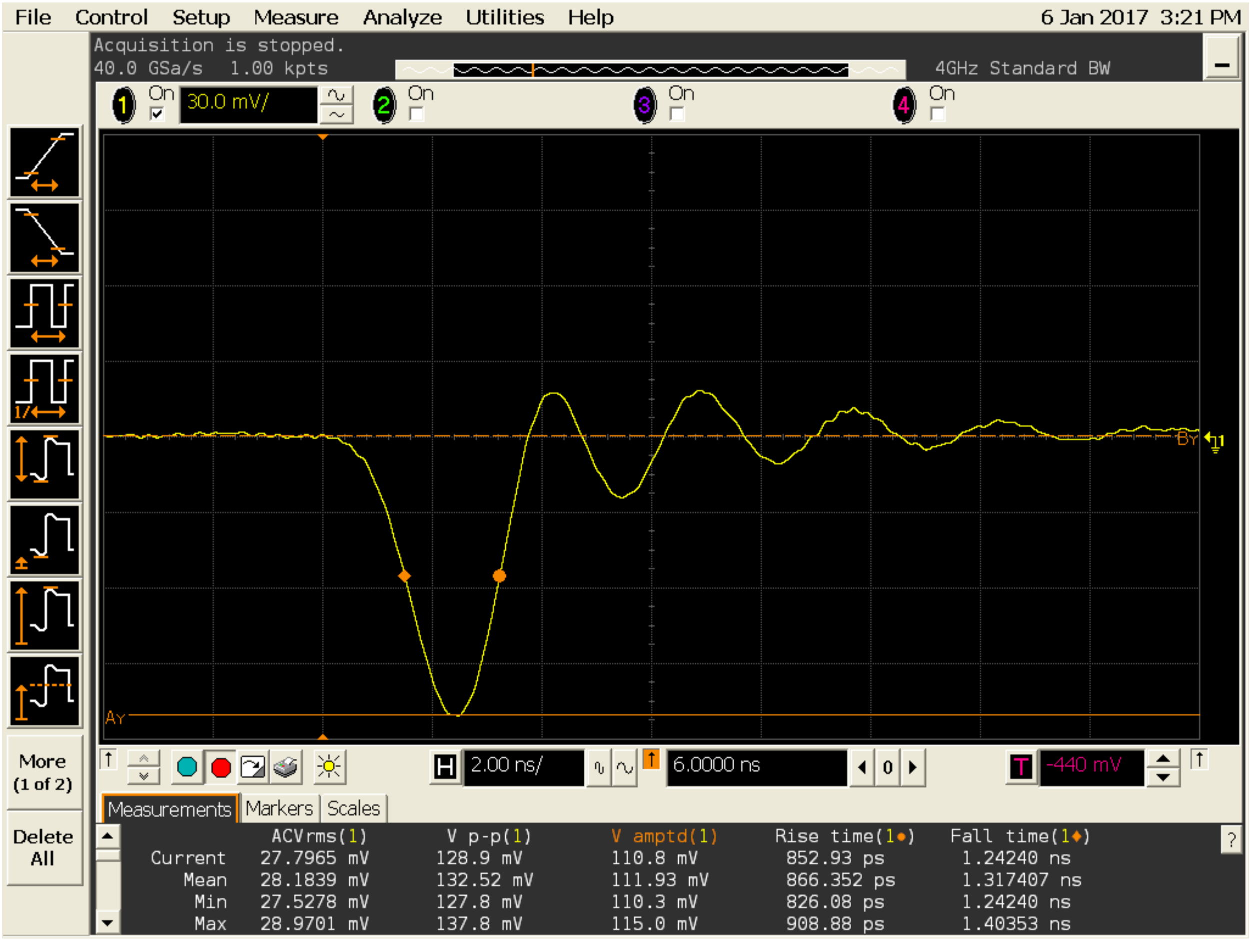
Sample 3: 22pF Detector Capacitance



- V_{cc}: 3.9V
- $V_{amplitude}$: 111mV
- $T_{leading\ edge}$: 1.35ns

Under 3.9V there are oscillations. LTspice shows that the current through the collector of the input transistor should be 11.6mA.

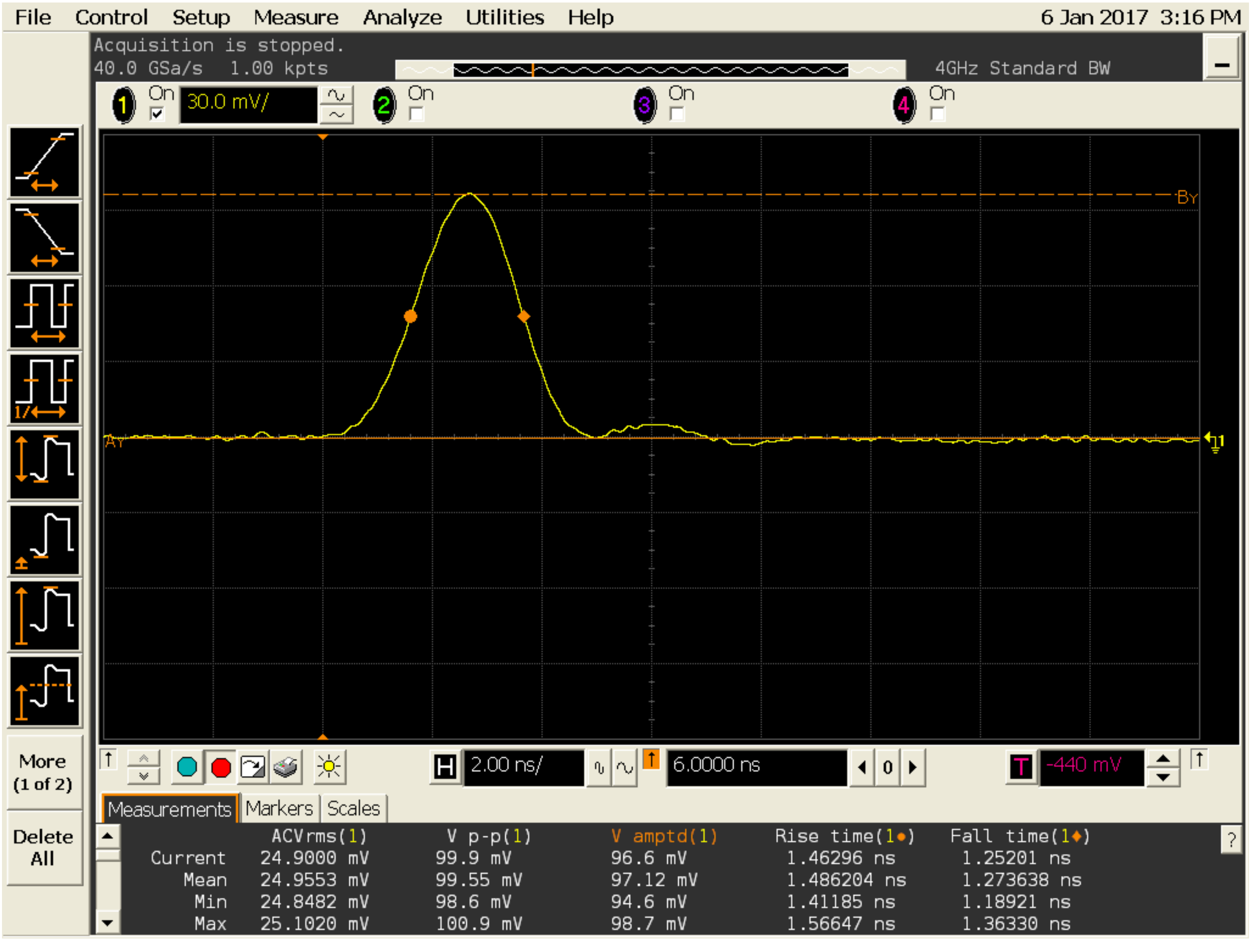
Sample 4: 22pF Detector Capacitance



- V_{cc}: 3.9V
- $V_{amplitude}$: 111mV
- $T_{leading\ edge}$: 1.24ns

Under 3.9V there are oscillations. LTspice shows that the current through the collector of the input transistor should be 11.6mA.

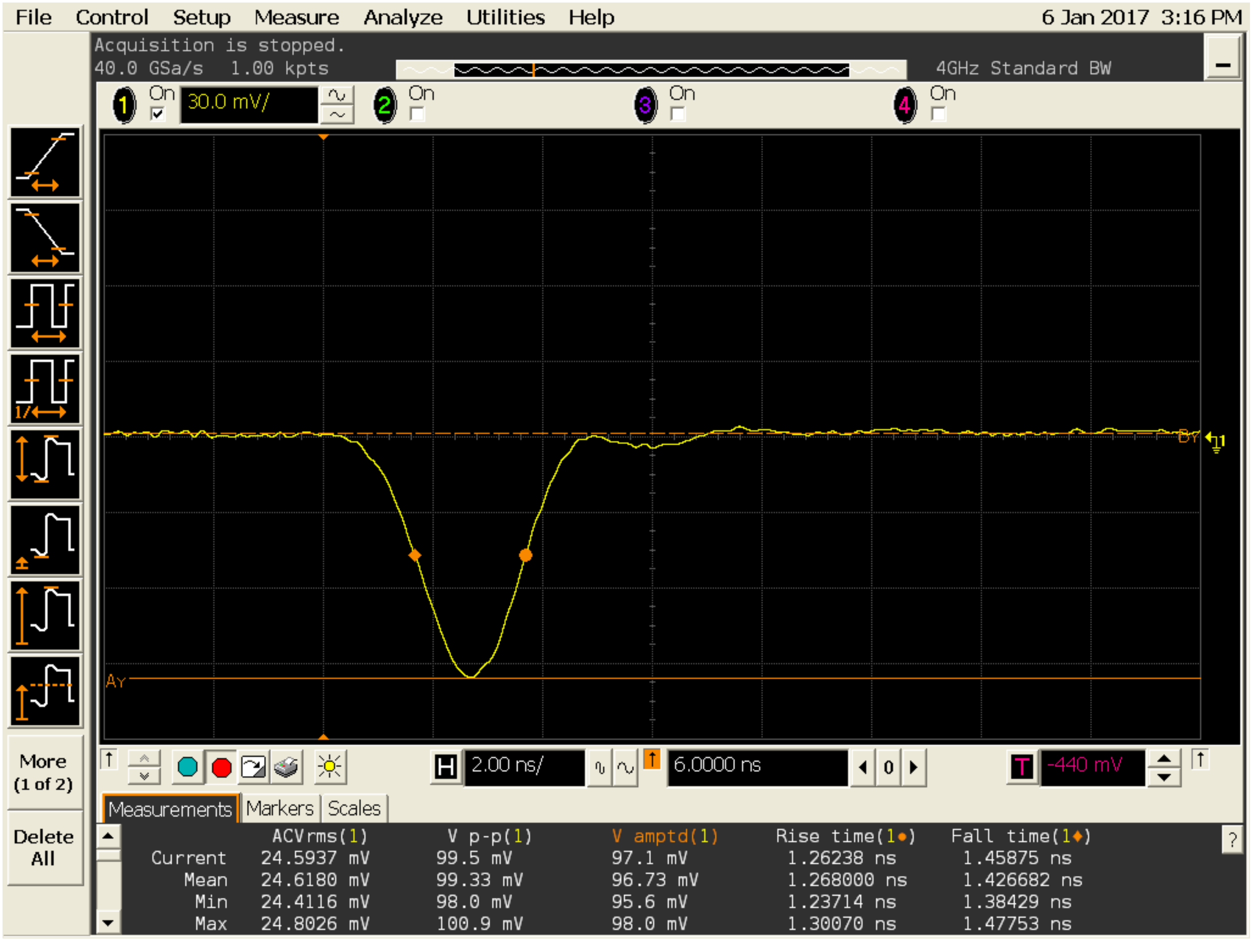
Sample 5: 22pF Detector Capacitance



- V_{cc}: 4.2V
- $V_{amplitude}$: 96.6mV
- $T_{leading\ edge}$: .1.46ns

Going over 4.2V doesn't make much difference. LTspice shows that the current through the collector of the input transistor is 13.8mA.

Sample 6: 22pF Detector Capacitance

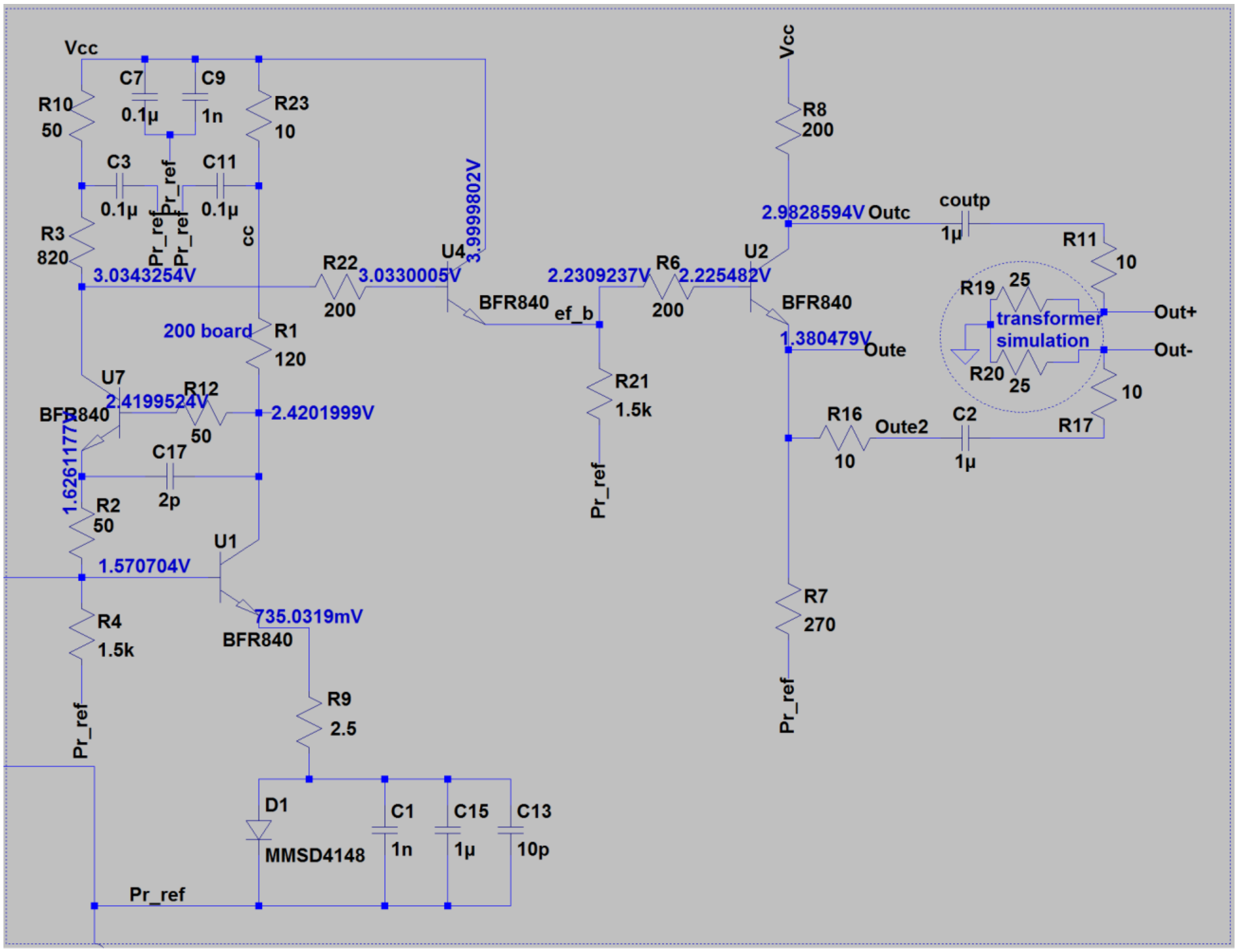


- V_{cc}: 4.2V
- $V_{amplitude}$: 97.1mV
- $T_{leading\ edge}$: 1.26ns

Going over 4.2V doesn't make much difference. LTspice shows that the current through the collector of the input transistor is 13.8mA.

January 8, 2017

LT Spice Schematic



Varying the voltage from 3.5V to 4.5V on LTspice shows the following current draw at R1:

Vcc (V)	R1 current (mA)
3.5	8.7
3.6	9.49
3.7	10.2
3.8	10.9
3.9	11.6
4.0	12.3
4.1	13.0
4.2	13.8
4.3	14.5
4.4	15.2
4.5	15.9