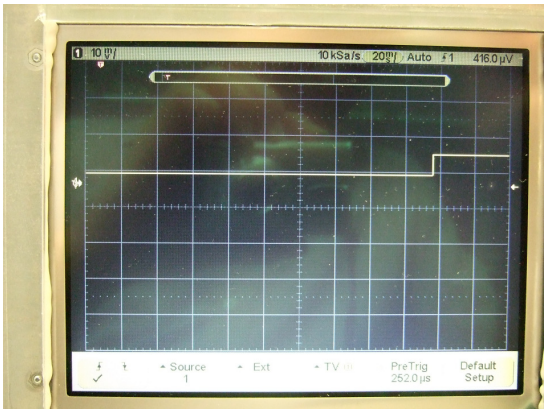
Modified Input Stage - frequency response measurement

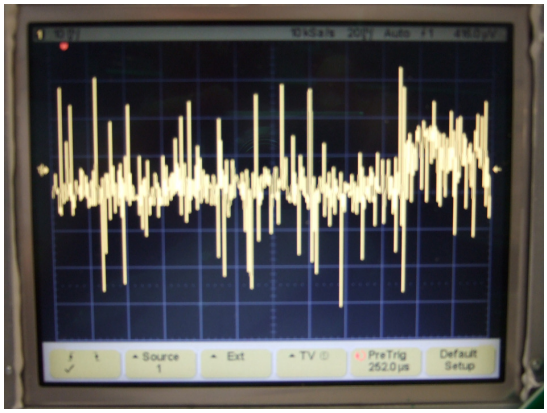
by: WMarton
DUT: Ch.1 on WELEC W2024A, FW: 1.2.OS.091

Measurement equipment: Signal Generator HP8642B, Oscilloscope TDS3034

1. HW modifications:
Considering the poor sensitivity, BW and noise performance reported by many W20xx owners and following proposals for (assumed) simple improvement, an attempt was started to replace the OpAmp in the 1st gain stage OPA656 by the higher BW device OPA657, increasing the scope sensitivity 10 times, significantly reducing the noise and improving the BW at the same time.
Following the DS description of the OPA657, changes have been done as listed below:
U3 – removed
R22 – removed
C12 – removed
R21 – replaced by 680 Ohms
R14 - replaced by 75 Ohms

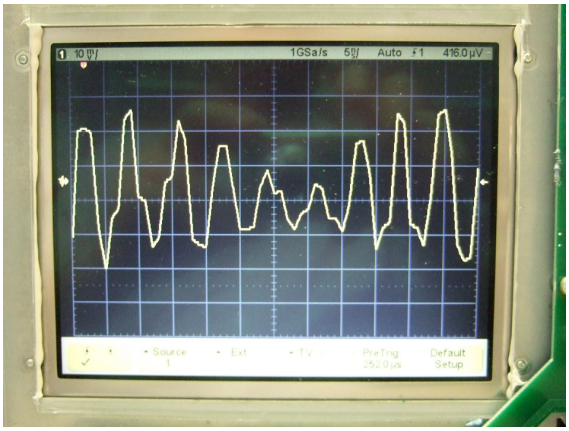
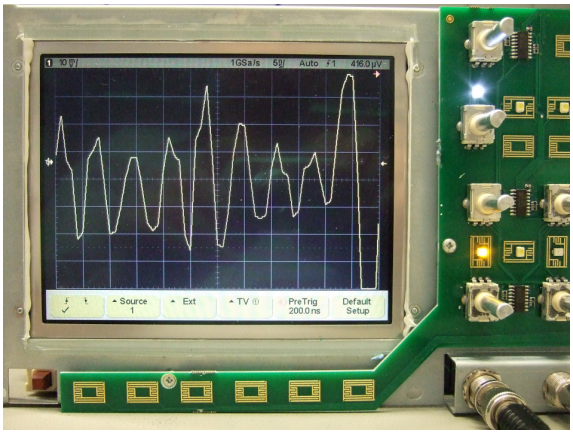
Expectation is to achieve 10x gain instead of 1x with improved frequency behavior and noise.
Having the described changes done, following was observed: - immediately after changing the time base, following picture occures for very short time (left side), followed immediately by a screen like this (right side):





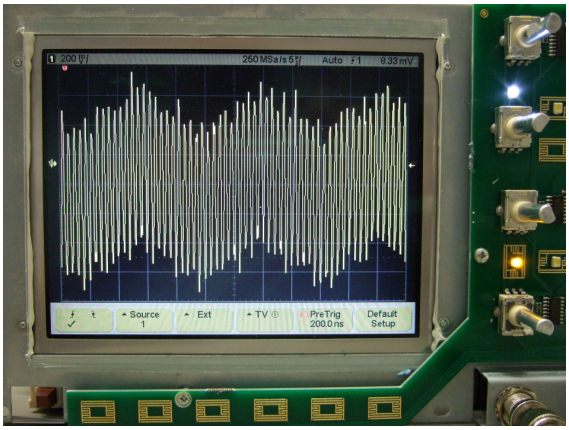
It is not evident so far, if this is result of the canges done, or if it is to be observed on every W20xx. There is a strange correlation between the step-point on the left side (which can't be measurement result) with the stepped signal on the right side. With another trials (changing the time base), the step appears on different possition, followed precisely by a signal step on the same position on the screen. Maybe further measurement results also from other W20xx owner can help to trace the reason?

Next observation was an instable trace behavior like this:

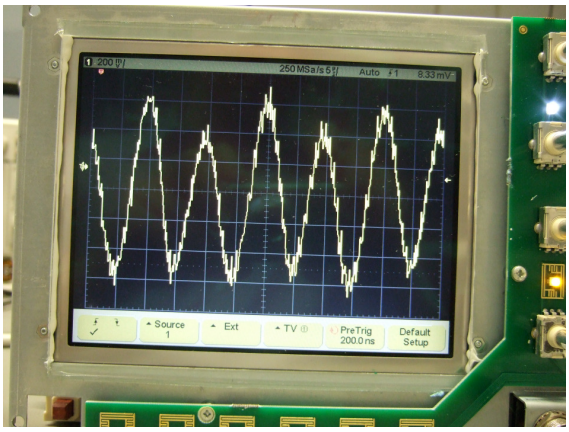



Without an input signal, there was obviously instability at ~200MHz, so I decided to disconnect the input of MAX4704 (pin12) temprary (19pF parasitic capacitance! + eventual capacitive load behind (depending on the control data)

Having done this, I still observed instability for the highest gain (corresponding now to 1mV/div). Switching to 200mV/ (in fact 20mV now), the instability seemed to disappear, but following was observed in addition:

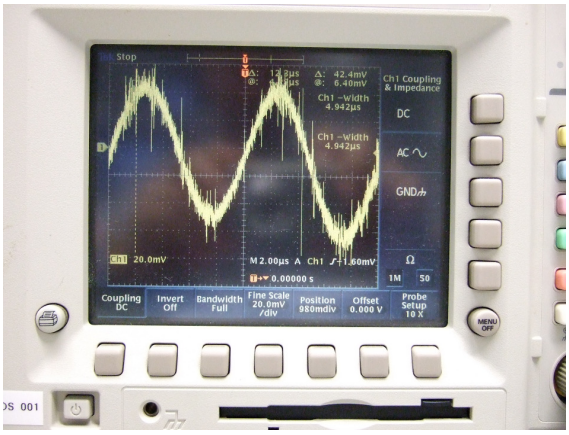


The higher frequency signal is supplied by the signal generator and not relevant in this case, but the zig-zak behavior shows a low frequency (50kHz) superimposed disturbance. André's assumption is, that it is coming from the TFT controls. Even considering the removed tin shielding during the measurement, the level of disturbance appears too high to me.
This disturbance appears on all further measurements, making a precise amplitude estimation quite difficult. So, starting with 100kHz signal at -22dBm, the amplitude level was estimated to 5,5div p-p, superimposed to 1div p-p of the mentioned 50kHz :



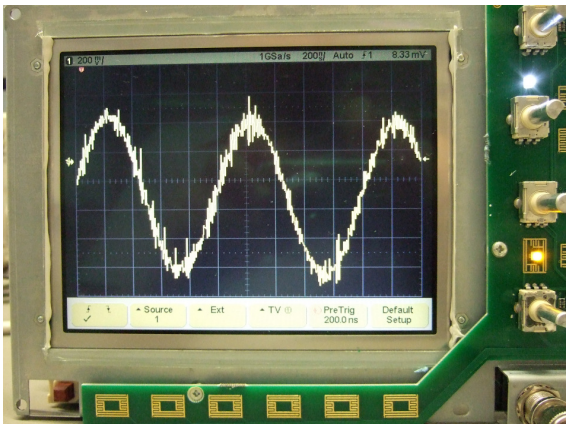
Considering the scaling of 200mV and the gain stage modification x10, we should expect a scaling of 20mV/div and consequently an input signal level ~110mVp-p.
Comparing to the supplied signal level (-22dBm ≈ 50mVp-p) please take into account, that this level is calculated for 50 Ohm load.
On the high impedance input of the W2024, this corresponds to 100mVp-p, so the level readout confirms the expected x10 gain.

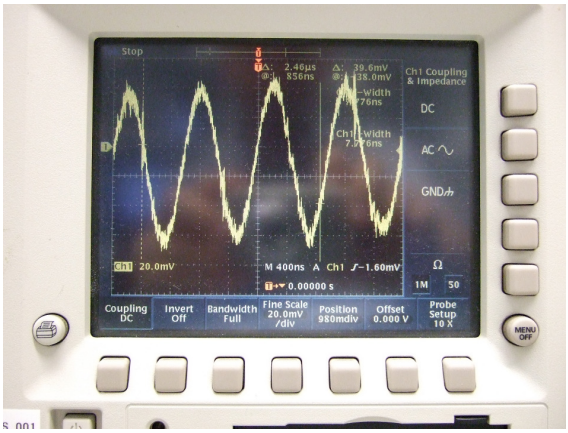
For better tracking reasons I connected an additional scope probe (TDS3034) to the input of U10 (pin8):



The amplitude at this point (~100mV readout) additionally confirms the readout on the W2024.

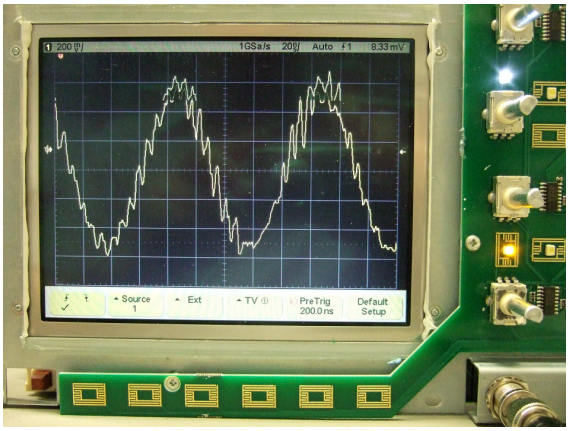
Further evaluation steps include a measurement at 1MHz (-22dBm input):

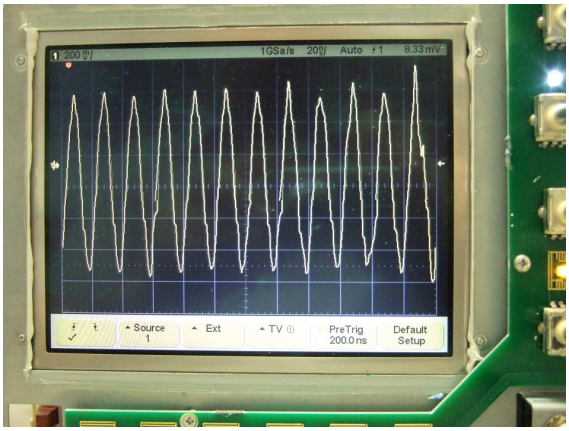




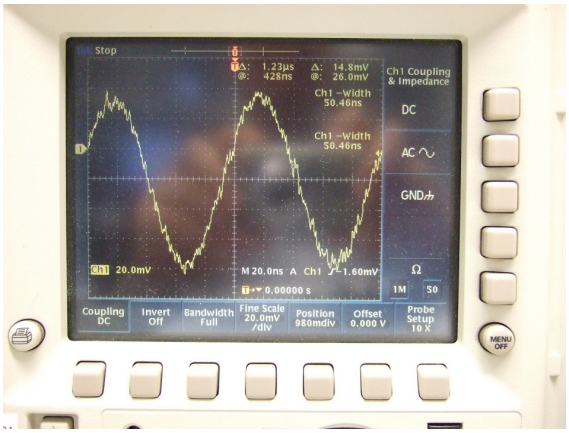
… and TDS3034 showing matching level

10 MHz at -22dBm:



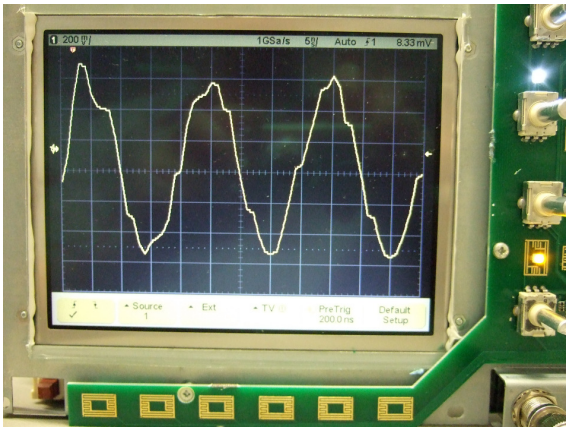


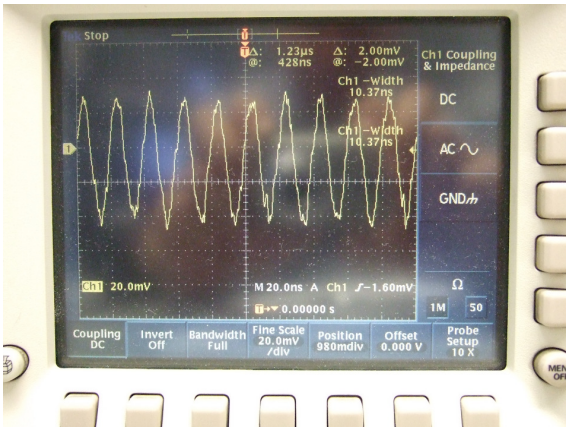
(catched just at screen refresh ☺)



… and TDS3034 showing matching level

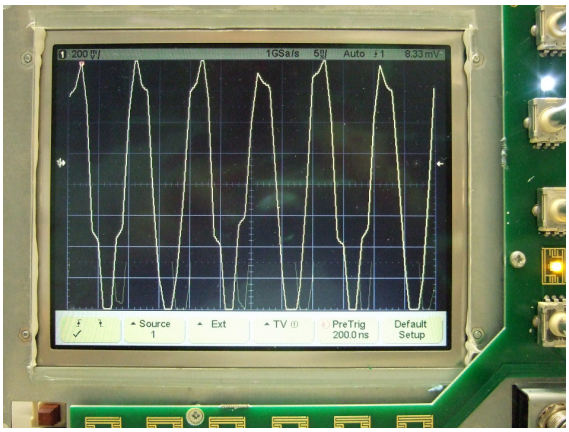
50 MHz at -22dBm:

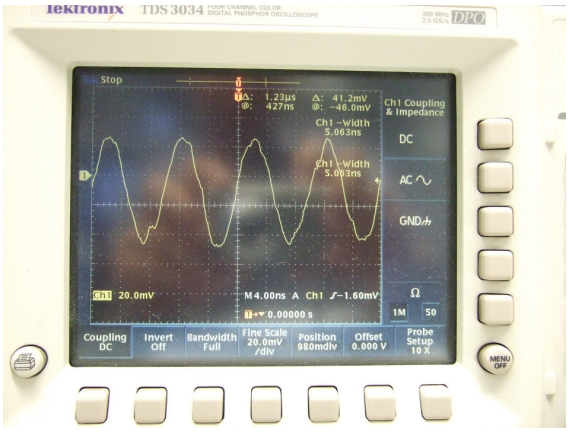




… but TDS3034 showing almost half of this level (~3,5divp-p) – a gain drop of ~4dB?

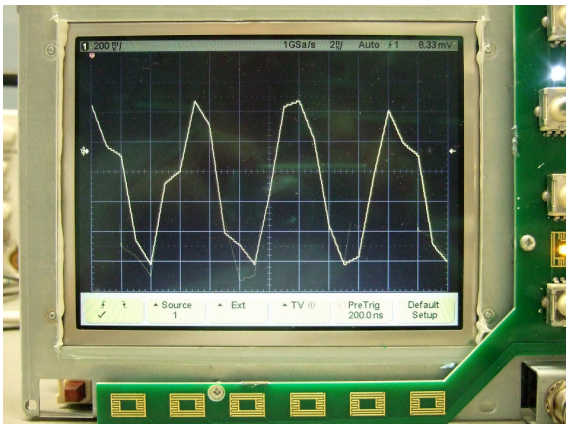
100 MHz at -22dBm:

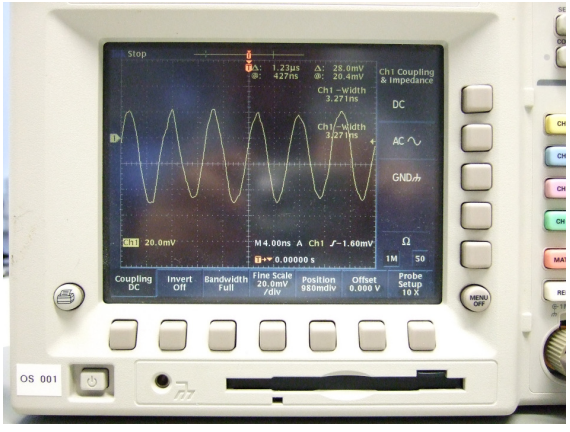




Increased level on W2024 but TDS3034 still showing ~3divp-p. – a gain drop of ~5dB?

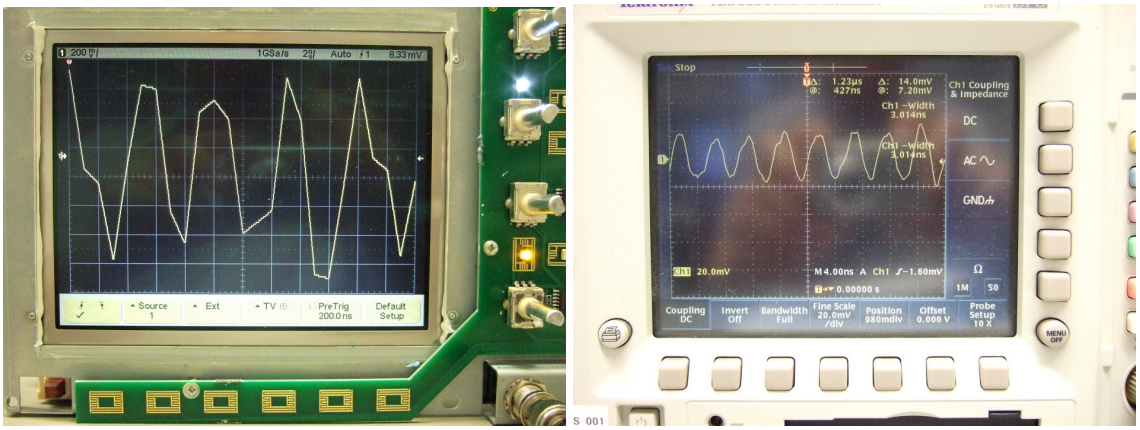
150 MHz at -19dBm:





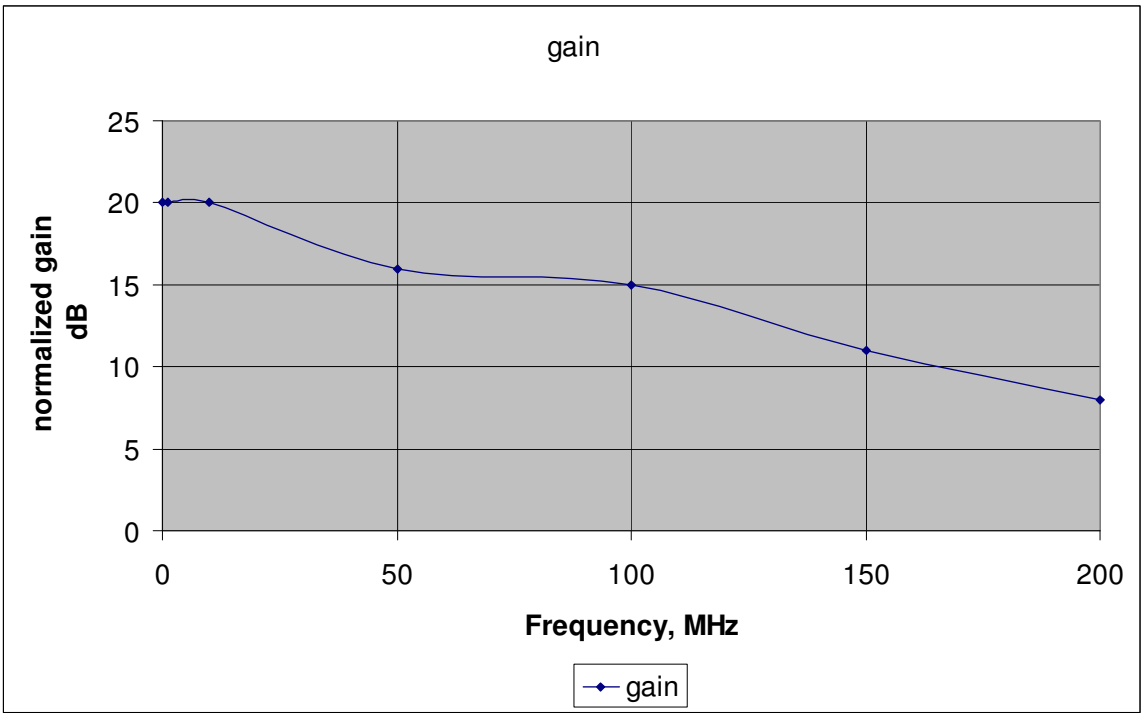
Input level increased to keep constant level on TDS3034 – a gain drop of ~9dB?

200 MHz at -19dBm:



Further gain drop OPA657 by 5dB more (-12dB total) – readout on the TDS3034, but somehow compensated on W2024

Considering all (coarse!) readouts, the gain of the OPA657 has following frequency dependence – a result, clearly needing further investigation:



Evaluating all the presented data and among many issues needing further investigation I was surprised by the nonlinear frequency response, obviously shown in the second amplifier chain of the scope (consisting of U10, U11, U12).

For this reason, a third measurement series was started as to be shown in the next report.