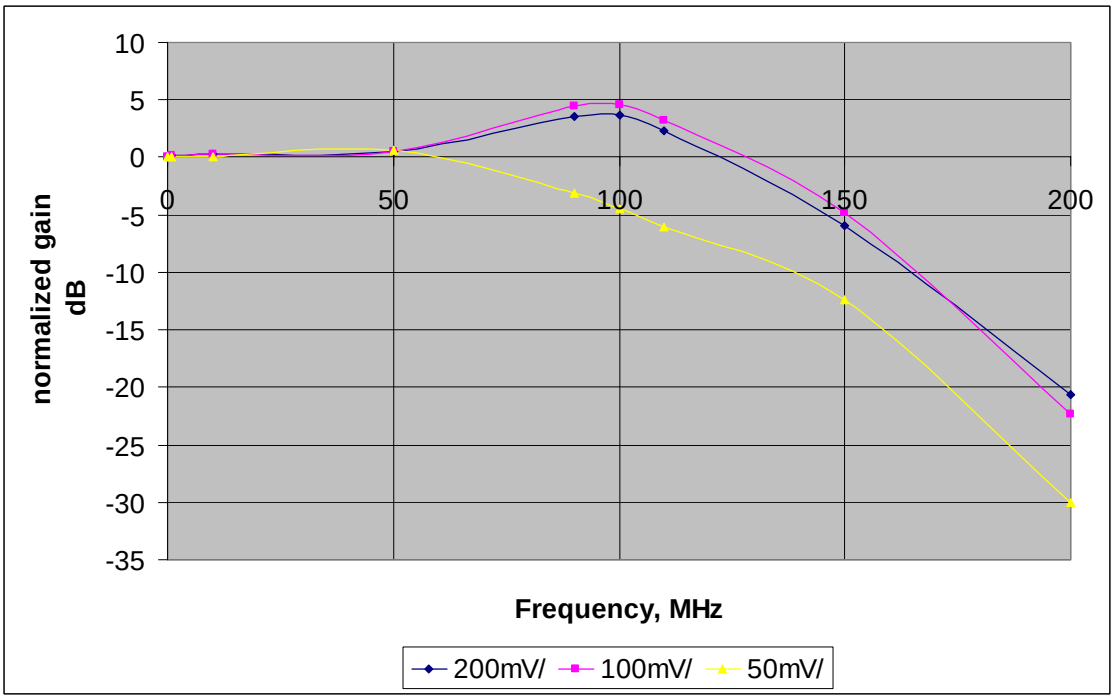
Original Input Stage - frequency response measurement

by: WMarton
DUT: Ch.1 and Ch.2 on WELEC W2024A, FW: 1.2.OS.091

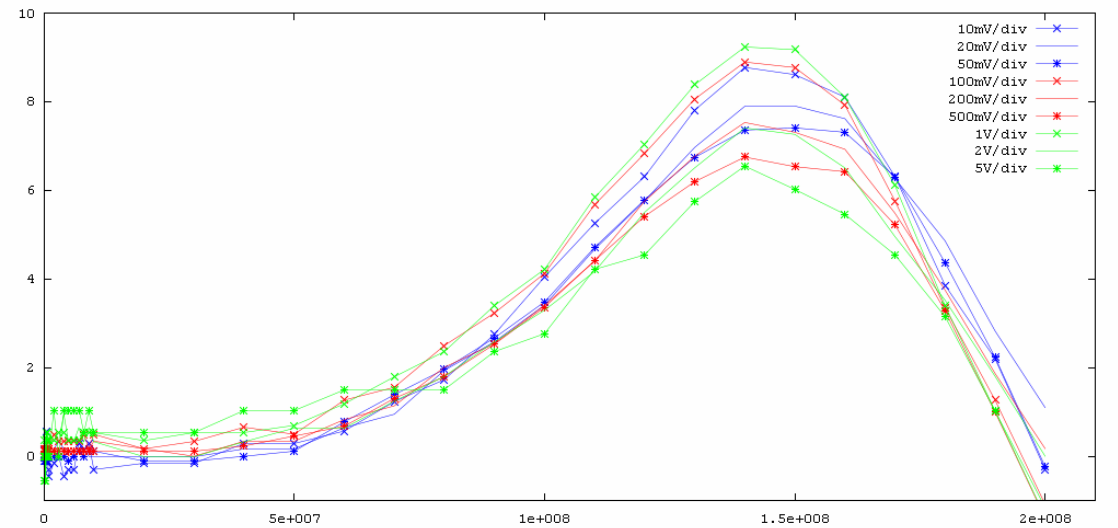
Measurement equipment: Signal Generator HP8642B

1. Original HW – frequency response
As reported earlier, the frequency response of the Ch1 input stage was measured as follows:

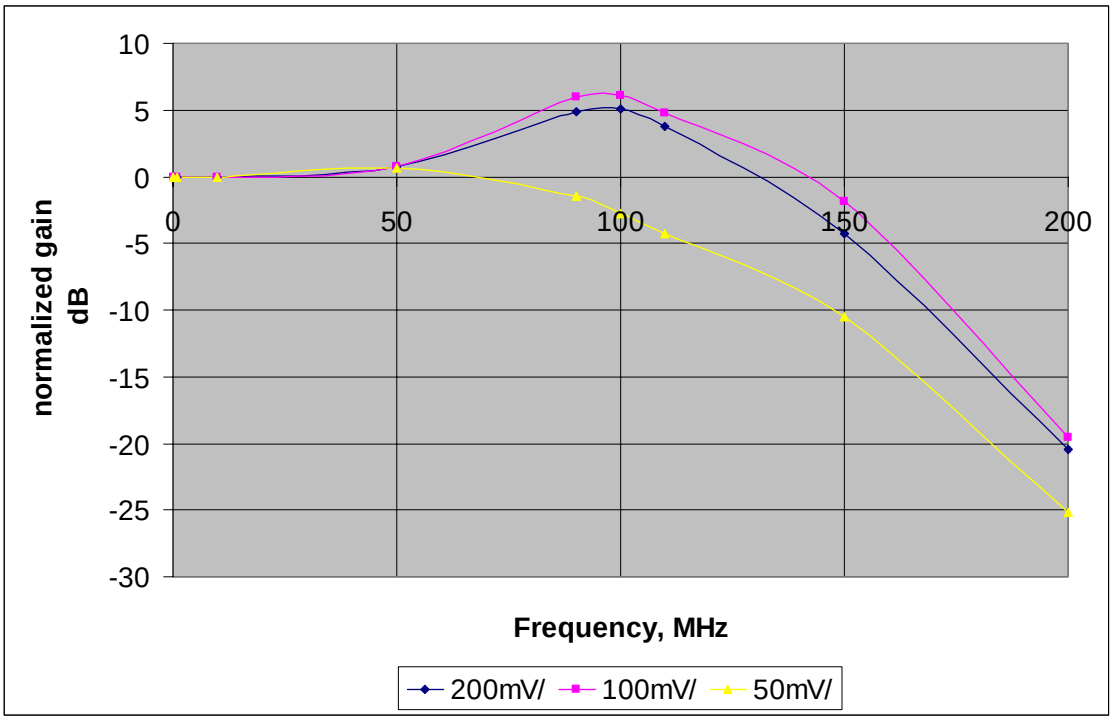


Conclusion was, that the frequency response of (my DUT) scope is up to 5dB gain peaking (+78% measurement error) with a BW significantly less then advertized and also depending on the selected sensitivity (esp. reduced by activating the x1,25 gain setting on OPA656).

A comparison measurement, done by André with the original HW on a W2014A shows a different result:

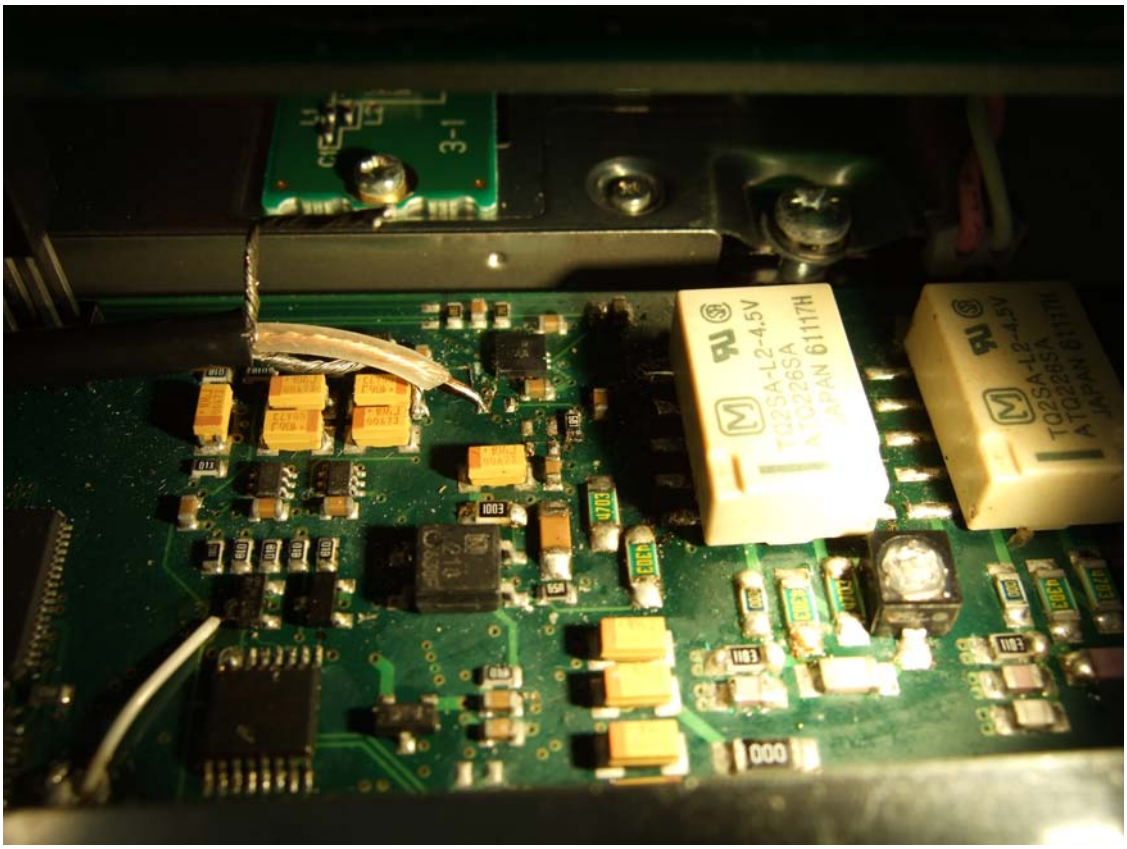


The gain peaking exceeds 9dB for the setting 1V/div, which is +180% measurement error for 150MHz signals.
On the other hand, the scope-BW exceeds 200MHz in this measurement.
Discussing the quite different results of both measurements, only one mismatch in the setup could be identified – my measurements have been done with a 50 Ohm output to the high impedance input of the scope, while André included a 50 Ohm load impedance on the scope input as well measurement.
Following the theory, a precise 50 Ohm output (as assumed) on the signal generator shouldn't show any frequency response difference (except of basic level), but nevertheless a comparison measurement on Ch2 of my scope (W2024A) with a 50 Ohm input impedance was done for comparison with results as follows:

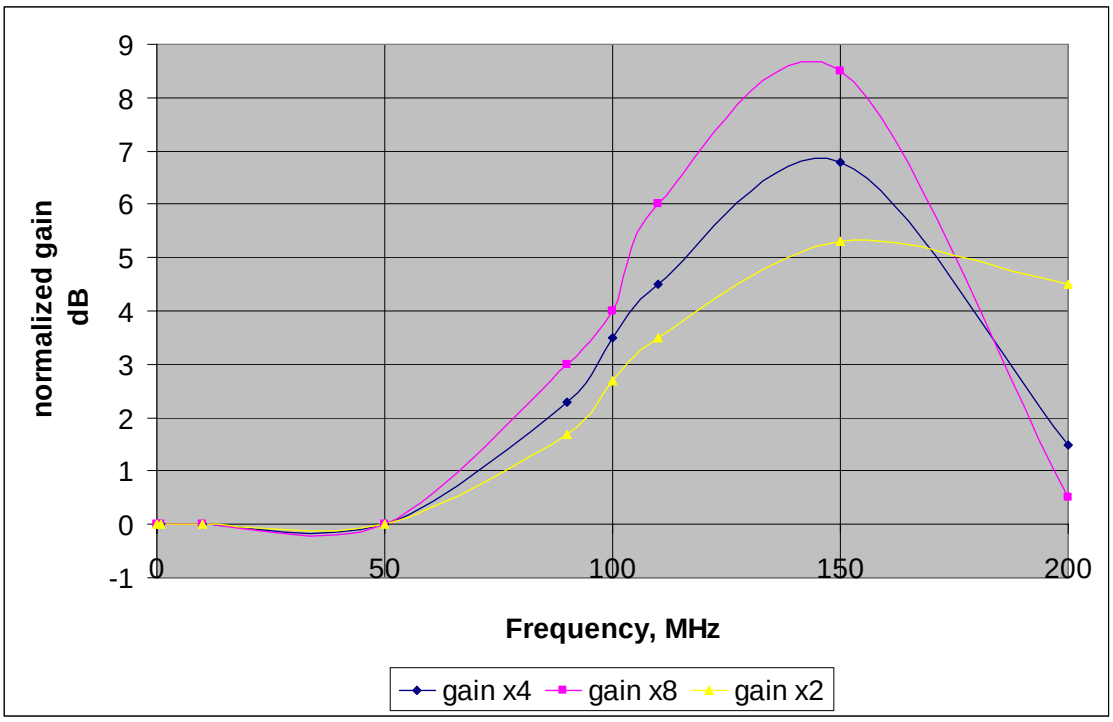


Consequently, the only possible explanation for the different results is the HW – either intended by circuit (which was not spotted yet) or due to BW-deviations of the used parts (OPA656 and/or AD8131).

Since the measured frequency response is a sum of the responses of every stage, a better understanding of the results is expected by splitting the measurements to parts of the circuit. As proposed earlier, a suitable split point is the input of U10 – pin8, where a single ended input signal with 50 Ohm source impedance can be easily applied to the amplifier chain U10-U11-U12. (R20 needs to be de-soldered for this purpose, and the input pin 12 of the MAX4704 disconnected to avoid any possible influence).



Doing this and applying a signal by 50 Ohm coaxial cable as shown on the picture above, following response was measured (depending on the total gain selected for this part of the circuit):
(selecting sensitivity of "5xx" corresponds to gain x8; "1xx" corresponds to gain x4; "2xx" corresponds to gain x2



There is obviously a gain depending frequency peaking close to 150MHz for this part of the circuit.
Similar behavior has to be expected from the first gain stage on OPA656 (implementing selectable gain of:
x1,00 for sensitivity settings of "1xx" or "2xx" and
x1,25 for sensitivity setting of "5xx"

Presuming a similar response for this part of the circuit on the W2014A of André (witch is matching quite well to his measurement results), I have to conclude, that the input stage on his scope has much higher BW (>=200MHz) and a flat response, while the input stage on my W2024A seems to be the limiting factor in terms of BW, cutting the frequency response quite earlier. One possibility is to assume BW deviations of the OPA656 (which is theoretically possible in series production but a bit too much to explain this big difference), another – to have a schematic difference between both scopes, which has not been found so far.

Further conclusion may be possible, if the frequency response of the input stage is measured separately, applying a signal to the scope input (BNC) and measuring the signal level at pin 8 on U10. This measurement may depend however on the input impedance and capacitive load of the measurement probe and lead to more discussions then conclusions.