

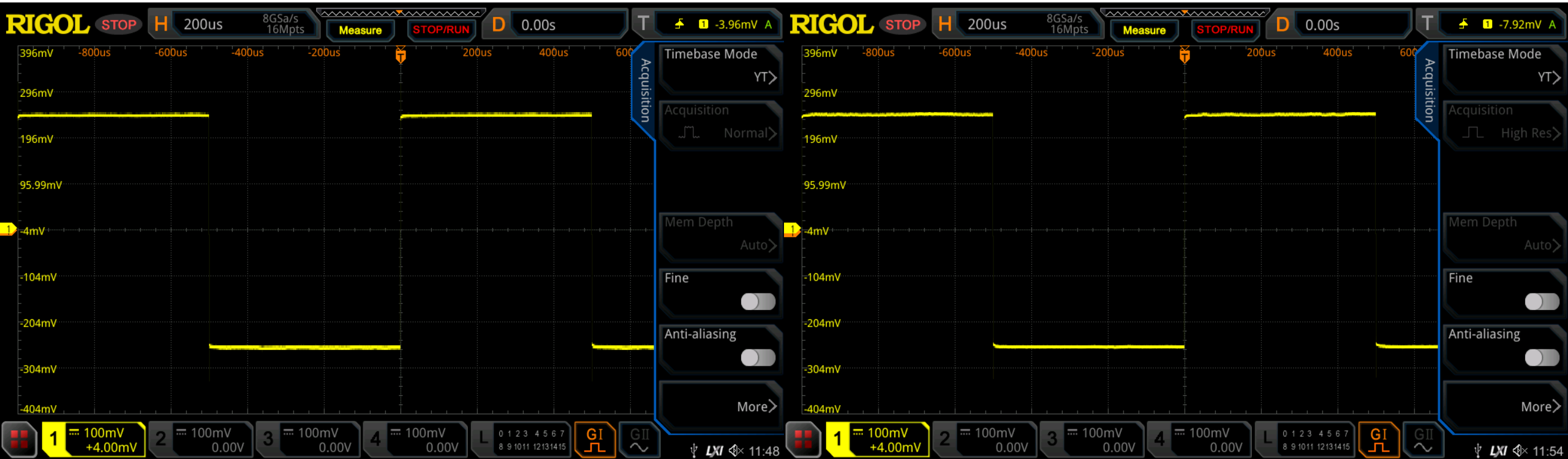
# Rigol MSO5074 'high res' and noise floor analysis

macaba @ eeVBlog forums - 2020/05/19 - v1

# Full waveform

1kHz 500mV square wave from onboard ARB

Left – normal, right – high res



# Digital Zoom Level A

1kHz 500mV square wave from onboard ARB

Left – normal, right – high res

Zoom is digital from the full scale paused acquisition  
(so the front end ASIC isn't zooming into the region)

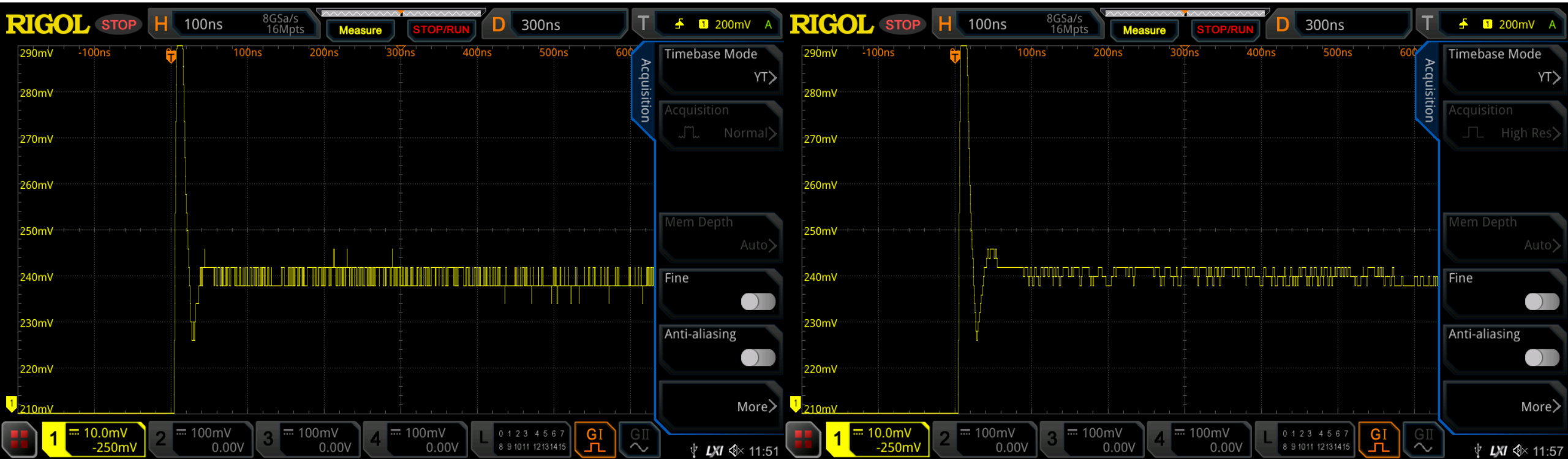


# Digital Zoom Level B

1kHz 500mV square wave from onboard ARB

Left – normal, right – high res

Zoom is digital from the full scale paused acquisition  
(so the front end ASIC isn't zooming into the region)

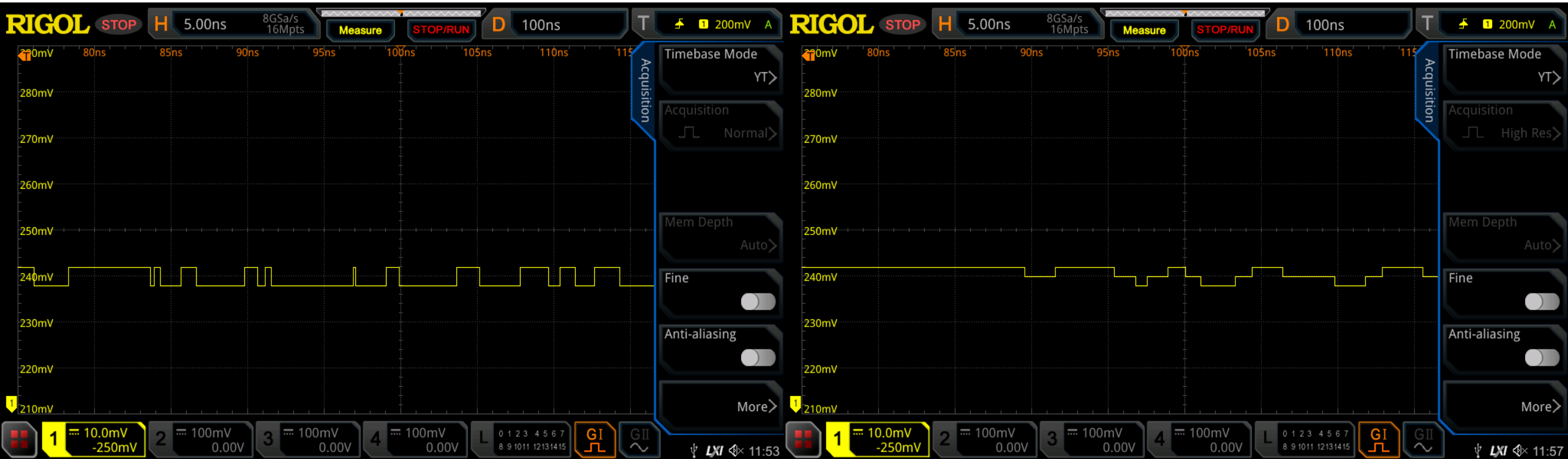


# Digital Zoom Level C

1kHz 500mV square wave from onboard ARB

Left – normal, right – high res

Zoom is digital from the full scale paused acquisition  
(so the front end ASIC isn't zooming into the region)



# Minimum bit width

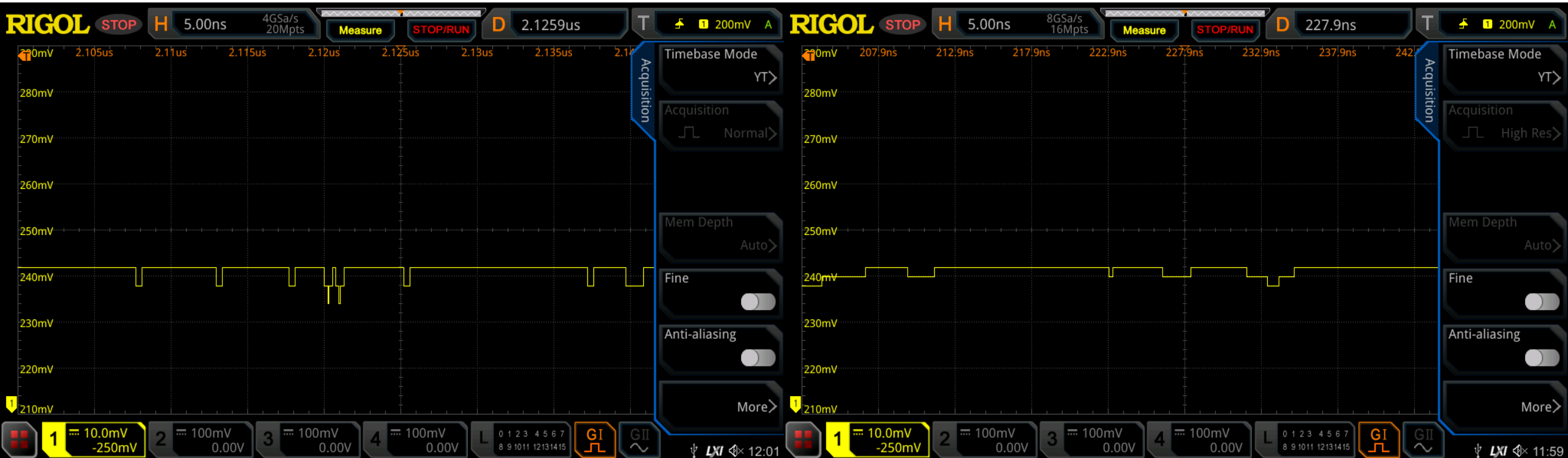
1kHz 500mV square wave from onboard ARB

Left – normal, right – high res

Zoom is digital from the full scale paused acquisition (so the front end ASIC isn't zooming into the region)

Possibly; 4 point oversampling to gain 1 bit of resolution  
(evidence: the minimum bit width is 4x greater in high res mode)

Annoyingly; no indication that this is happening  
(thought: shouldn't the '8GSa/s' indicator to drop to '2GSa/s'?)

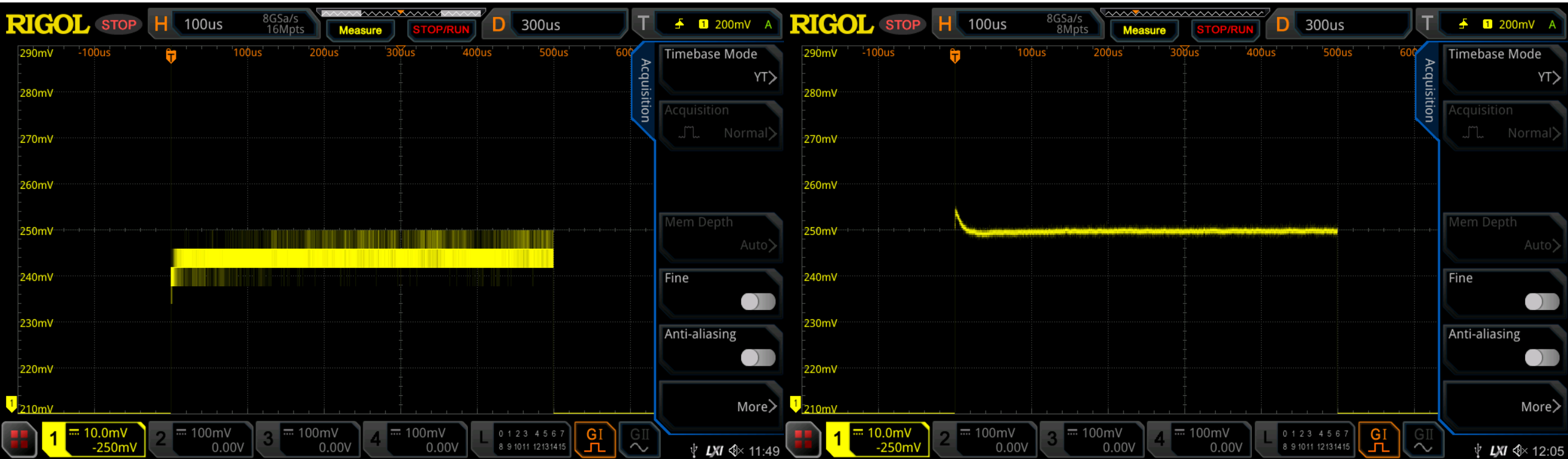


# Analog zoom (normal)

1kHz 500mV square wave from onboard ARB

What if we let the front end ASIC do it's job?

Left – digital zoom from full scale acquisition. Right – zoomed in acquisition.



# Analog zoom (high res)

1kHz 500mV square wave from onboard ARB

What if we let the front end ASIC do it's job?

Left – digital zoom from full scale acquisition. Right – zoomed in acquisition.

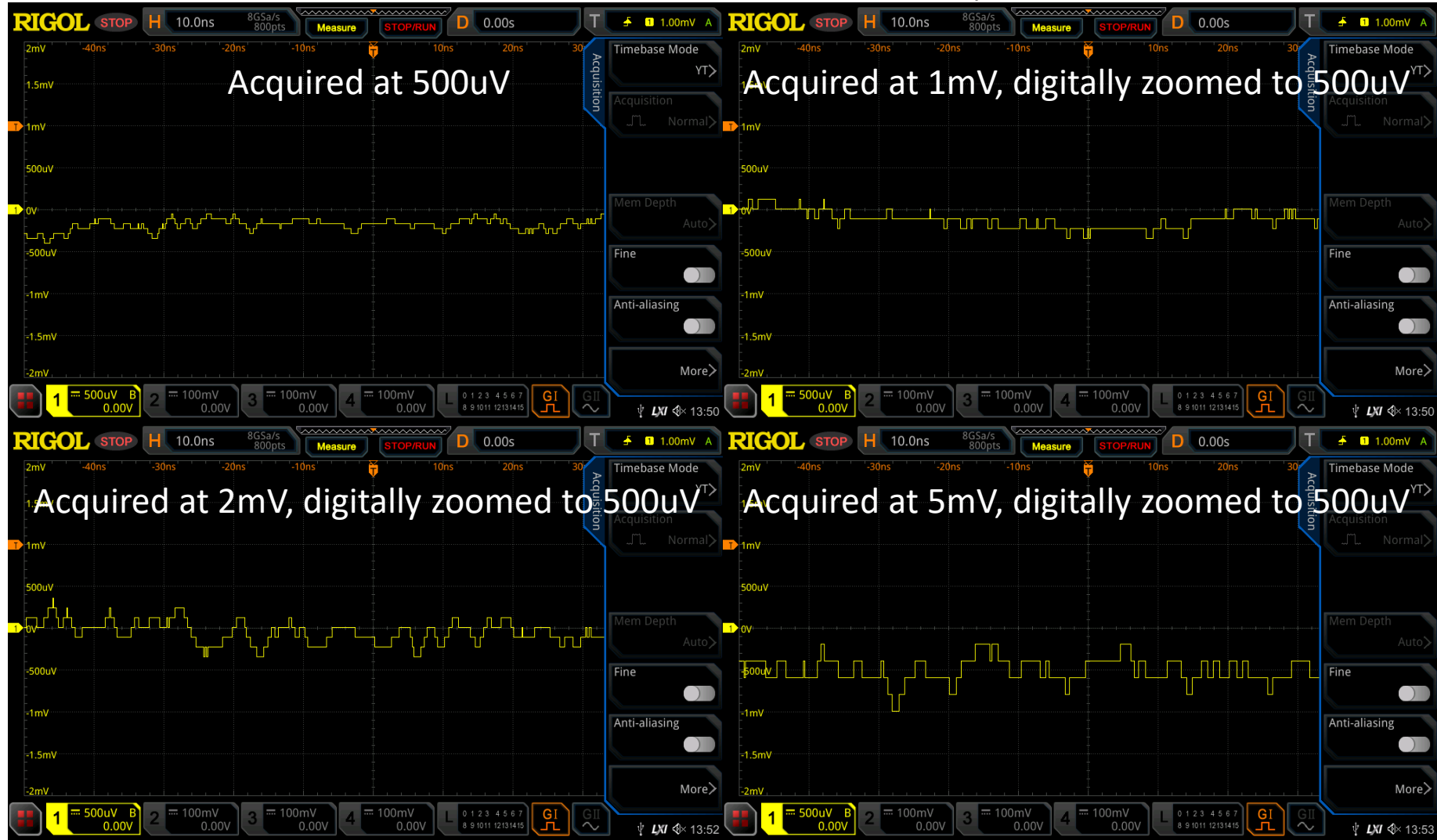




# Front end vertical gain (normal)

It seems that every vertical gain has an analog gain applied in the front end ASIC  
(can be seen by the change in LSB height when changing vertical gains)  
(or maybe it's further oversampling? Not indicated in UI)

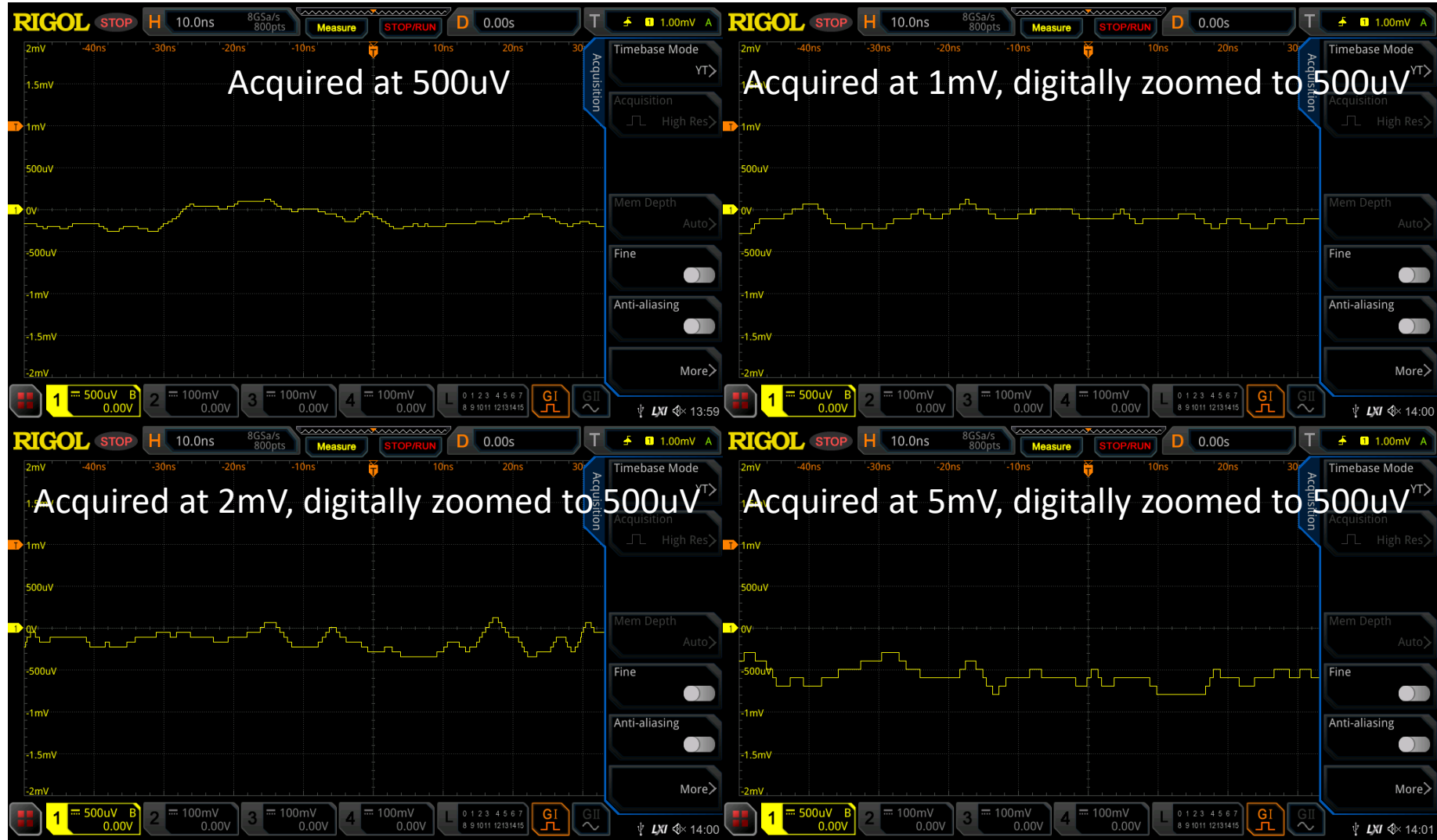
Therefore effective resolution (aka noise free) is limited by front end noise?



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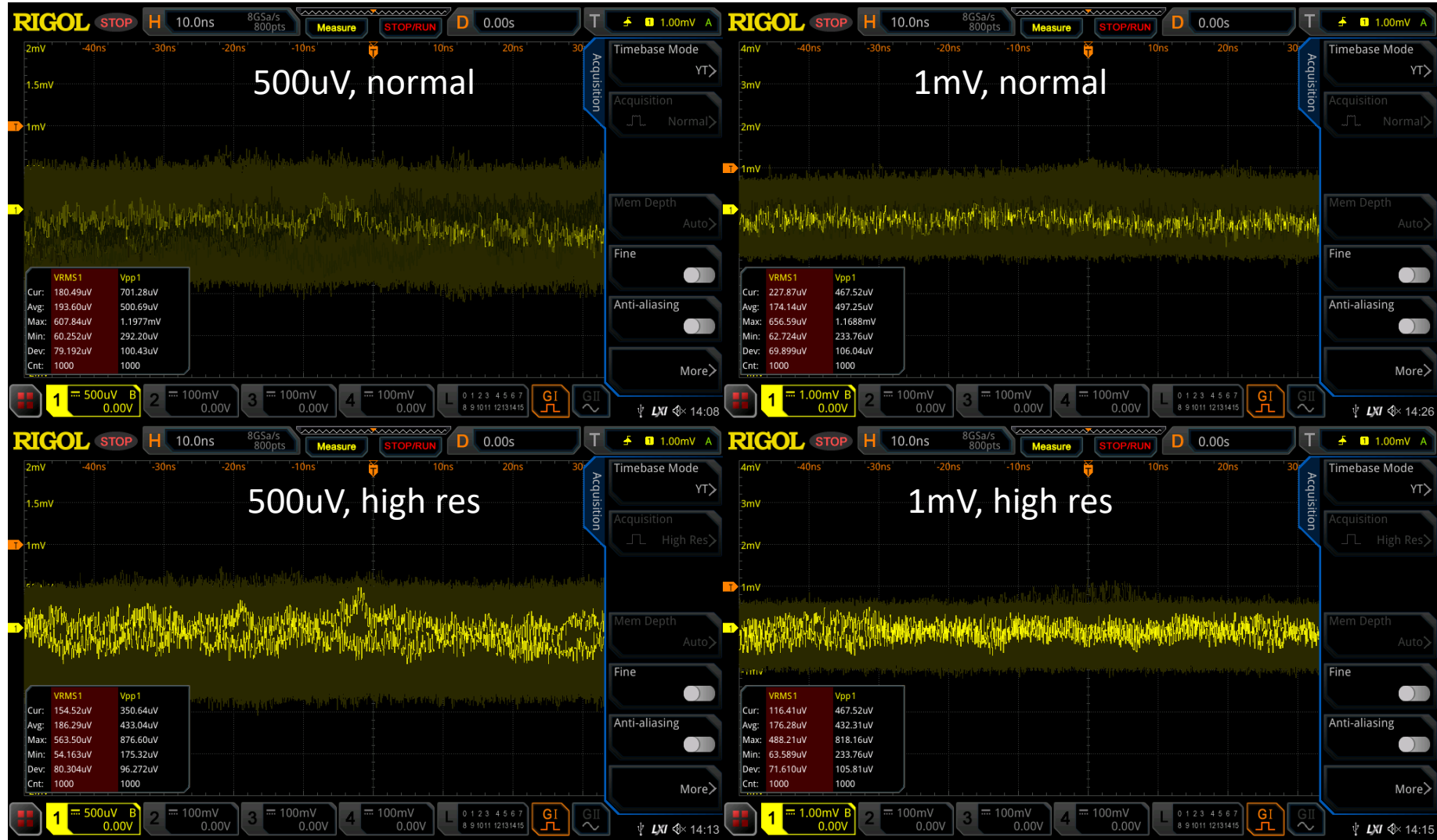
Therefore effective resolution (aka noise free) is limited by front end noise?



# Front end noise

Input: 50ohm terminator

Top – normal, bottom – high res



# Conclusions

- High res mode does exist, it's just 9 bits, not 10/12/14.
  - Could this be increased by further oversampling?  
(might be most effective on smaller ranges due to the presence of noise to act as dithering)
  - The fact that this is a 9-bit mode doesn't align with many people's expectations which would be both 10-bit, and contiguous sample averaging to reduce noise at smaller vertical divs.  
(say, 16x oversampling, and 16x averaging. 8GS/s would become 31.25MS/s.)
- The front end ASIC does analog scaling down to 500uV, or hidden oversampling.
- The noise floor makes the small ranges less effective. (0.5mVpp)
  - Could this be solved by contiguous sample averaging?  
(should be a separate option to oversampling. See 'Recommendations'.)

# Recommendations

- Add a 'High resolution' configuration page
  - Show a warning to say these settings will reduce maximum sample rate.
  - Have an option for 'Oversampling' where value is one of:  
1/4/16/64/256 (which displays 8/9/10/11/12 bits alongside)
  - Option for 'Contiguous sample averaging' where value is one of:  
1/4/16/64/256  
(which represent noise improvement of 0/3/12/18/24 dB)
- (Called 'contiguous sample averaging' to distinguish it from the 'Average' acquisition mode)
  - Contiguous sample averaging groups together samples in a batch and computes the average before sending to framebuffer.  
Example: 64 samples get averaged together to become 1 sample  
(8GSa/s becomes 125MSa/s, if oversampling = 1)
  - This really helps reduce noise in the 500uV/1mV/2mV/5mV gains
- The displayed sample rate at the top should reflect these 2 options when High Res is enabled.

Equation:

Sample rate/(oversampling \* contiguous sample averaging)

Example:

Where Oversampling = 16

Where Contiguous sample averaging = 64

$8[G]/(16*64) = 7.8125MSa/s$