Original Input Stage – Noise behind OPA656 (Part 4)

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DUT: WELEC W2014A, FW: 1.2.OS.091

Measurement equipment:
Signal Generator Rhode & Schwarz · 100 kHz … 1000 MHz · SMG, Oscilloscope TDS5104B

This part of measurement is about noise and parasitic signals. Impulse for this was a transient analysis with LTSpice showing a high frequency ringing by the coupling DAC path from OP1177 to OPA656.
Therefore the AD8131 gain stage was disconnected at U10 so that OPA656 is working together with OP1177.
Behind the 51 Ω load resistor on the output of OPA656 a RG174 cable was soldered.
On Welec-DSO vertical scale factor was set to 10 mV/div. This is equal to gain = 1 at OPA656 and the attenuator (input voltage divider) is deactivated. On the Welec-DSO input a 50 Ω resistor was plugged.
The RG174 cable was connected to a Tektronix TDS5104B with 50 Ω input.

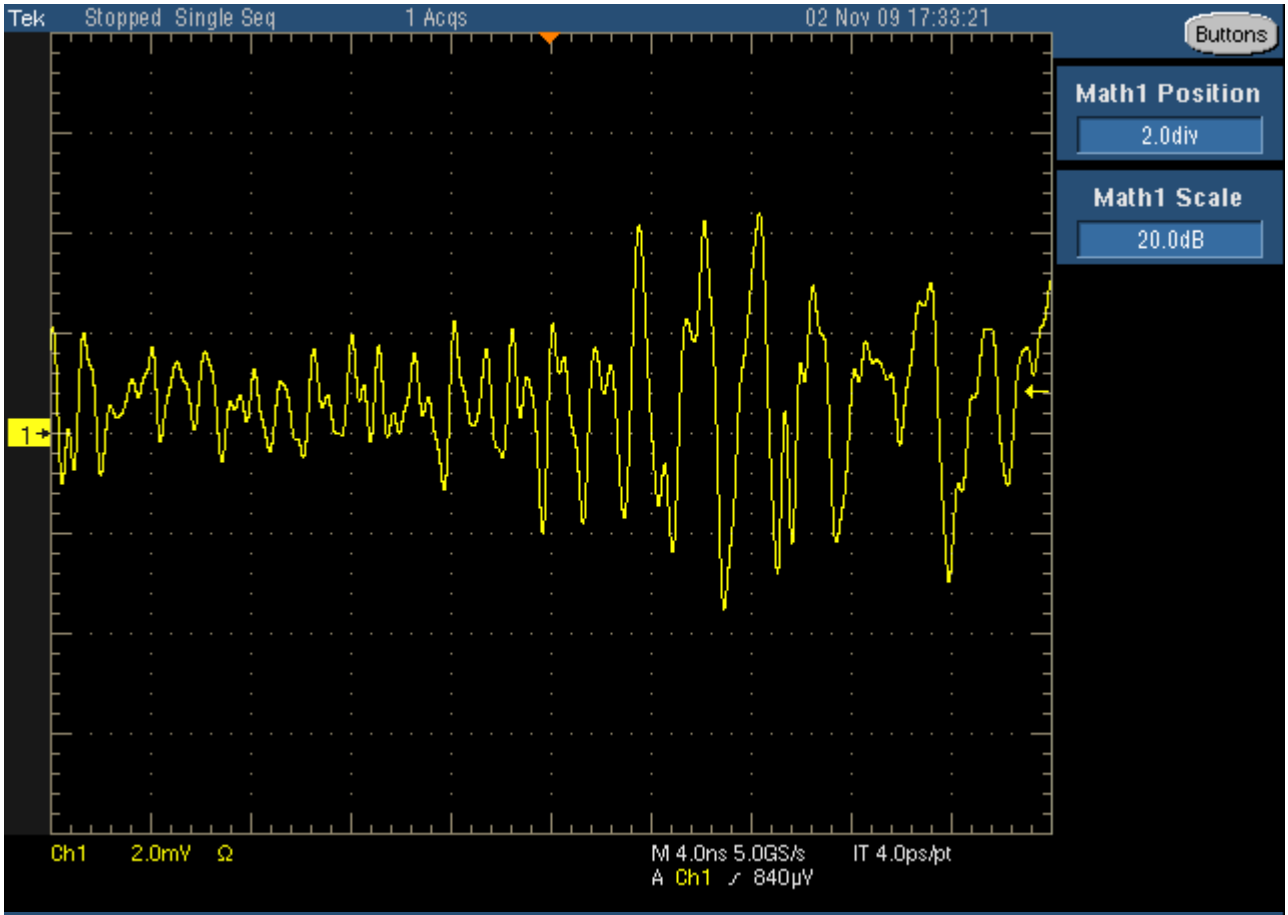
Notice, the signal amplitude in the following picture is not the amplitude at U10, because there is a 750 Ω resistor at its input.
This means, extracting the real amplitude at U10 from the picture you need to multiply the amplitude by 2 and by 7/8 equal to:

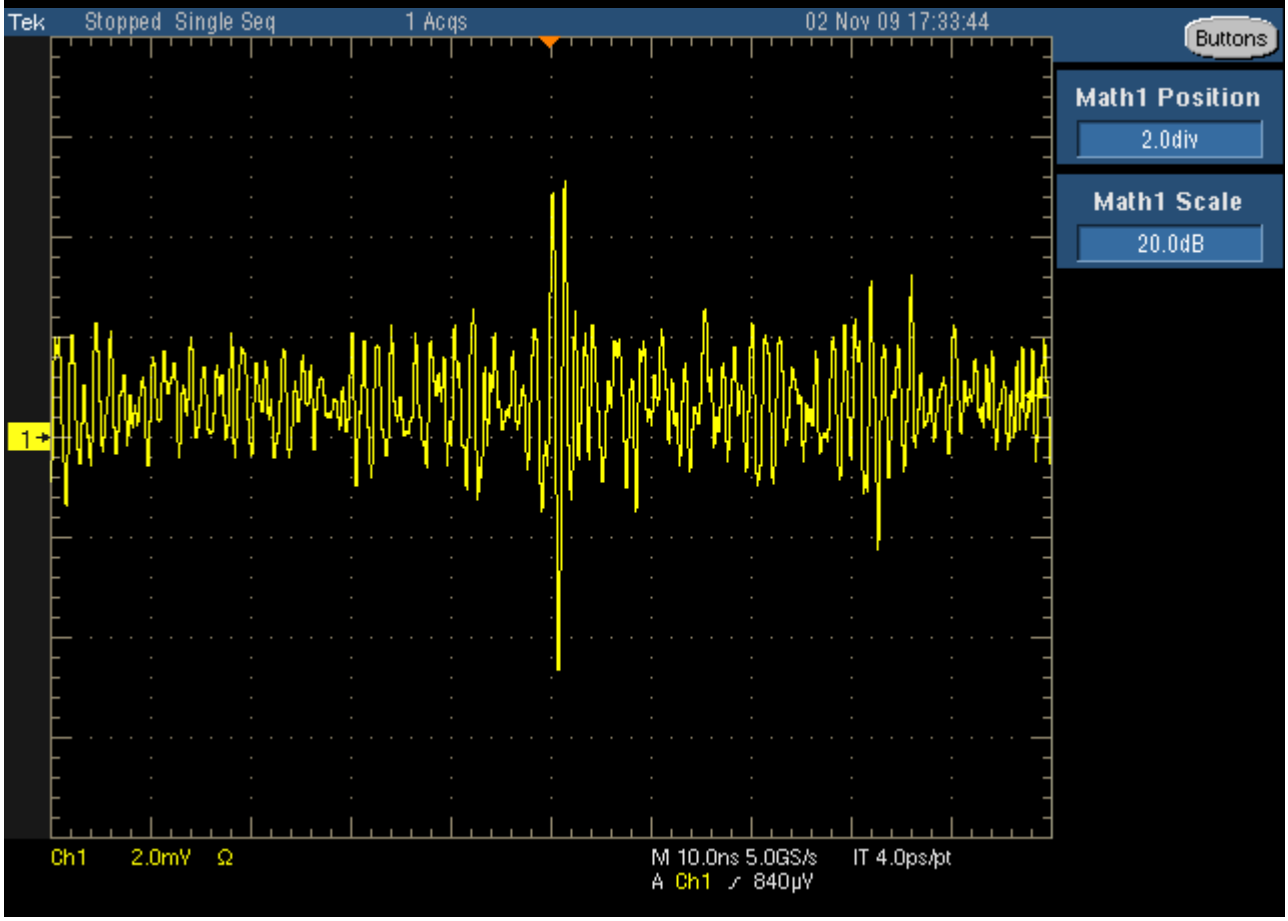
$$U_a = \frac{U_e * 750\Omega}{(50\Omega + 750\Omega)}$$

The following pictures are made by using SingleShot mode at 2mV/div.

Because SingleShot represents only a single moment the pictures were again recorded using FastAquisition mode on the Tektronix oscilloscope. FastAquisition is a special mode of digital phosphor oscilloscopes (DPO) showing a colored z-information equal to frequency distribution of a signal point. The more red the color the more frequent a signal value is reached. This pictures begins at page 11.

SingleShot


Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:33:21
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
Ch1 2.0mV Ω
M 4.0ns 5.0GS/s IT 4.0ps/pt
A Ch1 ⁄ 840µV


Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:33:44
Buttons
Math1 Position
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Math1 Scale
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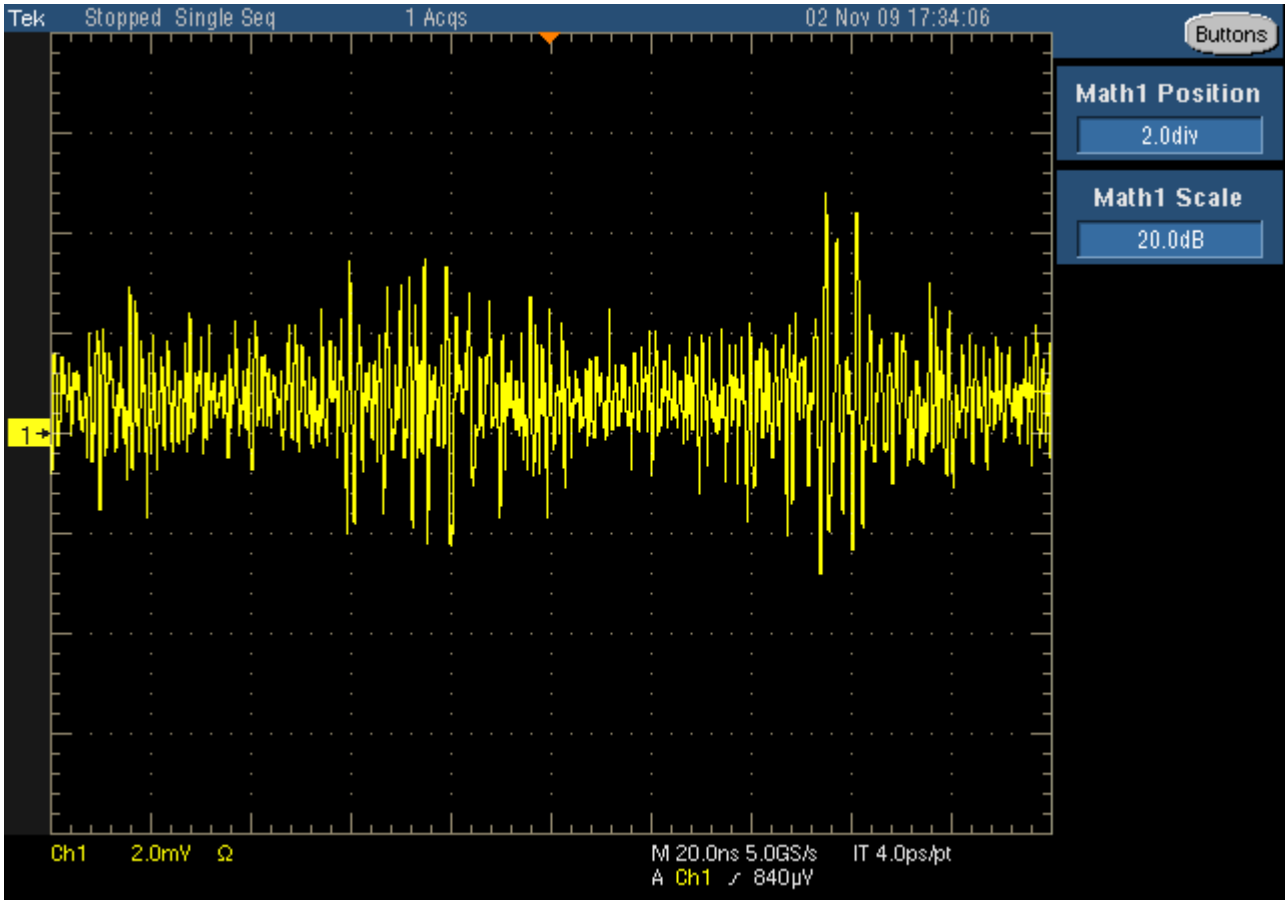
Ch1 2.0mV Ω
M 10.0ns 5.0GS/s IT 4.0ps/pt
A Ch1 ⁄ 840µV


Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:34:06
Buttons
Math1 Position
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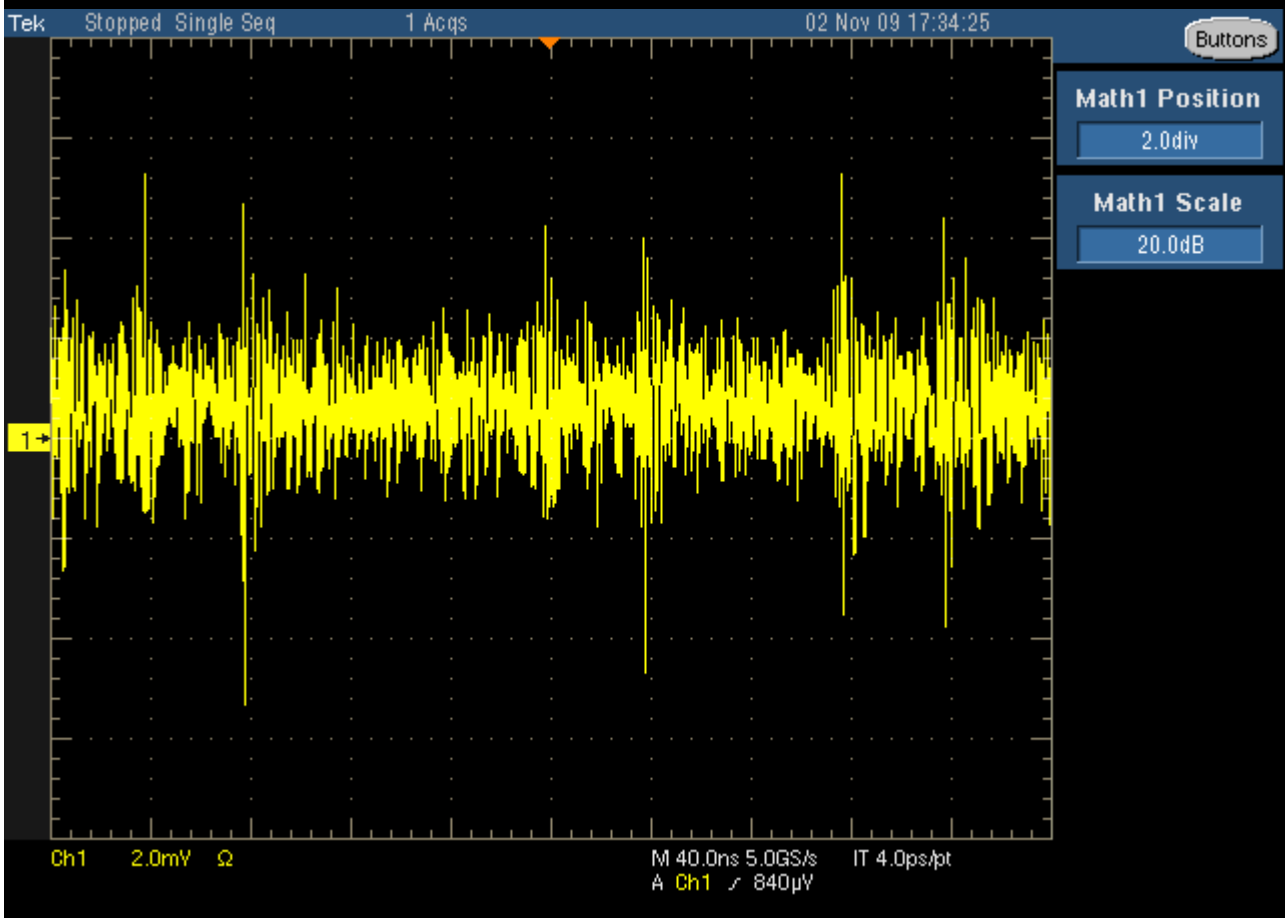
Math1 Scale
20.0dB
1→
Ch1 2.0mV Ω
M 20.0ns 5.0GS/s IT 4.0ps/pt
A Ch1 ⎍ 840µV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Buttons
Math1 Position
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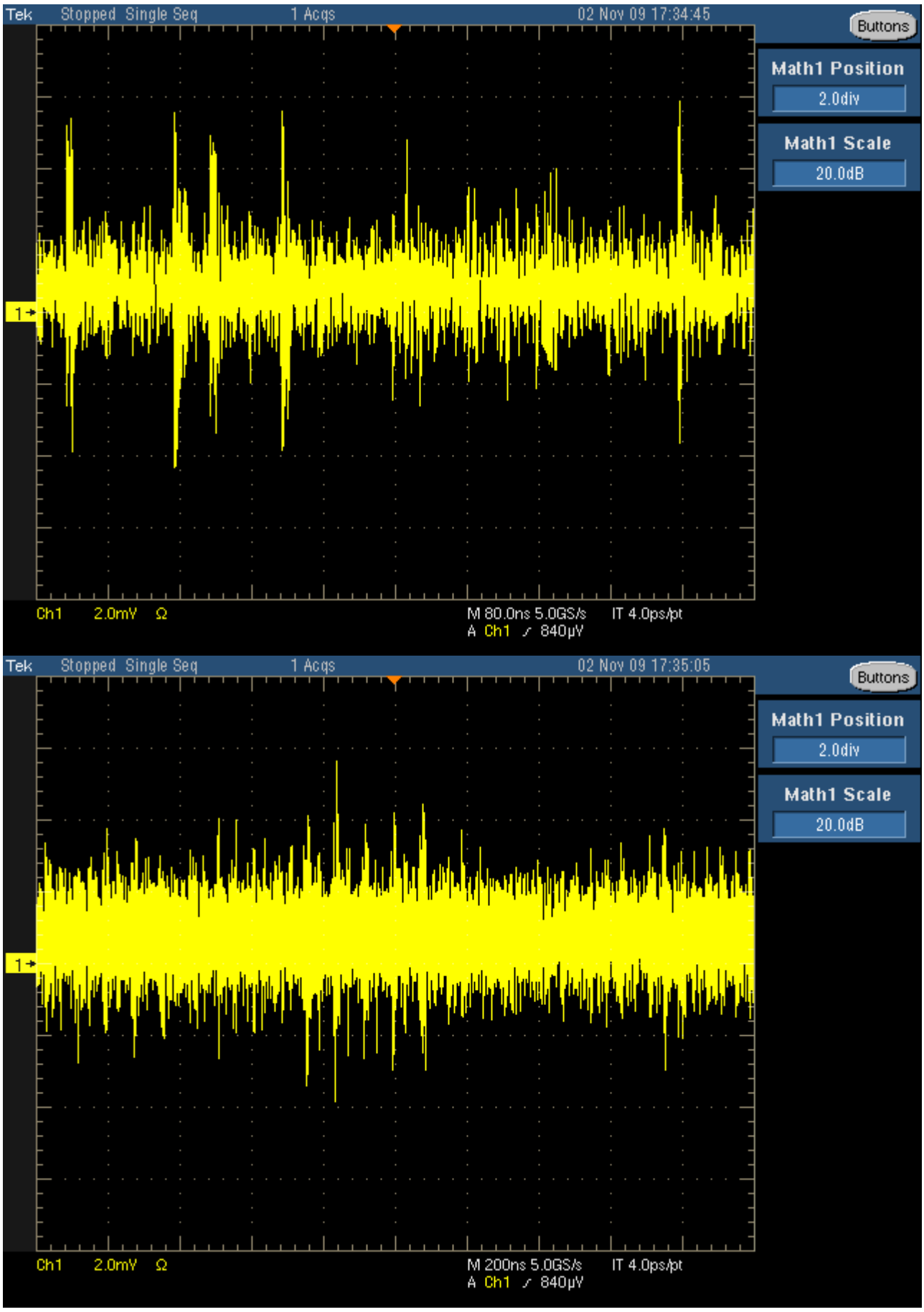
Math1 Scale
20.0dB
1→
Ch1 2.0mV Ω
M 40.0ns 5.0GS/s IT 4.0ps/pt
A Ch1 ⎍ 840µV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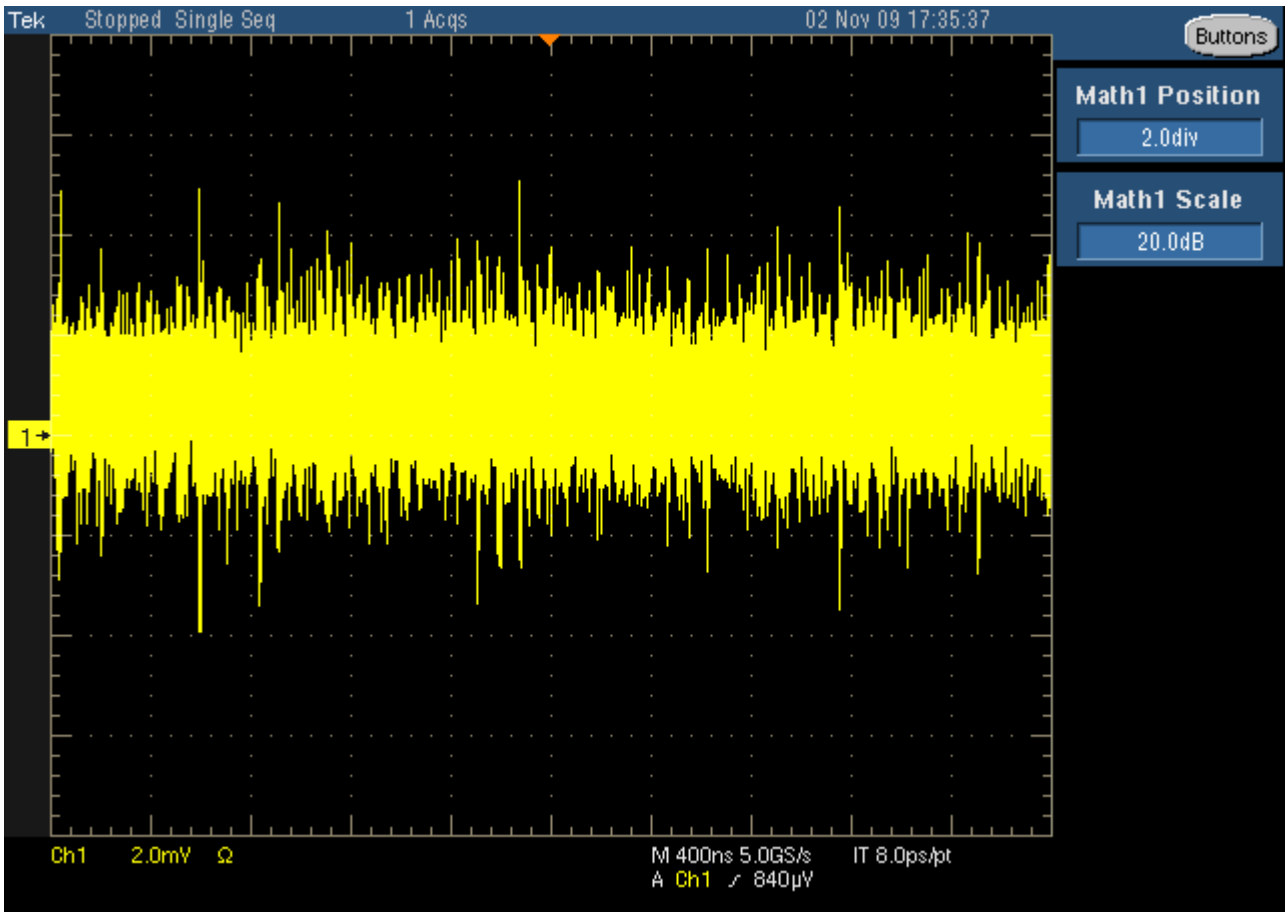
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 80.0ns 5.0GS/s IT 4.0ps/pt
A Ch1 ⁄ 840µV
Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:35:05
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 200ns 5.0GS/s IT 4.0ps/pt
A Ch1 ⁄ 840µV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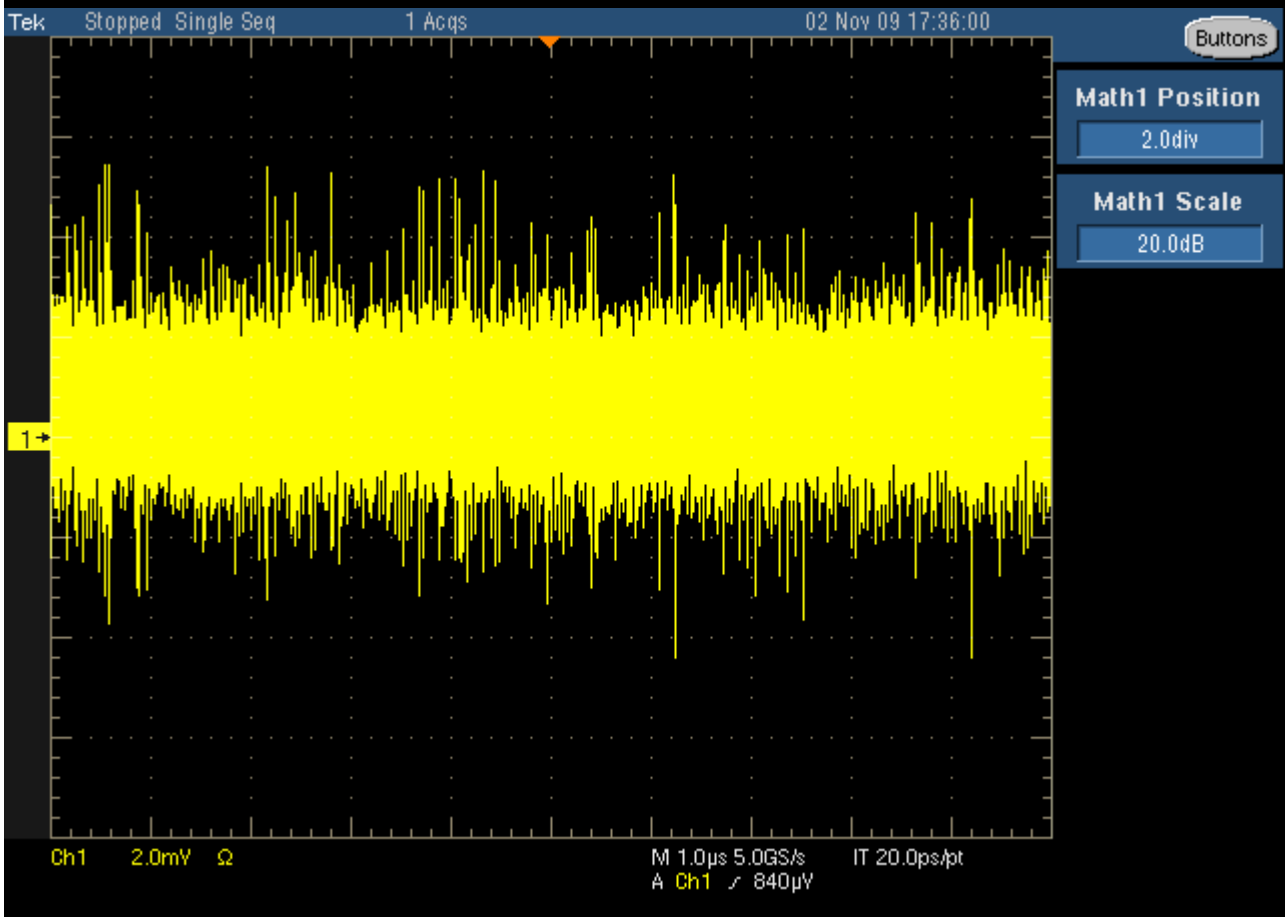
A Ch1 ⁄ 840µV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Buttons
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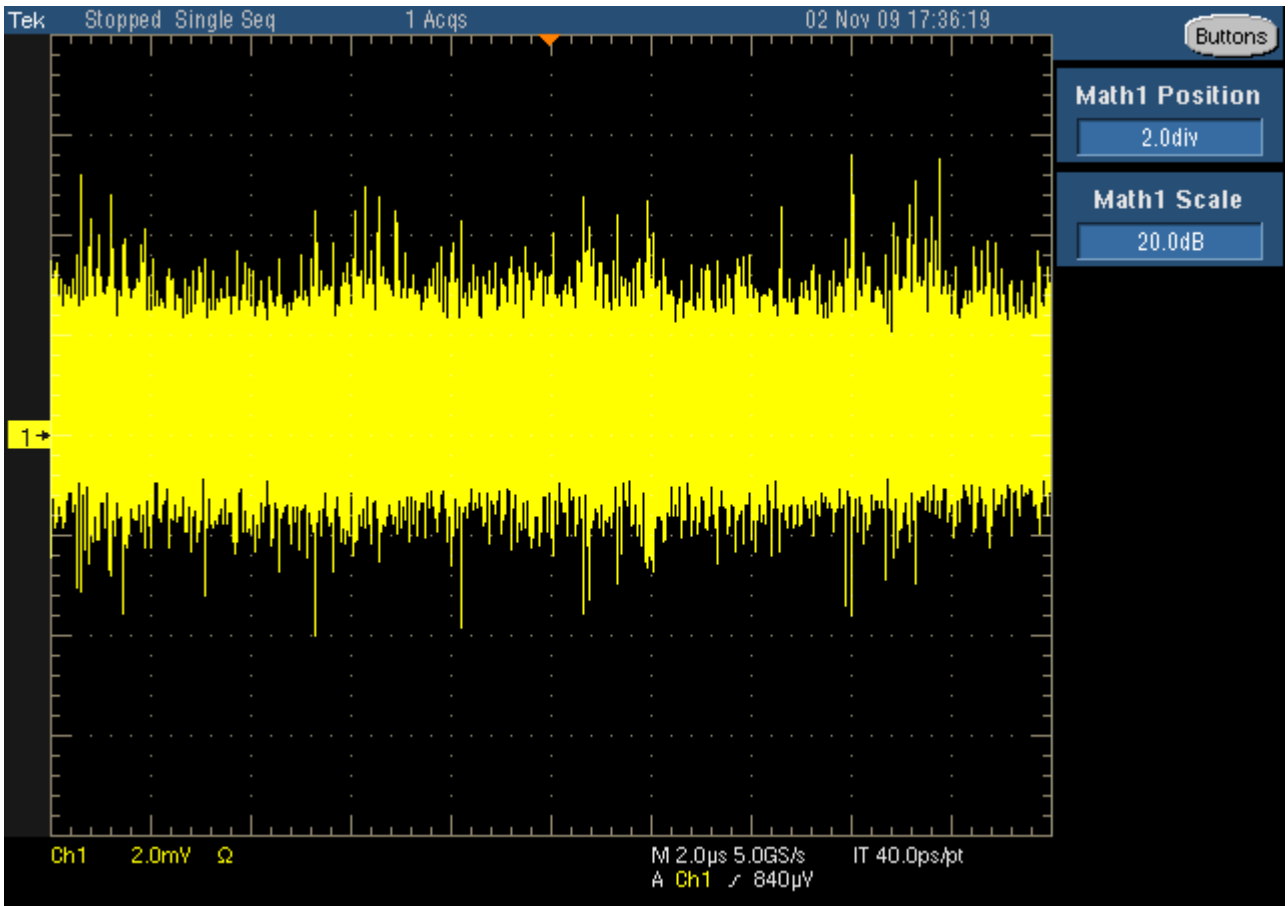
M 1.0µs 5.0GS/s IT 20.0ps/pt
A Ch1 ⁄ 840µV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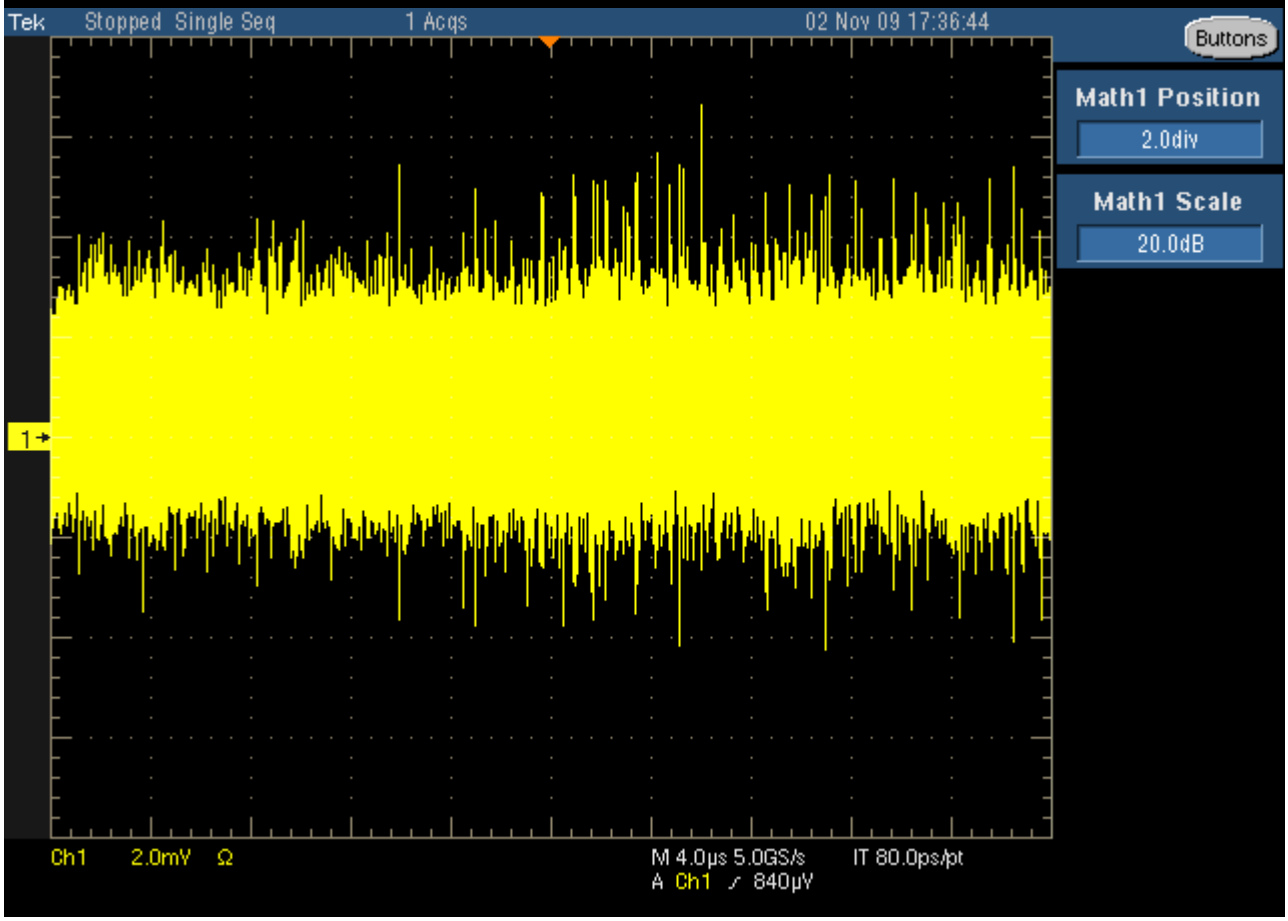
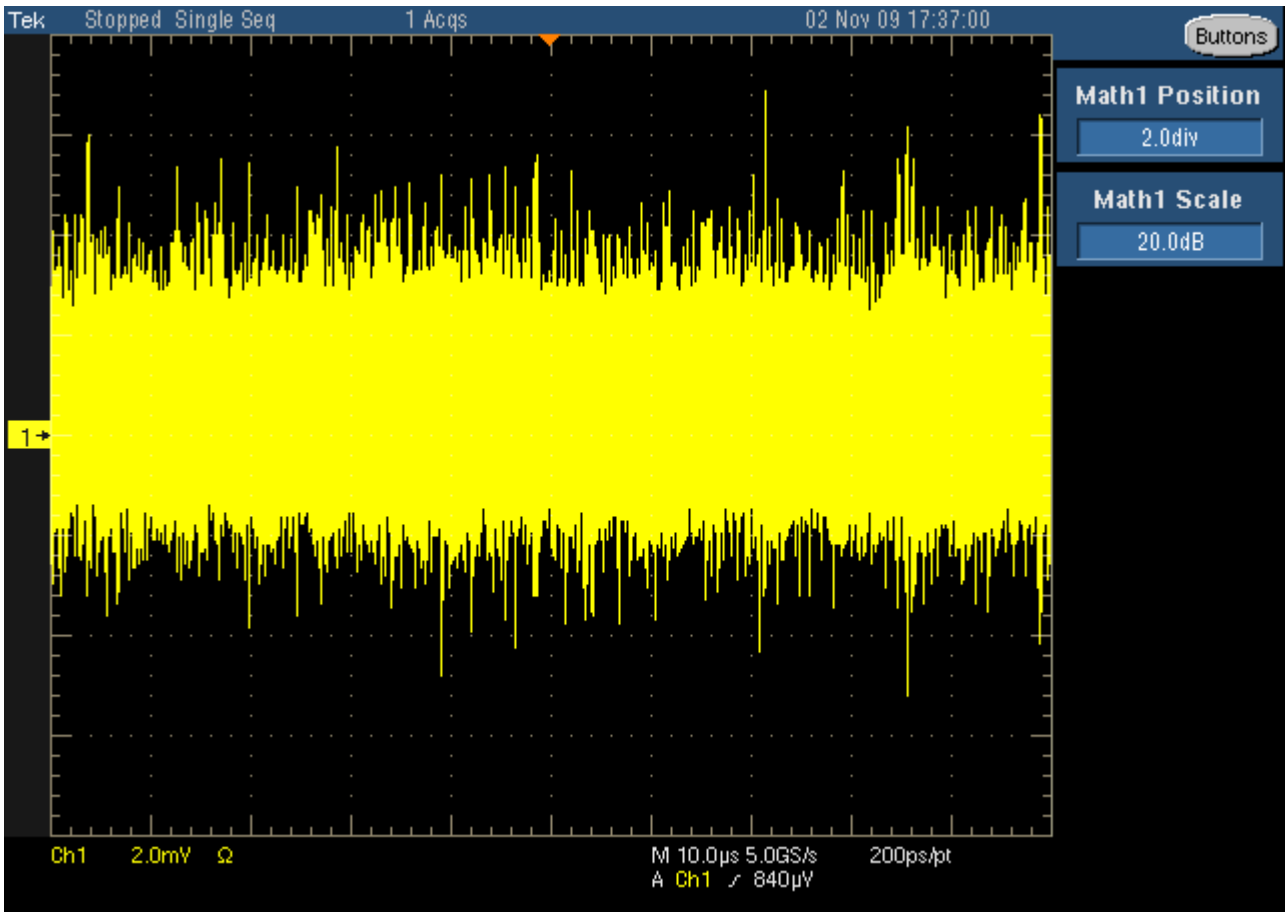
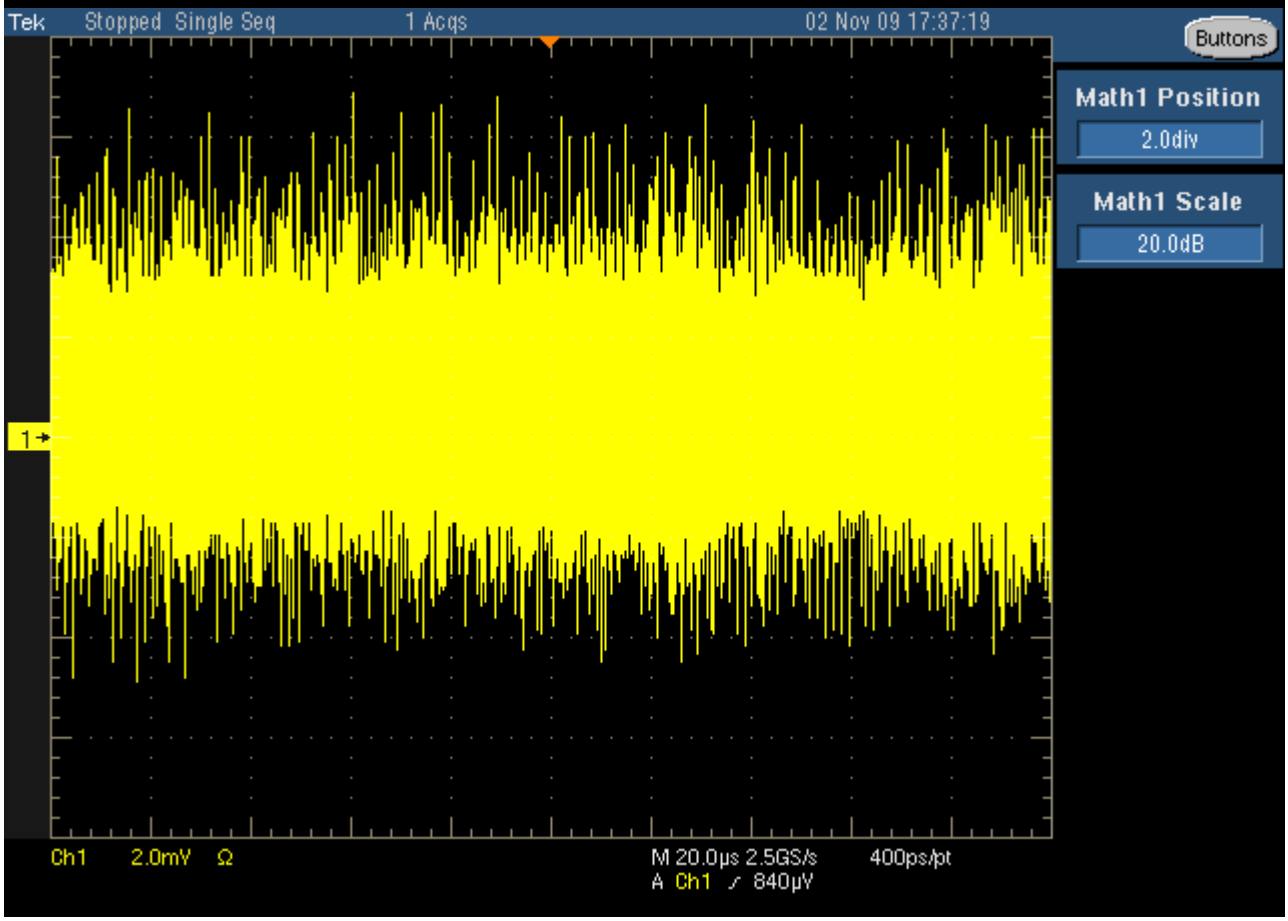
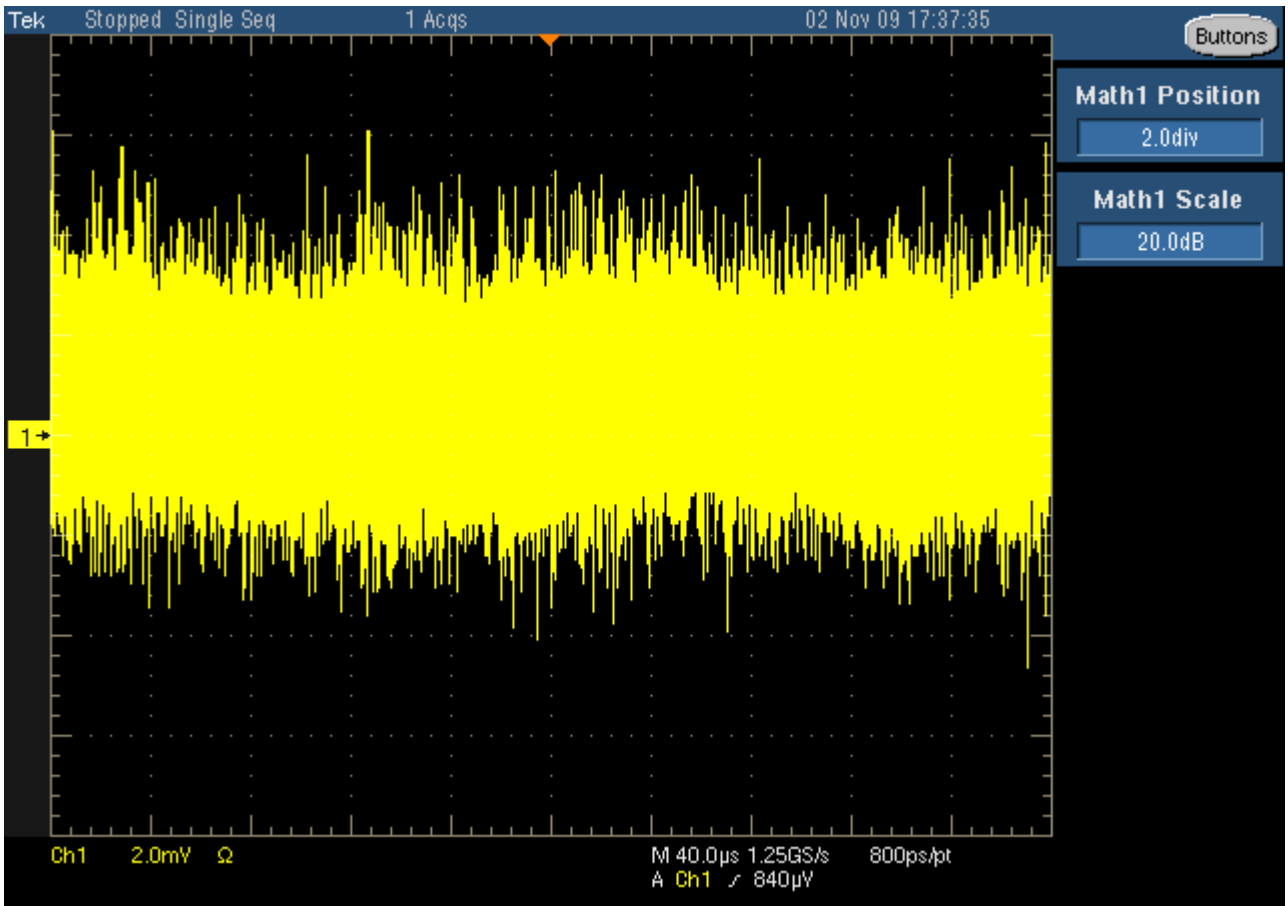
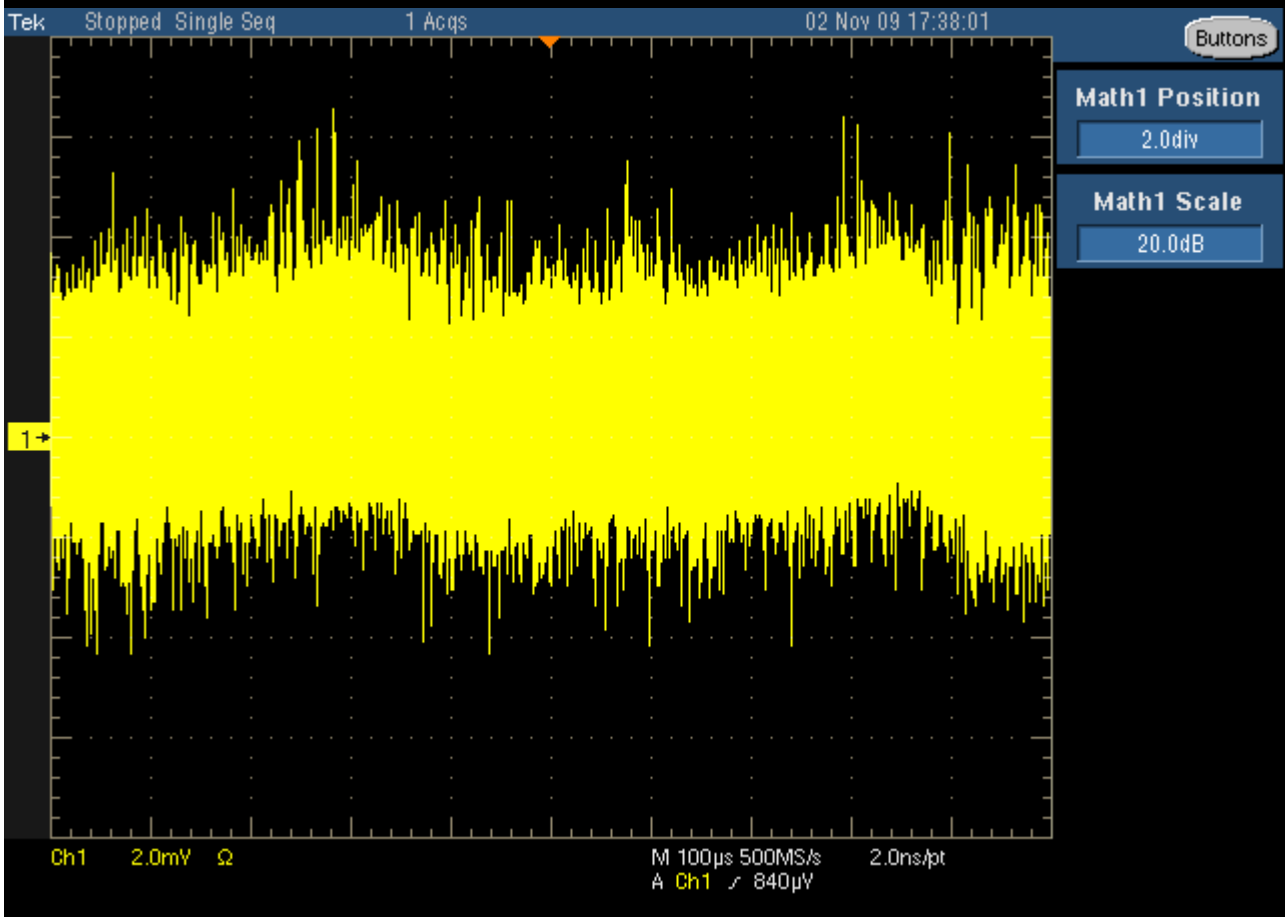
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 2.0µs 5.0GS/s IT 40.0ps/pt
A Ch1 ⁄ 840µV

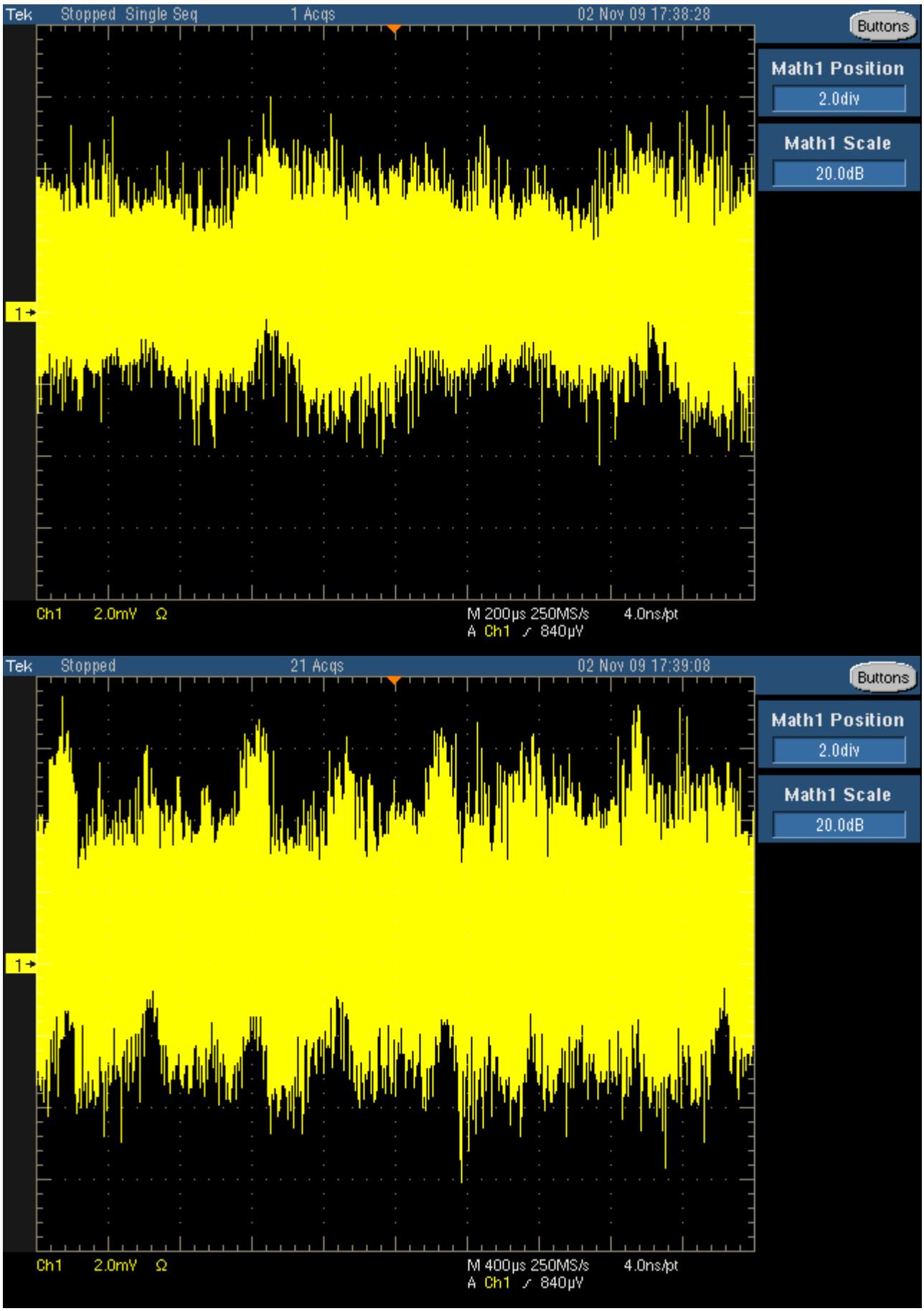

Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:36:44
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 4.0µs 5.0GS/s IT 80.0ps/pt
A Ch1 ⁄ 840µV

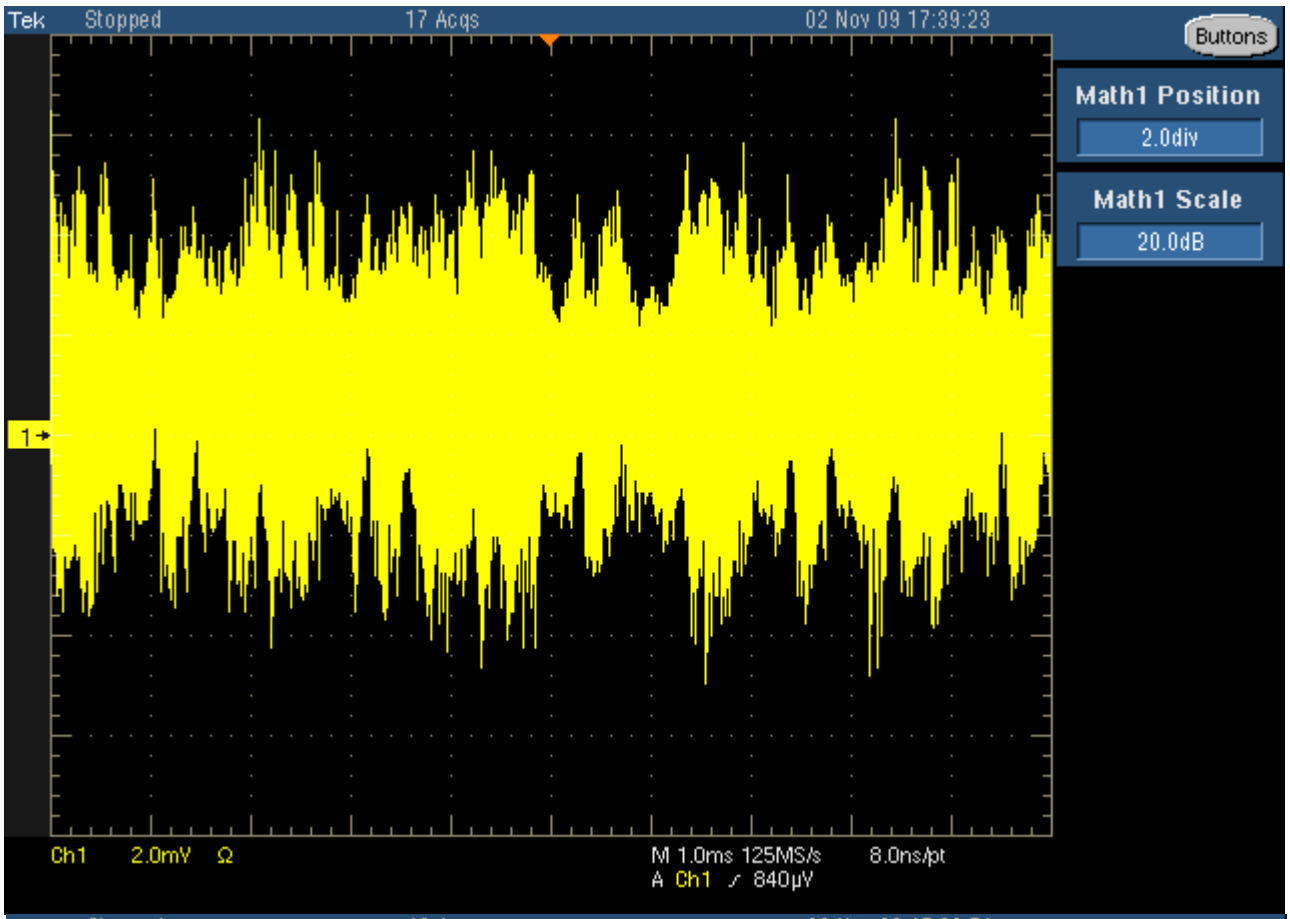

Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:37:00
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 10.0µs 5.0GS/s 200ps/pt
A Ch1 ⟋ 840µV

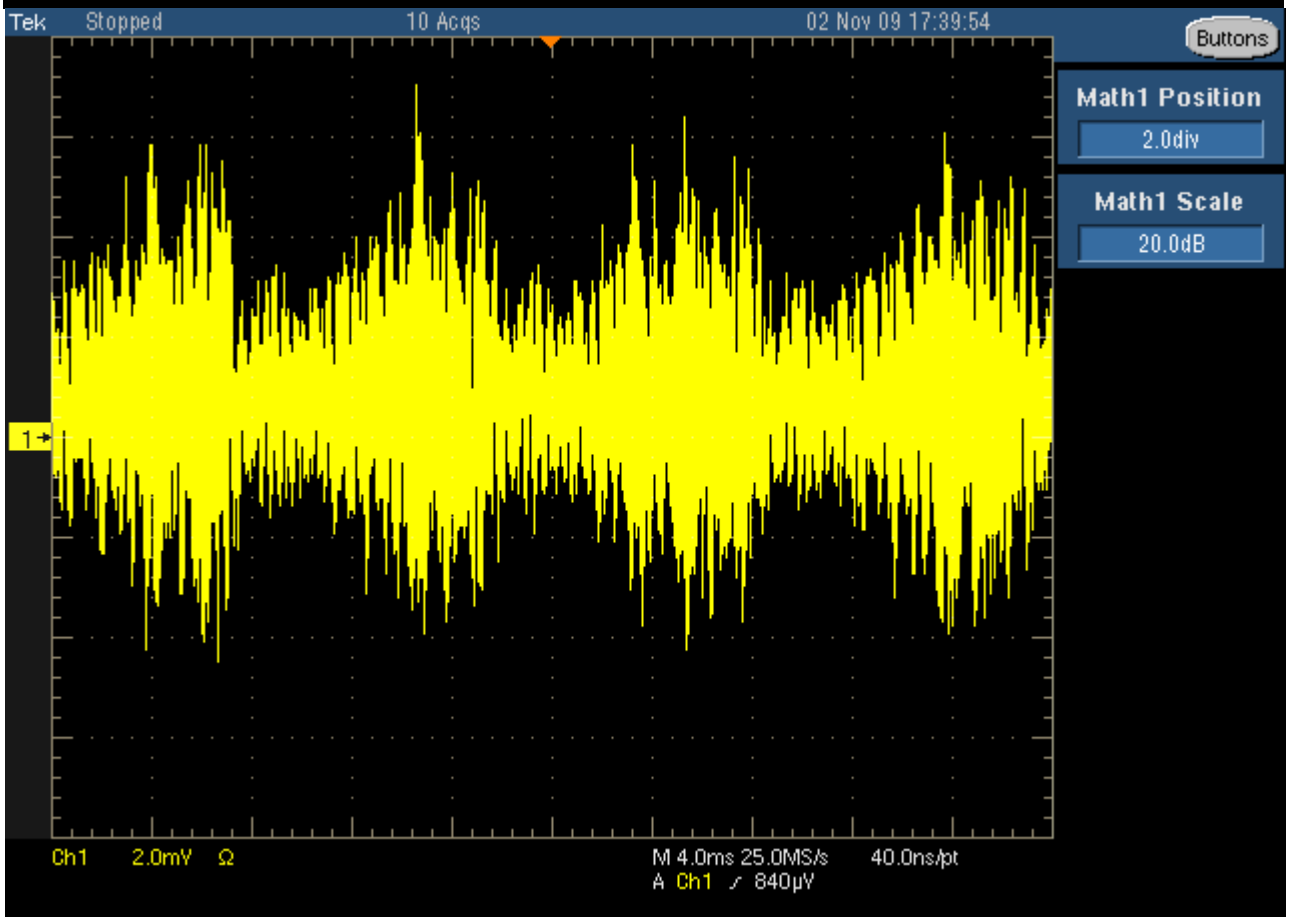

Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:37:19
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 20.0µs 2.5GS/s 400ps/pt
A Ch1 ⟋ 840µV


Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:37:35
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 40.0µs 1.25GS/s 800ps/pt
A Ch1 ⁄ 840µV

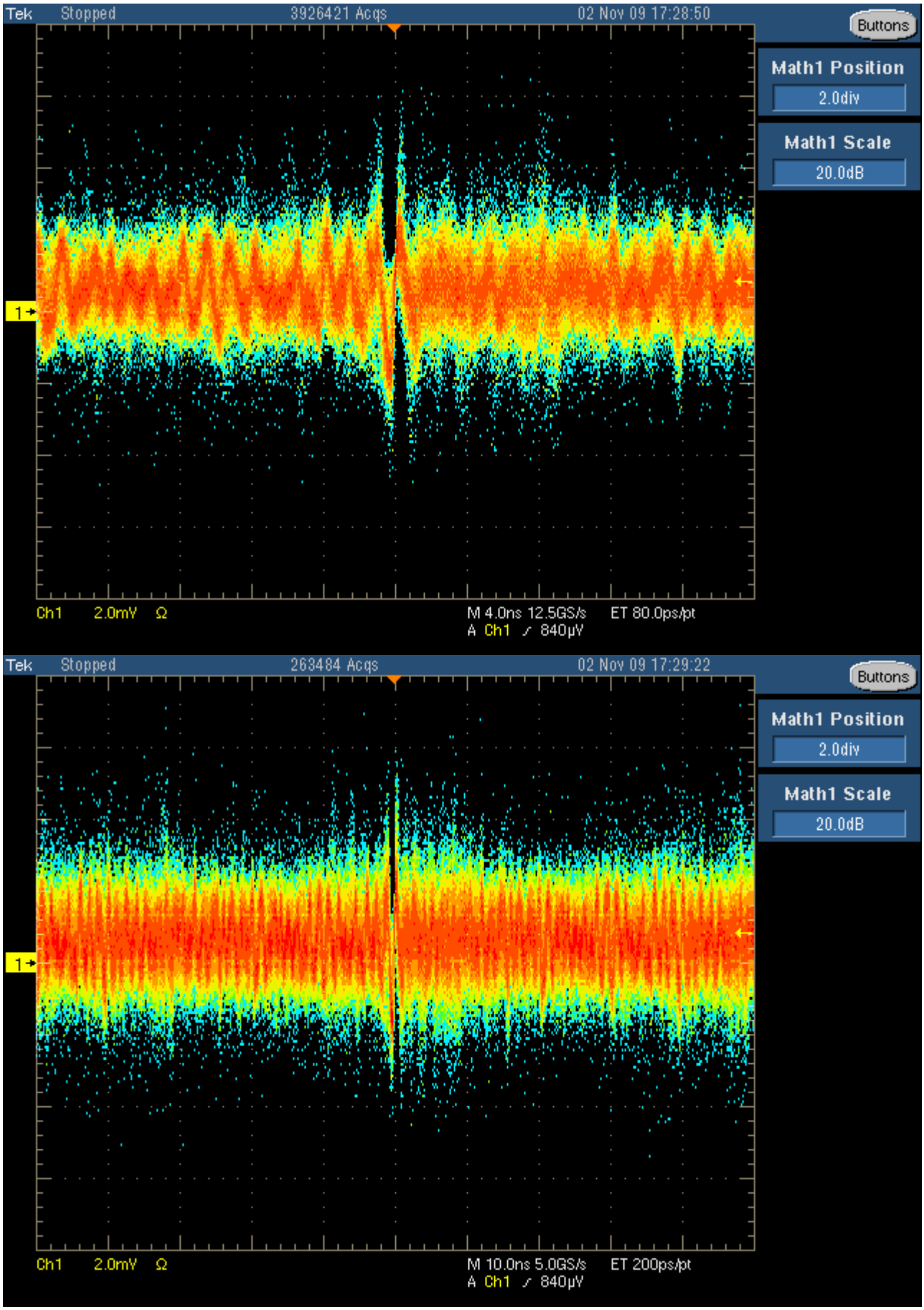

Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:38:01
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 100µs 500MS/s 2.0ns/pt
A Ch1 ⁄ 840µV

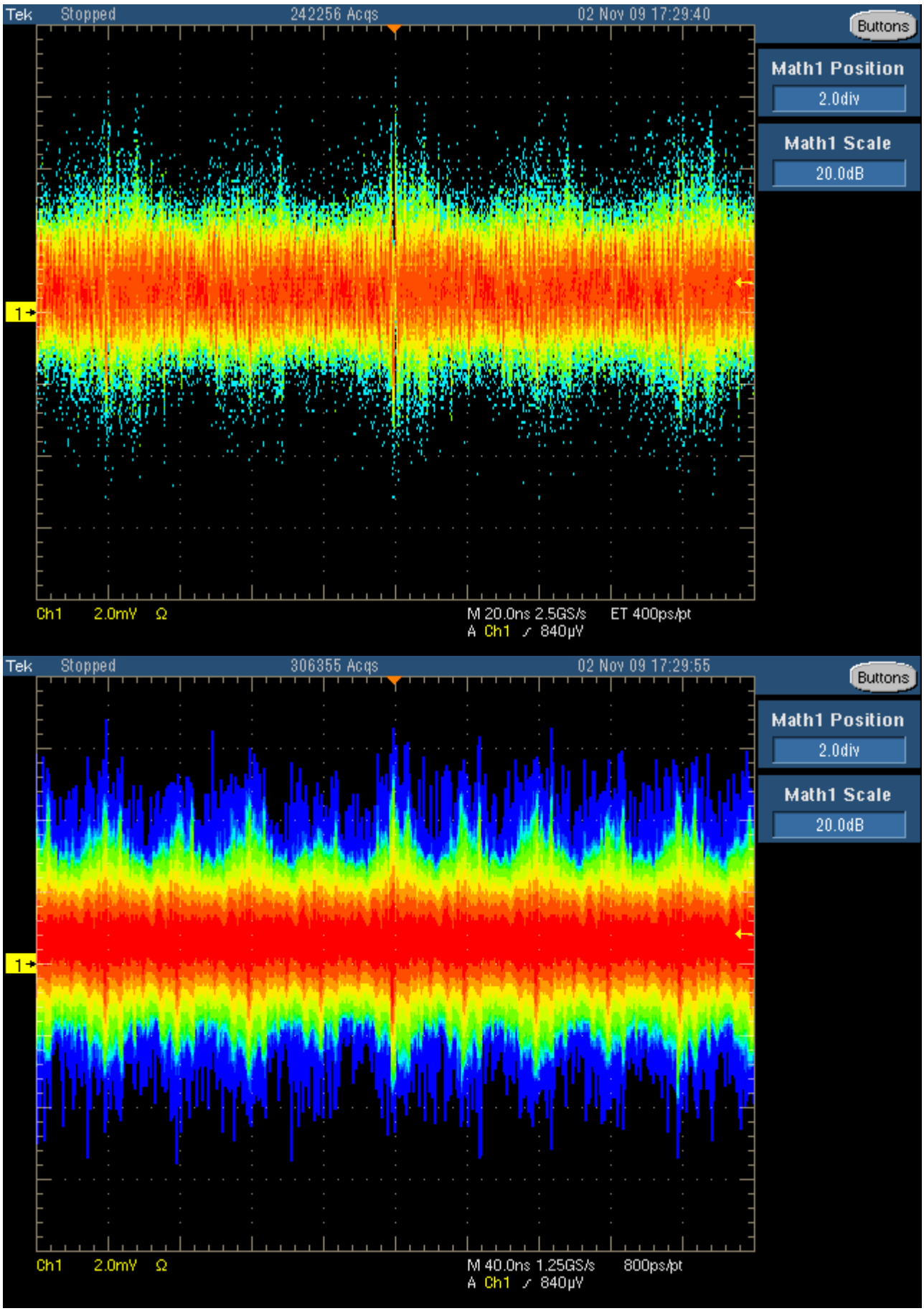

Tek Stopped Single Seq 1 Acqs 02 Nov 09 17:38:28
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 200µs 250MS/s 4.0ns/pt
A Ch1 ⟋ 840µV
Tek Stopped 21 Acqs 02 Nov 09 17:39:08
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 400µs 250MS/s 4.0ns/pt
A Ch1 ⟋ 840µV

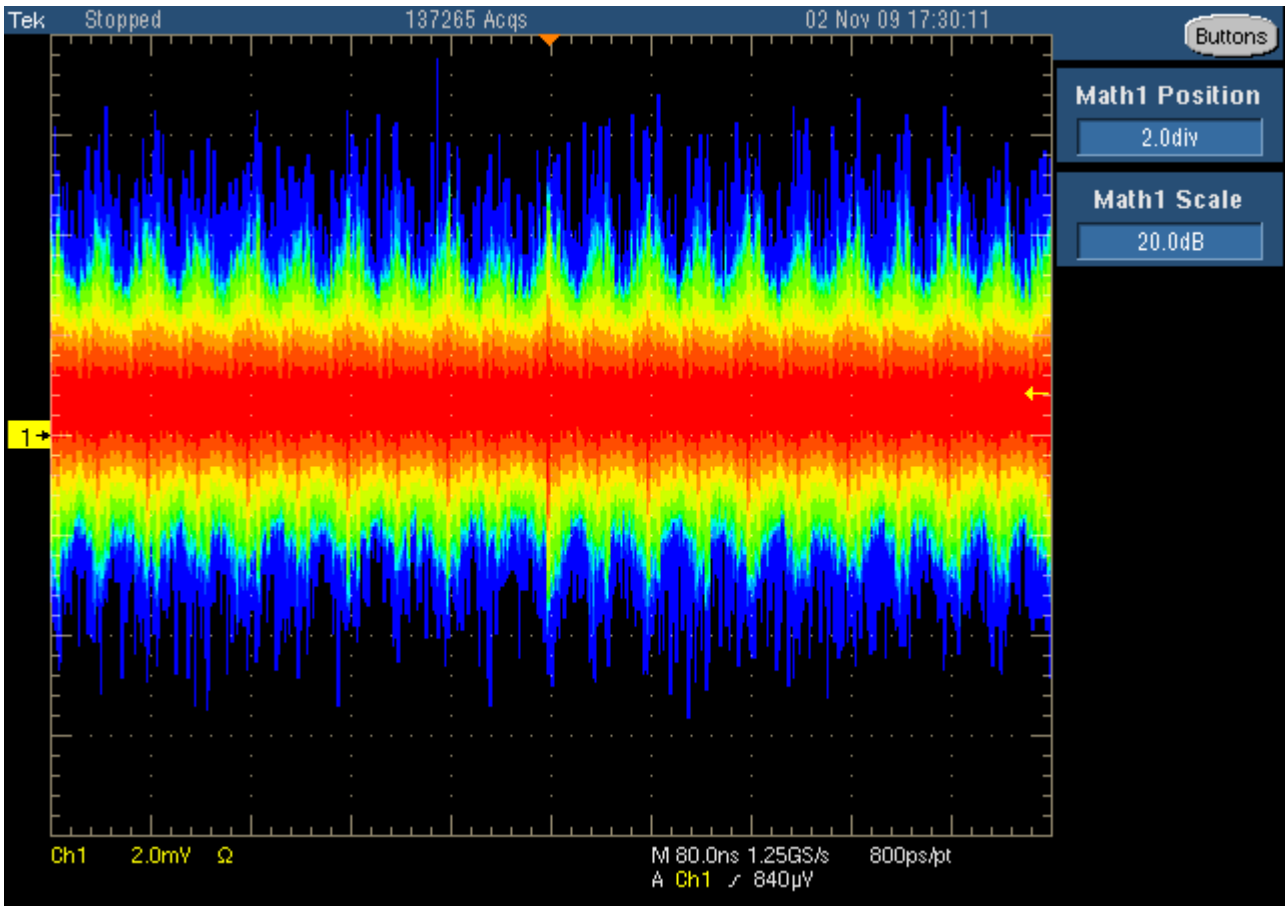

Tek Stopped 17 Acqs 02 Nov 09 17:39:23
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 1.0ms 125MS/s 8.0ns/pt
A Ch1 ⟋ 840µV

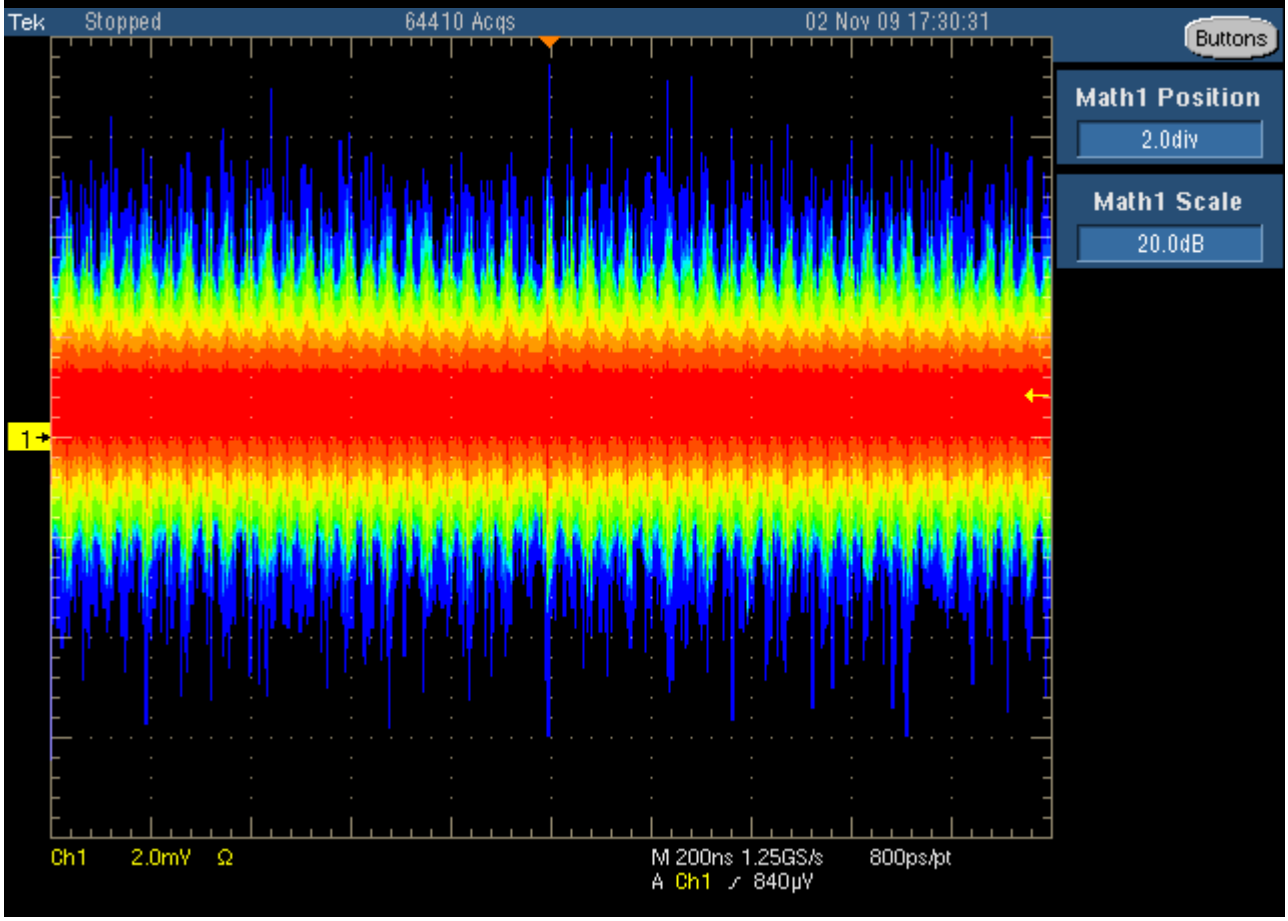

Tek Stopped 10 Acqs 02 Nov 09 17:39:54
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 4.0ms 25.0MS/s 40.0ns/pt
A Ch1 ⟋ 840µV

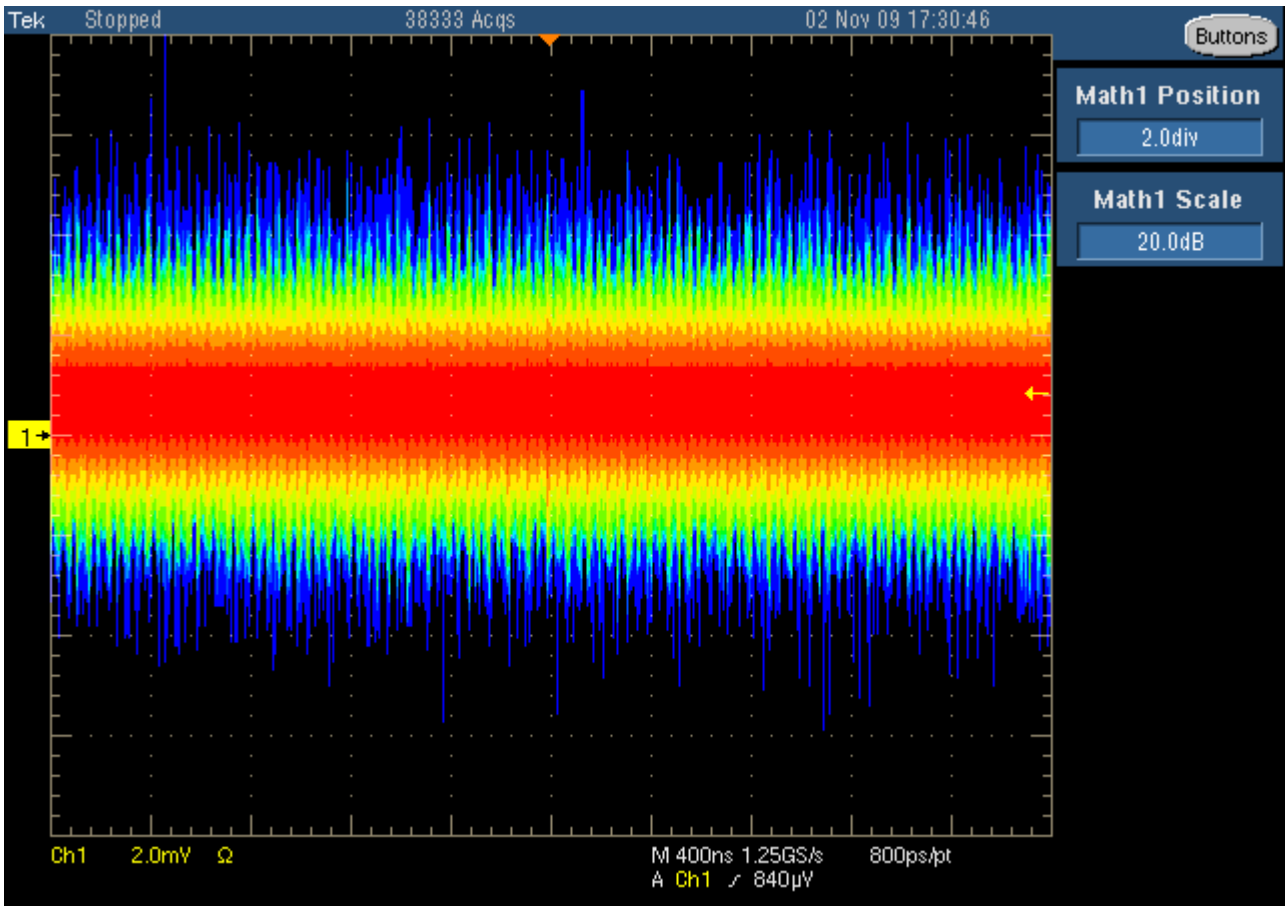
FastAquisition




Tek Stopped 242256 Acqs 02 Nov 09 17:29:40
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 20.0ns 2.5GS/s ET 400ps/pt
A Ch1 ⟋ 840µV
Tek Stopped 306355 Acqs 02 Nov 09 17:29:55
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 40.0ns 1.25GS/s 800ps/pt
A Ch1 ⟋ 840µV


Tek Stopped
137265 Acqs
02 Nov 09 17:30:11
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 80.0ns 1.25GS/s 800ps/pt
A Ch1 ⁄ 840µV


Tek Stopped
64410 Acqs
02 Nov 09 17:30:31
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 200ns 1.25GS/s 800ps/pt
A Ch1 ⁄ 840µV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38333 Acqs
02 Nov 09 17:30:46
Buttons
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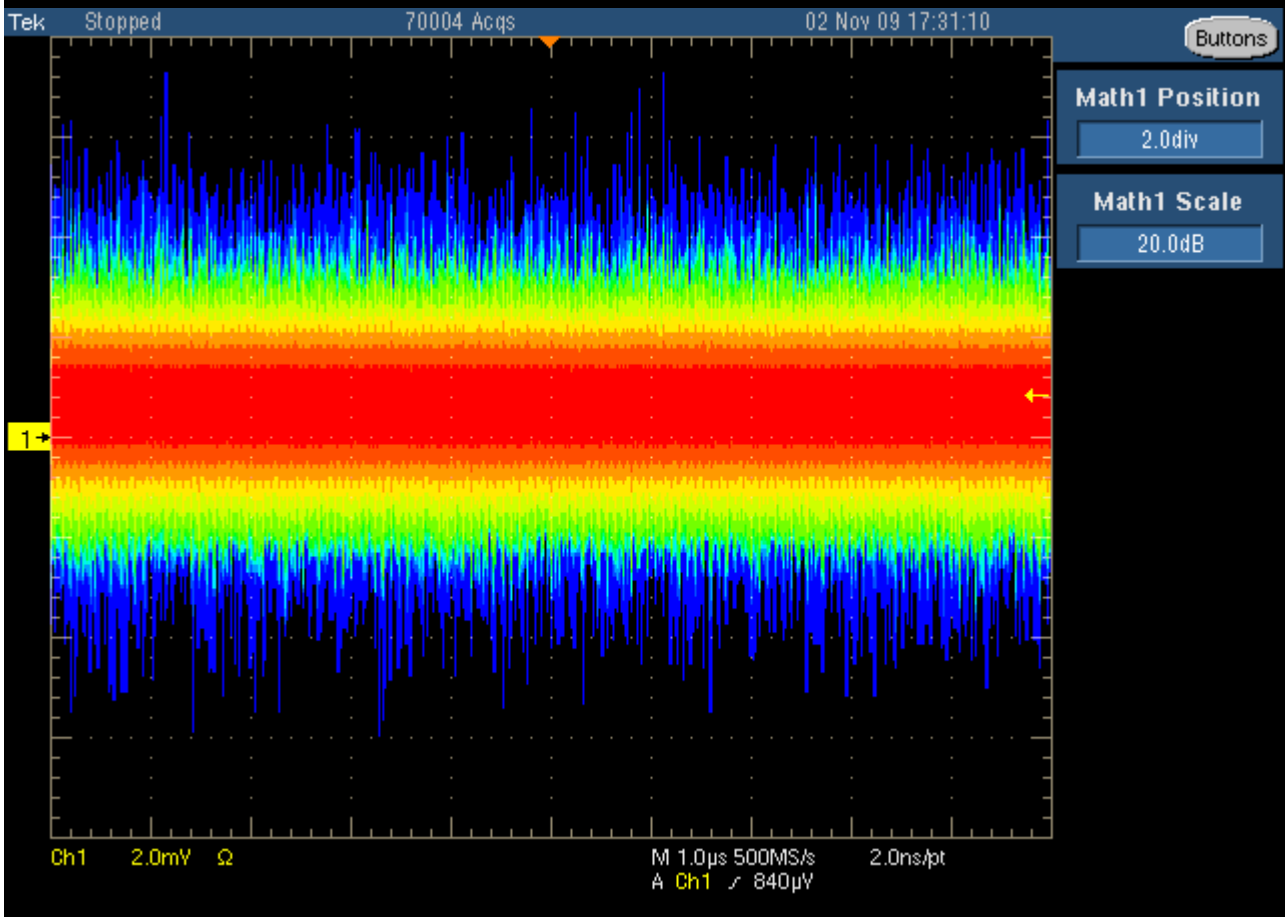
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 400ns 1.25GS/s 800ps/pt
A Ch1 ⁄ 840µV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70004 Acqs
02 Nov 09 17:31:10
Buttons
Math1 Position
2.0div
Math1 Scale
20.0dB
1
Ch1 2.0mV Ω
M 1.0µs 500MS/s 2.0ns/pt
A Ch1 ⁄ 840µV

Conclusion

As shown in the pictures above noise and parasitic signals like amplitude modulation and high frequency ringing (~650 MHz) as expected by the transient LTSpice simulation are present problems at the input stage of the Welec-DSO.

Real amplitude will be 14/8 times higher and this signal is than amplified by factor 8. The high frequncy signals parts are attenuated by the AD8131 gain stage, but this is no good assumption for further improvement.

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