

Adjustment of the offset when using the integration function on a scope

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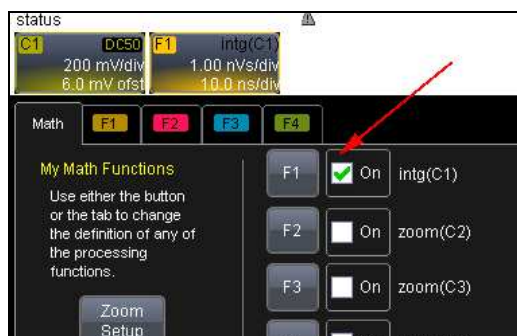
1. Introduction

This note deals with the adjustment of the offset when using the numerical integration function on a scope during the measurement of a pulse with a derivative sensor.

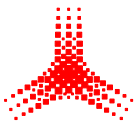
2. Oscilloscope settings procedure

The following procedure is valid for a LeCroy Waverunner Xi series oscilloscope, concerning a RS105 electric field measurement, or similar:

- Connect the measurement set-up to the oscilloscope.
- The correct correction factor must be used for the full measurement installation. That means that the attenuation of the fibre optic link, of the additional attenuators and of the cables must be taken into account. A measurement of these components must be carried out with a network analyser before using them. The frequency range must cover the frequency content of the pulse. See also the technical note no TN15 concerning the correction factors to use.
- Switch the oscilloscope on.
- Adjust the main settings of the oscilloscope to be adapted to the signal to measure. For instance: BW must be set to "full", impedance to "50 ohm" and noise filter to "none".
- Adjust the trigger delay to about 1 – 1.5 x the timebase value (example: trigger delay: about 20 to 30 ns if the timebase is set to 20 ns/div).
- Adjust the offset of the measured in order to have the signal (before triggering) placed to zero.
- Select the "Math" menu then click on "Math" setup.
- Activate the function in relation with the active trace (here: C1).



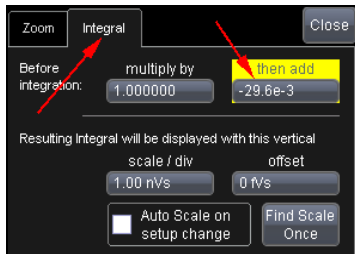
- Click on "F1"



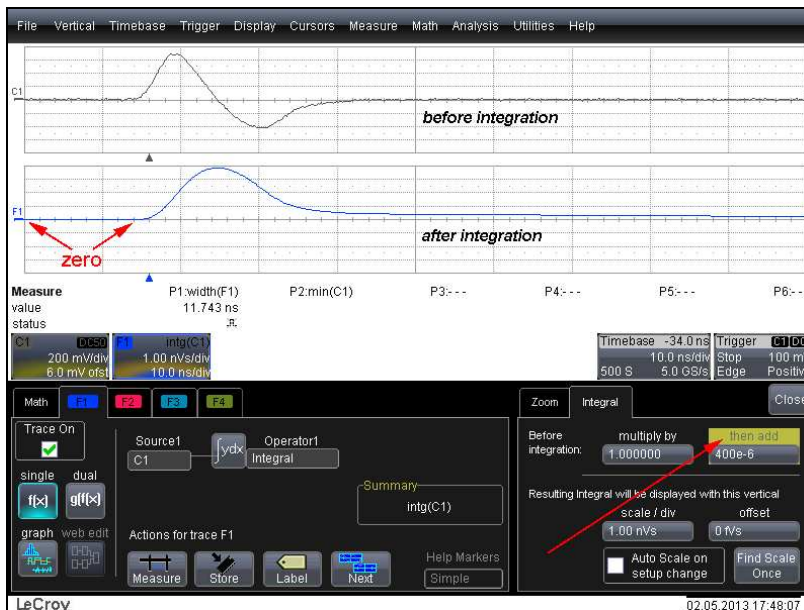
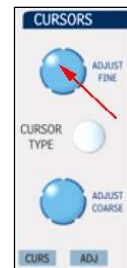
- Then select the math function "Integral" as shown the picture below.

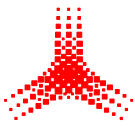


- Then click on the "integral" button. The adjustment of the curve must only be made with the value "then add". This is the compensation of the offset before integration.



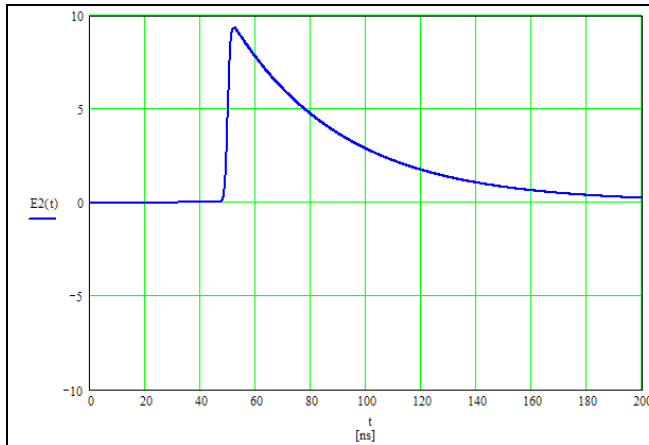
- Turn the "cursors" control button on the front plate of the oscilloscope until the first part of the curve (before the beginning of the impulse) is flat as shown in the picture below.





3. Analysis of the adjustment

The examples shown below concern the simulation of the measurement of a RS105 pulse with a D-Dot sensor, a fibre optic link and an oscilloscope using the function "integral". They show the effects of the adjustment on the measurement of the impulse main specifications.



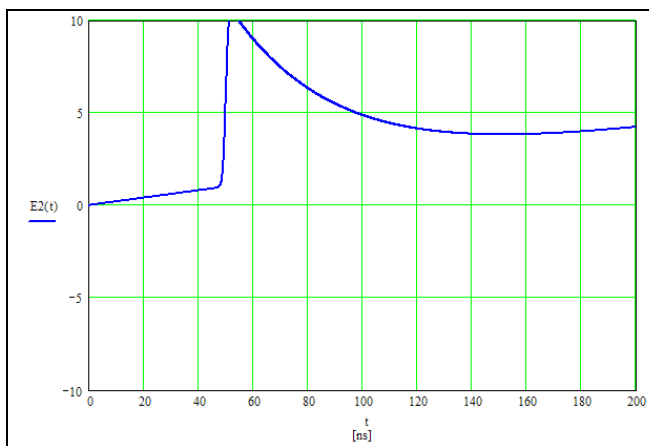
CORRECT

Setting:

- correct adjustment of the offset

Result:

- peak measurement: OK
- rise time measurement: OK
- duration measurement: OK.



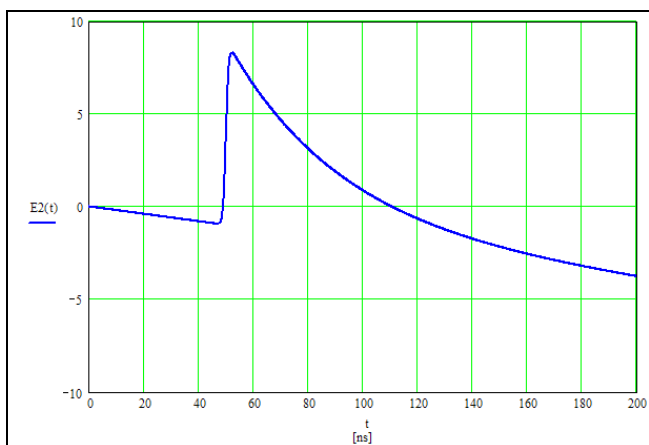
WRONG !

Setting:

- no adjustment of the offset (offset positive)

Result:

- peak measurement: wrong (too high)
- rise time measurement: small error
- duration measurement: wrong (too long).



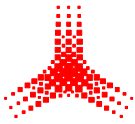
WRONG !

Setting:

- no adjustment of the offset (offset negative)

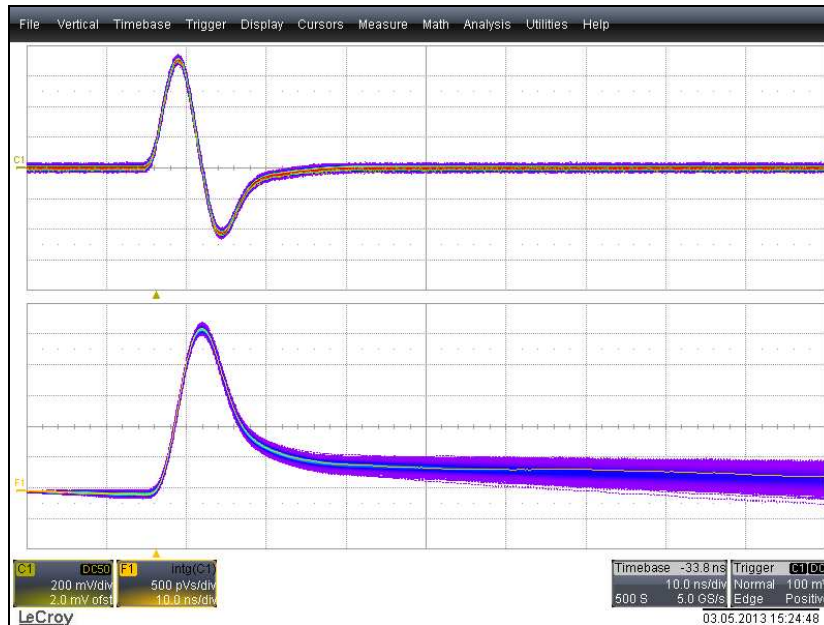
Result:

- peak measurement: wrong (too low)
- rise time measurement: small error
- duration measurement: wrong (too short).



Remark:

The adjustment of the compensation of the offset before integration must be repeated for each impulse because the random noise induces a variation on the curve drift as shown in the next figure. The curve at the bottom is the envelope of the integrated measurement results after many triggers.



4. Conclusions

The correct adjustment of the oscilloscope settings during the numerical integration is not obvious and big errors can be made if the offset compensation before integration is not correctly done. This is the case especially concerning the pulse duration measurement.

Even with a careful adjustment of the oscilloscope, very precise measurement of the waveform characteristics cannot be done, especially concerning the duration of the impulse. This is due to the curve drift produced by the random noise. This could be minimised by an averaging of the measurement but not for single impulses. It is recommended to use a test set-up using a passive integrator for more precise and reliable waveform measurement.