Rescaling WaveSurfer MXs-B

TEN MINUTE TUTORIAL

July 9, 2012

Summary

Many applications require that the vertical scaling and units for a measurement be changed to accommodate a variety of different sensors or probes. The Rescale math function handle this task.

Introduction

The Rescale function, a math function, lets you multiply the amplitude of an acquired waveform by a constant or multiply by a constant and then add a constant. Additionally, the units of measure for the rescaled function can be converted to a wide variety of common units.

This function is used with special sensors or probes to obtain calibrated amplitude readouts in the units that match the sensor readings. It can also be used to switch between one system of units and another.

In the following tutorial you will use the rescale math function to convert a voltage reading to a current reading, remove a bias offset, and scale measurements.

Equipment Required

WaveSurfer MXs-B Oscilloscope
Passive probe

Initial Setup

Displays shown in the tutorial are based on the following initial setup on a WaveSurfer MXs-B oscilloscope:

1. Connect a passive probe from Channel 1 to the CAL test point on the front panel. The CAL output is a 1 kHz square wave with an amplitude of 1 V
2. Recall the default setup by choosing: File> Recall Setup> Recall Default.
3. Turn off Channel 2.
4. Auto Setup the scope: Press Auto Setup on the front panel. Select Confirm from the pop-up menu.
5. Using the C1 dialog box, set the Channel 1 vertical scale to 200 mV/division and the vertical offset so that the bottom of the trace is one and one half divisions above the bottom of the display grid.
6. Set the trigger level to 500 mV.
7. This completes the initial setup. The scope display should be similar to Figure 1.

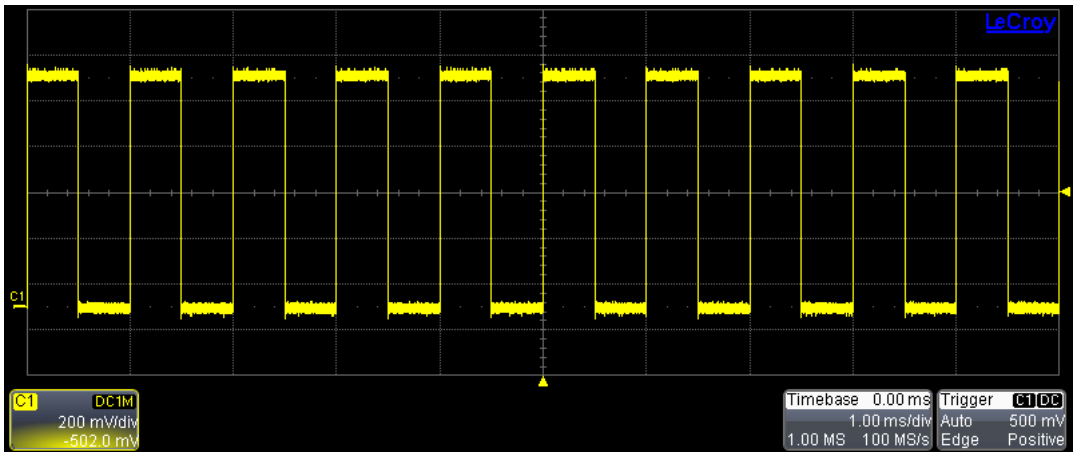

Figure 1: The scope display after performing the steps of the initial setup

Using the Rescale Function

1. We will rescale the waveform on Channel 1 to read the current into the probe tip. This is done by dividing the voltage waveform by the probe input resistance of 10 MOhms using the rescale math function.

2. Open the Math dialog box by choosing: Math>Math Setup>.

3. Select the source as Channel 1, the operator as rescale. Touch or click the Trace On box to display the trace.

4. Touch or click on the Rescale tab on the right side of the math dialog.

5. Double touch or click on the First Multiply By box. When the pop-up keypad appears, enter the number 100Exp -9 and press OK. This will cause all the samples in the channel 1 waveform to be multiplied by 1e-7 (the same as dividing by 10 MOhms).

6. Click or touch the Override Unit check box, a check mark will appear along with an Output Units box.

7. Touch or click on the output units box. An onscreen keyboard will appear. Type in the units as A for Amperes, then, press OK. The units in the Math trace annotation box should change to nA.

The screen should appear as shown in Figure 2.

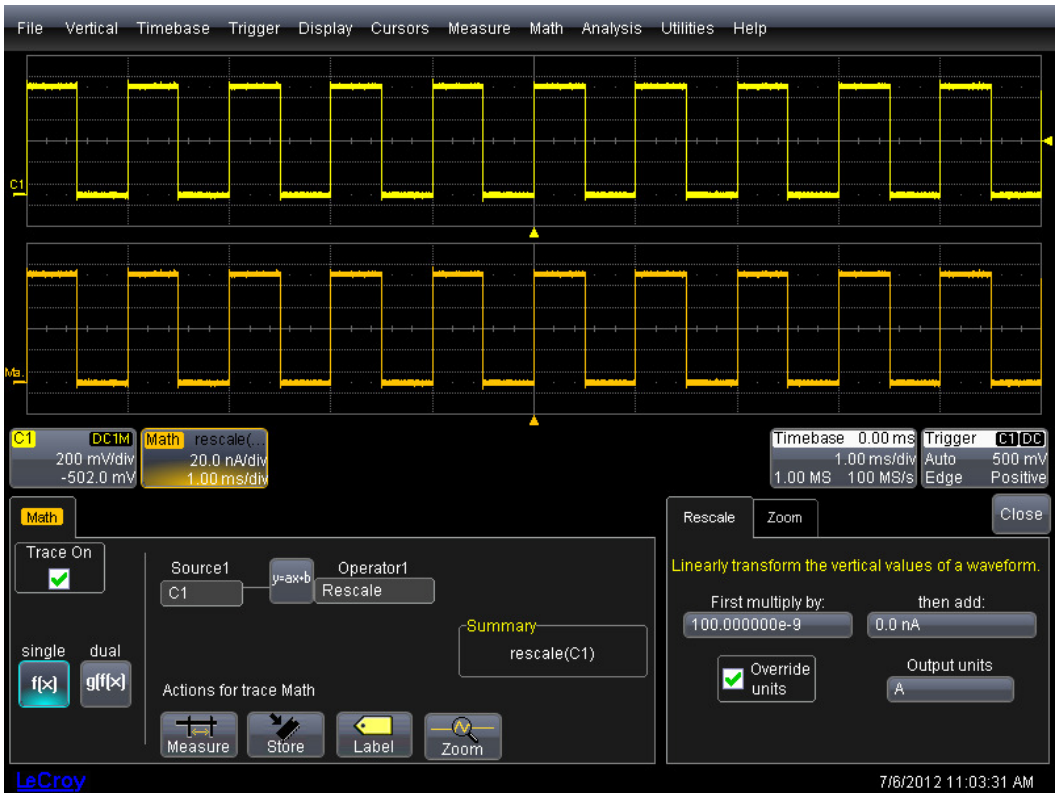

Figure 2: The setup for the rescale math function converting the voltage reading of Channel 1 into current drawn by the probe

Supported Output Units abbreviations are as follows:

1. (blank) - No units
2. A - Ampere
3. C - Coulomb
4. CYCLE - Cycles
5. DB - Decibel
6. DBC - Decibel referred to carrier
7. DBM - Decibel Milliwatt
8. DBV - Decibel Volts
9. DBUZ - Decibel Microamp
10. DEC - Decade
11. DIV - Divisions
12. Event - Events
13. F - Farad
14. G - Gram
15. H - Henry
16. HZ - Hertz
17. J - Joule
18. K - Degree Kelvin
19. CEL - Degree Celsius
20. FAR - Degree Fahrenheit
21. L - Liter
22. M - Meter
23. FT - Foot
24. IN - Inch
25. YARD - Yard
26. MILE - Mile
27. N - Newton
28. OHM - Ohm
29. PAL - Pascal
30. PCT - Percent
31. POISE - Poise
32. PPM - Parts per million
33. RAD - Radian
34. DEG - Degree (of arc)
35. MNT - Minute (of arc)
36. SAMPLE - Sample
37. SWEEP - Sweeps
38. SEC - Second (of arc)
39. S - Second
40. SIE - Siemens
41. T - Tesla
42. UI - Unit interval
43. V - Volt
44. VA - Volt amps
45. W - Watt
46. WB - Weber
47. MIN - Min
48. HOUR - Hour
49. DAY - Day
50. WEEK - Week

You can also enter combinations of the above units following the SI rules:

- For the quotient of two units, use the character “/”
- For the product of two units, use the character “.”
- Exponents can be represented by a digit appended to the unit without a space

For example:

- Acceleration can be entered as M/S2 for meters per second squared
- Volts seconds can be entered as V.S.

In some cases, the units entered may be converted to simple units. For example entering V.A will display W (watts)

Continuing With the Tutorial

Save the Math trace to M1 (File pull down>Save Waveform>Save To Memory>Source Math>Destination M1>Save Now!).

Open the Math dialog box again. Define the Math trace to be the integral of M1. Turn on the Math trace.

The screen should appear as shown in Figure 3:

Figure 3: Integrating the current waveform produces a ramp-like function due to the unipolar input signal

Because the trace M1 is unipolar positive, the integral produces a ramp-like waveform as the positive mean value (as measured using the parameter P1) accumulates with time. If we want to see the integral of the waveform separate from the accumulating offset, we need to remove the mean value. We can do this by subtracting the mean value of the waveform. Use the Then Add field of the rescale function to add a constant. In our case the constant is the value of the mean multiplied by -1 in order to subtract it from the integral operation.

1. Turn off the M1 trace and open the Math trace dialog box. Select the source to be C1 and the Operator to be Rescale.
2. Touch or click on the Rescale tab on the right side of the Math dialog.
3. Double touch or click on the First Multiply By box. When the pop up keypad appears, enter the number 100Exp -9 and press OK.
4. Click or touch the Override Unit check box, a check mark will appear along with an Output Units box.
5. Touch or click on the output units box. An onscreen keyboard will appear. Type in the units as A for Amperes, then, press OK. The units in the Math trace annotation box should change to nA.
6. Measure the mean of the Math trace using P1 (Measure Pulldown>Measure Setup…>Show Table checked> Statistics On >P1 >Source Math>Measure Mean>).
7. Using the Rescale tab in the Math setup dialog enter -1 times the mean value of the Math trace, as measured by P1, into the Then Add field. Save this waveform as M2 (File pull down>Save Waveform>Save To Memory>Source Math>Destination M2>Save Now!).
8. Turn off the measurement parameters. Note that the mean value of the Math waveform is now at zero
9. Select dual in the Math setup dialog. Select Operator2 to be integral.

The waveform should now appear as shown in Figure 4.

Figure 4: Using the rescale constant to remove the mean value of the waveform in Channel 1 before integrating

Note that the integral no longer increases with increasing time. The integral function also incorporates a rescale operation, and we could have done the same thing there. We chose to use the rescale function because it also offered the ability to redefine the units of the measurement. Note that the trace annotation box for the Math trace now lists the units as C for Coulombs. So once units are redefined subsequent math operations show the correct units of measure.

Conclusion

The rescale function allows us to scale waveforms by multiplying by a constant, and multiplying by a constant and then adding a constant. You can also use these functions to change the units of a trace or parameter .

This completes the tutorial.