Resolution of Hot-Wire Anemometry Measurements

Frequently Asked Question #10

Question:

I am measuring a very steady flow with my IFA300 and 1210-20 probe. The flow is being generated with the TSI model 1128B calibrator. When I look at the data (velocity vs time), I am not seeing a smoothly varying line, but a blocky looking line, almost like a square wave. What am I doing wrong? Is this related to the resolution of the system?

Answer:

You are exactly correct. What you are seeing is the resolution of the A/D card (integer bit-value steps in the velocity plot vs time). Since the 1128B is able to generate such a *perfectly* steady flow, you are able to see the A/D card resolution. You will always see this effect, but there are several ways to make sure you are getting the best resolution possible. The best way is to calibrate only over the range you expect to be measuring. For example, since you have a calibrator, it is easy to make calibrations, so you could have several calibrations for each of your probes, and then use the 'velocity specific' calibration for your runs depending on what velocity range you are expecting.

The other thing to do is adjust the gain and offset to use as much of the A/D board range as possible. You can use the gain and offset calculator but you can also check that it is okay by using a quick calculation. Let's say your minimum velocity gives you 0.5 volts, and your maximum velocity gives you 1.0 volt. Your Bridge Voltage is 1.6V. Then, to use the full -5 to +5 voltage range, use an offset of 0.5 + 1.6 = 2.1V and a gain of 20. If the gain is too high, you will see a yellow pop-up "Warning – A/D Over Range" or "Warning – A/D Under Range."

This is what ThermalPro does automatically in calibration. It conservatively aims to go no further than -3.5 volts to +3.5 volts. To do this manually you adjust the gain and offset in the Acquisition – Probe Table screen. Adjust the offset by the value of voltage you wish to cancel out, for example if the Bridge Voltage is 1.8V, set the offset to 1.8V. The Bridge Voltage is available in the Test Screen. Click "Output Voltage" and change it to "Bridge Voltage." Observe the value for the channel you are adjusting.

Be sure to press the "Save Line" button in the Acquisition – Probe Table screen, otherwise your settings will not be saved.

Assuming you've done everything mentioned above, then the other thing to take into account is the physical limitations of hotwire anemometry. Actually, at zero velocity, the probe itself is generating a flow due to the natural convection of heat from the wire. Although it is small, this can be a real consideration at low velocities. For air, the slowest measurable velocities are on the order of 10 cm/sec (Using special probes, etc… people claim to have been able to get as low as 6 cm/sec). In water we can do a little better, with velocities down to about 10 mm/sec.

One other note, when making calibrations at very low velocities, it is a good idea to shield the flow somehow to make sure that stray air currents are not affecting the calibration.

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