Shumatech DRO Jitter Conclusions

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Conclusion

It is possible to reduce the jitter of the decimal display down to almost zero with the digital filter turned off by the application of one or two simple hardware changes.

This article was updated with an alternate method of attaching the ground wires on the circuit board. Lester Caine (lester@lsces.co.uk) of the Shumatech group on Yahoo perfected it.

Background

Let's first define a few terms. First of all, what are the major parts of the DRO?
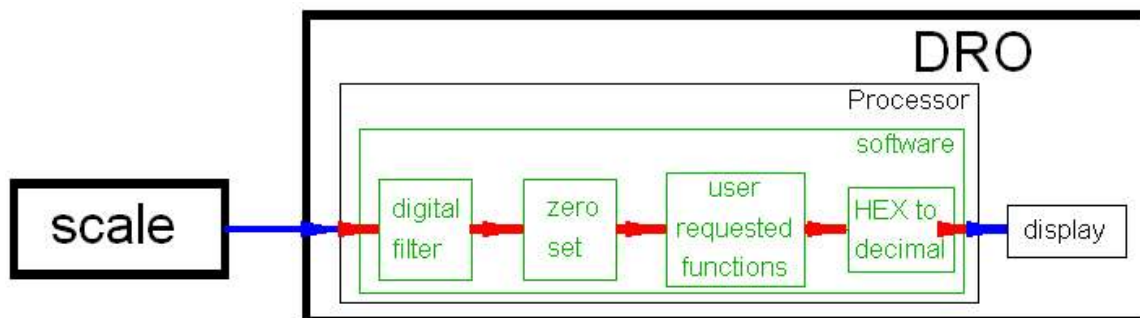
If we look at the hardware, we have between 1 and 3 scales connected to a box that I call the DRO. Inside the DRO are two key pieces of hardware: the processor and the display. The processor runs software.

Assuming the scale is what we commonly call "Chinese", it will have its own display that shows individual 0.001" steps plus has a 0.000 5" indicator. It sends a binary number to the DRO around 50 times each second. This

number represents the absolute position of the slider on the scale's bar. Ideally, this number does not change when the slider is motionless but, in fact, it typically changes a little in a complex little "dance".

The software takes this stream of dancing numbers and runs it through 4 major steps. First it applies a digital filter to extract an estimate of the average number. The user can set the filter value. If this value is 0, then no digital filtering takes place. Selecting the correct filter value can have a major effect on system accuracy. See http://rick.sparber.org/Articles/JB/JB4.pdf for details.

Next the software adds or subtracts a constant, which defines "zero". Say the number from the scale is 25. Zero set is instructed to define zero at this point. It records the 25 and then will subtract 25 from all future numbers. So you see that the absolute number out of the scale is harmless since we can set zero at any point.

The software then optionally performs logic and arithmetic on the number. For example, we can define a tool offset or request a bolt hole pattern. The result will be a number. This number is in hexadecimal (HEX) where *ideally* the least significant digit equals 1/20480 of an inch or around 0.000 05".

The final software step is to convert the HEX number to decimal inches (or mm). The display hardware shows steps of 0.001" plus has an indicator representing 0.000 5" which is exactly the data format present on the scale.

Now we can talk about jitter.
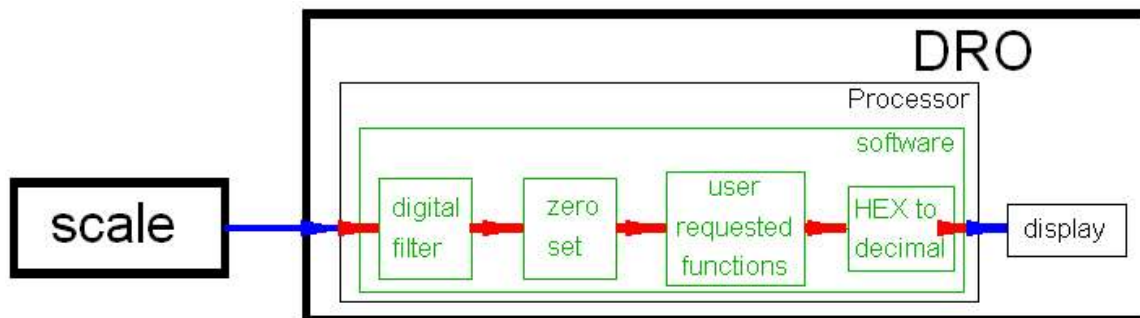
If things are very bad, we can have jitter on the scale's display. Most of the time we are talking about jitter on the DRO's display but here is where it can get confusing. Normally the HEX to decimal software is enabled so the

DRO display is showing decimal. In this mode we have 5 tenths indicator jitter and maybe thou indicator jitter.

However, it is possible to disable the HEX to decimal conversion and have the DRO display show HEX. In the HEX mode, the least significant digit *ideally* represents 0.000 05" so is far more likely to jump around. It is the best place to look when trying to see jitter and the effects of reducing this jitter.

Mommy, where does jitter come from?

There is an annoying little voice in all of our heads asking obvious and difficult questions. The source of jitter in the Shumatech DRO is high on my list. One thing that makes the answer so hard is that there is no standard configuration. For example:

- Some systems use less than 3 scales
- Some systems have a mix of Chinese scales and glass scales employing the QCC-100
- The length of each scale cable is not set
- Some systems use shielded scale cables which are grounded at both ends
- Some systems use shielded scale cables which are grounded at just the DRO end
- Some systems use shielded scale cables which are grounded at just the scale end
- Some systems use shielded scale cables which are not grounded at either end
- Some systems use unshielded scale cables
- Some systems have no capacitors at each scale and run on DRO supplied power
- Some systems run all scales on their internal batteries and have the +1.5V wire cut
- Some systems run all scales on their internal batteries and have the -1.5V wire cut
- Some systems run all scales on their internal batteries and also have the two power leads connected from the DRO

- Some systems have a high frequency capacitor (around 0.1 uF) and a low frequency capacitor (10 to 330 uF) at each scale
- Some systems have the metal of the scales insulated from the metal of the mill or lathe
- Some systems have the metal of the scales connected to the metal of the mill or lathe
- And I'm sure I've missed a few.

The bottom line is that many different configurations exist.

Who are you?

You might find yourself in one of the following camps.

A) If you are happy with the level of decimal display jitter seen, then your configuration is, by definition, fine.

B) If you are in the process of installing your DRO, I recommend the following to keep life simple and not increase jitter.

1. Ground your scales to your machine
2. Use unshielded cables
3. Remove all batteries from the scales
4. Solder a 0.1 uF high frequency capacitor plus a 330 uF low frequency capacitor to each scale (the 330 uF is probably over kill but if you go lower and find you need more, it is a pain)

C) If you are not happy with decimal display jitter, then things can be done that should help a lot. No promises here because these fixes have not been applied to many systems.

In the interest of keeping life simple, start with the easiest changes and escalate as needed.

Ground Noise Fix

This fix only applies to users that have both power leads connected to each scale. Details are provided at http://rick.sparber.org/Articles/spn/spn.pdf .
This fix requires you to open up the DRO box, cut 3 wires, and solder them

to a common point on the circuit board. Although the article says this fix has not proven to reduce jitter, subsequent testing shows that it can help a lot.

Scale Voltage Fix

While the ground noise problem is easily explained, the scale voltage fix is closer to "magic". It is easy to try and remove. If it works, great. Three people have applied both the ground noise and scale voltage fixes and had their HEX display jitter reduced substantially. This means that they can run in decimal display mode and see almost no jitter with the digital filter turned off.

The fix consists of solder a 68 ohm resistor in parallel with R35. This lowers the scale voltage from around 1.55V down to 1.45V. It is possible to more finely adjust this voltage and get any scale to have no HEX display jitter but the jitter goes back up slightly when the scales moves. The three people that tried these fixes found a HEX display jitter of around 2 from a starting value of around 9.

The Great Unknown

There is a jitter component that still comes to visit me once in a while. I see it after disrupting power to the DRO. Before unplugging power, the HEX display jitter will be around 2 counts. When power is restored, I might see a jitter of 7. By reapplying power, I will eventually return to the low jitter state. As long as you have reliable commercial power, this will not be a problem if you put the DRO in standby (FCN + 9) when not in use.

The only faint indication of what might be going on here comes from looking at the display driver signal and a scale clock signal at the same time on a scope. You can see that every few seconds the scale clock signal is synchronized with the display. The rest of the time they are independent. The display driver signal is software driven and not constant. It is possible that the "dance" mentioned earlier is from this effect. It is also possible that the jitter related to power on is also related. I don't own the proper test equipment to pursue this lead.
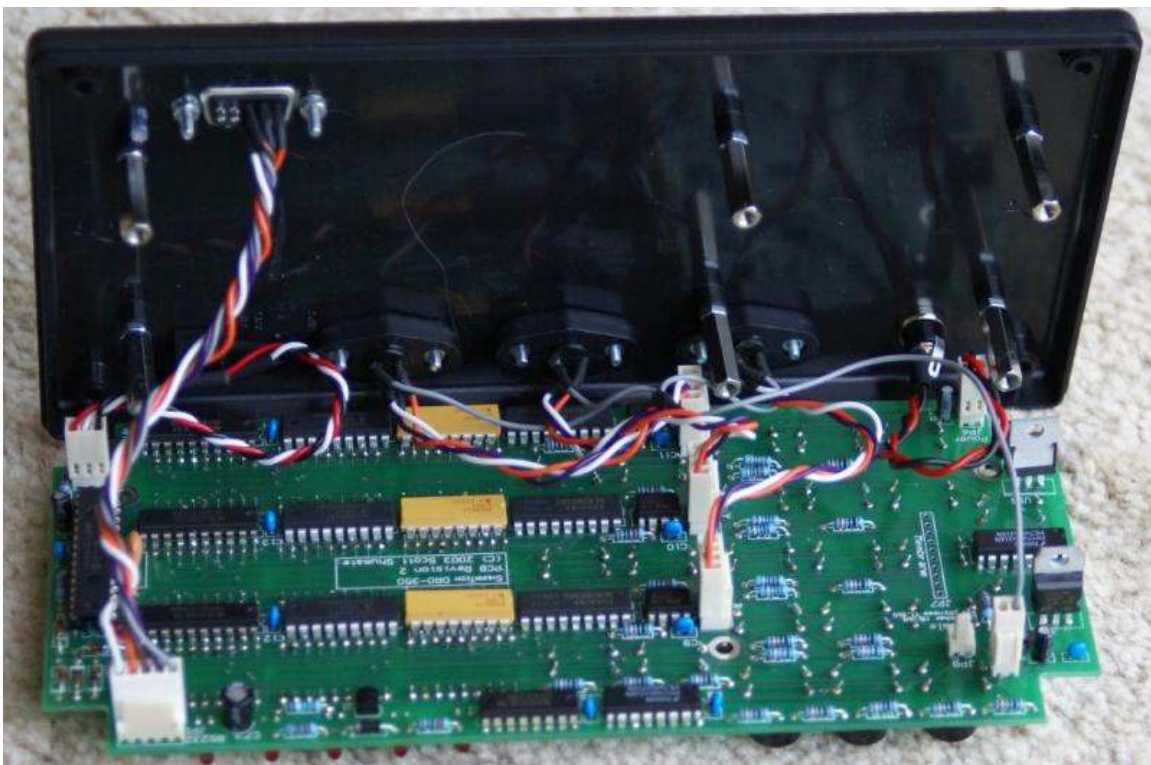
Additional Information

You will find numerous articles related to the Shumatech DRO on my web site.

What next?

As more people try one or both of these fixes and report back to the group, a better picture will appear. You are also welcome to contact me directly.

Lester Caine of the Shumatech site (lester@lsces.co.uk) came up with a clean way to move the ground wires.

Note the gray wire going to the two pin header in the lower right hand corner. The gray wire connects to the ground wires of the scales.
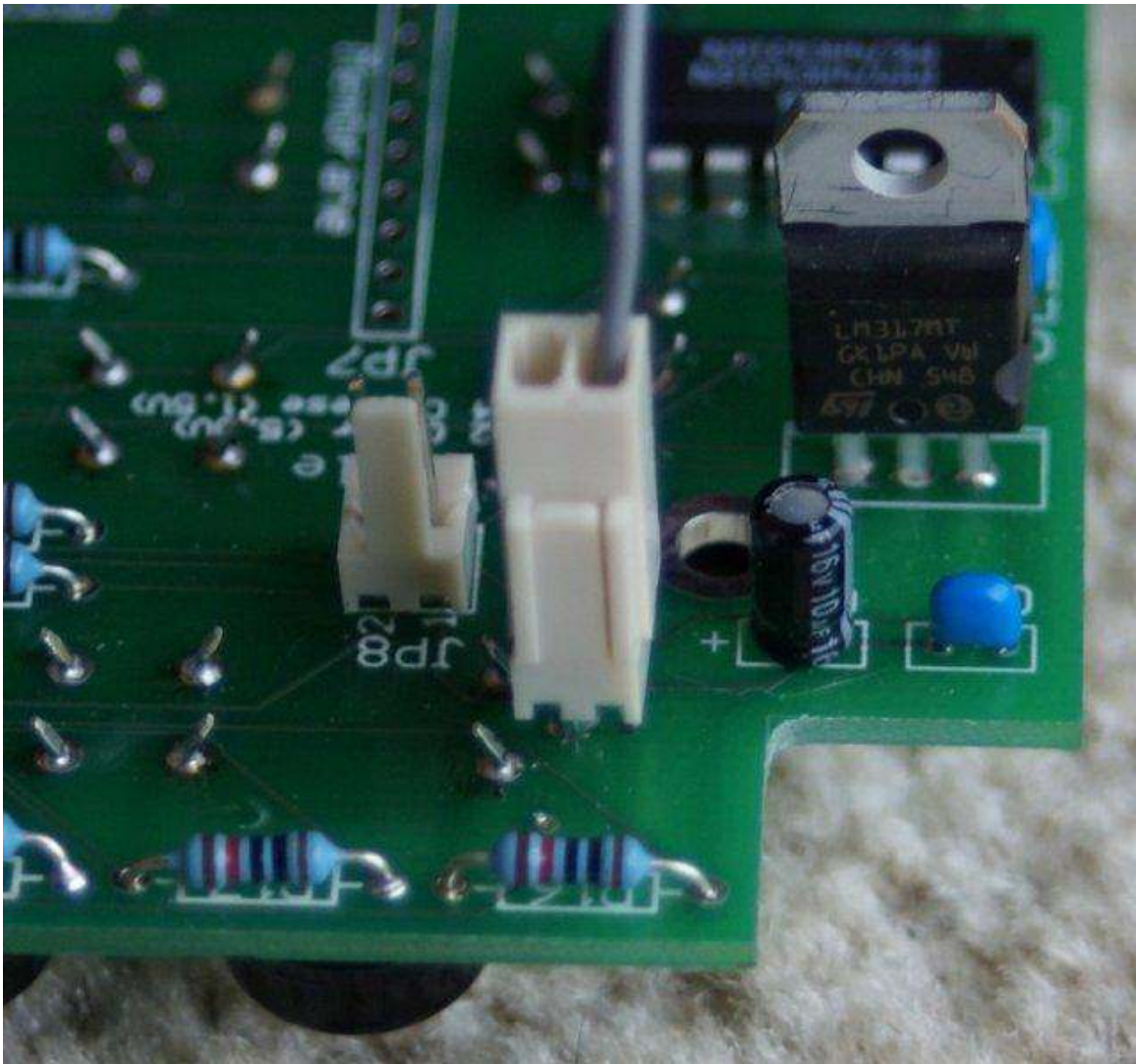
Here is a close up. It sure looks cleaner than my rewiring attempt. Thanks Lester!

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