UPCX530

Step-Response Tuning

Content

Preamble

This manual describes the PID tuning of the UPCX530 control loop using the step-response function build into the UPCX530 tuning tool software.

The UPCX530 is a motion controller that is based on a Microchip dsPIC MCU. The initial development of its firmware has been done by the following persons:

Lawrence Glaister (dsPICServo): http://www.members.shaw.ca/swstuff/index.html

Maximilien Mousset (YAPSC): http://www.max-mod-shop.com (Link currently broken)

I have added support for sensored BLDC motors and some additional features to the initial firmware.

The firmware for the UPCX530 is published under the GNU GPL license 3.0.

This manual covers the practical PID tuning only. For more details, additional stuff and downloads visit my website: http://www.vbesmens.de.

Some more detail on how PID loops work can be found in the following document that is part of my pick and place machine project:
http://www.vbesmens.de/images/Downloads/PP4ElectronicsSetup.pdf

V. Besmens, August 2014

Preparation

Connect the UPCX530 circuit to a power supply. **Use a current limited supply for the motor supply!** Use the same voltage for the motor supply that will be used in your final product.

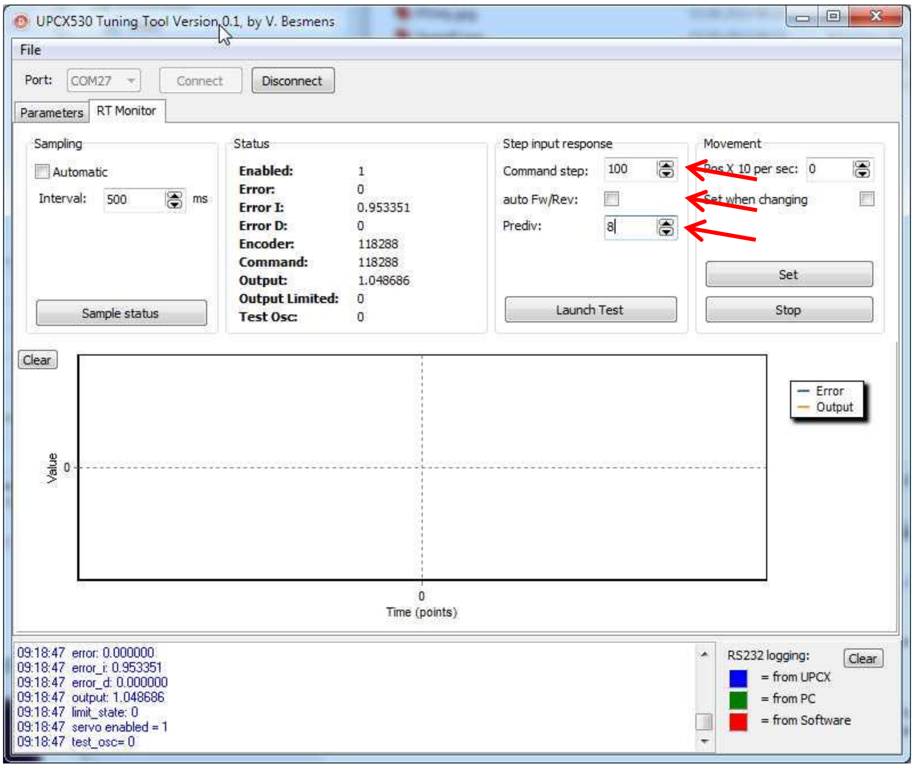
Connect the circuit to a PC using the serial interface of the UPCX530. Open the UPCX530 tuning software and connect it to the right COM port. Enable the UPCX530 by pulling the enable pin low.

Do not connect the motor to the mechanics now. You will later - when the motor is connected to the mechanics - have to go thru this manual again to fine-tune the values.

All UPCX parameters for the adjustment should be at their default state after programming the firmware.

Adjustment of P

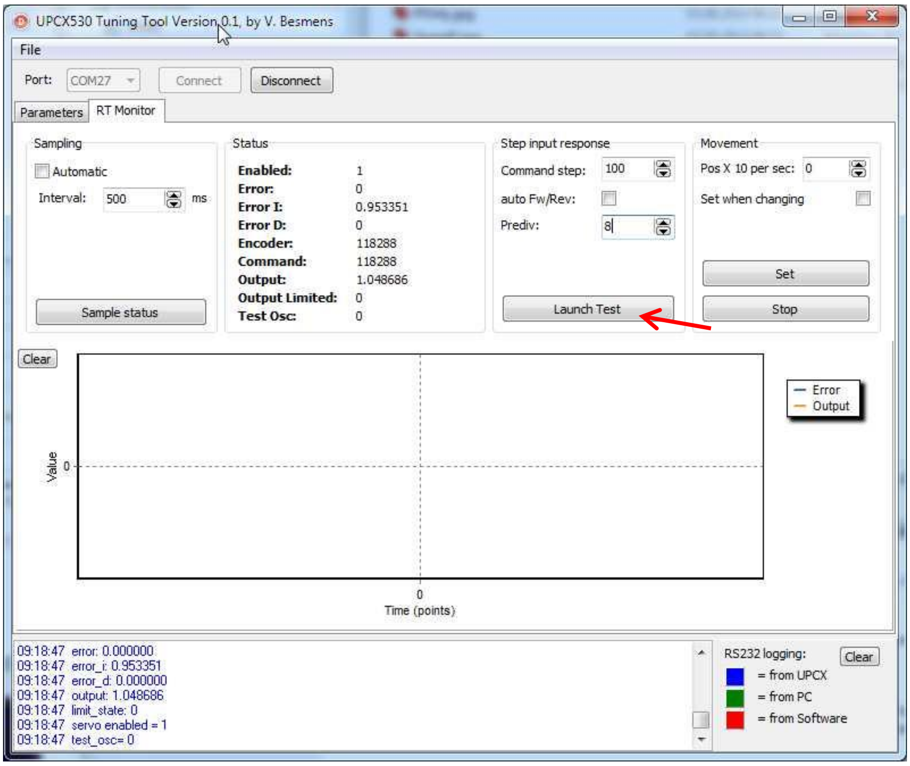
On the RT-Monitor tab set a “Command step” of 100 (500cpr X 4 encoder) and a “Pre-devider” of 8. When the motor is connected to the mechanics (only after initial adjustment) set “Auto Fw/Rev”.



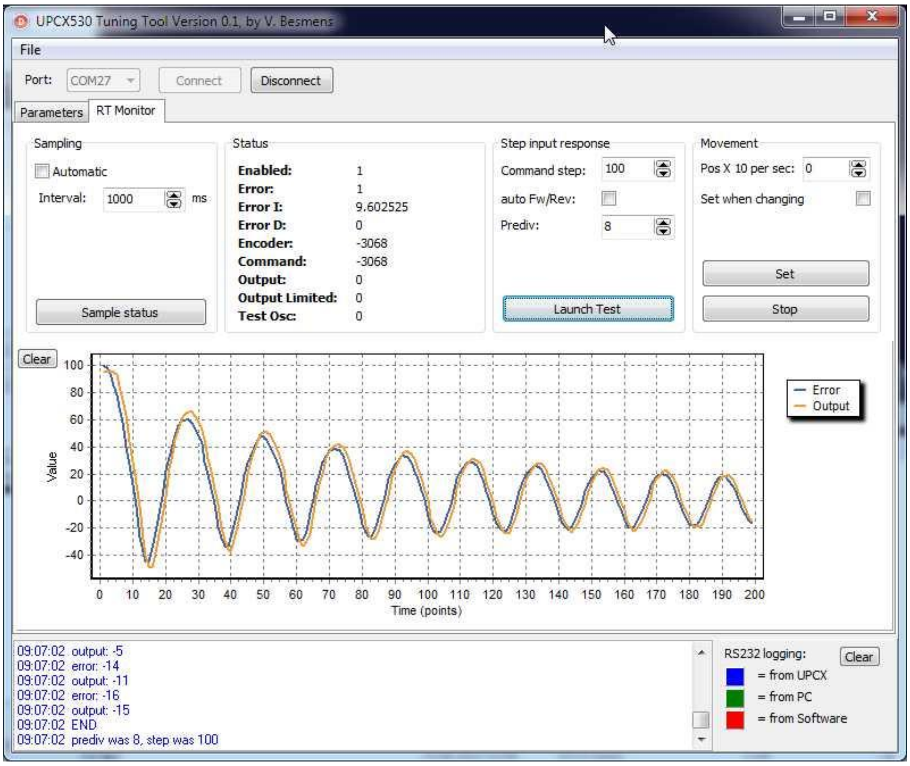
Now increase P and write the data on the “Parameters” tab. Increase it by 0.1 at a time. Then write the data to the UPCX. You will find that the motor has some force when you turn its shaft after you have increased P a little.

Note:
If you find the motor shaft snapping into the wrong direction disconnect the motor power and swap the motor leads or encoder phases (for a DC servo) or recheck the order of the 3 motor phases / hall sensors and / or encoder phases (for a BLDC servo). For details have a look at my website.

Click on “launch test” while increasing P further:



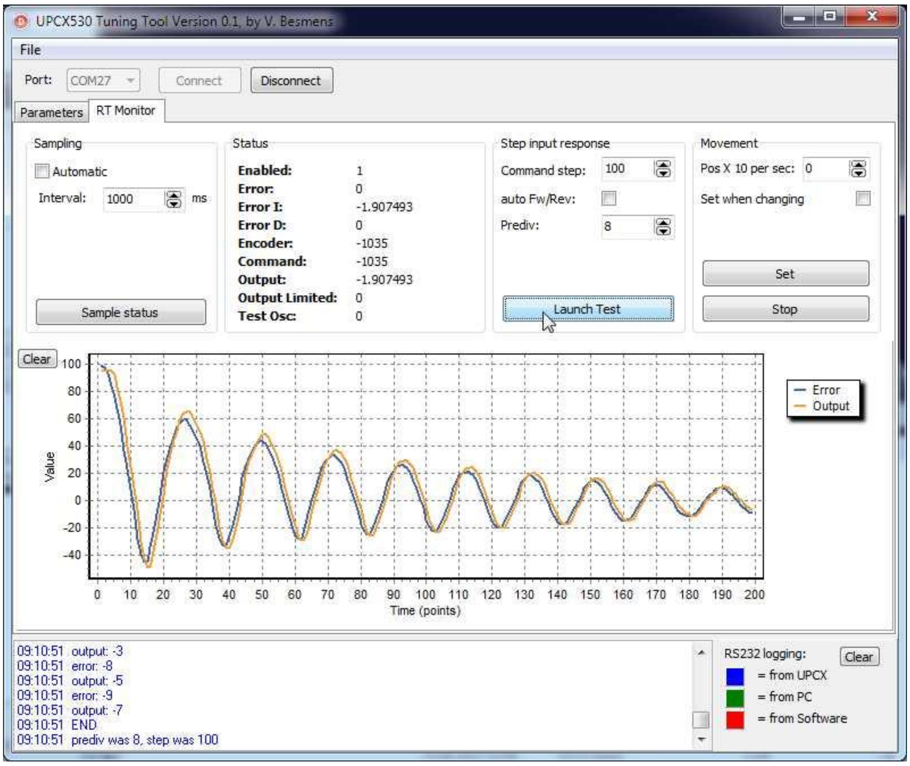
At some P value the motor will start to vibrate when you increase P further and the amplitude of the graph will increase rather than decrease. Reduce P to 2/3 of the value where you found the motor starting to vibrate. Clear the graph now and do another test. The result should look like this:



Adjustment of I

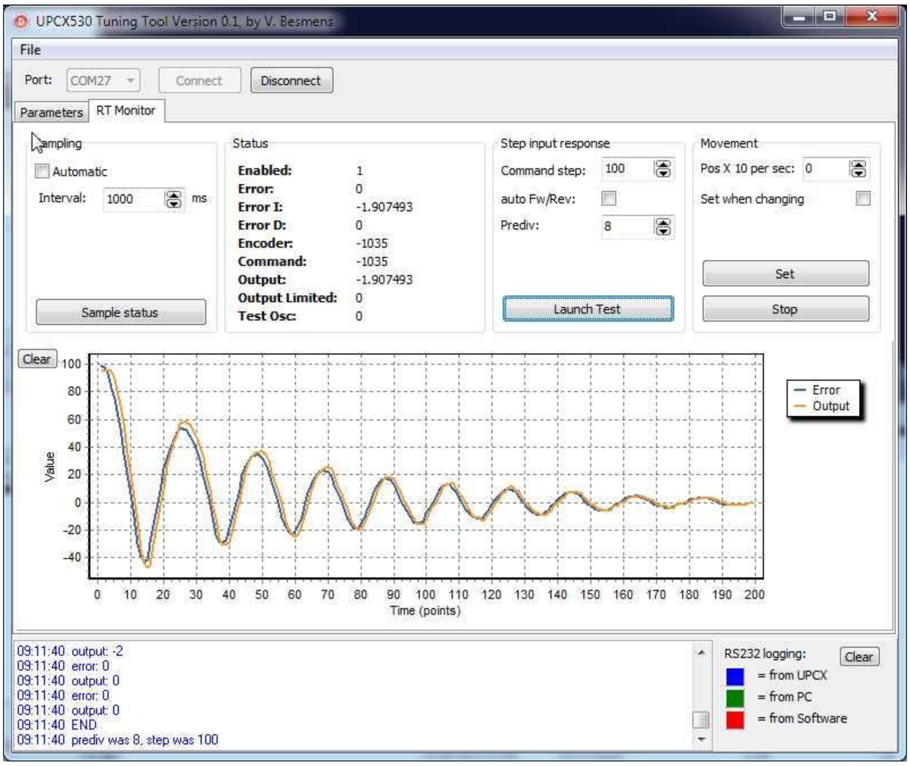
Now increase I in 0.1 steps and write the data to the UPCX530. Do step-input response tests each time after increasing. Also try to move the motor shaft by hand. You will find it holding its position better while you increase P.

Increase I only up to a point where the graph does not get worse than it was with P only. The sinusoidal response should stay mainly the same over time and in amplitude. It might even be a little better at some point:

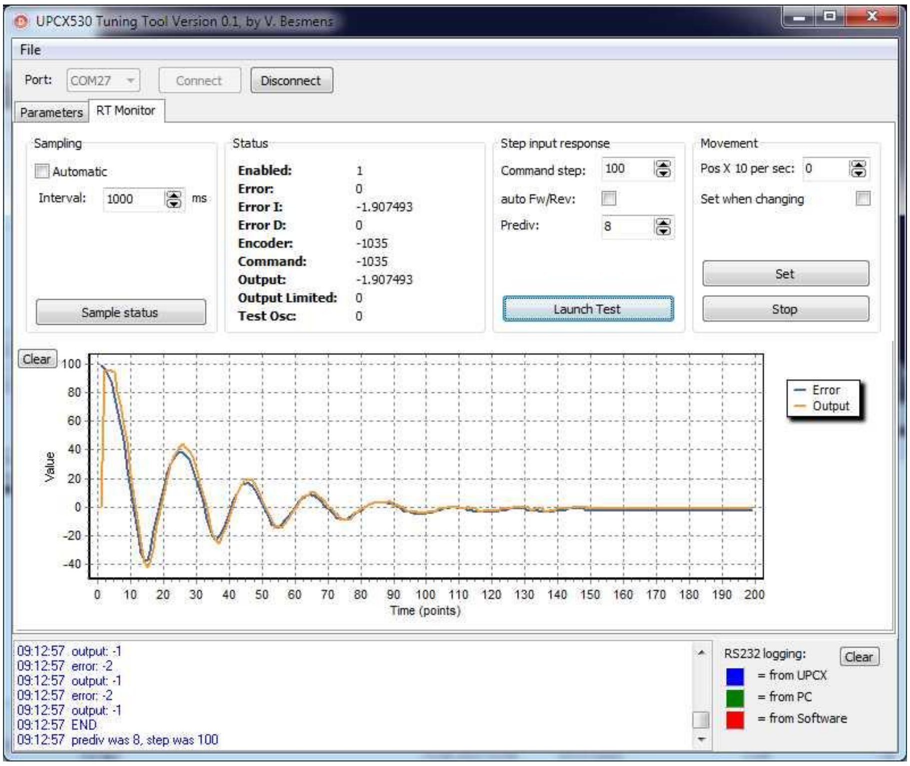


Adjustment of D

Now increase D in 0.0001 steps. Do step-input response tests and clear the graph each time after increasing it. This will dampen the sinusoidal curve:

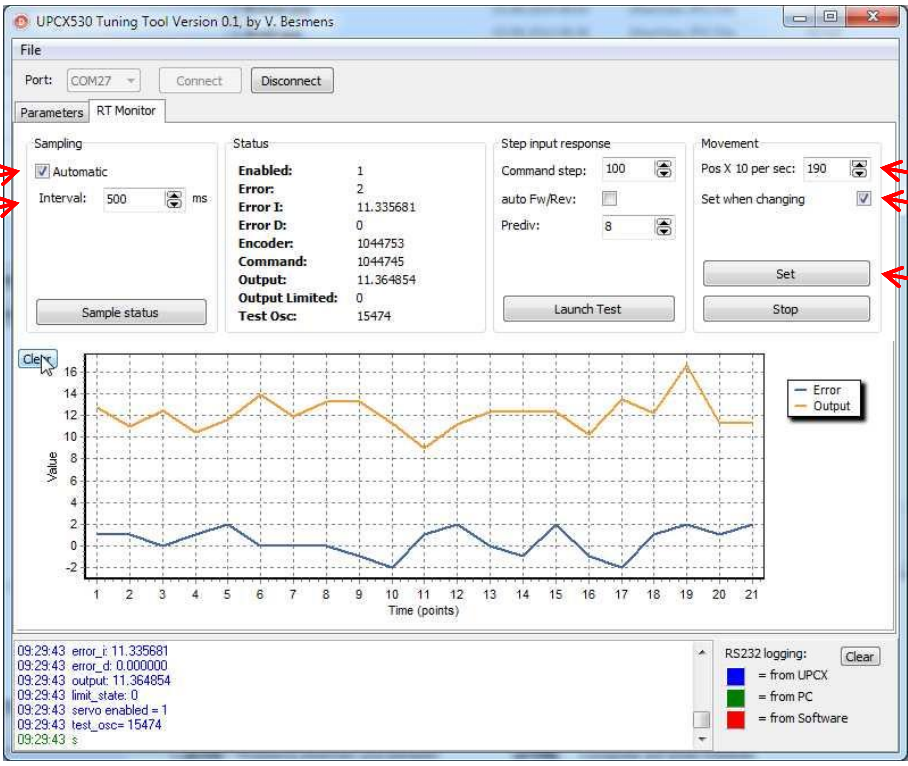


At some optimal point the result should look like this while the motor still holds its position well when its shaft is turned by hand and does not start vibrating again:



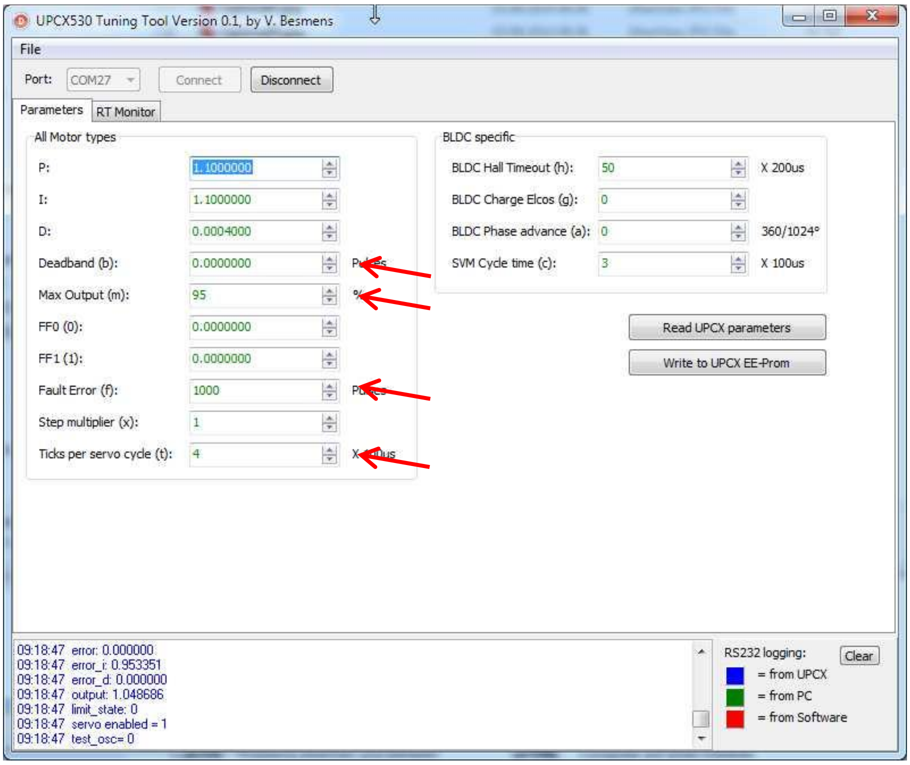
Oscillator test

Now use the test oscillator together with automatic sampling at a 500ms interval to move the motor continuously. Its position error (blue line) should stay within a couple of pulses from 0 without load.



If you stop the motor shaft a little by hand, the positioning error will increase a little but the regulation will kick in and put it back to 0.

Additional settings



Increase the deadband in 0.01 steps if you cannot get rid of micro vibrations while the motor stands still.

Set the "Max Output" to limit the maximum PWM percentage that drives the motor. You cannot increase it to more than 98% because the high side FET drivers need some "low time" to charge their bootstrap capacitors.

Leave the feed forward values at zero. In my opinion they do not make sense.

Set the fault error to something meaningful that protects your mechanics.

The "Ticks per servo cycle" define the cycle time of the PID regulation. You can decrease them to 3x100us. One would usually think that a shorter cycle time gives better regulation but that is not always the case. When you alter the ticks, the entered PID values will automatically compensate for the new cycle time.

Adjust the overcurrent protection (pot on the PCB) to something meaningful.

Do it again

After you have connected the motor to your mechanics, you can re-adjust the values. You will most likely be able to increase P and I a little further due to dampening of the mechanics. You will probably be able to reduce D a little.

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