GDtool 0.11 manual

Document version 0.31

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Introduction

GDTool software allows you to set **VSD-A** drive control loop parameters to match your control system. You don't need additional hardware (oscilloscope for example) to get essential information because GDTool reads data directly from drive and plot's it to your PC screen.

Requirements

- Windows[1] operating system
- Parallel port
- VSD-A Drive connected to motor and power supply
- Cable or breakout board to connect your PC and Drive

Cabling

Please read VSD-A **data sheet** for hardware information. To connect drive and PC, use 25 pin D-SUB cable or VSD-A breakout board. You can also build your own data cable according to following schematics.

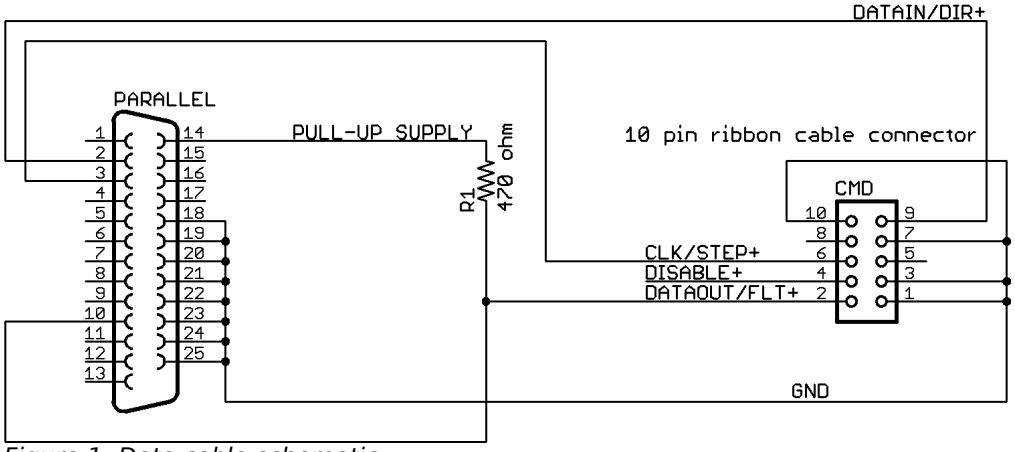

Figure 1: Data cable schematic

1 Windows Vista x64 is not supported

Installing software

1. Download latest GDtool binary from products/downloads section of www.granitedevices.fi
   Direct link: http://www.granitedevices.fi/pub_files/bin/GDTool.exe
2. Run installer with your preferred settings

Introduction to servo system

VSD-A firmware uses *closed-loop system* with negative feedback.

Closed-loop system (servo system) means that the result (feedback) is subtracted from the command value, to achieve proper control value so that the command value matches to the measured value (encoder signal).

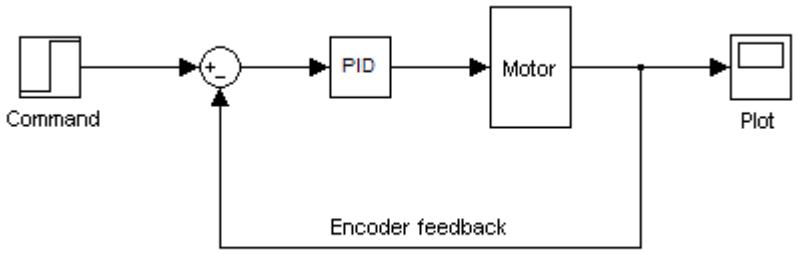

Figure 2: Basic control loop

Three different *control methods* can be used with VSD-A:

- Speed servo
- Position servo
- Torque servo

Proportional-integral-derivative controller (*PID* controller) is used to correct the error between an command and measured value. Command value is also called as setpoint value.

Input value of PID controller is the error value (difference). PID controller uses following formula to calculate output:

$$u(t) = K_p \cdot e(t) + K_i \cdot \int e(t) + \frac{K_d * de}{dt}$$

u, output

e , difference

Kp, gain factor of proportional part

Ki, gain factor of integration part

Kd, gain factor of derivation part

If gain factor are set too high system can become unstable.

Example:

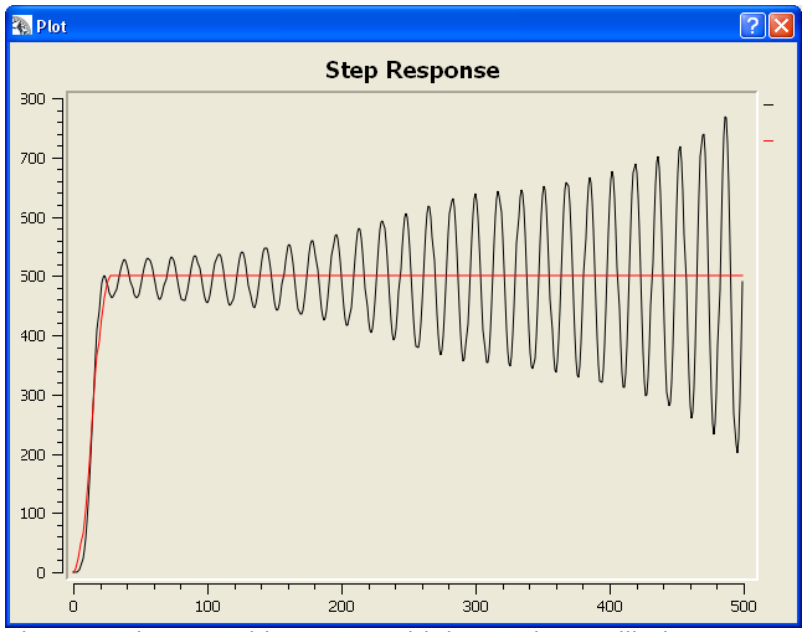

Figure 3: Plot, unstable system with increasing oscillation

The **red** line is the target value and **black** is the real measured output value. In this case the output starts oscillate. Oscillation causes eventually follow error to occur and stop the drive, if the boundary value is set properly.

The **X** axis is **time** and the **Y** axis is the **encoder count** value in position mode. In velocity mode Y axis equals speed value in encoder counts per PID cycle (400 µs in VSD-A).

Preferred reading:

Modern Control Systems, by Richard C. Dorf and Robert H. Bishop

Getting started with GDTool

1. Check cable connections and enable logic supply

   Warning! Do not enable high voltage supply before setting correct motor parameters!
2. Check that drive's led indicates power
3. Start program from start→Programs→Granite Devices→GDTool

In current software version, there are 2 option *pages*:

- **Motor page** contains motor parameters and current loop configuration.
- **Position page** contains position and velocity mode parameters.

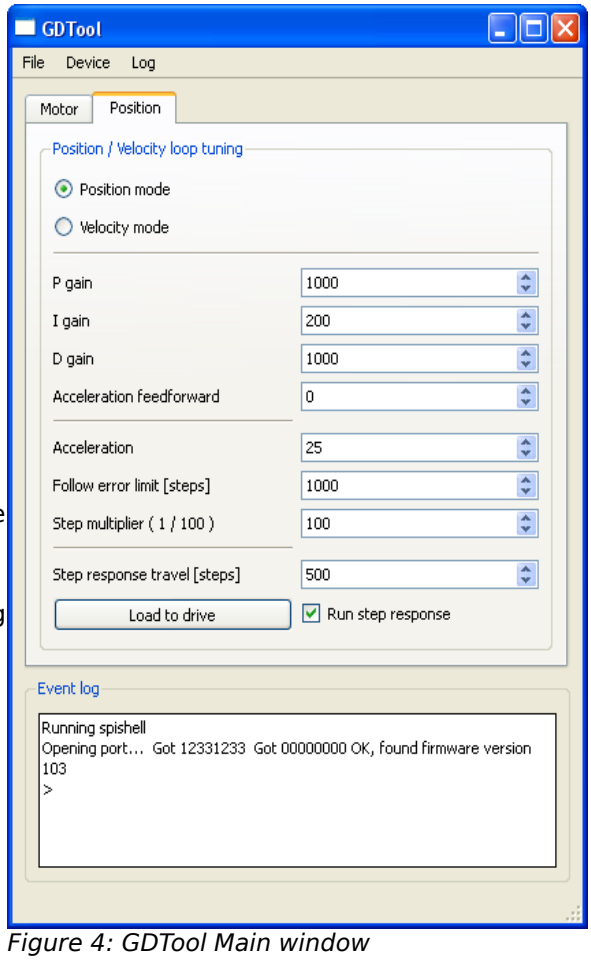

Figure 4: GDTool Main window

Description of basic functions

Load to drive button loads parameters to drive and if **Run step response** box is checked then the software commands motor to spin steps box value amount of steps.

To save configuration permanently to drives memory use "**Save to drive**" menu item from **Device menu**.

To reconnect use **connect** menu item from **Device menu.** You need to reconnect every time after restarting device!

Note that this version of GDtool does not support *downloading settings from drive*, so every time the software is started, default settings are restored. It is a good practice to write down correct values before closing GDtool.

Warning! Do not press "Load to drive" button if spinning motor can cause injury.

Configuring motor parameters

Choose motor page.

First thing is to set motor parameters correct. If you are uncertain about your motor values please contact to your motor supplier before continuing.

Motor type

Choose motor type. 3 phase brushless motor (AC) or direct current (DC) motor.

AC phasing current (AC only)

This is the current that is driven to AC servo windings at power-up to align rotor. This has no effect in DC servo mode.

Encoder resolution (counts per revolution)

Sets encoder resolution value to match your motors encoder. This is number of counts in via 4X decoding, so CPR equals 4 times the encoder line or pulse count.

Motor pole count (AC only)

This is the number of magnetic poles in AC servo rotor.

Max peak current

Maximum peak current output value [mA]. This is DC or peak of sine wave value.

Max peak cont. current

Maximum continuous current value [mA]. This is DC or peak of sine wave value.

P gain

Gain factor of proportional part of torque PI-controller

I gain

Gain factor of integration part of torque PI-controller

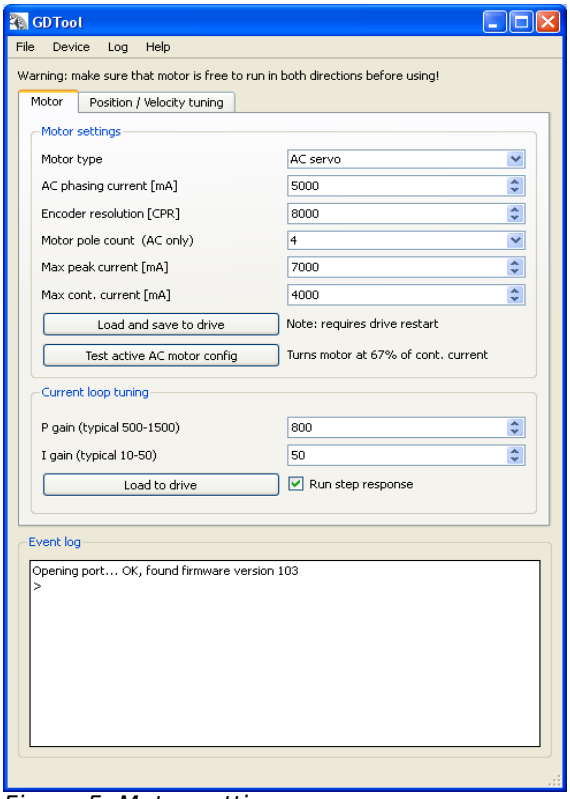

Figure 5: Motor settings

1. After adjusting correct settings press “Load and save to drive” button to save values.
2. Drive's red led should be on and green blinking. This is the *permanent stop* status.
3. Switch power off.
4. Switch on high voltage supply and logic voltage supply
5. To verify your AC motor settings you can use “**Test active AC motor config**” button. If you experience motor *runaway* and *follow errors* in DC motor mode, you may have wrong polarity of motor leads. In this case, try swapping the + and – leads of DC motor.
6. Next task is to do current loop tuning. Press “**Load to drive**” button to test current response with default settings. Step response window should appear (figure 6). The black line is the target value and red is the real measured current value. The X axis equals time in PWM cycles (about 55 µs in VSD-A)

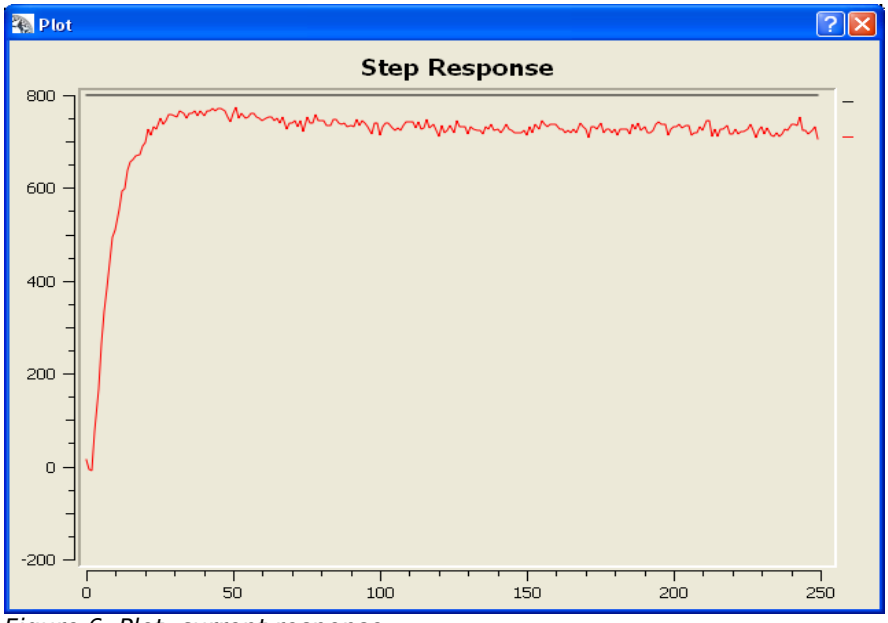

Figure 6: Plot, current response

With default values, the current probably doesn't reach the target value so the gains can be increased.

You can try the following method. First set **I-gain** to zero, and keep increasing **P-gain** until current value reaches the target line (figure 7).

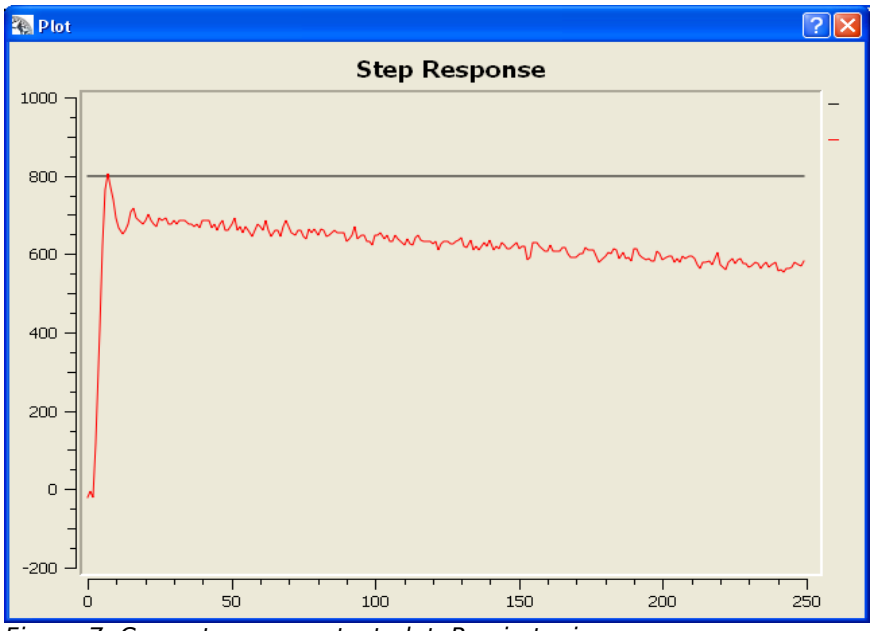

Figure 7: Current response test plot, P-gain tuning

Second, start increasing **I-gain** and decreasing **P-gain** to get minimal overshoot but still reach the target

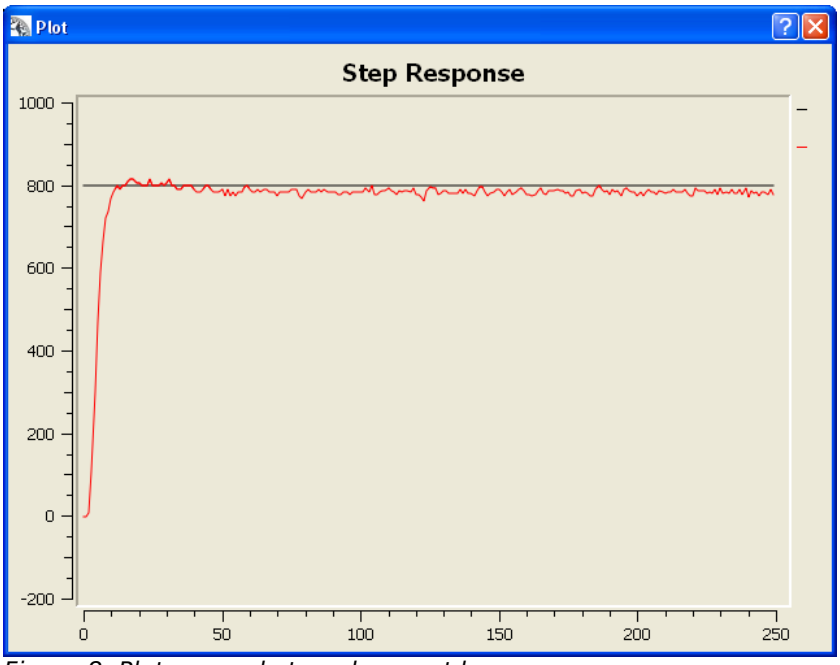

Figure 8: Plot, properly tuned current loop

7. When finished you can save the configuration to drive by choosing “**Save to drive**” menu item from Device menu.

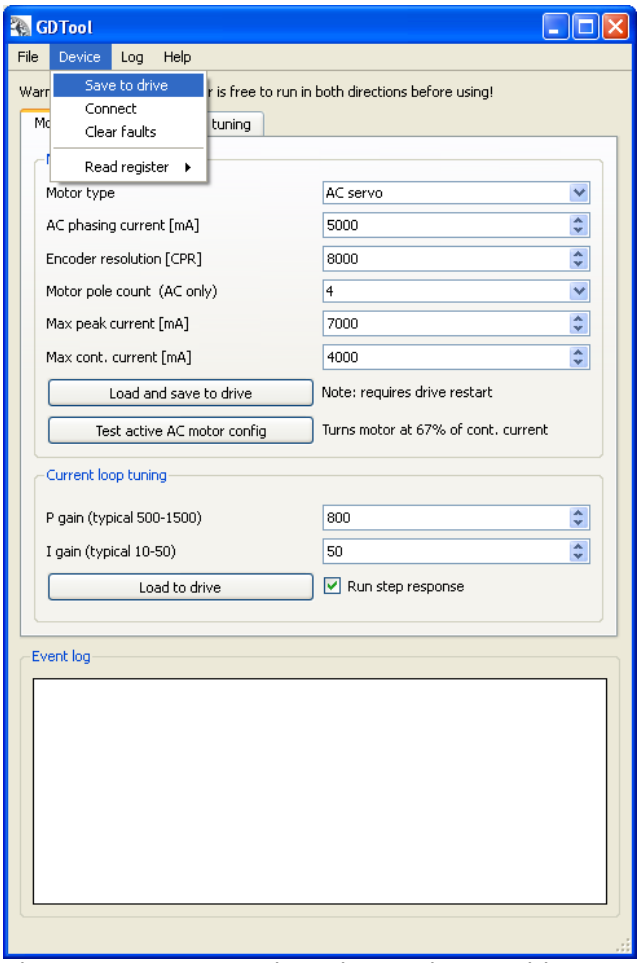

Figure 9: Save currently active settings to drive

Position or velocity tuning

1. Depending from your application you should choose drive to be in **position** or **velocity** mode. Choose the proper mode using Position/Velocity loop tuning section.

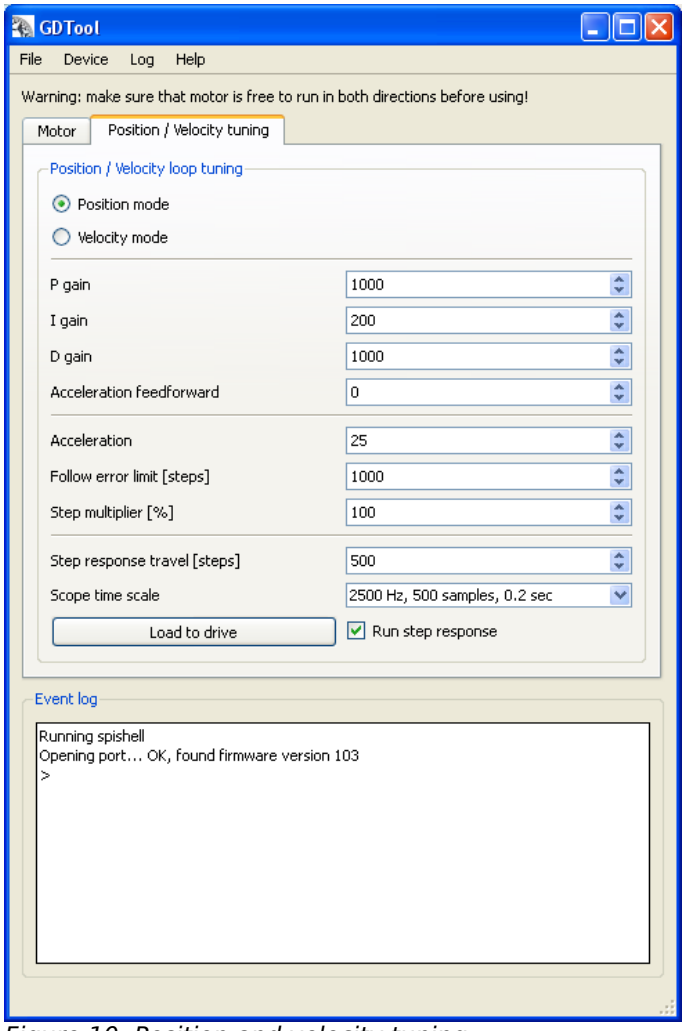

Figure 10: Position and velocity tuning

Position mode

Set position mode enabled

Velocity mode

Set velocity mode enabled

P gain

Gain factor of proportional part of PID-controller

I gain

Gain factor of integral part of PID-controller

D gain

Gain factor of derivation part of PID-controller

Acceleration feedforward

Acceleration feed forward gain to control-loop

Acceleration

Limits the acceleration rate to prevent the saturation. Increase for faster acceleration and decrease for lower acceleration

Follow error limit [steps]

Follow error is the difference between the commanded value and the measured value (position or speed references).

Follow error variable sets the upper boundary to the difference that causes the drive error occur when value exceeds.

Step multiplier

Multiplies the input step/speed reference value. Default value is 100% which equals multiplier of 1.00.

Step response travel [steps]

How many steps are traveled in step response test or how fast to run in speed mode.

Scope time scale

Adjusts scope time scale. To get better fit to your plot you can adjust the length of sample time.

Available sample frequencies:

- 625 Hz
- 1250 Hz
- 2500 Hz

Tuning the position mode

1. Choose **position** mode from switch box
2. Set **I-gain** and **acceleration feed forward** to zero
3. Set **Acceleration limit** to quite a low [5 – 20] at beginning. Other values can be left in default values
4. Press "**Load to drive**" button
5. Increase or decrease **P-gain** value to get response with little amount overshoot

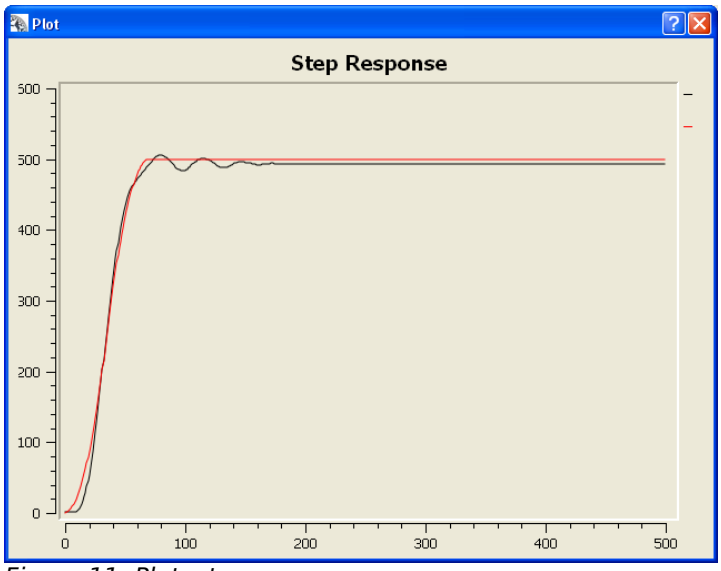

Figure 11: Plot, step response

6. Start increasing **I-gain** so that actual value reaches the target
7. Increase **D-gain** to get faster response
8. Set step length to match average step length of your application to get better performance

   If step length is too long follow error may occur. To clear follow error choose **Clear Faults** from **Device** menu. Try to increase **follow error** limit value or decrease **step length**.

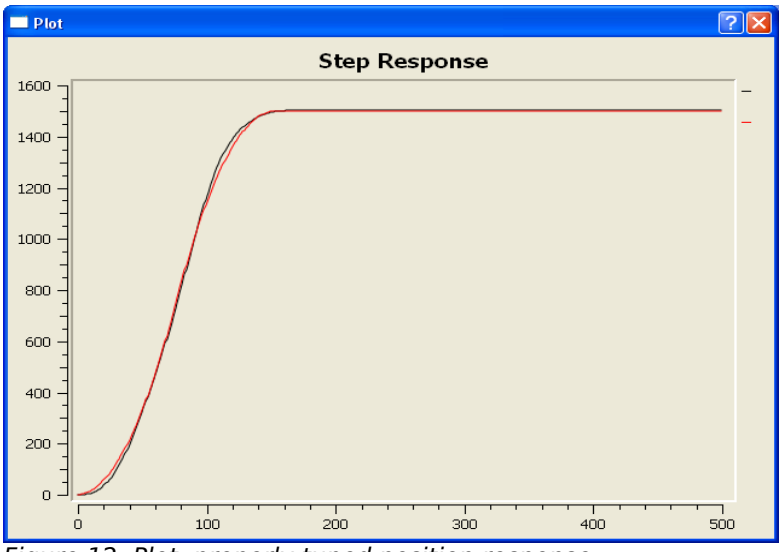

Figure 12: Plot, properly tuned position response

Note that too tight settings can cause system to be unstable and cause oscillation to output. Figure 13 illustrates an example of too high d-gain value

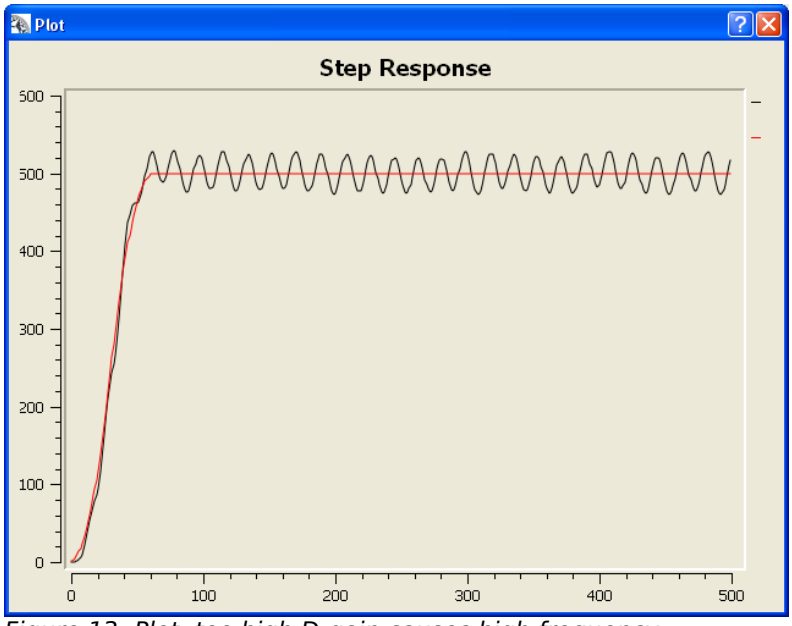

Figure 13: Plot, too high D-gain causes high frequency oscillation

Tuning the velocity mode

1. Choose **velocity** mode from switch box
2. Set **I-gain** and **acceleration feed forward** to zero
3. Set **step response travel** value to 20 – 60
4. Set **P-gain** to low value
5. Press "**Load to drive**" button

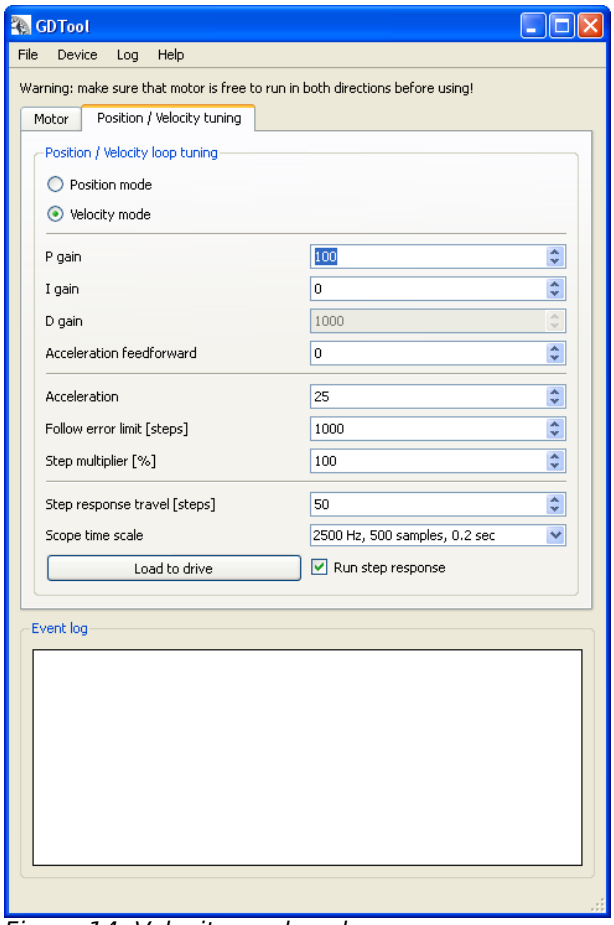

Figure 14: Velocity mode values

From the following picture we see that gains are too low. Start increasing **P-gain** until measured value reaches the command value. After that increase **I-gain**.

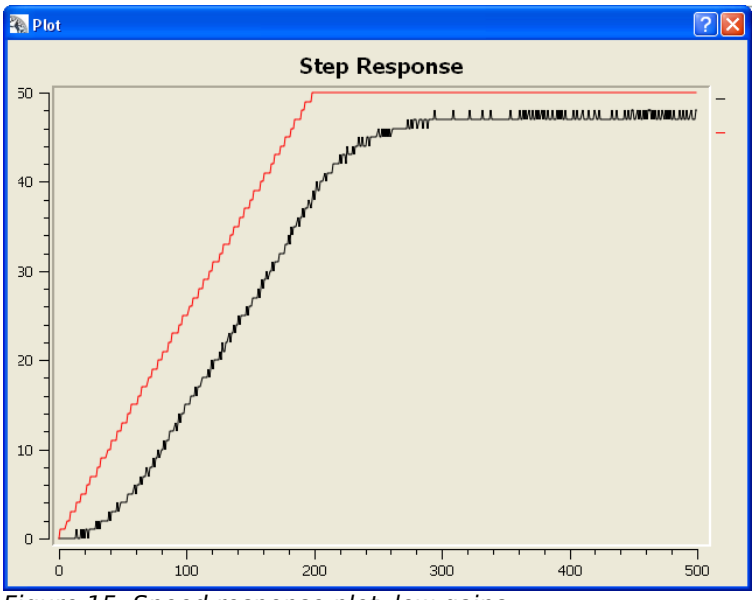

Figure 15: Speed response plot, low gains

The result should be something like this, of course depending on your system.

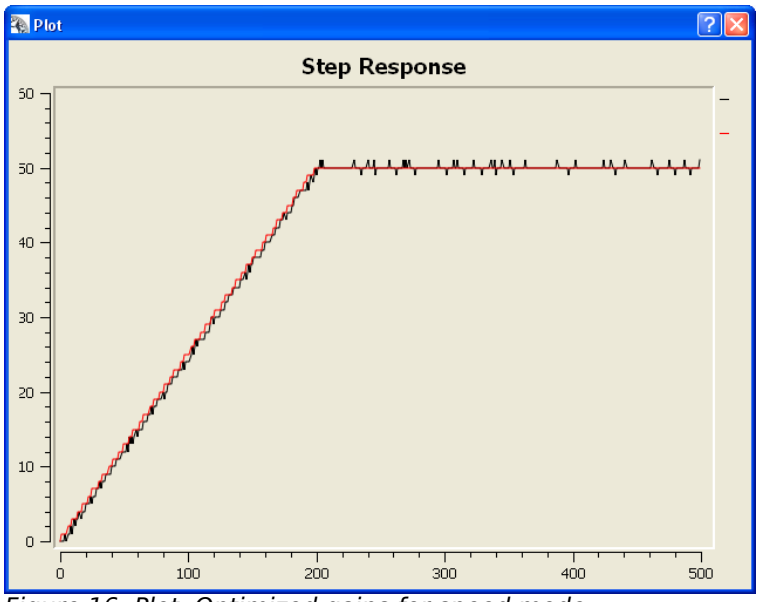

Figure 16: Plot, Optimized gains for speed mode

If you set too high step response travel value the following output may occur. Try decreasing travel value.

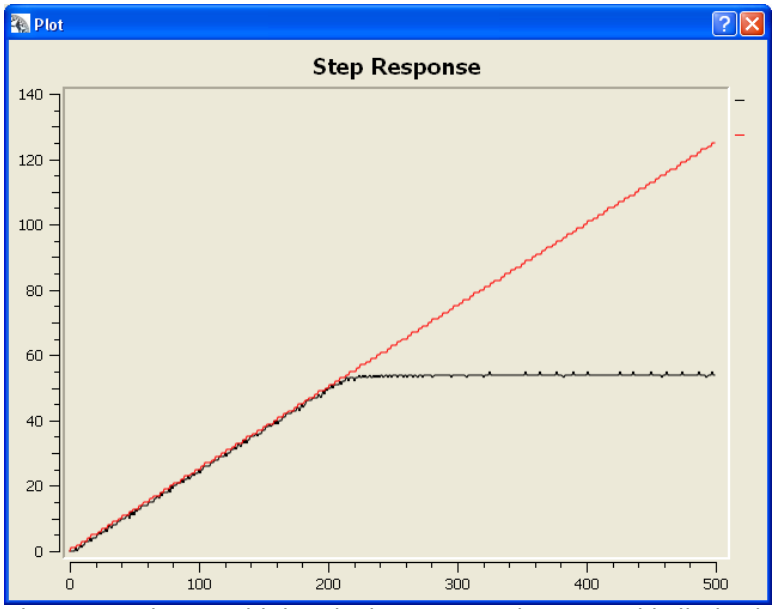

Figure 17: Plot, Too high velocity target value. Speed is limited by supply voltage.

Flasher

Flasher tool is used to upgrade or downgrade **firmware**. Latest firmware can be found from downloads section of Granite Devices website.

Using flasher:

1. Set **CLR** jumper on (see VSD-A data sheet)
2. Enable logic supply. No HW supply needed
3. Start Flasher program
4. From flasher program choose "**Open**"-button to select firmware file

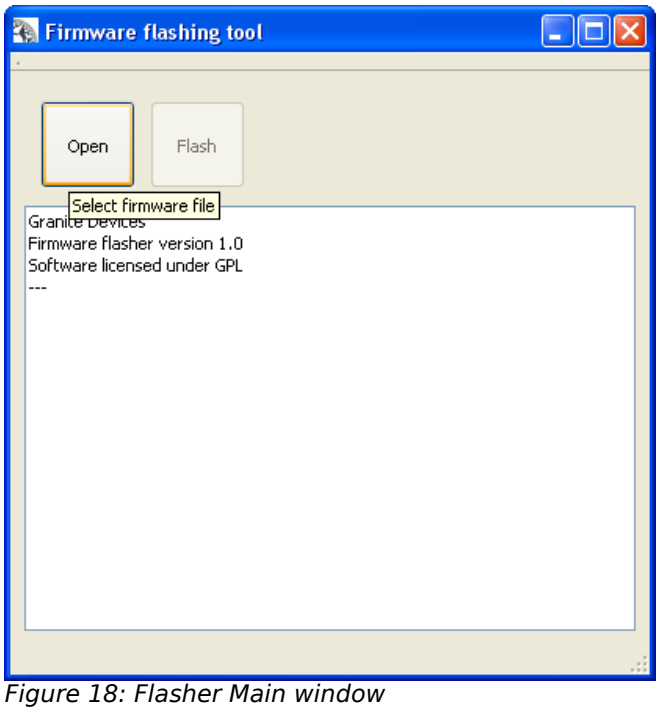

Figure 18: Flasher Main window

5. After you have selected proper file press "**Flash**"-button to upgrade firmware
6. Wait until flashing finished
7. Turn power supply off
8. Remove **CLR** jumper

Troubleshooting

“ERROR: Unable to communicate with drive”

Check cabling and try reconnecting from Device menu.

“ERROR: Checksum error”

Try to restart drive and GDtool software.

Follow error

Choose Device→Clear faults menu item to clear error state

Questions or problems?

Contact support@granitedevices.fi

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