



Manual for the PC-Tool / GUI for the TMC-AC-840 v1.3 Stepper Motor Evalution Demo Design

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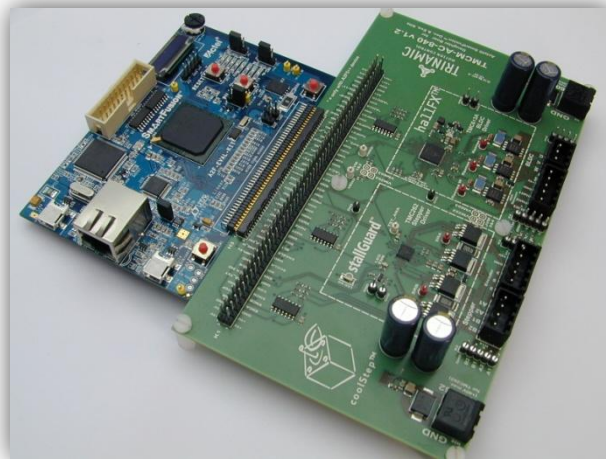
1 Features

The TMC-AC-840 V1.3 addon board for Actel SmartFusion Development and Evaluation Kits contains two different Motor drivers. The TMC262 is a high quality stepper motor driver and the TMC603A is BLDC motor predriver IC.

This Demo Design primarily features the stepper motor part using the TMC262 stepper motor driver. The Actel SmartFusion is used as a host for interfacing with the PC / workstation for visualization and control of all parameters. It is also used as motion controller (in software) and SPI master (within FPGA) to communicate with the TMC262.

Highlights:

- Play with stepper motors!
- Evaluate all features of the TMC262
- Use stallGuard2™ with your motor
- Use coolStep™ with your motor
- Control all parameters from a PC
- Motor current can be set to up to 2A (RMS)
- Supply voltage up to **40V** (the used MOSFETS are only 40V-Types)
- **Motor type:** 2 phase Stepper



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3 General Description of the PC Tool

The PC-Tools allows for control of all stepper driver parameters, for visualization, and for loading/storing/exporting parameters.

Each of the configuration registers of the TMC262 stepper motor driver has an own tab. In additionally, there is a status tab, a stallGuard™/coolStep™ visualization tab, and the step/dir tab.

The step/dir tab is used to actually start rotation of the motor.

4 Further Functions of the Demo Design

Besides the PC Tool, the demo design has some extra functions using the on-board peripherals of the SmartFusion Evaluation Kit.

- 1.) When pressing the on-board button **SW1**, the motor changes rotation direction to left with the latest speed configured.
- 2.) When pressing the on-board button **SW2**, the motor changes rotation direction to right with the latest speed configured.
- 3.) When pressing the on-board button **SW1** and turning the **potentiometer** of the SmartFusion kit, the motor will turn left and the potentiometer can be used to change the rotation speed accordingly.
- 4.) When pressing the on-board button **SW2** and turning the **potentiometer** of the SmartFusion kit, the motor will turn right and the potentiometer can be used to change the rotation speed accordingly.
- 5.) When pressing **SW1** and **SW2** at the same time, the motor immediately stops.

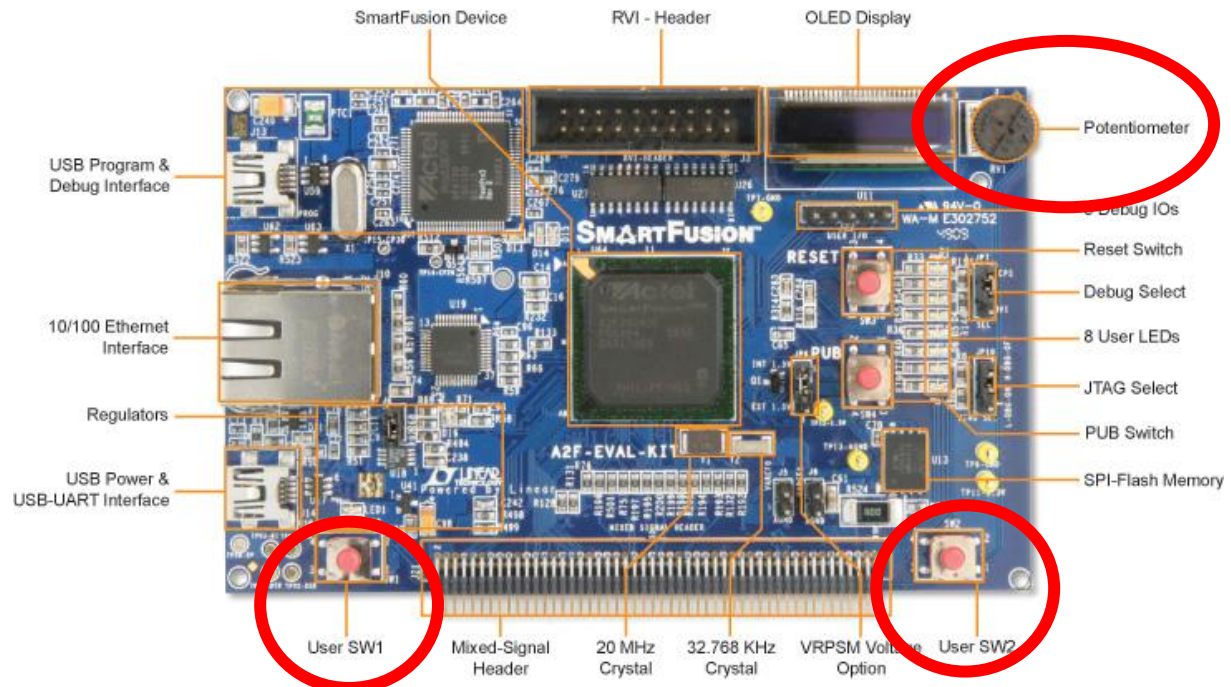


figure: SmartFusion Evaluation Board peripherals

5 **Getting started**

Connect the TMC-AC-830 V1.3 daughter board with the SmartFusion Evaluation Kit/Development Kit.

Connect a stepper motor to the board. Connect the PC via USB to the SmartFusionboard.

Use a laboratory power supply or the 24V/1A desktop power supply (delivered with the kit) to power the board with 24V.

Configure the SmartFusion board with programming file included in this demo design.

Start the GUI software (PC Software) included in this demo design.

5.1 **Connecting to the board**

In the GUI, select "Interface / Open" from the top menu, then elect the appropriate port.

For USB connection, the board uses a virtual COM port.

You should have installed the proper driver.

We therefore refer to the manual and guidelines for the Actel SmartFusion Evaluation and Development Boards.

5.2 **Starting Rotation**

A default parameter set that works with the motor delivered with the kit is within the direction of the demo design files (file: quickstart_settings.262).

In the GUI, select "File / Load" and choose this file. Now, all the parameters of this file are immediately loaded and also configured in the TMC262.

Go to the last tab (Step/Dir) and click button "Rotate".

The motor should now start rotation. Go to the tab "Graph" to see the latest values read back from the stepper driver regarding the actual current level used to drive the motor and the actual load value. When putting more load on the motor shaft (try with your fingers to hold the shaft) the blue graph indicating the actual load value should decrease. When reaching the configured threshold, the current should be automatically increased by the driver to adapt to the load condition.

6 GUI Details

The following sections describe the tabs of the GUI in detail.

Basically, the first five tabs represent the five configuration registers of the TMC262.

Each tab has a Get- and a Set-button to read/write the actual configuration from/to the TMC262.

! The functions of each parameter are not described here in detail. We refer to the datasheet of the TMC262 stepper driver. This datasheet is included in the demo design zip archive or can be downloaded from <http://www.trinamic.com> .

6.1 DRVCTRL Tab

In this tab, you can choose the microstep resolution and configure two modes that are used to reduce the required step frequency generated by the microcontroller / motion controller.

When INTPOL is enabled, the stepper driver requires only step pulses for 16 microsteps but internally interpolates to 256 microsteps. The MRES parameter cannot be changed during this mode.

When DEDGE is enabled, the stepper driver is sensitive to the rising and falling edge of the step pulse input. When DEDGE is disabled, the stepper driver is only sensitive to the rising edge.

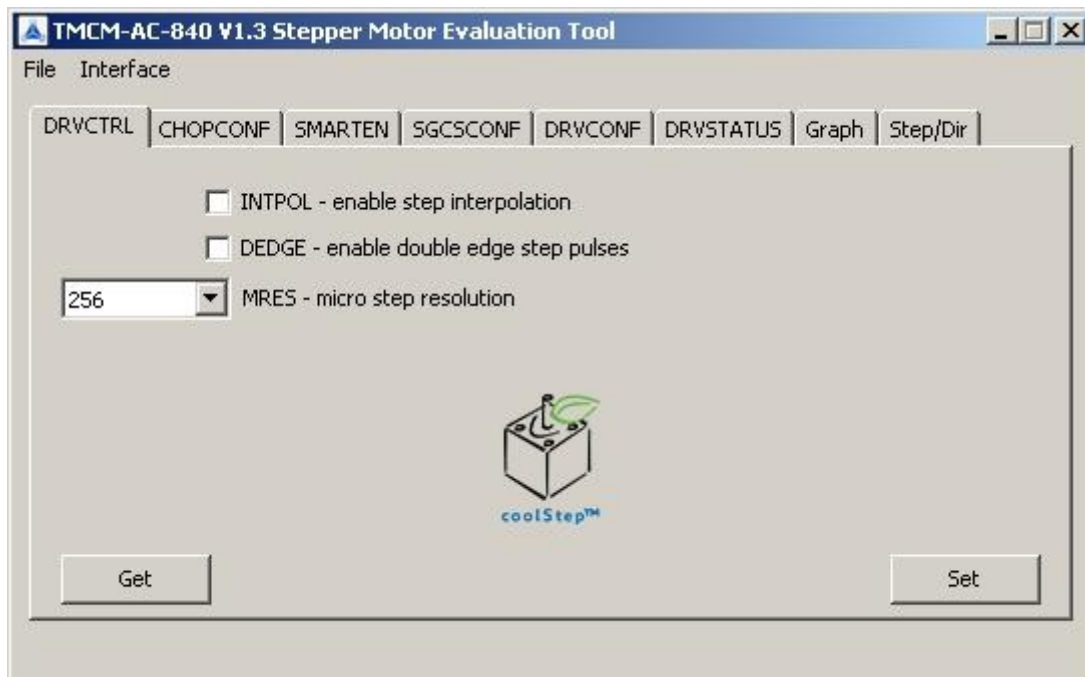


figure: DRVCTRL configuration register tab

6.2 CHOPCONF

In this tab, different parameters to adapt the chopper mode of the stepper driver can be modified.

The standard chopper mode of the TMC262 is a special hysteresis chopper. Alternatively, the user can switch to a typical constant T_{off} chopper scheme.

6.2.1 Optimizing the chopper settings

In principle, you can run the motor with default settings, but you might want to try improving or modifying the chopper setting for smoothest performance of the motor and for low chopper noise. Start the motor at the desired velocity, e.g. a medium velocity to tune const toff mode fast decay time, or a low velocity to tune chopper hysteresis setting or sine wave offset in const toff mode. There is no need to modify the blank time, unless you change the MOSFETs on the board. Now, you can select standard chopper or classical const toff chopper. For both modes, the off time TOFF is a major component. A setting between 4 and 7 fits most motors. In the standard mode, you can check behavior for different HSTART settings to improve motor behavior. In constant toff mode, a positive sine wave offset improves zero transition performance; fast decay time influences motor noise. You might try pure slow decay operation if fastest velocity is desired.

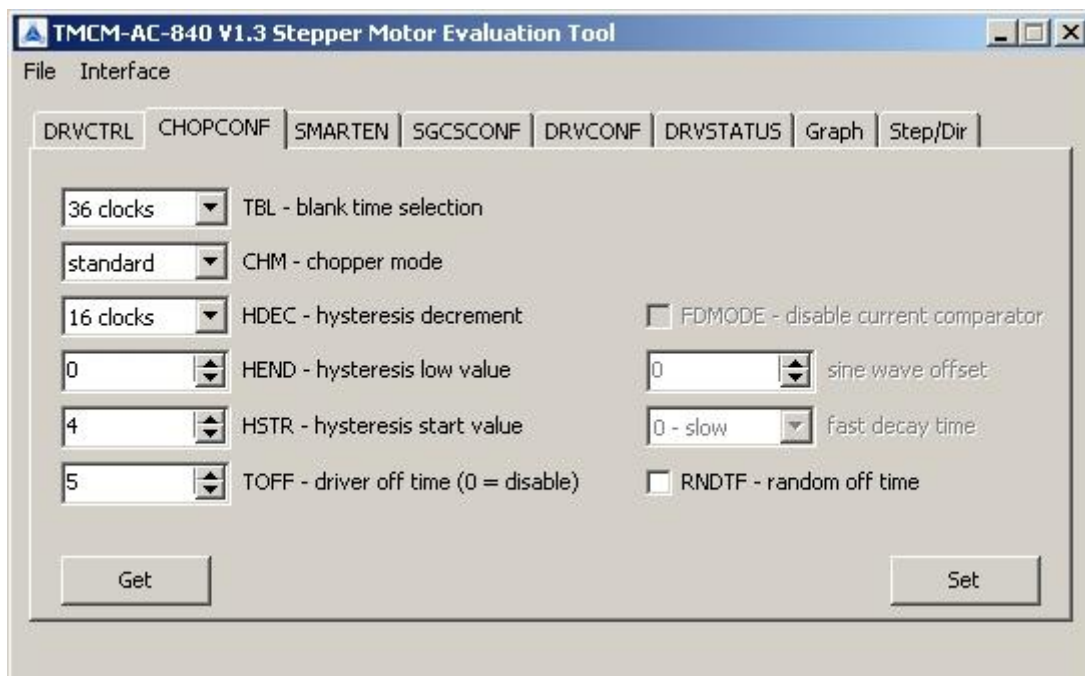


figure: CHOPCONF configuration register tab

6.3 SMARTEN Tab

This tab allows for configuration of the parameters for stallGuard2™ and coolStep™ functionality. stallGuard2™ is used for stall protection and load measurement.

coolStep™ is used for automatic current adaptation to the load. With coolStep™ the motor current is reduced to save energy, to reduce heat dissipation and to overcome peak load situation by using current values above the motor specification for a short time. It makes the motor driver stage much more efficient.

6.3.1 Using stallGuard2™ and coolStep™

In order to use the stallGuard2™ functionality and coolStep™, you should first tune the stallGuard2™ sensitivity. As a first step, you should enable the stallGuard™ filter bit SFILT in the tab SGSCONF.

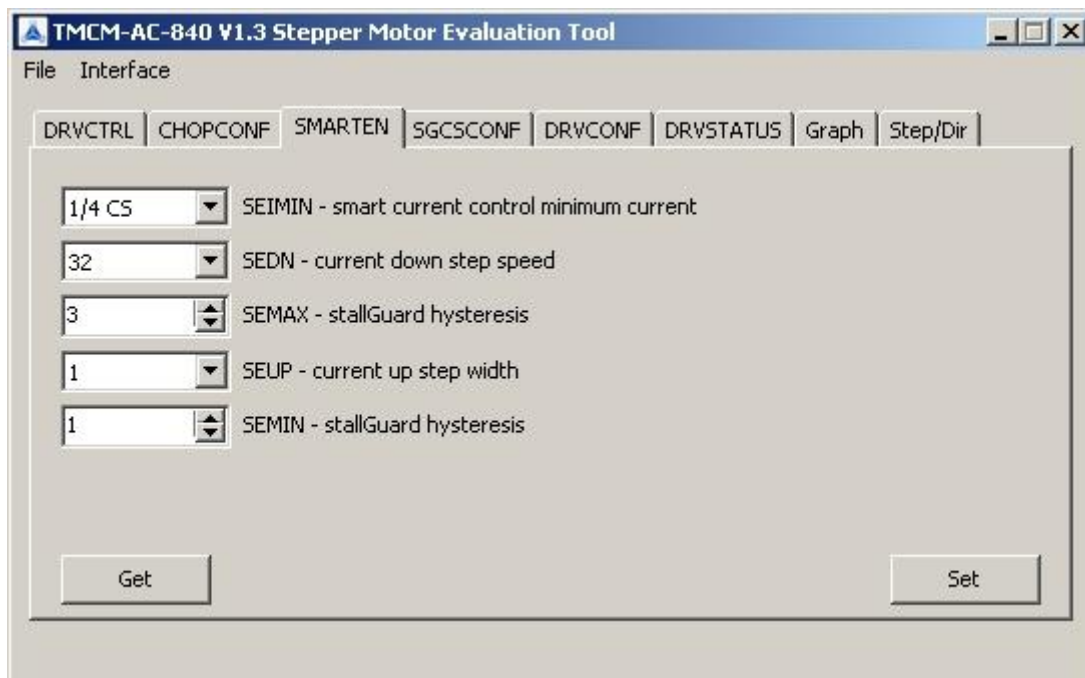


figure: SMARTEN configuration register tab

Therefore, operate the motor at a reasonable velocity (taking into account your application) and look at the stallGuard™ value (SG) in the DRVSTATUS tab or watch the stallGuard value in the Graph tab. Now, apply slowly increasing mechanical load to the motor. If the motor stalls before the stallGuard™ value reaches zero, go to the SGSCONF tab and decrease the stallGuard threshold value (SGT). A good starting value is zero. You can apply negative values and positive values. If the values leave a range outside +/-10, probably your velocity setting is too high or too low. If the SG value reaches zero far before the motor stalls, increase the SGT value (SGSCONF tab).

The optimum setting is reached, when the stallGuard2™ value reaches zero at increasing load shortly before the motor stalls due to overload.

Now, you are ready to enable coolStep™! Go to the SMARTEN tab and set SEMAX and SEMIN to a value different from 0. This enables coolStep. A good value for both is 1 or 2 for most motors. Now, coolStep is enabled and you should see the current scale SE decreasing when the motor does not see any load (see tab Graph). You can modify current increase and current reduction speed by changing SEUP and SEDN. You can select, if the current becomes scaled down to 1/2 of CS or to 1/4 of CS, using SEIMIN setting.

For details and sample traces, please see the TMC262 data sheet.

Hint: For first tests, we recommend setting SEIMIN to 1/2, as the 1/4 setting might not work stable with increasing load without adapting the SGT value to the actual motor current.

6.4 SGCSCONF Tab

This tab allows configuration of the SGT (stallGuard threshold) and CS (current scale) values. Furthermore, you can see the actual values for the RMS and peak current that will be used to power motors. The current values depend on the sense resistor used on the TMC-AC-840 addon board as well as on the actual parameters CS and VSENSE (DRVCONF tab).

As a first step, you should set the appropriate current setting for your motor: Go to the tab SGCSConf and select the correct value for the sense resistor, to see the actual current setting. The current scale can be selected from 7 (default) to 31. You get the best motor performance with a high value between 16 and 31. If your calculation shows, that you need a value below 16, please go to the tab DRVCONF and select VREF=1/36 instead of 1/18. If you cannot reach the desired motor current, please change the sense resistor to a lower value. Please refer chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** for sense resistor selection.

Please be careful to not select a too high current value, as a too high current setting could destroy the motor by overheating.

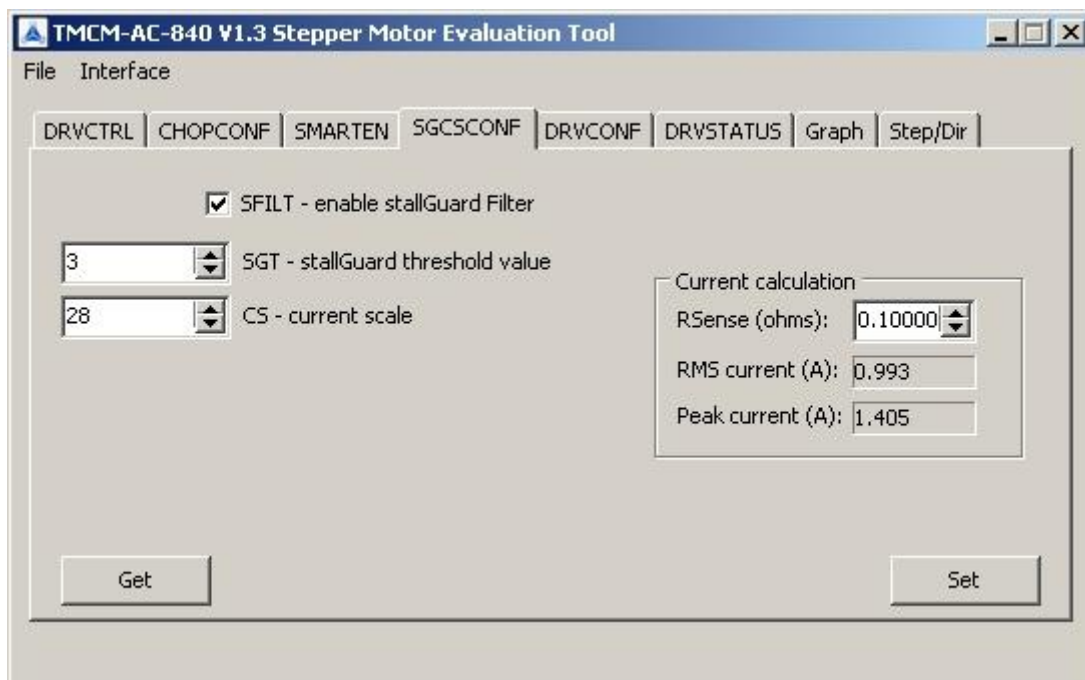


figure: SGCSCONF configuration register tab

Now, please check the DRVSTATUS tab. The indicators should give a reading and show stable values.

6.5 DRVCONF Tab

This tab allows for modification of driver related parameters and protection features.

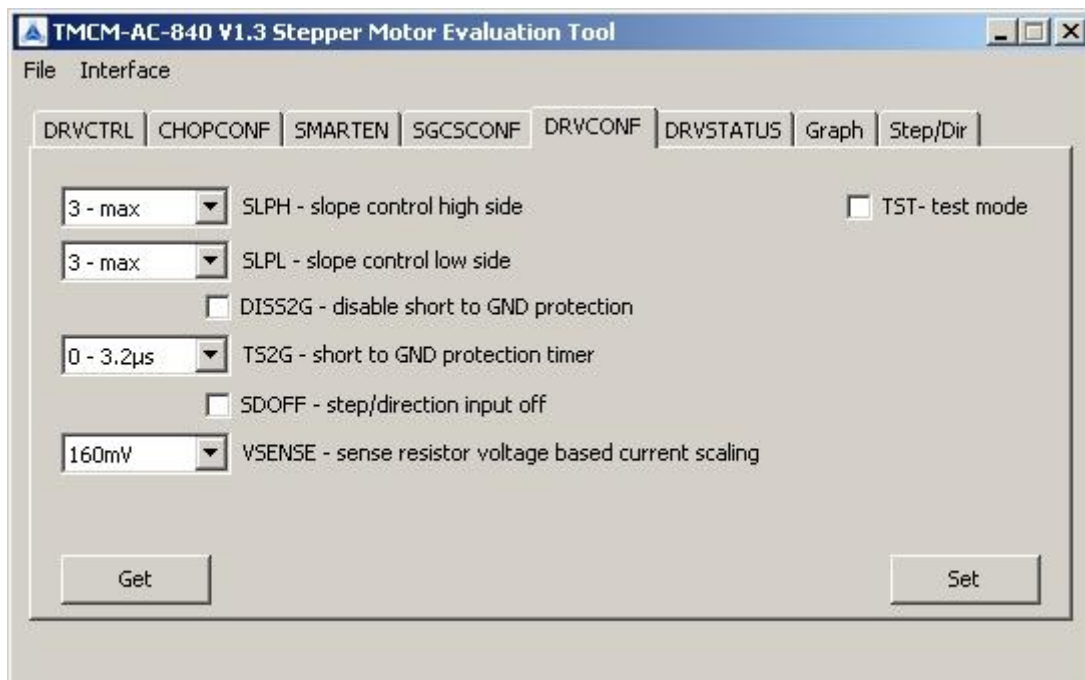


figure: DRVCONF configuration register tab

6.6 DRVSTATUS Tab

The driver status tab shows the current state of the driver and the bridges. For example, you can see the actual microstep position or some diagnostics.

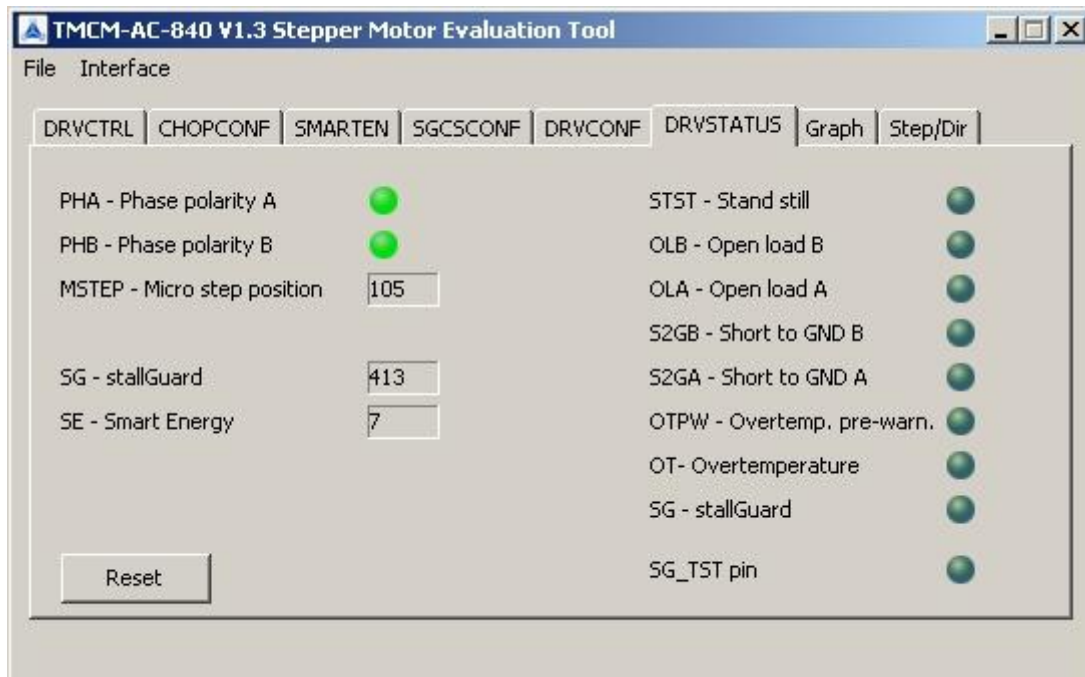


figure: Driver status tab

6.7 Graph Tab

This tab shows a graph for visualization of the stallGuard2™ and coolStep™ feature.

The respective load and current values are shown in real time.

Furthermore, the squares filled with red and blue background represent the current and stallguard ranges.

The current range (red) depends on the CS and SEIMIN parameters.

The stallGuard range/hysteresis values (blue) depend on SGT, SEMIN, and SEMAX parameters.

Therefore, the board must stay connected to the PC as a steady data stream from the stepper driver over the SmartFusion to the PC is required.

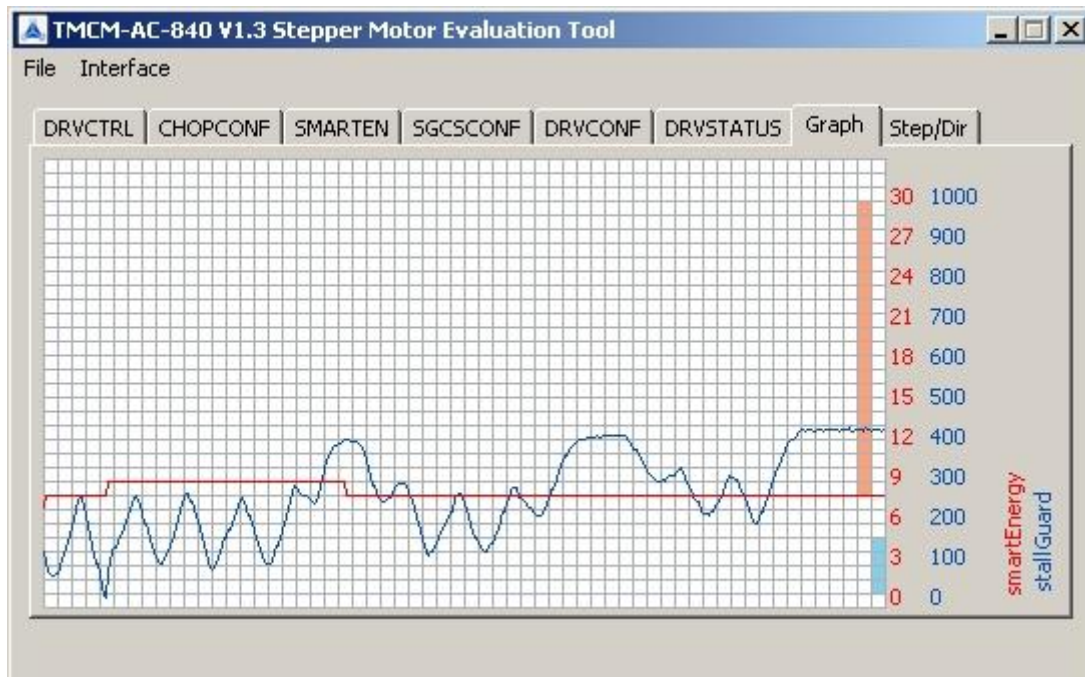


figure: Graph tab for showing current and load values over time

6.8 Step/Dir Tab

To move the motor using the internal step and direction source, select acceleration and velocity (signed) setting and press the Run button. Press the get button in any of the tabs, to read out actual settings. In case you want faster motion, stop the motor, go to the tab DRVCTRL and reduce microstep resolution. Best performance is achieved in 256 times microstepping, or in 16 times microstepping with step interpolation active (please check INTPOL).

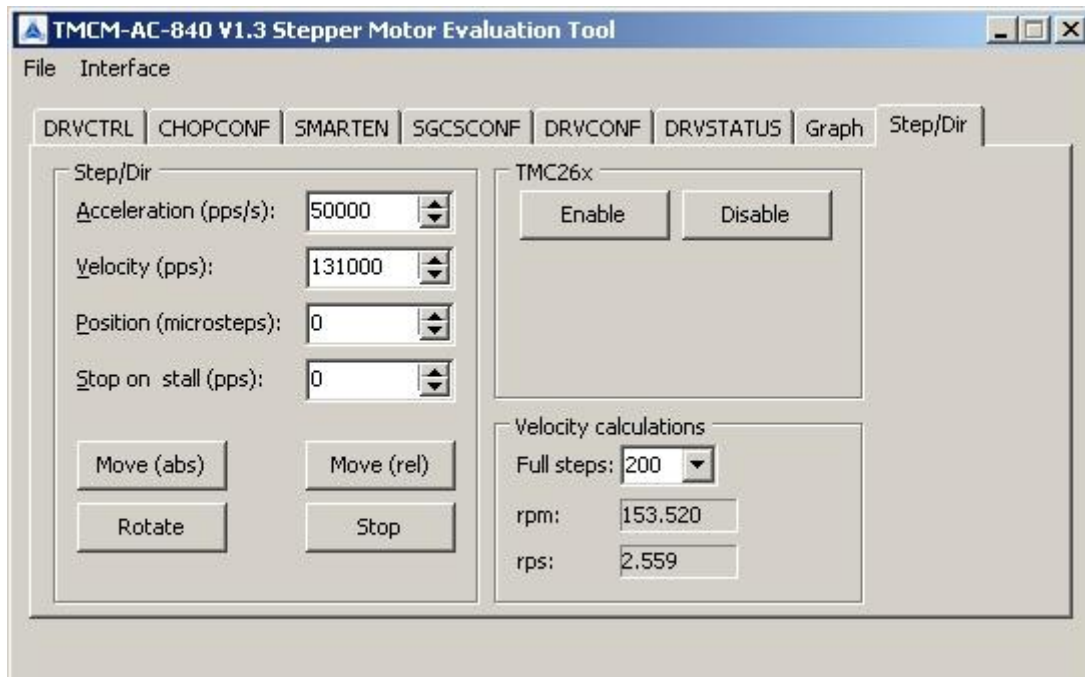


figure: motor control tab

6.9 Writing/Loading the settings to/from a configuration file

You can load and store all settings made in the evaluation board.
They are stored in a .262 text file.

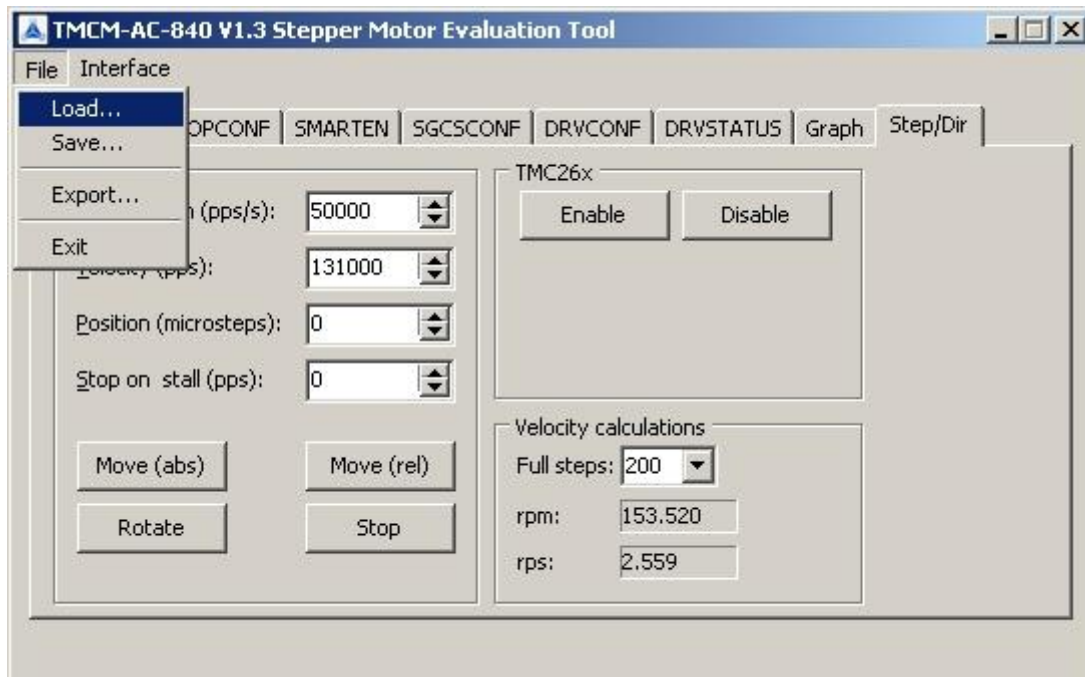


figure: Load/save configuration files

The .262 files can be modified in a text editor.

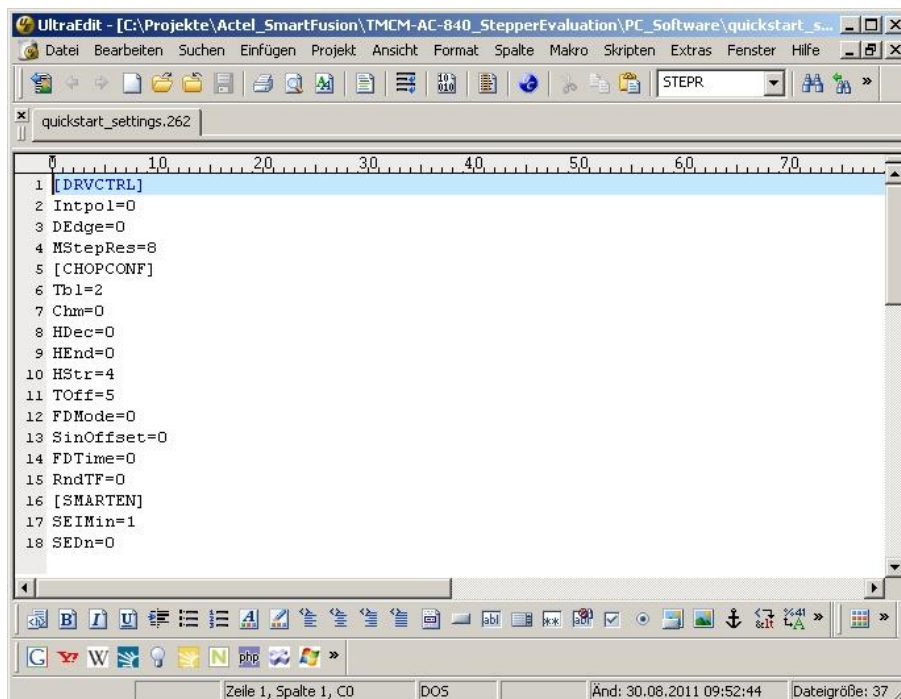


figure: modifying configuration files with a text editor