WaveSculptor Software & Firmware Changes

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Brisbane, Australia
http://www.tritium.com.au

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1 PURPOSE

The purpose of this document is to detail the differences between firmware versions TRI50v3.13 to TRI50v3.31. The differences between the WaveSculptor controls and configuration software version 2.07 to 3.05 are also described.

2 FIRMWARE CHANGES

TRI50v3.13 was the very first version of firmware released.

Firmware Version	Description of differences compared to the previous version
TRI50v3.13	• First version of firmware released.
TRI50v3.14	• Bug fix relating to the motor temperature measurement • Fixed default scale and offset factors for hardware over-current set point and motor temperature measurements.
TRI50v3.15	• Support for the 40kW IPM based WaveSculptor incorporated into same firmware as the 20kW MOSFET based WaveSculptor. • Firmware version will report 100 higher when run on a WaveSculptor40 as oppose to a WaveSculptor20. Eg this version would report as v103.15 instead of v3.15.
TRI50v3.16	• Bug fix relating hall position readings after a reset. This bug was most obvious when resetting the controller while the motor was spinning. Doing this sometimes caused a hall error or worse resulted in the controller attempting to drive a non-torque producing phase of the motor. • A method is circumventing the log fit constants (lfc) of the motor temperature sensor was also added. Now, if the lfc A is set to zero the entire lfc equation will not be applied. This allows the use of a LM35 style voltage output temperature sensor instead of a thermistor. Any offset required should be added to the existing -0.1 offset and any scale factor required should be multiplied with the existing 1.25 scale factor.
TRI50v3.17	• Separate limits for sinewave, sixstep and software over-current have been created. This gives more flexibility for the controller to work with motors and inductors of differing ratings. The software over-current limit is set at 165A in the WaveSculptor20 and is not user adjustable. The sinewave and sixstep limits have been tested to 100Arms and 100A respectively on the Tritium dyno using a set of Tritium inductors and a CSIRO motor. With CSIRO inductors the current limits may have to be reduced below 90A. • The config version was changed from 1.00 to 1.01 to accommodate the two new constants, sixstep current limit and software over-current setpoint. The configuration file gets updated when you “Upload” config with the new version of controls and config software. You can update the firmware first then the config, or can update the config then the firmware. New constants in configuration files are ignored by older firmware. Constants missing from the config default to pre-set values set in the firmware.
TRI50v3.18	• The warning LED in version TRI50v3.17 was mistakenly left as a debugging output. In version TRI50v3.17 the warning LED turns on if the WaveSculptor disengages from sinewave control because the the error between the observer predicted rotor position and the hall sensor predict rotor position was too great. Version

	TRI50v3.17 turns the warning LED off when entering sinewave control mode. In version TRI50v3.18 the warning LED once again operates was described in the online documentation. • A configuration error was not being generated when configuration constants were missing. This is only a minor bug as WaveSculptor still operates with missing configuration constants by using firmware set default constants. The warning serves only to advice the user to update the configuration file on the DSP.
TRI50v3.19	• The velocity loop constants have been significantly reduced to account for measurement noise. Assume for example a 300kg car with 30kg rotating; TRI50v3.18 would have selected a proportional constant of 170A/(km/h) and TRI50v3.19 will select a proportional constant 11A/(km/h). • A first order digital filter, F(z)=0.1z/(z-0.9), was added to the velocity feedback measurement of the control loop. This helps to smooth velocity measurement noise and hence the resultant motor current. The extra pole at z=0.9 does not impact on the stability of the system due to the low gains now being used, • The motor RPM at which the WaveSculptor changes over from six-step to sine-wave is now independent of motor pole count. This means that low pole count motors, such as the NGM, will change over at the same speed as high pole count motors, such as the CSIRO.
TRI50v3.20	• CAN Auto Bus On set
TRI50v3.21-3.30	• Not released
TRI50v3.31	• A silicon bug work around for the ADC module in the DSP has been implemented. • The scaling of the phase voltage measurements have been fixed. • A 1/sqrt(3) scale factor has been added to the calculation of the modulation index while in neutral and the current loop gain constant while in drive. • The following constants have been added each motor configuration file: 1) disable hall checking 2) engage speed 3) disengage speed settings. • Trajectory control and inter-loop saturation feedback has been added to all the control loops. This allows for a "smooth" transition as one control loop takes over control from another. A good example of this improvement will be noticed when the vehicle automatically and “smoothly” transitions velocity control to max bus current or max bus voltage control as the vehicle begins a large descent down a hill. • Added bus current sign awareness to the maximum bus voltage control loop. This eliminates the stuck on the start line because of over charging scenario. • Minimum update rate for hall effect calculated velocity has been increased from 0.9Hz to 14.3Hz. Combined with additional checking the sensorless velocity output before disengaging makes for a more robust disengage from sensorless to hall effect feedback during rapid deceleration. • The transmit and receive error count has been added to the status information packet as part of the Tritium CAN specification. • Removal of feedforward term in the Idc control loop

3 SOFTWARE CHANGES

3.1 VERSION 2.09

Version 2.07 of the WaveSculptor controls and configuration program has been updated to version 2.09. Version 2.09 is compatible with the new configuration version 1.01. In version 2.09, the current limit setting has been split into two, the Sine Current Limit (Arms) and the SixStep Current Limit (A), shown in the top left corner of Illustration 1. There has also been an extra setting for the software over-current set point added to the calibration screen, which should read 165A.

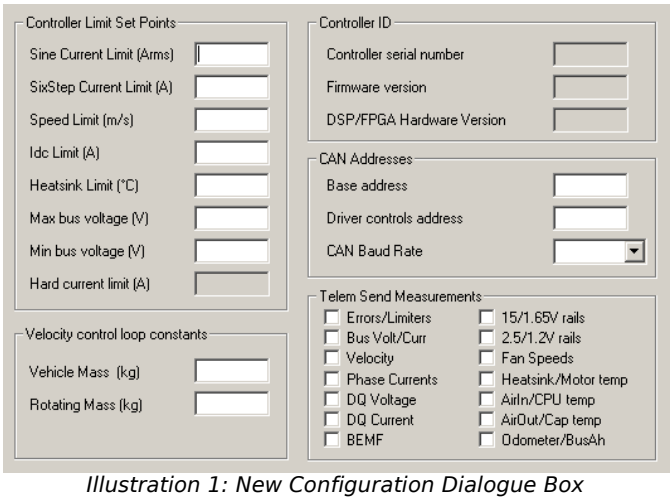

Illustration 1: New Configuration Dialogue Box

3.2 VERSION 3.02

3.2.1 Sensorless engage

Three more fields have been added to the calibration section of the configuration file. These are:

- Check observer against halls, a zero (or false) setting here means that once above the engage speed the sensorless system is no longer compared to the hall effect output. This can be helpful if the hall effect output is of quite poor quality.
- Engage motor speed, the mechanical motor frequency that the sensorless system will take over position feedback from the hall effects position sensors.
- Disengage motor speed, the mechanical motor frequency that the sensorless system will hand over position feedback back to the hall effect position sensors.

Contact Tritium if you wish to have these parameters changed.

3.2.2 Configuration Upload

The Transfer->Upload command on the menu of the configuration screen will now only upload to the controller if the selected controller's serial number matches the serial number of the configuration file you are trying to upload.

This change is meant to fix a problem that many teams encountered in the lead up to WSC'07. If the configuration file was not read from the controller, default values are displayed instead of actual configuration values from the controller. If the person adjusting the configuration parameters did not notice this, then when they upload their changes, the default values for all the parameters that they did not change are also upload. This sequence of events will not be able to occur now, because the default serial number will not match the serial number currently in your controller.

3.2.3 Active motor display

The motor that is currently active is now displayed in the main dialogue box. This is the variable, Active Motor, broadcast in the status information packet.

3.2.4 CAN error counters

The CAN transmit and receive error counters are now display in the main dialogue box. These counters are just a display of the actual counters in the DSP's CAN module. They behave as described by the CAN 2.0 specification and are provided by Tritium to give an indication of the integrity of the CAN network in your vehicle. If they stay at zero and you are able to send and receive data over the network then all is well. If they count up at any time then you should investigate why.

3.2.5 Plot function

The plot functions used to display PhasorSensor and ParamExtract results has been upgraded and should produce clean and clear plots that conveys the results more concisely.

3.3 VERSION 3.03

The user can now adjust the engage and disengage motor frequency and also make the controller ignore the halls once the sensorless mode is engaged. This can be done for each of the 10 motor config settings.

3.4 VERSION 3.04

Column labelling errors in the logging file have been fixed. The driver control setpoints and the controller's send and received CAN error counters are also now logged.

3.5 VERSION 3.05

Configuration files can still only be overwritten if the serial number of the new configuration file matches the serial number of the existing configuration file on the WaveSculptor, as per the change described in section 3.2.2 above. However, an exception to this rule has been made for configuration files that have a 00000 serial number. This feature allows users that have overwritten configuration files (the serial number reads 00000) to fix the overwritten configuration file. Refer to document “TRI50.033v3 – Firmware update procedure.pdf” for more information on how to fix an overwritten WaveSculptor configuration file.

4 REVISION RECORD

REV	*DATE*	*CHANGE*
1	1 October 2007	Document creation (DAF)
2	5 October 2007	Added information about the changes between TRI50v3.17 and TRI50v3.18. (DAF)
3	9 October 2007	Description of changes made in version TRI50v3.19 have been added.
4	5 February 2008	Added description of changes between TRI50v3.19 and TRI50v3.26. Changes made to the windows software between v2.09 and v3.02 are also detailed.
5	13 November 2008	Added description of changes between TRI50v3.26 and TRI50v3.31. Changes made to the windows software between v3.02 and v3.05 are also detailed.