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HEINZMANN®
Electric Drives

Motor Controller for Permanent Magnet AC-Synchronous Motor (Axial Flux Motor)

Gen4 Sevcon Controller

Setting-Up Sevcon Controller Connection Diagram

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1. Safety instructions

1.1 Warnings, cautions and notes (from Sevcon Manual)

Special attention must be paid to the information presented in Warnings, Cautions and Notes when they appear in this manual. Examples of the style and purpose of each are shown below:

A WARNING is an instruction that draws attention to the risk of injury or death and tells you how to avoid the problem.

A CAUTION is an instruction that draws attention to the risk of damage to the product, process or surroundings.

A NOTE indicates important information that helps you make better use of your Sevcon product.

1.2 General safety and protective functions (from Sevcon Manual)

Electric vehicles can be dangerous. All testing, fault-finding and adjustment should be carried out by competent personnel. The drive wheels should be off the floor and free to rotate during the following procedures. The vehicle manufacturer's manual should be consulted before any operation is attempted.

The battery must be disconnected before replacing the controller. After the battery has been disconnected wait 30 seconds for the internal capacitors to discharge before handling the controller or discharge with a resistor (for example 22 Ohm, 300 Watt)..

Never connect the controller to a battery with vent caps removed as an arc may occur due to the controller's internal capacitance when it is first connected.

As blow-out magnets are fitted to contactors (except 24V) ensure that no magnetic particles can accumulate in the contact gaps and cause malfunction. Ensure that contactors are wired with the correct polarity to their power terminals as indicated by the + sign on the top molding.

Do not attempt to open the controller as there are no serviceable components. Opening the controller will invalidate the warranty.

Use cables of the appropriate rating and fuse them according to the applicable national vehicle and electrical codes.

Where appropriate use of a suitable line contactor should be considered.

Electric vehicles are subject to national and international standards of construction and operation which must be observed. It is the responsibility of the vehicle manufacturer to identify the correct standards and ensure that their vehicle meets these standards. As a major electrical control component the role of the Gen4 motor controller should be carefully considered and relevant safety precautions taken. TheGen4 has several features which can be configured to help the system integrator to meet vehicle safety standards. Sevcon accepts no responsibility for incorrect application of their products.

2. General

2.1 Documentation

This document is quoted as an additional document from Heinzmann, to support the setting-up of Sevcon Controller with Heinzmann PMS-Motors. See also:

- Sevcon “Gen4 Application Reference Manual” controller manual)
- Sevcon “Gen4 Object Dictionary” (parameter list)
- Heinzmann “Installation Guide” (motor manual).

Clients who buy Sevcon Controller with USB to CAN Adapter and Handheld Calibrator directly from Heinzmann GmbH & Co. KG will get the access to the download section on the Heinzmann website http://www.heinzmann.com/en/electric-and-hybrid-drives/download-electric-and-hybrid-drives for software, documentation and 3D-models of the controller.

This document was provided after best knowledge and certain and lays also no claim on correctness and completeness in writing and contents.

2.2 Product liability Sevcon Controller

Due to the Gen4 controller are no Heinzmann products, but Sevcon products, Heinzmann cannot assume the product liability. In case of reclamation, we will receive the ware, improve the case of warranty and will pass thru the product liability of Sevcon.

2.3 Purchased parts package of controller with software

Each motor will be tested with controller on load at nominal speed and nominal torque. The controller is load with the actual firmware and with a base parameter setting, which fits to our test-bench requirements. The client needs to change parameters for his own application. All further application-specific programming or implementation of CAN accessories need to realise be the client or a separate calculated project must be generated and quoted.

An implementation of a Heinzmann drive system in a client’s vehicle is always an additional complexity and not included in delivery of our drive system.

3. Connection Diagram

3.1 Safety Instructions for Cabling

The Key Switch must be mounted at an accessible position!
To interrupt the power supply of the motor open Key Switch!

The Foot Switch is the digital input 1 Pin 18 and needs to be mounted separate as a Start Switch or best in the digital input of the throttle or handle.
Only if the Drive Enable or Foot Switch is set in the parameter setting of the controller, the safety function is active.

3.2 Motor – Controller Set

Each motor needs to be connected with the inherent motor, which is adjusted to the controller. By changing controller or motor “Encoder fault” can occur! To correct read chapter “Controller adjustment with commission encoder” and “Faults and Warnings”.

3.3 Minimal traction application of the Gen4 Controller

- Key Switch with fuse 2,5A F (fast)
- Main Contactor (fuse on Gen4 Controller already installed)
- Foot Switch (FS1) Pin 18, if only FS1 is configured, see “Input/Output table” at “Change Parameters
- Speed Potentiometer / Throttle / Handle Pin 22 (Potentiometer 5 to 10 kΩ or hall throttle), if only one Throttle is configured in software (see “Input/Output table” at “Change Parameters)

For pump or fan application a setting with only key switch is possible.

3.4 Vehicle application

- Key Switch with fuse 2,5A F (fast)
- Main Contactor with 2 changeover contacts (fuse on Gen4 Controller already installed)
- 2 digital inputs: Forward and Reverse Switch serial with the Foot Switch (FS1) integrated in the throttle. Configure only Forward and Reverse Switch in the Software “Digital Input Configuration”.
- Speed Potentiometer / Throttle / Handle (Potentiometer 5 to 10 kΩ or hall throttle).
  Configure only one Throttle in the Software “Digital Input Configuration”.

3.5 Advises for wiring, EMC protection by Heinzmann

- The CAN bus should be installed separate from power cables (motor cable, battery cable, +12V supply) using a shielded twisted-pair cable with shield termination on one side.
- In some applications the CAN bus cable should be terminated at both sides.
- Sensor cables should be installed separate from power cables (motor cable, battery cable).

3.6 Can Bus termination

If your system has more than one CAN node, connect the nodes in a „daisy chain” arrangement and terminate the connections of the two end nodes with a 120Ω resistor. If the end node is a Gen4, link pins 2 and 24 on the customer connector, a 120 Ω resistor is built into the controller. If you have a single node system the termination resistor should be connected so that the bus operates correctly when configuration tools are used.

3.7 EMC Guidelines (from Sevcon Manual)

The following guidelines are intended to help vehicle manufacturers to meet the requirements of the EC directive 89/336/EEC for Electromagnetic Compatibility. Any high speed switch is capable of generating harmonics at frequencies that are many multiples of its basic operating frequency. It is the objective of a good installation to contain or absorb the resultant emissions. All wiring is capable of acting as a receiving or transmitting antenna. Arrange wiring to take maximum advantage of the structural metal work inherent in most vehicles. Link the vehicle metalwork with conductive braids.

3.7.1 Power Cables

Route all cable within the vehicle framework and keep as low in the structure as is practical - a cable run within a main chassis member is better screened from the environment than one routed through or adjacent to an overhead guard. Keep cables short to minimize emitting and receiving surfaces. Shielding by the structure may not always be sufficient - cables run through metal shrouds may be required to contain emissions.
Parallel runs of cables in common circuits can serve to cancel emissions - the battery positive and negative cables following similar paths is an example. Tie all cables into a fixed layout and do not deviate from the approved layout in production vehicles. A re-routed battery cable could negate any approvals obtained.

3.7.2 Signal Cables

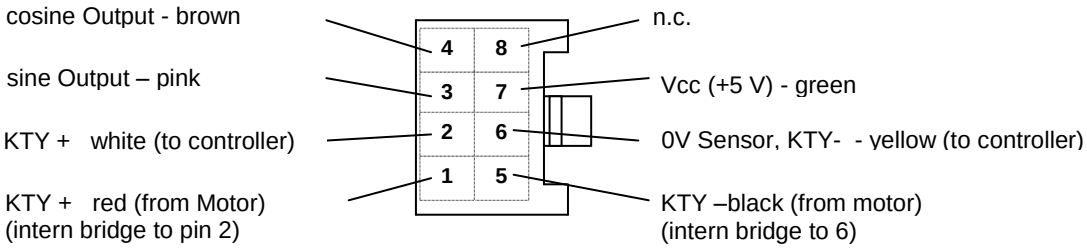
Keep all wiring harnesses short and route wiring close to vehicle metalwork. Keep all signal wires clear of power cables and consider the use of shielded cable. Keep control wiring clear of power cables when it carries analogue information - for example, accelerator wiring. Tie all wiring securely and ensure it always follows the same layout.

3.7.3 Controller

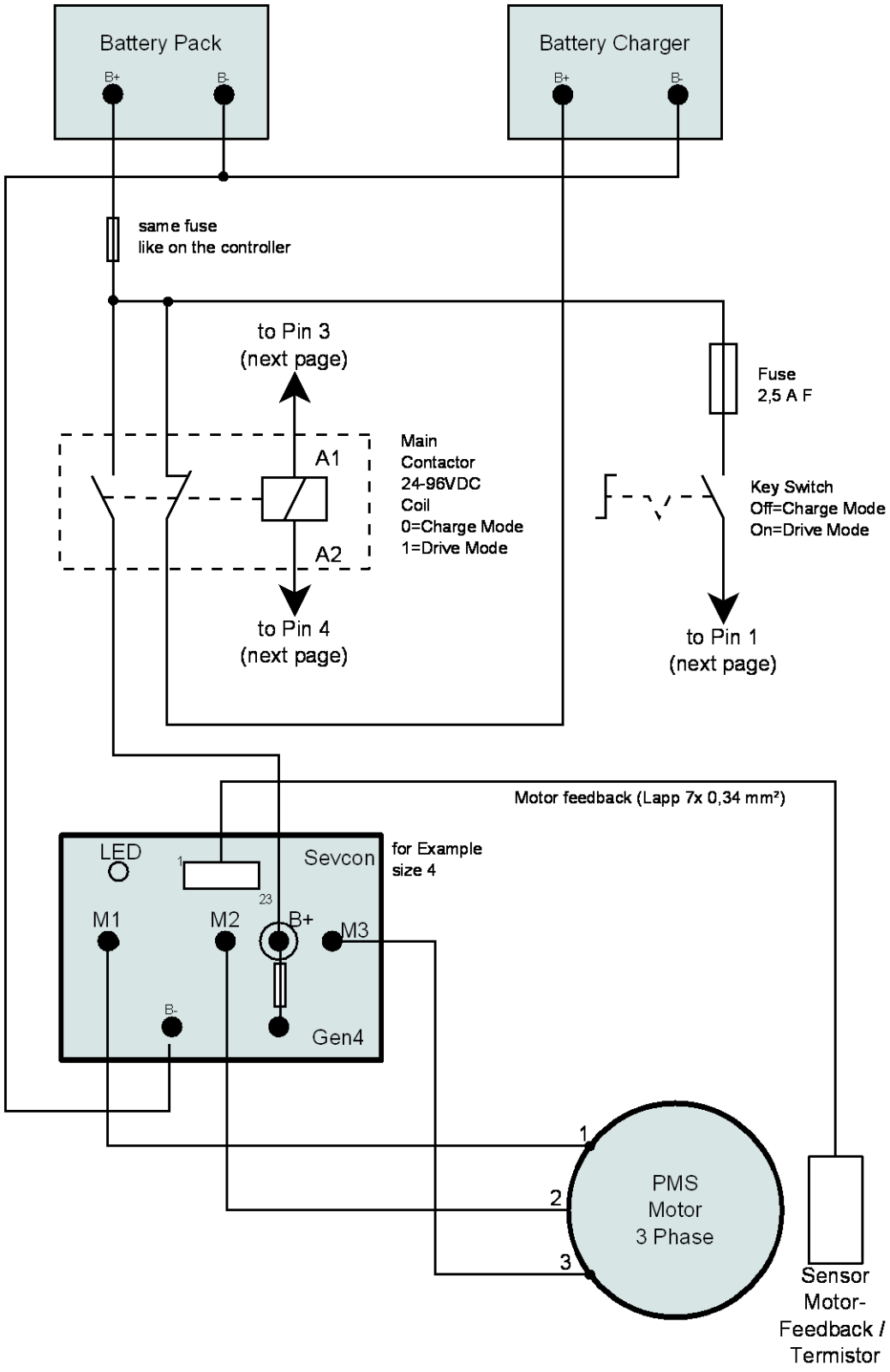
Thermal and EMC requirements tend to be in opposition. Additional insulation between the controller assembly and the vehicle frame work reduces capacitive coupling and hence emissions but tends to reduce thermal ratings. Establish a working balance by experiment. Document the complete installation, in detail, and faithfully reproduce it on all production vehicles. Before making changes, consider the effect on EMC compliance. A simple cost reduction change could have a significant negative effect on the EMC compliance of a vehicle.

3.8 Motor Connector of rotor position sensor and thermistor

The sensor connector (analogue hall sensor and thermistor KTY 84 Series) is inside the motor cover on the B-side (opposite of shaft).
Attention to the wire colours of the sensor cable 7x0,34mm².
The old sensor cable 7x0,25mm² is black for the sine output and beige for the KTY+ signal.

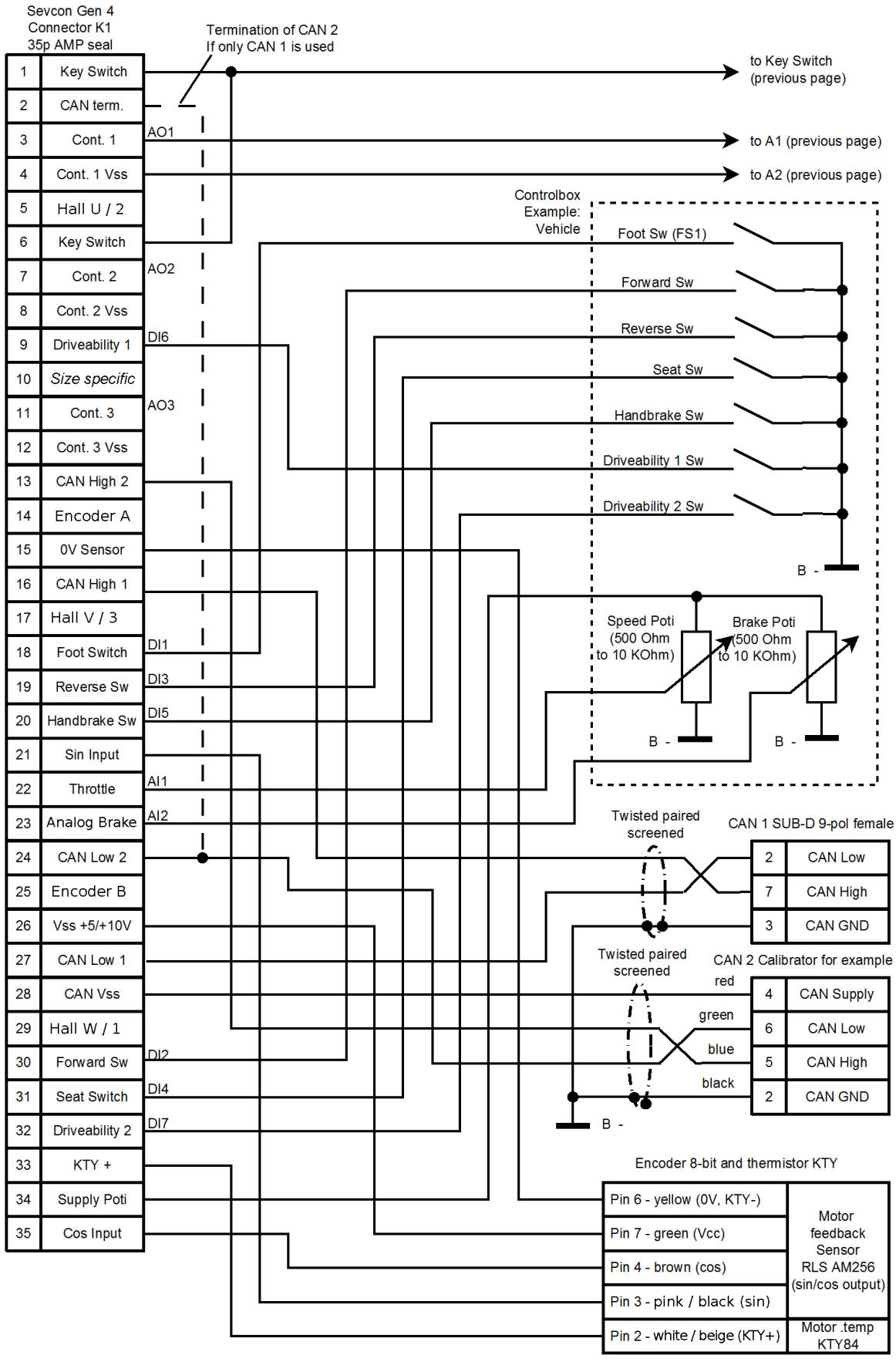


3.9 Connection Diagram SEVCON GEN4 – Power Supply



When using battery pack and battery charger in the same time without switching the main contactor, the controller could be damaged.

3.10 Connection Diagram SEVCON GEN4 – Controller Cabling



3.11 Setting up electro mechanical brakes (parking brake)

The controller has the ability to trigger an electro mechanical parking brake via its open contactor output pins. However, the following important points must be considered:

The pull in and hold voltages applied to the brake's terminals must suit the brake's parameters.
To ensure the flawless functionality of the brake, the controller must be set up correctly!

If the voltage parameter values are set too high, the brake coils might overheat and damage or destroy the brake.
Incorrectly set up pull in and hold voltages can destroy or damage the brake!

If the voltage parameter values are set too low, it is likely, that the brake clamps will not open or will close suddenly during driving.
Incorrectly set up pull in and hold voltages can lead to undesired behaviour of the brake!

Incorrectly set up pull in and hold voltages might increase the aging rate of the brake drastically.

When setting up target voltages make sure, they contain a big enough tolerance range to cover the full possible voltage range of your DC-voltage supply as well as your break.
Especially consider the voltages in recuperation and deep discharge mode as well as cable losses!

This document assumes, that you connect the brake to contactor output 2 (PINs 7 and 8) of the Sevcon controller and that the parameters of this contactor are set up correctly

Cabling and parameter set up is at your own risk!

This section assumes, that you have read and understand section 4.3 of this document and therefore are able to use the DVT software.

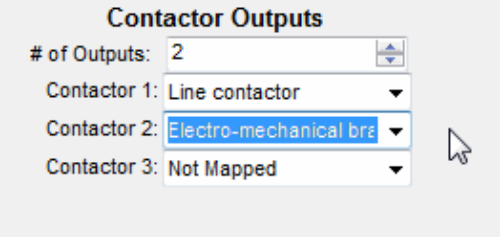
There are basically three possibilities to set up an electro mechanical parking brake with the Sevcon controllers. Which one to use depends on the application and the general set up.
Generally this section assumes, that your brake is connected to contactor output 2.

3.11.1 Setup with line contactor and brake with the same voltage range

If the electro mechanical brake has the same voltage range (the same pull in as well as hold in voltage) as well as the same pull in time as the line contactor you are using, both can use the same voltage setup (but will of course get triggered separately).

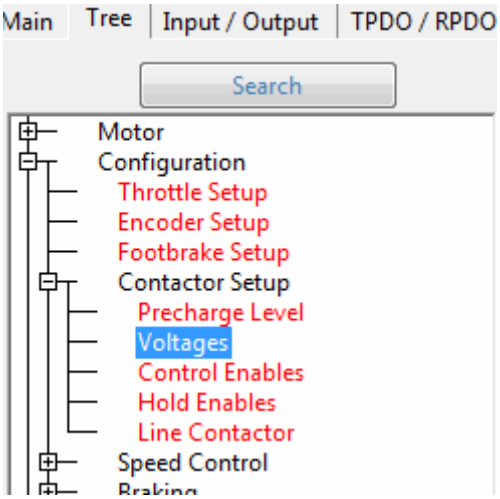
First of all, make sure, that the electromechanical brake is set up correctly at contactor 2. To do this:

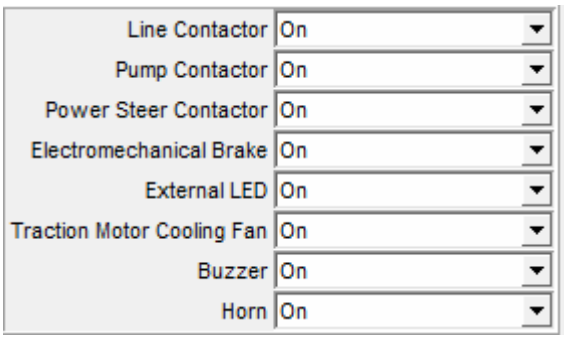
- Connect the controller to your PC
- Start the **DVT** software and open the helper window
- Switch to the *"Input/Output"* tab
- Set *"# of Outputs"* to *2*
- Set *"Contactor 2"* to *"Electro-mechanical brake"*
- Save the setting



Now enable the pull in and hold voltages for the electro mechanical brake. To do this:

- Switch to the *"Tree"* tab
- Open *"Configuration" -> "Contactor Setup"*
- Select *"Control enables"*
- Make sure "*Electro-mechanical brake"* is set to on
- Save the setting
- Select *"Hold enables"*
- Make sure "*Electro-mechanical brake"* is set to on
- Save the setting





Finally set the voltage and pull-in time values appropriately. To do this:

- Click on *"Voltages"*
- Set the values as calculated below
- Save the setting

As the most kinds of brakes need a higher voltage for open up the brake's clamp than for holding it open, the pull-in and the hold-in voltages can be set up separately.

As mentioned in the beginning of this section, make sure to define the voltages under consideration of the tolerance of your DC-voltage supply as well as the tolerance of your brake and other voltage drops like cable losses. Calculate the minimum and maximum allowed voltages based upon the minimum and maximum voltages of your DC-voltage supply considering the maximum and minimum voltage drop via cable losses and the like.

3.11.2 Setup with line contactor using the battery voltage

If the electro mechanical brake has a different voltage range (different pull in and/or hold in voltage) than the line contactor you are using, you cannot use the same voltage setup for both. The only possibility in that case would be to disable the voltage control of the line contactor – this will force the controller to use the battery voltage for closing the line contactor.

If you set up your system the way described in this section, you must ensure, that the line contactor can be run continuously on the voltage of your battery.

Some line contactors will get damaged when a too high voltage is used for keeping the contactor closed.

To set up your system using the battery voltage for the line contactor, Follow the steps in section 3.11.1, but set the *"Control enables"* of the *"Line contactor"* to *"Off"* and set the *"Pull-in"* and *"Hold-in Voltages"* as well as the *"Pull-in time"* after the definition of the used brake – and make sure to save the settings in every step.

3.11.3 Setup with control via a CANOpen master controller

In case your application contains a CANOpen master controller and neither section 3.11.1 nor section 3.11.2 are working for you, you can still use the master controller to write the wished output voltage for the brake via an SDO to the controller. To do this:

- Follow the steps in section 3.11.1, but set the *"Control enables"* of the *"Electro-mechanical brake"* to *"Off"* and set the *"Pull-in"* and *"Hold-in Voltages"* as well as the *"Pull-in time"* after the definition of the used line contactor – make sure to save each setting.
- Make sure, that the contactor output 2 is in voltage mode. Therefore bit 2 of object **0x46A1 subindex 1** must be 0. (*Note:* in almost all applications, all contactor outputs are set to use voltage mode therefore 0x46A1:1 is 0x00)
- Depending on your application, your master controller has to monitor different objects of the Sevcon controller to decide when to open as well as to close the brake. To finally open (or close) the brake, the master controller has to write the value of the needed voltage to object **0x6C11 subindex 2** (as before: it is assumed that the brake is connected to contactor output 2).

3.12 Starting-Up a PMS Motor with a Sevcon Controller

Before starting-up the motor be sure of all necessary hardware and software settings.
If during start-up the controller LED starts flashing see chapter “Faults and warnings”.

The sequence of Key Switch and other Switches must be complied! If not, faults can occur!

Example for vehicle application:

- Key Switch, Foot Switch (FS1), Forward Switch and Reverse Switch off
- Throttle on zero
- Key Switch on
- Waiting till contactor have closed (after changing parameter it can take up to 2s)
- Forward or Reverse Switch on
- Increase Throttle (Foot Switch FS1, in throttle integrated, on) than acceleration

4. Software for Changing Parameters and Diagnose

DVT is our official tool for the parameterization of Sevcon Controllers. All settings can be done with use of DVT.

The old software ***Drive Wizard*** is not supported anymore. If you have got a version of Drive Wizard installed, it can still be used. But **do not open** DVT and Drive Wizard in same time.

You need a fully functional direct internet connection for installing the DVT_Customer software. The Setup-File will download up to date versions of the needed libraries and toolkits during download.

4.1 Sevcon Controller Program Installer

To install the DVT Software, start the SevconDVT_Customer_Online.exe with Administrator rights. Follow the guide through the installation process and once the first additional setup gets started, follow the steps below to ensure that everything will be installed correctly:

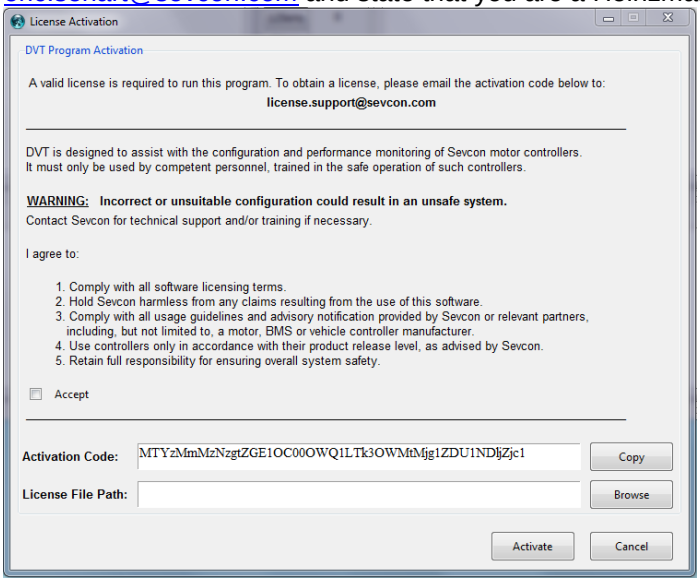
- **ActiveTCL installer:** Just accept the defaults for everything. It is important that ActiveTCL gets installed to C:\TCL as some of the install scripts are based on this setup.
  ActiveTcl is the script interpretation environment that the DVT_Customer software is written in.
- **Teacup Widgets installer (Terminal window):** The teacup widgets will automatically be installed. As soon as the install is complete just hit any key.
  In case there are any errors shown, make sure you are connected to the internet without correctly and without proxy server.
- **Ixxat drivers:** Install the Ixxat drivers for the Ixxat USB-to-CAN. **DO NOT RESTART** after the end of the setup.

If the PC shuts down during setup, just restart the installer and follow the steps above. If you have already installed one of the program parts, you can disable the steps in the selection menu in the beginning.

Once these three components are installed, setup will install DVT_Customer and prompt you to restart the computer. Accept the restart this time. Once the computer is restarted, everything should be ready to go.

4.1.1 Activate the DVT_Customer software

After starting DVT_Customer the window below will pop up. To speed up the activation process, please follow the steps explained on the window, but instead of the shown mail address, send the mail to eric.senart@sevcon.com and state that you are a Heinzmann customer.



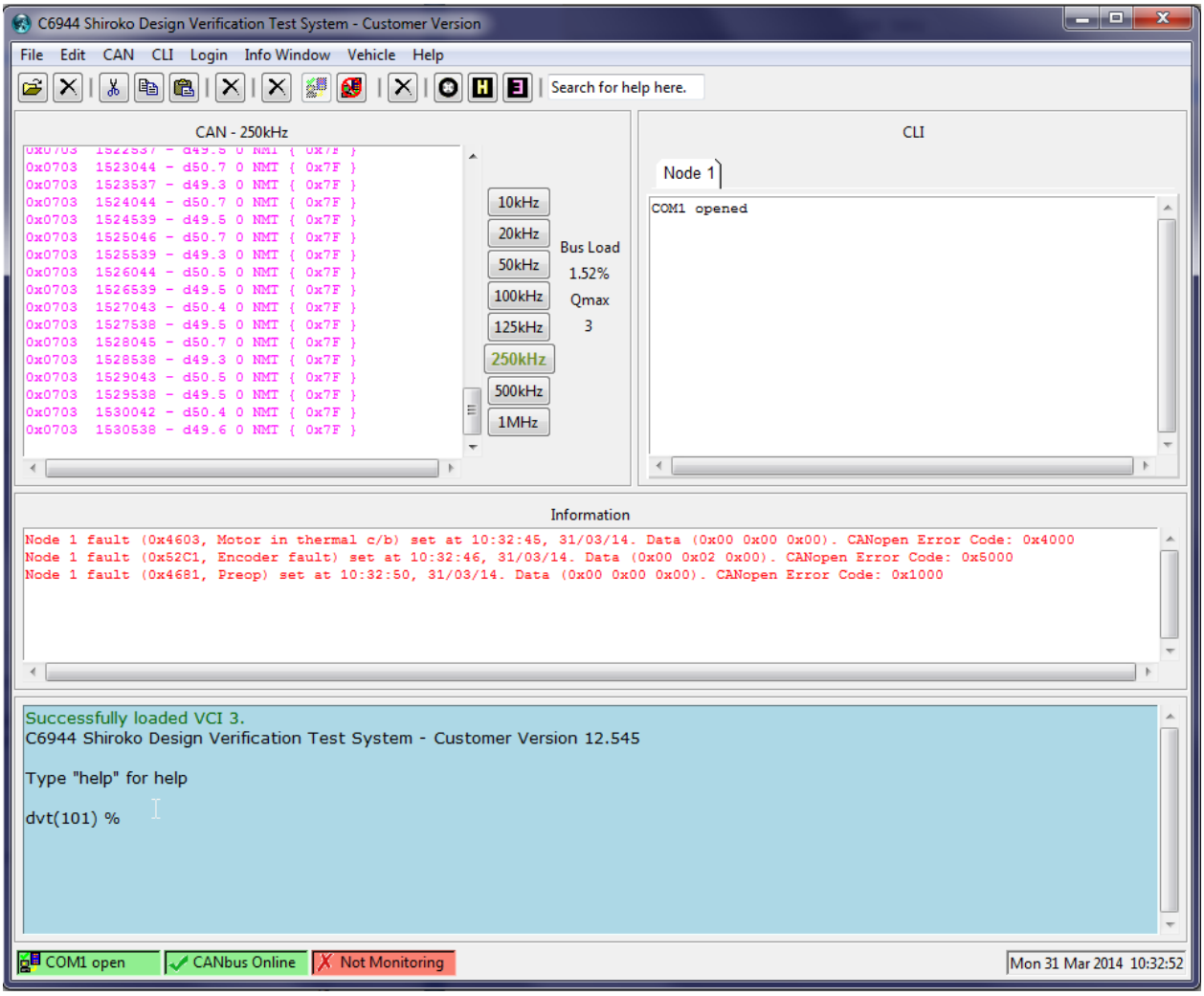
4.2 Update DVT

If you have got an older version of DVT installed, save the directory “program\EDS” from the DVT directory, as you will need the contents after update. Once you followed the complete installation routine of the new DVT version, copy the contents of the “program\EDS” directory to the appropriate directory of the newly installed DVT version.

4.3 Connection to the controller via CAN-Adapter and DVT Software

1. Connect PC over CAN adapter to the Gen4 controller.
2. Prepare the right voltage of power supply
3. Put “Key Switch” on
4. If the controller is in operational mode and no faults are active, the green LED inside the controller case will glow continuously and the main-contactor will close.
   If the controller is in pre-operational mode or faults are active, the green LED will start flashing and the main-contactor will not close. Anyways, the CAN communication will be active and usable.

- Open DVT)



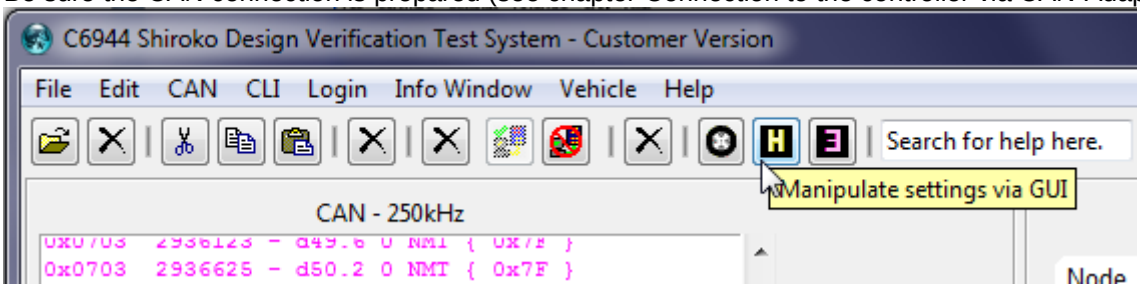
If you don’t see the CAN communication baud buttons (1MHz, 500KHz, etc.), select “CAN - Show CAN baud buttons”, to make them visible.
If the lines in the CAN window do not scroll down choose another speed.
At a good communication two green lights at the CAN adapter are lightening.

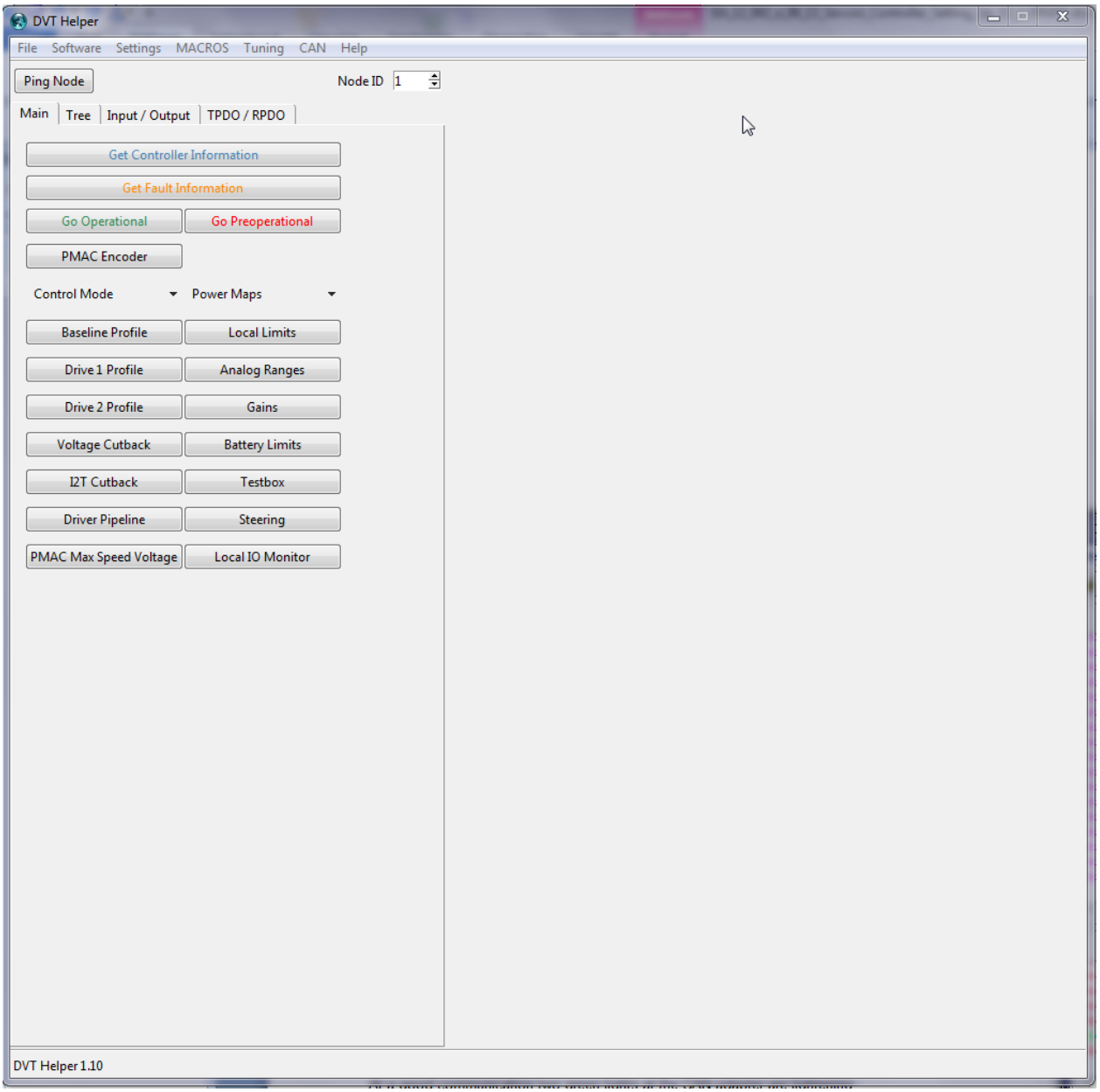
4.3.1 Show controller faults

Type `flts` in the window on the bottom.
If another CAN node ID than “1” or more controllers are used, type in `lg <node ID>` and than `flts <node ID>`

4.4 DVT Helper

In the DVT Helper parameters can be saved, loaded, changed, watched online and firmware can be updated.
To open the “DVT Helper” choose the H-icon in the upper icon row.
Be sure the CAN connection is prepared (see chapter Connection to the controller via CAN-Adapter).

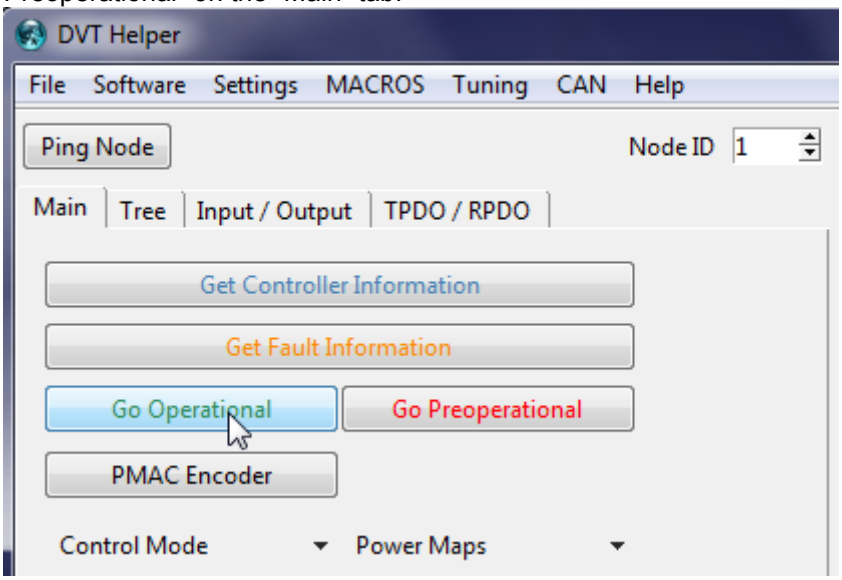




Choose the Node ID in the right top corner, if necessary
Press “Get controller information” or “Ping Node” to connect to the chosen controller

4.5 Change Operational and Preoperational Mode

Open DVT Helper, connect to the controller (see chapter DVT Helper) and chose “Go Operational” or “Go Preoperational” on the “Main” tab.

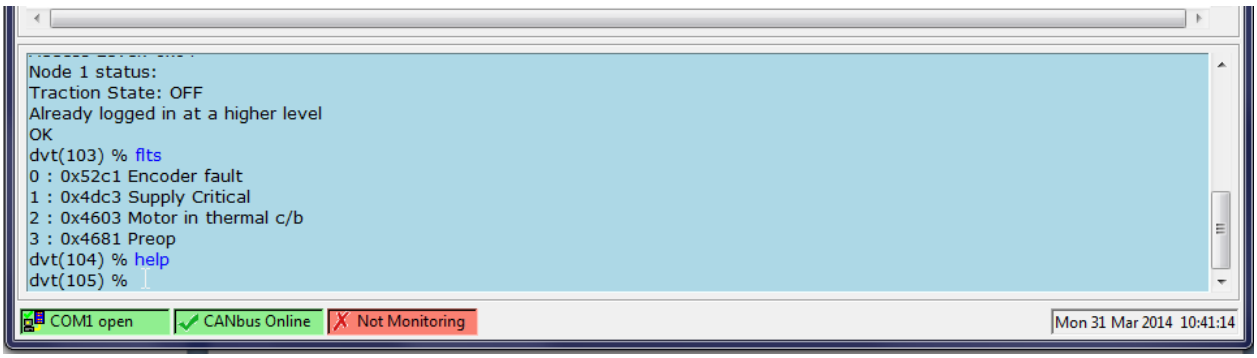


After changing to Operational Mode or to Preoperational Mode recycle Key Switch.
Only after recycling Key Switch, the information of the new mode is saved.

4.5.1 DVT commands

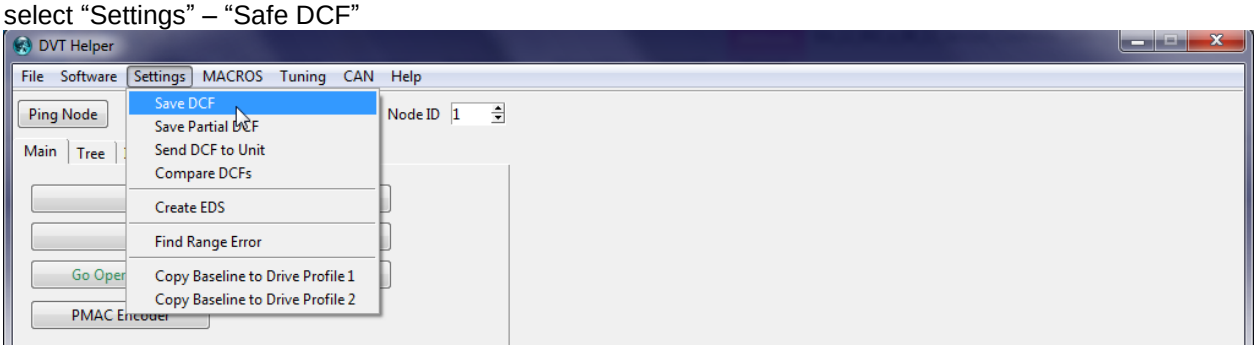
The following list contains the most important commands, that can be used for the communication with the controller. You can type them in the command window of DVT (on the bottom, left).
In this <n> should be replaced with the Node ID (<n> = 1 for new controllers).

`fpo <n> op`	Switch into operational mode – activates the controllers functionality.
`fpo <n> pre`	Switch into preoperational mode – deactivates the controllers functionality and gives the possibility to setup parameters that are not accessible in operational mode.
`fpo <n>`	Toggles between operational and preoperational mode.
`flts`	Will show the fault protocol
`help`	Shows a list of available commands

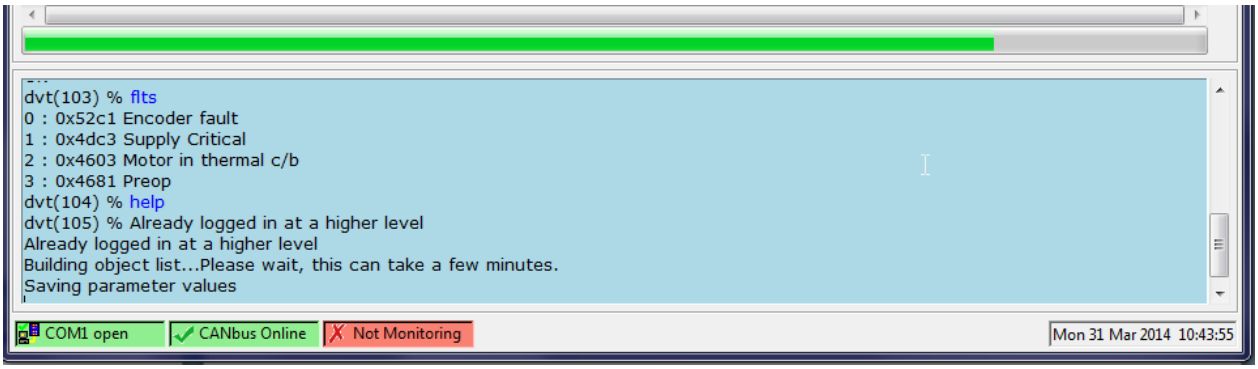


4.6 Safe parameter from controller to DCF file

To save/backup the parameters set in your controller, open the DVT Helper (see chapter DVT Helper) and select “Settings” – “Safe DCF”



When the window “Creating file…” closed (or if that is not shown - the statusbar in the main window reached 100% and disappeared) and the communication screen starts scrolling again, the backup is done.

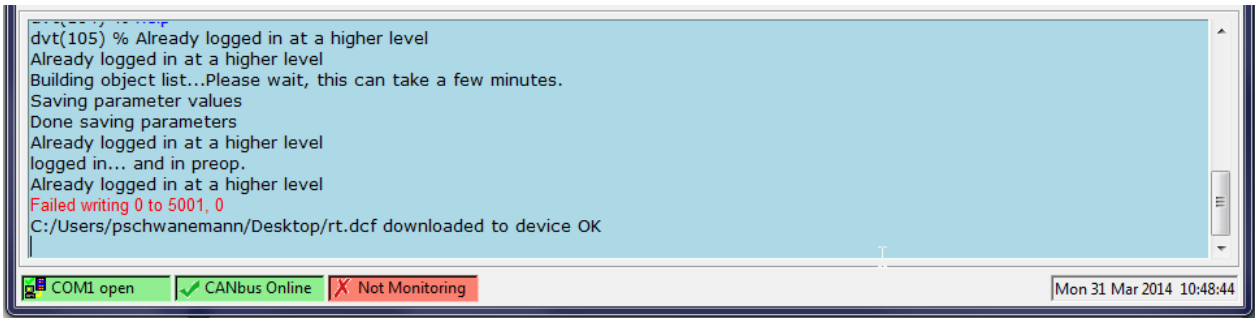


During saving the controller tries to automatically switch to preoperational mode!
To run the motor, the controller needs to switch back in operational mode (recycle key switch before and after changing back to operational mode.

4.7 Load parameter from DCF file to controller

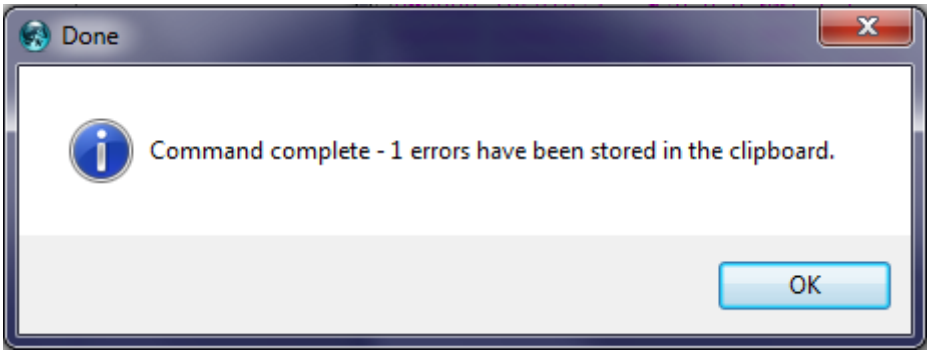
To download a previously saved parameter set to your controller, open the DVT Helper (see chapter DVT Helper) and select “Settings” – “Send DCF to Unit”

Once the parameter set was downloaded completely, a window with a warning message might pop up.
As well as an error message (“Failed writing 0 to 5001, 0”) might be shown in the terminal window of DVT_Customer:



This warning message as well as the pop up are okay. Explanation: The warning results from a password parameter stored with the dcf that has been reset directly after it was set and therefore is invalid – but is not needed at all anyways.

Close the pop up it with “OK”



When the window “creating file” closed and the communication screen stars scrolling, the backup is done.

Recycle Key Switch.

Attention:
During saving the controller automatically switches to preoperational mode!

4.8 Change Parameters

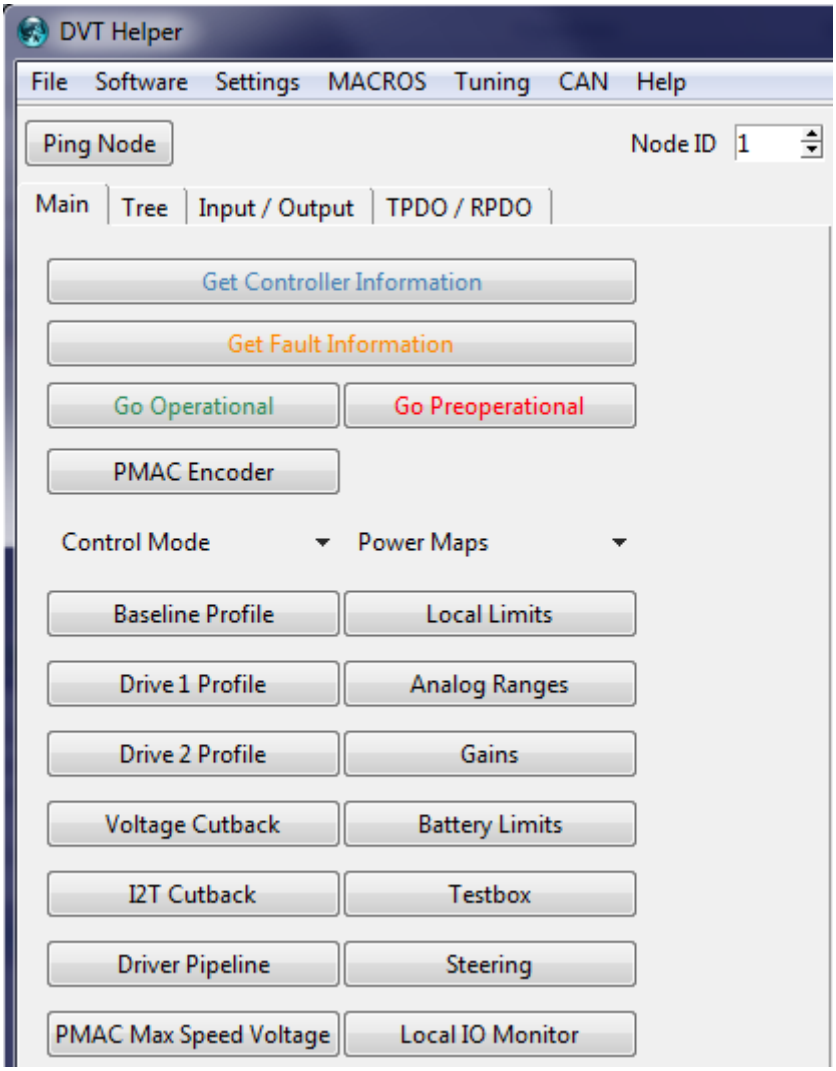
Some parameters can only be changed in preoperational mode, for example inputs / outputs (to change the mode see chapter “Change Operational and Preoperational Mode”)

The parameters of the controller can be changed via the DVT Helper (see chapter DVT Helper). Basic parameters can be changed via the interfaces on the tabs “Main” or “Tree”. Digital and analogue inputs and outputs can be changed via the interface on the tab “Input/Output. And the “PDO” setup for the CANOpen PDO communication can be setup via the interfaces on the “TPDO/RPDO” tab.

Attention:
To be sure, that modified parameters are saved and active, recycle key switch.

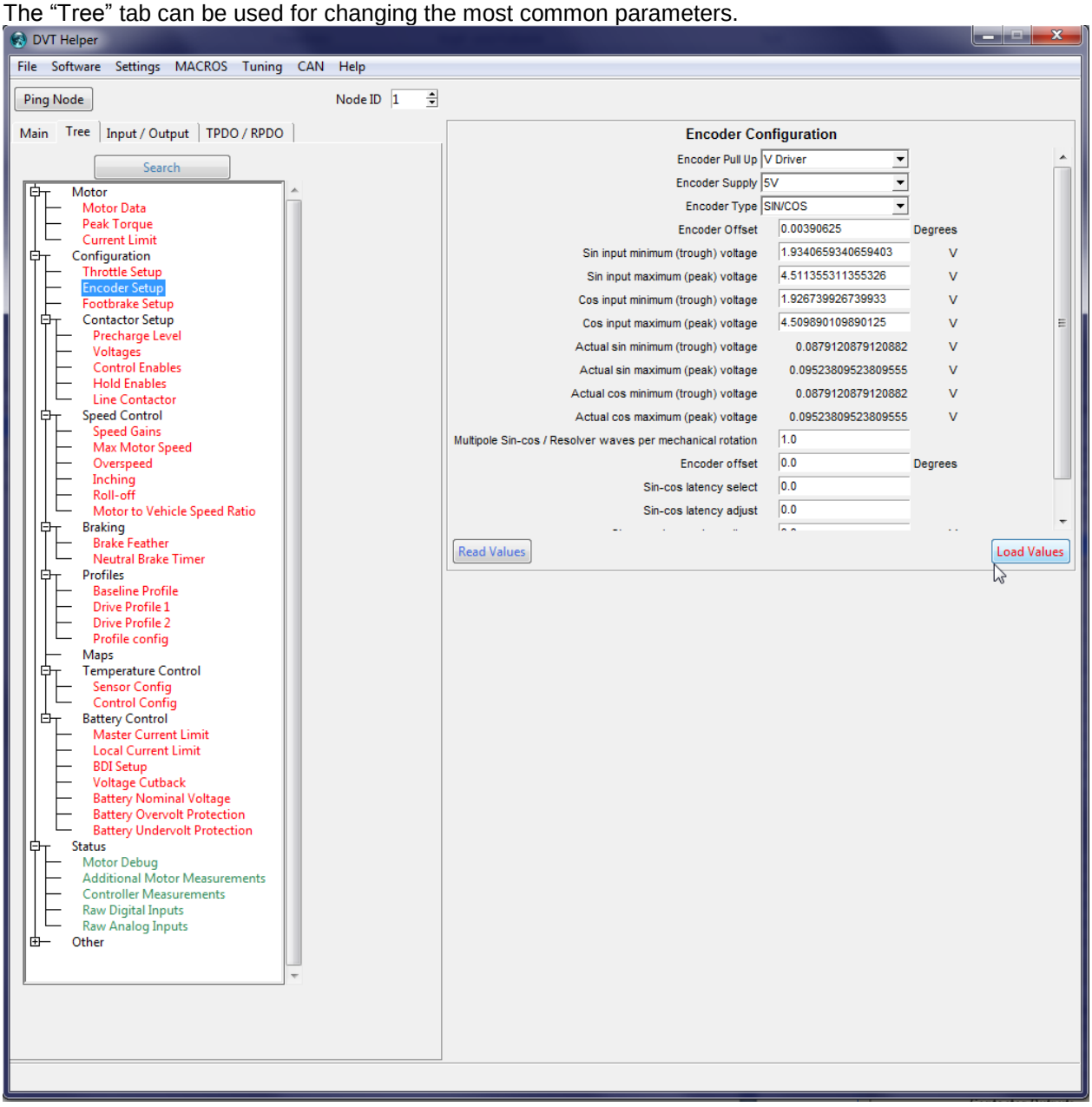
4.8.1 Main tab

The “Main” tab shows some useful information and can be used for changing basic parameters



4.8.2 Tree tab

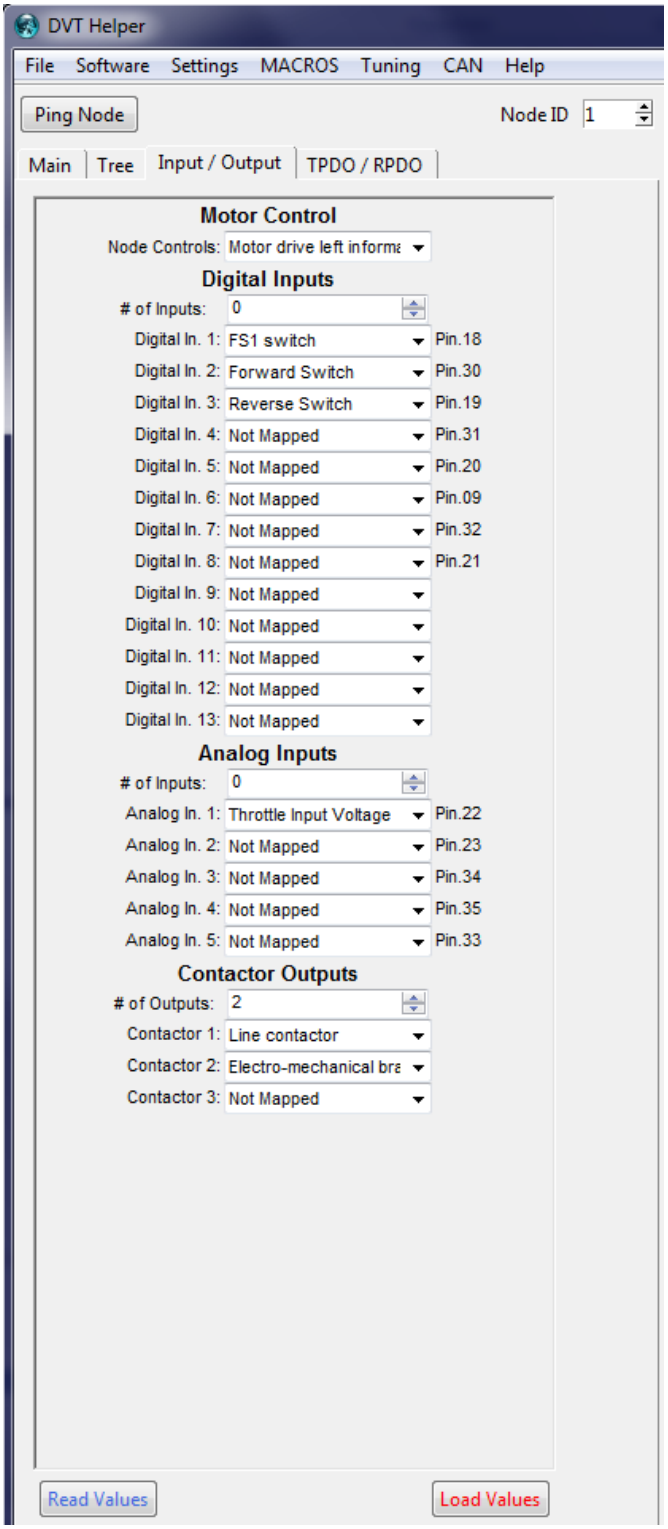
The “Tree” tab can be used for changing the most common parameters.



4.8.3 Input / Output tab

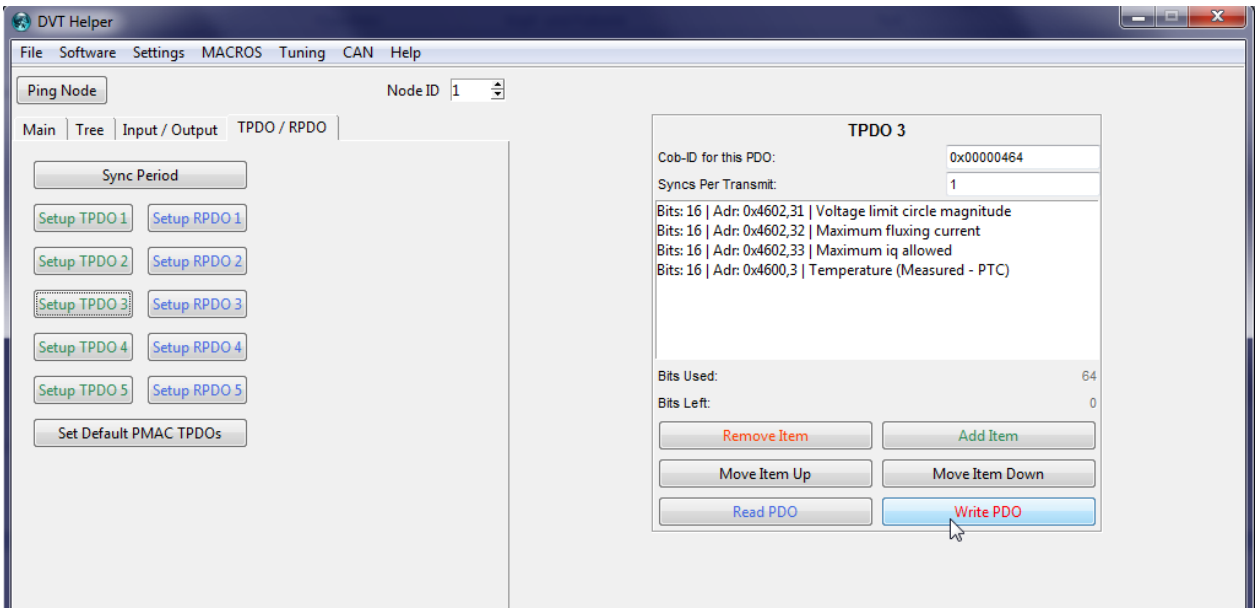
The “Input / Output” tab can be used for changing digital and analogue inputs as well as the contactor outputs (preoperational mode only).

Note that you have to set the *“# of inputs*” value for each section in order to make the selected inputs and outputs work.
Only the first # (beginning from 1) will be activated and used, all others will be ignored and deactivated, even if a function is set up for these in-/outputs.



4.8.4 TPDO / RPDO tab

The TPDO / RPDO tab can be used for changing the configuration of the communication between the controller and other instances (like DVT) via CAN bus (preoperational mode only)

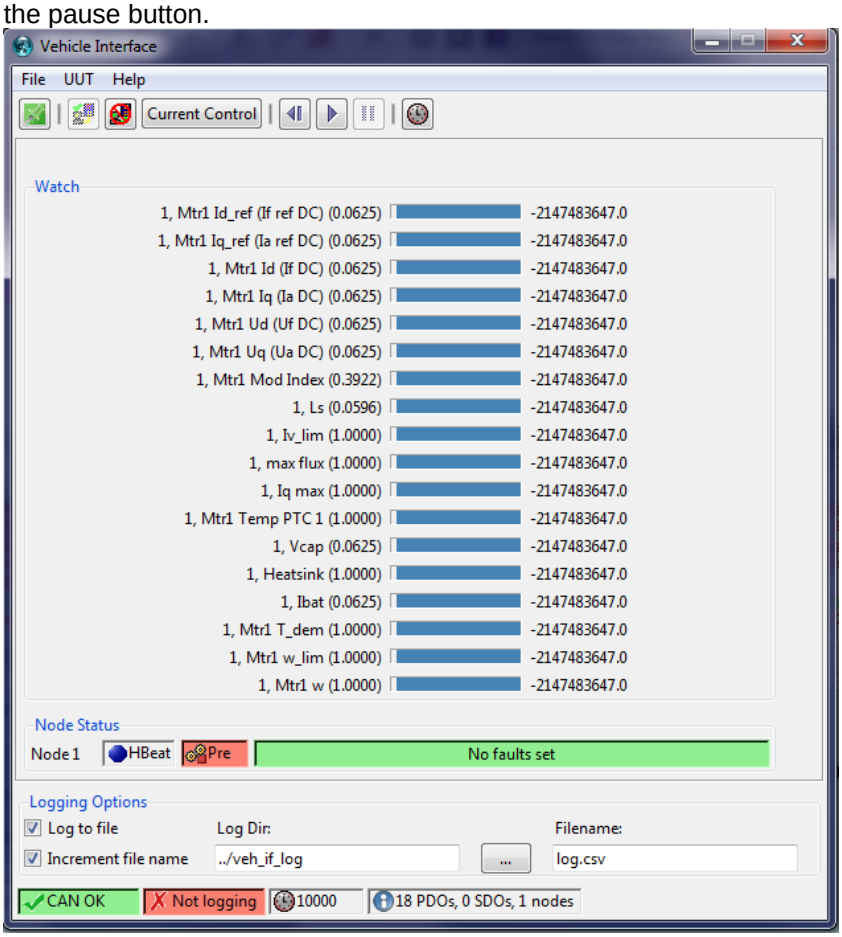


4.9 Object Dictionary

The Object Dictionary lists all parameters of your controller for the firmware version you use. It contains further information for the different parameters.

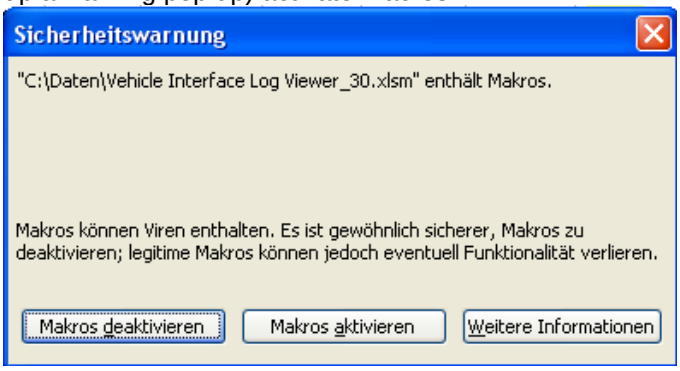
4.10 Vehicle Interface for drive tests and gain setting

The “Vehicle Interface” tool can be used for checking the actual status of the controller during runtime as well as for logging a trace with the wheel button.
To log a trace, activate „Log to file“, start the trace with the play button and finally end the recording with the pause button.

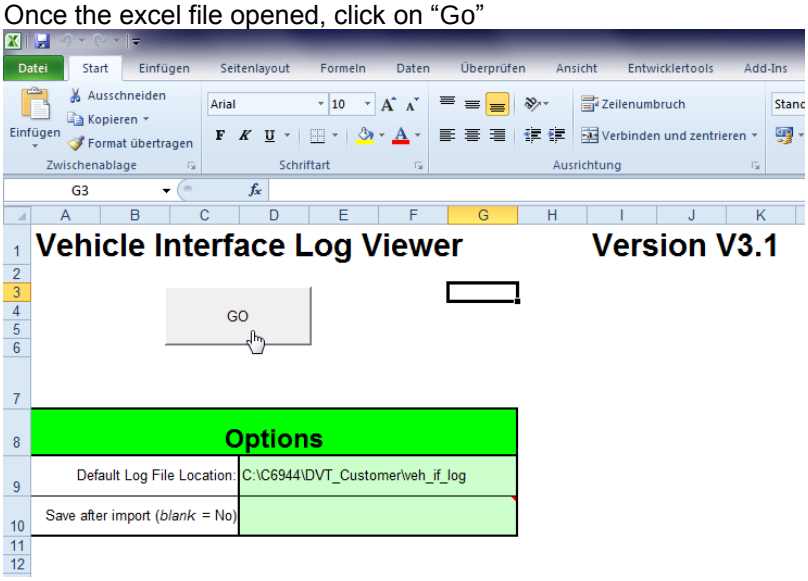


The trace will be saved in the path “<DVT_Customer Programm Directory>\veh_if_log” as a csv file.

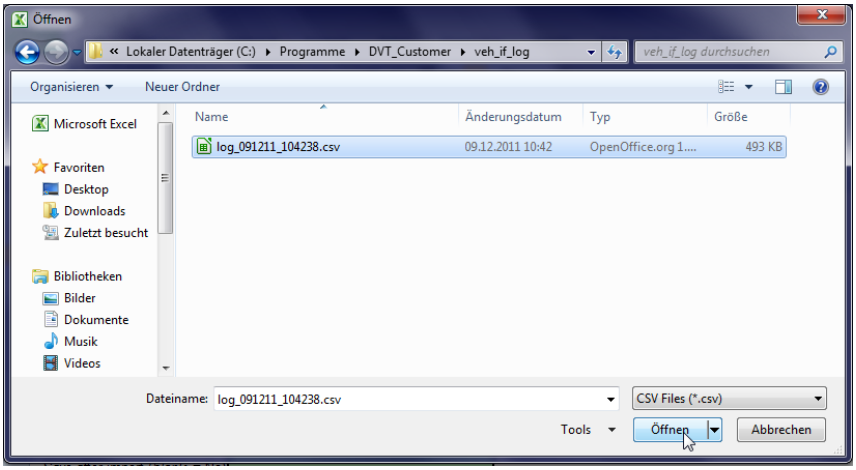
Open the excel file “Vehicle Interface Log Viewer.xlsm” (same directory as the trace) and (if Excel opens up a warning pop up) activate macros.



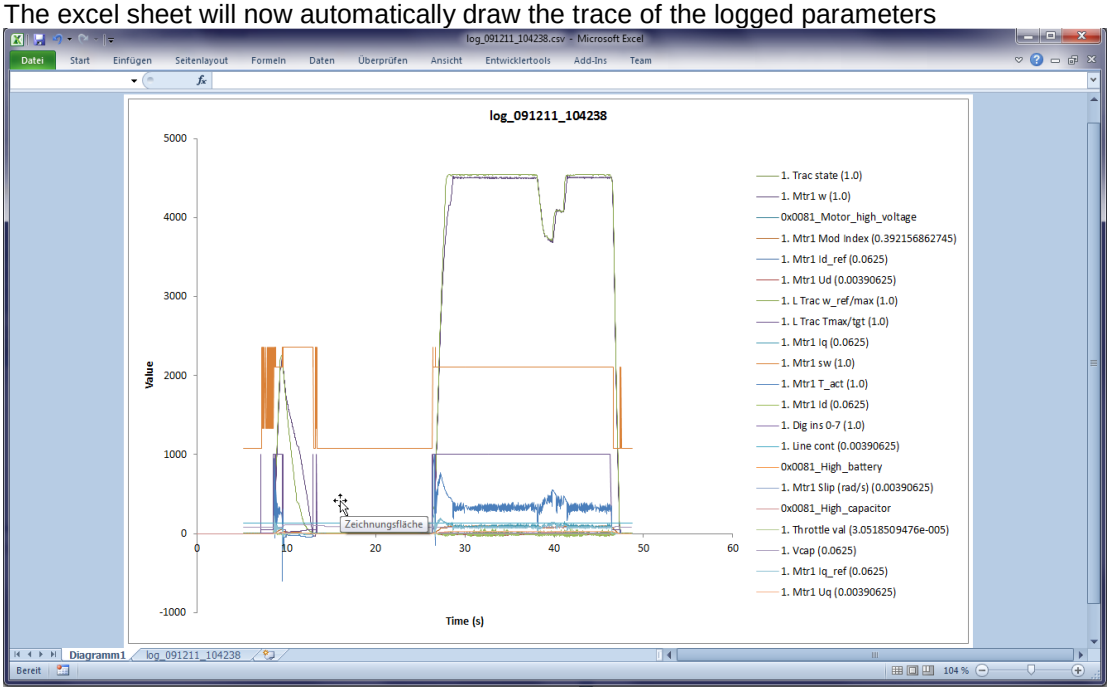
Once the excel file opened, click on “Go”



Choose the saved trace .csv file

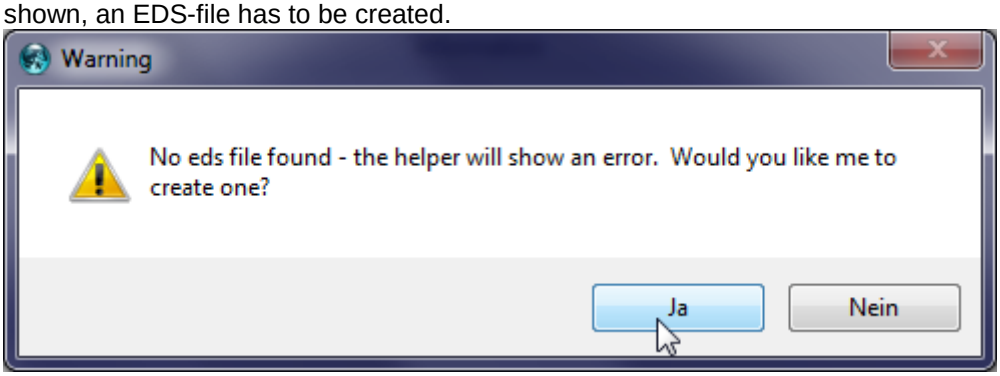


The excel sheet will now automatically draw the trace of the logged parameters

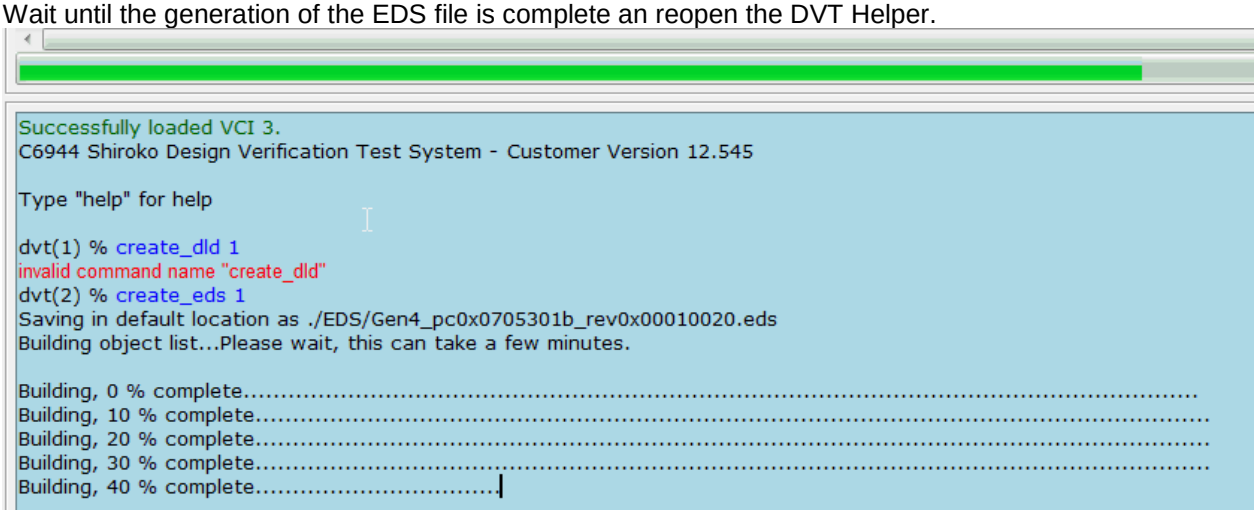


4.11 Create EDS-file

If you connect a new controller to your PC, you open up the DVT Helper and the following pop up is shown, an EDS-file has to be created.



Confirm the question or alternatively, type `create_eds 1` in the DVT terminal window.
Wait until the generation of the EDS file is complete an reopen the DVT Helper.



4.12 Update Firmware with DLD file

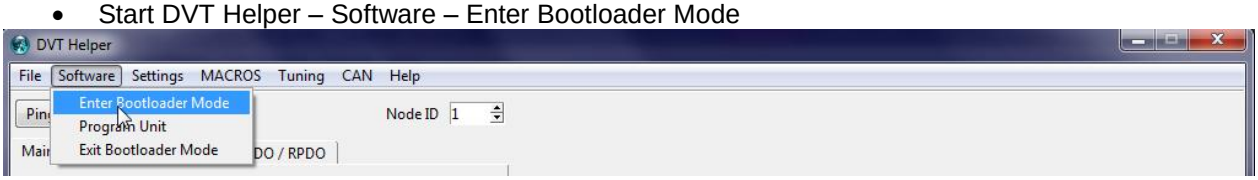
After firmware update, the parameters have been changed and need to be modified or a DCF setting, applicable to the firmware and controller, has to be loaded. Loading or setting up a structure of the parameter setting that is not applicable to the firmware, can damage the controller and will void your warranty.
Please contact Heinzmann or Sevcon first, to check if a firmware update is necessary.

An firmware update will change the parameter setting of your application!

Before updating the firmware for example to SN0058_34.dld, change to preoperational mode and recycle Key Switch.

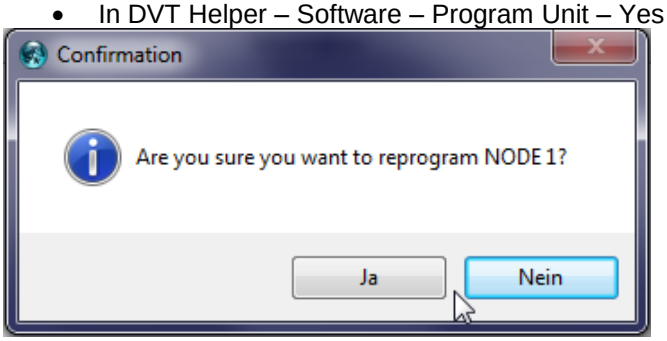
Enter Bootloader mode

- Start DVT Helper – Software – Enter Bootloader Mode



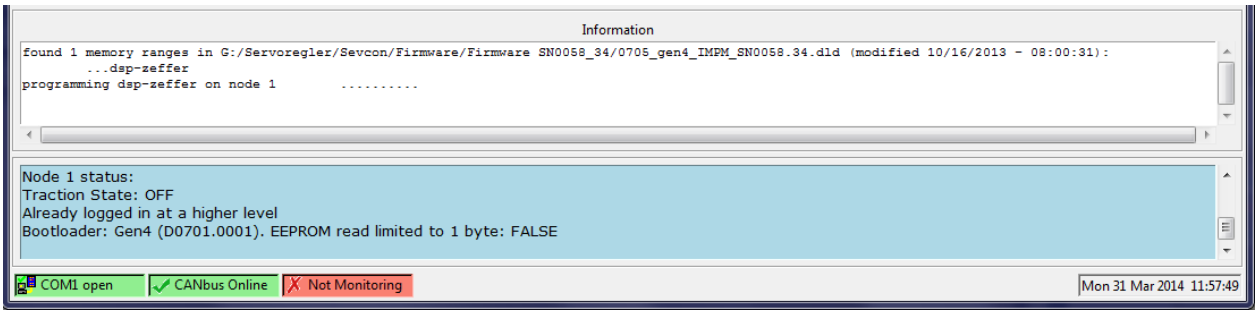
Program Unit

- In DVT Helper – Software – Program Unit – Yes (Ja)



Choose the correct DLD file from your installation path.

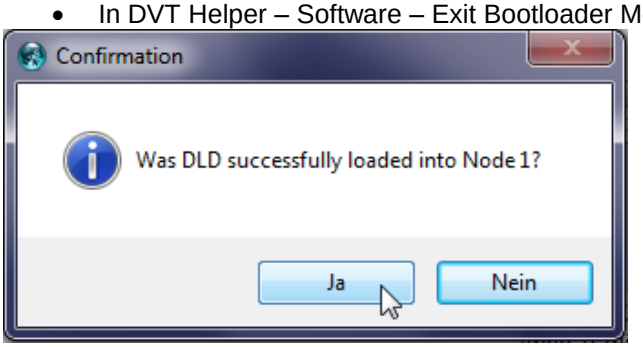
After you have chosen the dld file, it takes 1-2 minutes to start with the update.
After that time the firmware update will show the progress with dots in the Information box.



Wait until the firmware update has finished: State OK

Exit Bootloader Mode

- In DVT Helper – Software – Exit Bootloader Mode – Yes (Ja)



When the communication screen starts scrolling again, the controller left the bootloader mode.

Recycle Key Switch

4.13 Firmware update in Backdoor Bootloader Mode

Background
The bootloader backdoor mode was introduced as a method of being able to force a controller into bootloader mode in the event that communication with the main application software is lost.

By activating the bootloader backdoor, the controller will start up in bootloader mode, completely bypassing the application software. This will allow it to be reprogrammed with good software.

If the controller after new-start flashes he is in preoperational mode or has any faults. With continuous LED light the controller is in operational mode without faults, ready for run the motor. If the LED of the controller flashes once long and twice short, he is in bootloader backdoor mode. And the following steps have to be arranged.

After firmware update, the parameters have been changed and need to be modified or a DCF setting, applicable to the firmware and controller, has to be loaded. Loading or setting up a structure of the parameter setting that is not applicable to the firmware, can damage the controller and will void your warranty.
Please contact Heinzmann or Sevcon first, to check if a firmware update is necessary.

A firmware update will change the parameter setting of your application!

- The EDS must be in the dvt_customer\eds folder.
- Power off controller and disconnect sub-D connector from Ixxat
- Start DVT with command (copy and paste this line into DVT toolbox): can send "`0x7FA 0x48 0x65 0x79 0x73 0x6c 0x69 0x70`"
- Reconnect sub-D connector to Ixxat and key switch on.
- Switch to bootloader mode
  `bts 1`
- If it has worked, you will see the LED give one long flash followed by five short ones. The controller is now in bootloader mode and can be programmed with the new firmware.
- Load new firmware:
  `load_dld 1` - choose the firmware version and Wait till the update starts by showing progress poins (this can take 2 min).
  After showing .....OK the firmware load is finished. this can take 10 min.
- If it does not run change CAN frequence and load firmware again
- If it does not run restart with the whole procedure
- If it the download of the firmware is finished exit bootloader mode:
  `bte 1`
- The communication should run now

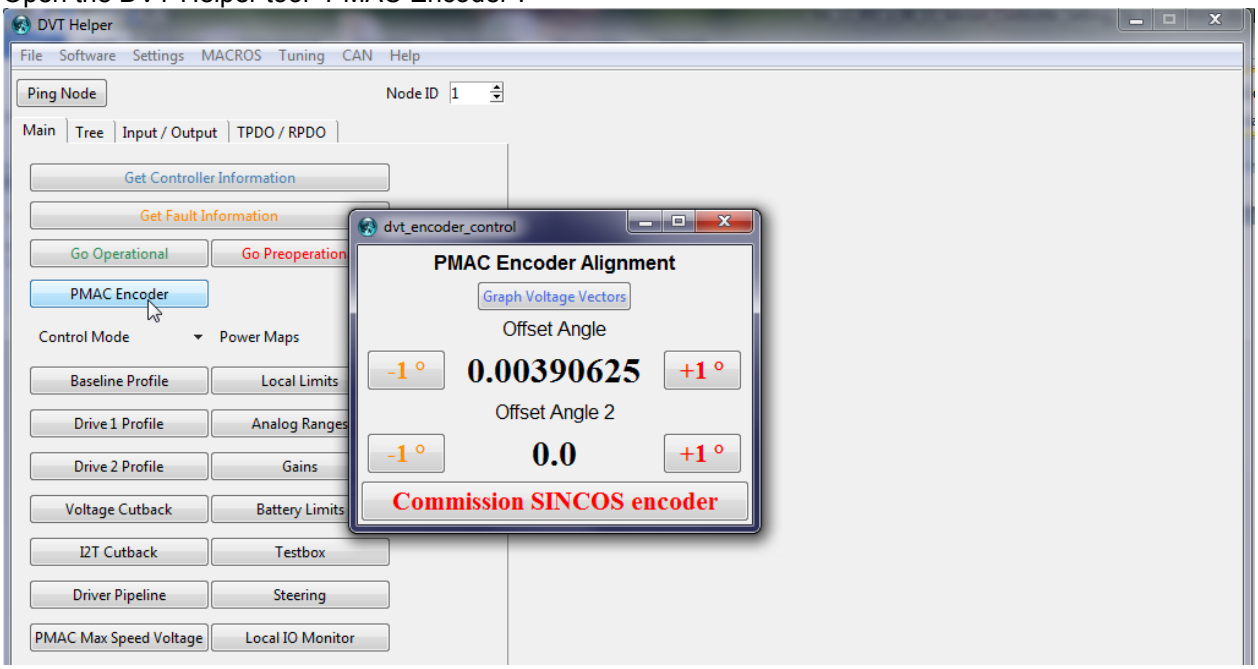
5. Controller Adjustment with Commission Encoder

Each motor has to be adjusted with one adapted controller.
Especially if an encoder fault appears it might be, that the controller cannot read the encoder signal correctly and therefore an encoder adjustment has to be done.

```
dvt(106) % flts 1
0 : 0x52c1 Encoder fault
1 : 0x5319 Mtr Slv in Wrong State
```

To adjust the controller to the encoder PCB must be mounted to the motor and must be in the range of the encoder magnet. (The distance from the encoder to the magnet on the turning axe is important.)

- Open the DVT Helper
- Change in preoperational mode (`fpo 1 pre`).
- Recycle key switch
- Open the DVT Helper tool “PMAC Encoder”.



- Turn motor shaft twice to three times by hand
- Click on “Commission SINCOS encoder”

A window will appear showing the result of the commissioning.
If the acknowledgement in the window is “OK” the commission encoder procedure was successful.

- To activate the motor control again, switch back to operational mode (`fpo 1 op`).
- Recycle key switch

6. On-Highway Vehicles (from Sevcon Manual)

6.1 General

This applies to all on-highway vehicles, such as motorcycles and cars.
The installer must ensure an appropriate controller configuration is set to ensure that the vehicle remains in a safe condition, even in the event of a fault.

6.2 Inputs

Always ensure drive inputs have adequate protection. Inputs such as the throttle should have appropriate wire-off detection configured. Single point failures should never cause an unsafe condition.
Gen4 supports wire-off detection on all analogue inputs, and it contains various safety interlocks to prevent unexpected drive due to a wiring fault (e.g. FS1 switch, dual throttle inputs).

Sevcon recommends that the following features are enabled for all applications:

- Wire-off detection on analogue inputs, particularly the throttle.
- A valid analogue input voltage which is more than 0.5V from wire off limits
- Appropriate safety interlocks to ensure a single point of failure cannot cause an unsafe driving condition.

Refer to sections Analogue inputs (page 6-14) and Vehicle performance configuration (page 6-17) for more information.

6.3 Notes on features

The Gen4 is a generic motor controller intended for use in both highway AND non-highway industrial applications. Not all of the controller features are suitable for an on-highway vehicle. Some features, if activated, could lead to the controller forcing a motor condition that is not directly requested by the throttle, such as undesired drive or harsher than expected braking.

Sevcon recommends that the following features are DISABLED for any on-highway applications:

- Proportional Speed Limit
- Hill Hold
- Controlled Roll-Off
- Speed mode (or speed control)
- Electromechanical Brake output
- Inching
- Belly switch
- Unused Driveability Profiles

NOTES:

- These features can cause the traction motor/wheel to remain locked or brake severely if the wheel is momentarily locked due to loss of traction on a slippery surface and/or mechanical braking.
- These features can cause unexpected drive if accidentally activated.
- This feature can cause a sudden reduction in maximum speed if a driveability profile is accidentally activated and is incorrectly configured.

In addition, the following features must be configured correctly

- Steering map, if used to reduce maximum outer wheel speed with steering angle.

7. Faults and Warnings

7.1 Introduction (from Sevcon Manual)

In the event of a fault Gen4 takes the following action:

1. Protects the operator and vehicle where possible (e.g. inhibits drive).
2. Sends out an EMCY message on the CAN bus.
3. Flashes the LED in a pattern determined by the fault type and severity.
4. Logs the fault for later retrieval

7.2 Fault Identification (from Sevcon Manual)

You can identify a fault as follows:

- Check the number of LED flashes and use below to determine what action can be taken. A complete and comprehensive fault identification table will be available from Sevcon in due course.
- Pick up the EMCY on the CAN bus and read the fault condition using configuration software
- Interrogate the fault on the node directly using Drive Wizard or other configuration software.

7.3 LED Flashes (from Sevcon Manual)

Use below to determine the type of fault from the number of LED flashes. The LED flashes a preset number of times in repetitive sequence (e.g. 3 flashes – off – 3 flashes – off – and so on). Only the faulty node in a multi-node system flashes its LED. Possible operator action is listed in the right hand column of the table.
If the LED of the controller flashes once long and twice short, it is in bootloader mode. And a special procedure has to be arrange, see chapter “Firmware update in Backdoor Bootloader Mode“.

LED Flashes	*Fault*	*Level*	*Set conditions*	*Operator action*
0 (off)	Internal hardware failure	RTB	Hardware circuitry not operating.	
1	Configuration item out of range	VS	At least one configuration items is outside its allowable range.	Set configuration item to be in range. Use 5621h to identify out of range object.
1	Corrupt configuration data	VS	Configuration data has been corrupted.	
1	Hardware incompatible with software or invalid calibration data	VS	Software version is incompatible with hardware. Calibration data for sensors invalid.	
2	Handbrake fault	I	Direction selected with handbrake switch active.	Release handbrake
2	Sequence fault	DI	Any drive switch active at power up.	Reset drive switches
2	SRO fault	DI	FS1 active for user configurable delay without a direction selected.	Deselect FS1 and select drive
2	FS1 recycle	DI	FS1 active after a direction change	Reset FS1
2	Seat fault	DI	Valid direction selected with operator not seated or operator is not seated for a user configurable time in drive.	Must be seated with switches inactive
2	Belly fault	DI	Set after belly function has activated.	
2	Inch sequence fault	DI	Inch switch active along with any drive switch active (excluding inch switches), seat switch indicating operator present or handbrake switch active.	
2	Invalid inch switches	DI	Inch forward and inch reverse switches active simultaneously.	Both inch switches inactive.
2	Two direction fault	DI	Both the forward and reverse switches have been active simultaneously for greater than 200 ms.	Reset switches
2	Invalid steer switch states	VS	Steering switches are in an invalid state, for example, both outer switches are active.	Check steer switches.
3	Fault in electronic power switching circuit	VS	Fault in electronic power switching circuit (e.g. MOSFET s/c).	

LED Flashes	Fault	Level	Set conditions	Operator action
3	Hardware over voltage activated	VS	Hardware over voltage circuit activated	Investigate and reduce battery voltage below user defined maximum level. Ensure suitable over voltage is configured in 2C01h and 4612h.
3	Hardware over currenttrip activated	VS	Hardware over current circuitactivated	Check motor load andwiring. Check motorparameters are correct.
4	Line contactor welded	S	Line contactor closed at power up or after coil is de-energized.	Check line contactor condition / wiring.
4	Line contactor did not close	S	Line contactor did not close when coil is energized.	Check line contactor condition / wiring.
5	PST fault	DI	Fault detected on PST power steer module.	Check PST condition.
5	Motor open circuit	S	Unable to establish current in motor.	Check motor condition / wiring.
6	Throttle pressed at power up	DI	Throttle demand is greater than 20% at power up.	Reduce demand
6	Analog input wire-off	VS	Analog input voltage is outside allowable range.	Check analog input wiring
6	Analog output fault (over/under current, failsafe, short circuit driver)	VS	Analog output fault caused by over current (>4A), under current if actual current < 50% target (current mode only), failsafe circuit fault, short circuit driver MOSFET.	Check analog output wiring.
7	BDI warning or cutout	I	BDI remaining charge is less than warning or cutout levels.	Charge battery.
7	Battery low voltage protection	I	Battery voltage or capacitor voltage is below a user definable minimum battery level for a user definable time.	Increase battery voltage above user defined level
7	Controller low voltage protection	I	Battery voltage or capacitor voltage is below the minimum level allowed for the controller.	Increase battery voltage above minimum level
7	Controller high voltage protection with line contactor closed.	I	Battery voltage or capacitor voltage is above the maximum level allowed for the controller with line contactor closed.	Investigate and reduce battery voltage below maximum level.
7	Battery high voltage protection	I	Battery voltage or capacitor voltage is above a user definable maximum battery level for a user definable time.	Investigate and reduce battery voltage below user defined maximum level.
7	Motor low voltage protection	I	Capacitor voltage has entered the motor low voltage cutback region defined in 4612h.	Increase battery voltage above start of motor low voltage cutback region.
7	Motor high voltage protection	I	Capacitor voltage has entered the motor high voltage cutback region defined in 4612h.	Reduce battery voltage below start of motor high voltage cutback region.
7	Controller high voltage protection with line contactor open.	S	Battery voltage or capacitor voltage is above the maximum level allowed for the controller with line contactor open.	Isolate controller and investigate high battery voltage
7	Battery voltage below critical level for controller.	S	Battery voltage is below the absolute minimum voltage at which the controller hardware is guaranteed to operate.	Increase battery voltage.
7	Precharge failure	VS	Capacitor voltage is less than 5V after pre-charge operation is complete.	Check controller wiring to ensure there are no short circuits between B+ and B-.
8	Controller too hot	I	Controller has reduced power to motor(s) below maximum specified by user settings due to controller over temperature.	Remove loading to allow controller to cool down.
8	Controller too cold	I	Controller has reduced power to motor(s) below maximum specified by user settings due to controller under temperature.	Allow controller to warm up to normal operating temperature
8	Motor over temperature	I	Controller has reduced power to motor(s) below maximum specified by user settings due to motor over temperature.	Reduce load to motor to allow it to cool down.
8	Motor too cold	I	Motor thermistor reports less than -30ºC.	Allow motor to warm up. Check motor thermistor.
8	Heatsink over temperature	VS	Heatsink temperature measurement has exceed absolute maximum for controller and system has powered down.	Remove loading to allow controller to cool down.
10	Pre-Operational	I	Controller is in pre-operational state.	Use DVT to put controller into operational state.

LED Flashes	Fault	Level	Set conditions	Operator action
10	RPDO Timeout	I / DI / S	One or more RPDOs have not been received within 3s at power up or within 500ms during operation.	Check CANbus wiring and PDO configuration.
11	Encoder fault	VS	Speed measurement input wire-off is detected.	Check encoder wiring
11	Over current	VS	Software has detected an over current condition	Check motor load and wiring. Check motor parameters are correct.
11	Current Control fault	VS	Software is unable to control currents on PMAC motor.	Check motor load and wiring. Check motor parameters are correct.
12	Communication error	S	Unrecoverable network communication error has been detected.	Check CANbus wiring and CANopen configuration.
13	Internal software fault	RTB	Software run time error captured	
13	Current sensor autozerofault	RTB	Current sensor voltage out ofrange with no current.	
13	DSP parameter error	RTB	Motor parameter written to while motor control is operational.	Recycle keyswitch to allow parameters to be reloaded correctly.
14	3rd Party Anonymous Node EMCY received	I / DS / RTB	3rd party node has transmitted an EMCY message.	Check CANbus wiring and 3rd party node status.
15	Vehicle service required	I	Vehicle service interval has expired.	Service vehicle and reset service hours.

8. History of Updates

Date	Version	Update
18.02.2011	1.4	Controller adjustment of sensor signal --> copy commission_encoder_2.tcl in c:\DVT_customer\program
26.05.2011	1.5	Heinzmann Test Configuration: - DI 1 FS1 Sw – Pin 18 - Di 2 Forward Sw – Pin 30 - DI 3 Reverse Sw – Pin 19
07.10.2011	1.6	Firmware update in bootloader mode
01.03.2012	1.8	New Sensor cable 7x0,34mm² with different colours (old 7x0,25mm²) New DVT update V 12.458 is available (the old firmware is function with limited options)
14.03.2013	1.9	Update for new version + added some notes + layout improvement
19.06.2013	2.0	Added section about electro-mechanical (parking) brakes
31.03.2014	2.1	- Update of software part - Update cabling (Pin10) - Update of DVT manual