Use of the DVTC Software Tool for the SEVCON GEN4 AC Controllers

Application Note - EK016-EN - September 2019

Sébastien JACQUES & Thierry LEQUEU

E-mail : <u>thierry.lequeu@gmail.com</u> – Phone: +33 6 89 73 80 58 – Fax : +33 9 72 44 29 60 152, rue de Grandmont – 37550 SAINT AVERTIN – France





Revision history:

17/09/2019 S. JACQUES - Translation of AN-EK016-FR-2018-11-14.docx.
21/09/2019 T. LEQUEU - Check of the english version.

Table of Contents:

1 Ir	ntroduction	5
1.1	Foreword	5
12	Pre-launch Verification of the DVTC Software Tool	5
13	Launching the DVTC Software Tool	5
1.5	Choice of the Transmission Frequency of the CAN bus	6
1.1	The "Information" Window	0
1.5	The Online Command Window	7 7
1.0	The Other DVTC Software Modules	/
1./		0
2 T	"he "Helper" Script – Getting Started with the SEVCON GEN4 AC	
Contro	oller	9
2.1	Foreword	9
2.2	Creating the EDS File when the "Helper" Is Launched	9
2.3	The GEN4 Controller Home Screen	9
2.4	The "Input/Output" Tab – Definition of Inputs/Outputs	
2.5	The "Tree" Tab – Function Settings	13
2.5	5.1 The « Search » Button	13
2.5	5.2 Setting of the Line Contactor	13
2.5	5.3 A Few Words about Voltage Reduction	15
2.5	5.4 Accelerator Pedal Settings	17
2.5	5.5 Parameter Setting of the Motor Temperature Sensor	19
2.5	5.6 Voltage Limits of the Battery	20
	2.5.6.1 The Limits of the "app_cutback" Battery	20
	2.5.6.2 Limiting Voltages of the "motor_cutback" Application	21
	2.5.6.3 Limiting Voltages of the SEVCON GEN4 AC Controller	22
2.5	5.7 Motor Torque-Speed Characteristic	23
	2.5.7.1 Setting the Motor Limits: the "Profiles"	24
	2.5.7.2 Tracuon Basenne Prome	24
	2.5.7.4 "Driveability Select 2 Profile"	25
2.6	Managing DCF Configuration Files	
2.6	5.1 The "Save DCF" menu	26
2.6	5.2 File Naming	27
2.6	5.3 The "Send DCF to Unit" Menu	28
3 Т	"he "Helper" Script - Advanced Functions	20
21	Changing the Access I evel	···· 27
2.1	Changing the Newingl Valtage and Correct Values	29
3.Z	Les lines "Software DID" File into the Controller	29
3.3	Loading a "Software DLD" File into the Controller	31
3.3 2.2	5.1 Saving the Controller Configuration	31
3.3 2.2	5.2 The Software menu	31
2.2	D.S Switching to the Bootroader mode	52
3.3	5.5 Exiting the "Bootloader" Mode	32
3.3	5.5 Exiting the Bootloader Wode	32
3.3	After Undating a New "Software"	33
34	The "TPDO/RPDO" Tab	34
ד.כ גר	1 Some References on this Tonic	34
3.4	Configuration of "RPDOs"	34
3.4	L3 Configuration of "TPDOs"	
3.5	The "Change Baud Rate" Menu	
3.6	Definition of the Motor Characteristics	39

4 The "Vehicle Inter	rface" Script	
4.1 Introduction		
4.2 Data Display		
4.2.1 The Output Fi	le	
4.2.2 The Control B	uttons	41
4.3 Data Processing U	Jsing EXCEL	41
5 The "Editor" Scrip	ot	
5.1 Introduction		
6 References		
7 Appendix 1 – Che	cks Before the Launch of DVTC	
7.1 The Controller W	iring – Power Part	
7.2 The Controller W	iring – Control Part	
7.3 Checking the USI	3-to-CAN interface	
8 Appendix $2 - Nur$	nbering of SEVCON GEN4 AC Controllers	49
8.1 Product identifica	tion label	49
8.2 Numbering of SE	VCON GEN4 AC Controllers	50
8.3 Glossary of Term	s	
0 Appendix 3 Onl	ine IT Orders	51
9 Appendix $3 = 0$ in 0.1 The Principle of 7	The TT Orders	
9.1 The Efficiple of 1 9.1 Displaying a T	el/ 1 K Commands	
912 Comments		51
9.1.3 Variables		
9.1.4 Calculations		
9.1.5 Calculation lo	əps	
9.1.6 Declaration of	Procedures	51
9.2 CANopen Comm	ands of SEVCON GEN4 AC Controllers	
9.2.1 Manual Loadin	ng of a DCF Configuration File	52
9.2.2 List of "Active	e Faults"	52
9.2.3 Manual Loadin	ng of a DLD "Software" File	52
10 Appendix 4 – The	Variables of the Motor	
10.1 The "Save Parti	al DCF" Command in the "DVTC Helper"	
10.2 List of Variable	s Provided by "Add PMAC Motor Items"	55
10.2.1 Variable 0x46	11 – Motor power limit map	56
10.2.2 Variable 0x46	15 – Motor power limit map 2	56
10.2.3 Variable 0x46	17 – Programmable User Data	
10.2.4 Variable 0x46	20 – Motor Temperature 1 (Measured - T1)	
10.2.5 Variable 0x46	21 – Motor Temperature Setup	
10.2.6 Variable 0x46	20 – Encoder Configuration	
10.2.7 Variable 0x40 10.2.8 Variable 0x40	40 – Motor Nameplate Data	
10.2.6 Variable 0x40 10.2.9 0x4650 Variab	+1 – AC Motor data (manufacturer specific)	
10.2.9 0x4030 valiat	75 and 0x6076 Variables	
10.2.11 0x6090 Varial	ble – Encoder Resolution	
11 Appendix $5 - Tipe$	s for Adjusting Correctors	50
11 1 Speed Loop	, 101 / 10justing Contectors	
11.2 Current Loop		

1 Introduction

1.1 Foreword

This application note explains how to use the SEVCON DVTC software tool to configure SEVCON GEN4-series AC controllers. The installation of the DVTC software tool was covered in the AN-EK015 application note [1]. It is strongly recommended to read the SEVCON drive documentation [4] and the AN-EK005 [5] application note.

The version of the SEVCON DVTC software tool used in this report is the April 2019 version (*i.e.*, "version 13.9").

1.2 Pre-launch Verification of the DVTC Software Tool

The IXXAT USB-to-CAN interface has two LEDs: the first one for the USB bus, and the second one for the CAN bus. These LEDs provide information on the communication status [6].



Fig. 1. The IXXAT USB-to-CAN interface [6].

If the LED for the USB bus is green, the communication with the interface via the USB port is possible. However, if the USB indicator is red, the communication is not possible.

In this case, it will be necessary to check if you have installed the latest drivers for your operating system (*i.e.*, "VCI version 4").

In case of problems, the latest versions of the USB-to-CAN interface drivers can be downloaded from the IXXAT website at:

https://www.ixxat.com/support/file-and-documents-download/drivers

When the communication via the USB port is operational, you can then launch the DVTC software tool.

1.3 Launching the DVTC Software Tool

The DVTC launch script is available in the following directory:

C:\DVTC\customer\program\dvt.tcl

It is strongly recommended to create a shortcut on the desktop for the execution of the DVTC software tool.



Fig. 2. Shortcut for the execution of the DVTC software tool (version 2018).



The DVTC software tool (i.e., version 13.9) is composed of several information windows.

Fig. 3. Information windows of the DVTC software tool (i.e., version 13.9).

1.4 Choice of the Transmission Frequency of the CAN bus

The "CAN" window displays the frames when the communication speed is correct (in that case, 250 kHz).

To display the traffic on the CAN bus, the different baud rates must be selected until the "Bus load" is different from 0%.

It is also necessary to check in the "CAN" drop-down menu that there is indeed data selected in the display.

The "CAN" drop-down menu is also used to suppress the display of CAN frames by the "Show None" option.

This menu is also used to display the CAN bus speed selection buttons on the main window by checking the "Show Can baud Buttons" option.



Fig. 4. The CAN menu of the DVTC tool.

1.5 The "Information" Window

To display the "Information" window, it is important to tick the "Show" option in the "Info Window" menu.

In Info Window V	Information
× Show	Hode 1 fault (0x4F4:, Internal) set at 14:00:55, 27/03/18. Data (0x00 0x00). CANopen Error Code: 0x6100 Hode 1 fault (0x4F4:, App mgr S3) set at 14:00:55, 27/03/18. bata (0x00 0x00 0x00). CANopen Error Code: 0x6100 Node 1 fault (0x504; Param fixed range) set at 14:00:55, 27/03/18. Data (0x00 0x00 0x00). CANopen Error Code: 0x630 Hode 1 fault (0x504; Param fixed range) set at 14:00:55, 27/03/18. Data (0x00 0x00 0x00). CANopen Error Code: 0x630
Clear	Node 1 fault (0x4F4), Internal) set at 14:00:55, 27/03/18. Data (0x00 0x00 0x00). CAMopen Error Code: 0x6100 Node 1 fault (0x4F5), App mgr SS) set at 14:00:56, 27/03/18. Data (0x00 0x00 0x00). CAMopen Error Code: 0x6100 Node 1 fault (0x52C), Encoder) set at 14:00:56, 27/03/18. Data (0x00 0x00 0x00. CAMopen Error Code: 0x4000

g. 5. The Thjo wir menu.

Fig. 6. The "Information" window.

The information window displays the CAN bus states, GEN4 drive error messages, progress of DVTC software tasks...

1.6 The Online Command Window

The lower area of the DVTC software window allows you to enter orders online. More information is available in section 9.2 of Appendix 3 and by typing the "help" command.



Fig. 7. The online command window of the DVTC software tool.

1.7 The Other DVTC Software Modules

Sevcon - Device Verification Tool - Customer Version	
File Edit CAN CLI Login Info Window Vehicle Velp	
🐴 🗙 😹 🔊 🗙 🗙 📪 🗙 🚱 🔛 🖪 🚜 👫 Search for hep here.	
	cu
0x0457 1822610 - d 0.5 0 Unknown (0xD4 0x7D 0x97 0x00 0x1C 0x01 0x26 0x.	Note 1
0x0233 1822614 - d 0.4 0 Unknown (0x3D 0x03 0x15 0x00 0x10 0x3C 0x03 0x64) 0x0458 1822619 - d 0.5 0 Unknown (0x00 0x00 0x00 0x00 0x00 0x00 0x00 0	Launching.
0x0080 1822815 - d20.0 0 SYNC	Launening.
0x0351 1822820 - d18.1 0 Unknown (0x00 0x00 0x00 0x00 0x00 0x00 0x00 0	"Vehicle Interface"
0x0427 1822817 - d 0.7 0 Unknown (0x00 0x00 0x00 0x00 0x00 0x00 0x02) 50kHz 13.46	s - veniere miteriace,
0x0457 1822812 - d 0.5 0 Unknown (0x04 0x7D 0x97 0x00 0x1C 0x01 0x26 0x00) 100kHz Qmu	"Helper"
0x0458 1822842 - d 0.5 0 Unknown (0x00 0x00 0x00 0x00 0x00 0x00 0x00 0	- morpor ,
0x00900 1823014 - d15.5 0 SYNC 0x0351 1823019 - d17.7 0 Unknown (0x00 0x00 0x00 0x00 0x00 0x00 0x00 0	- "Editor"
0x0427 1823015 - d 0.6 0 Unknown (0x00 0x00 0x00 0x00 0x00 0x00 0x9F 0x02)	- Eulior .
0x0457 1923019 - d 0.4 0 Unknown (0xD4 0x7D 0x97 0x00 0x1C 0x01 0x26 0x00)	
0x0458 1823019 - d 0.5 0 Unknown (0x00 0x00 0x00 0x00 0x00 0x00 0x00 0	
	· · · · · · · · · · · · · · · · · · ·
Informa	ution
	A
COM1 could not be opened	
Successfully leaded VCL3. Sevcon - Device Verification Tool - Customer Version 13.9	
Type "help" for help	
dvt/22) %	
	•
COML open CANbus Online X Not Monitoring	Sun 22 Apr 2018 17:35:2

Fig. 8. Choice of the CAN bus speed and launch of the "Helper".

The "CROSS" or small "WHEEL" button allows the launch of the "Vehicle Interface" window, which is a graphical interface for displaying and recording drive variables.	Fig. 9. Execution button of the "Vehicle Interface" script.
The " H " button allows the launch of the "Helper" window, which is a graphical interface both for communication and configuration of the controller.	Fig. 10. Execution button of the "Helper" script.
The "E" button allows the launch of the "Editor" window, which is a graphical interface for reading and editing offline DCF files.	Fig. 11. Execution button of the

2 The "Helper" Script – Getting Started with the SEVCON GEN4 AC Controller

2.1 Foreword

The "Helper" script is a graphical interface for communication and configuration of the AC controller. This chapter presents the main commands used to operate the controller and adjust the parameters to a specific application.

2.2 Creating the EDS File when the "Helper" Is Launched

When the "Helper" is executed for the first time or if a new AC controller is installed, the script checks the presence of the EDS file on the computer.

If this is not the case, it is proposed to create a new one: it is **IMPERATIVELY NECESSARY to answer "YES"** to the question "Do you want to create one?"!

At the end of the procedure (which is very long, but only once), an EDS file is created in the directory:

C:\DVTC\common\program\EDS

The file name follows the following formalism:

Gen4_pc0x0705301b_rev0x0001001c.eds

- "Gen4": type of product;
- "_pc": product number "Product code: 0x0705301b";
- "_rev": software revision number "Rev. Number: 0x0001001c".

The ".eds" file is a text file in XML format.

It contains about 22,000 lines of text, for a size of about 450 kB.

It represents the definition and values of the 4200 CAN objects defined for the parameter setting of the SEVCON GEN4 drives. The list of objects is available in the file:

C:\DVTC\Object Dictionary\Master_Object_Dictionary_Database.xls

2.3 The GEN4 Controller Home Screen

The "Helper" home screen is empty of information when it is opened.

IMPORTANT: Make sure that the CAN node number is correct! "Node ID".

By clicking on "Get Controller Information", you can retrieve the drive configuration information:

- Software Ver.: 0705.0012
- Hardware Ver.: 0x01070004
- Product Code: 0x0705301b
- Serial Number: 1012200139

This allows to validate the communication between the software and the GEN4 drive.

This information partly corresponds to the information on the product identification label (see §8.1).



Fig. 12. AC controller home screen with the "DVT Helper".

Application Note EK016 - Use of the DVTC Software Tool for the SEVCON GEN4 AC Controllers - September 2019

DVT Helper			8 3	
ile ∑oftware Settings <u>N</u> Ping Node Main Tree Input / Outpu	MACROS Juning CAN H	ode ID 1		CAN node number of the AC controller
Get Controlle Get Fault Ir Go Operational PMAC Encoder	r Information		To get the information about the AC controller	
Control Mode 👻	Torque Maps 👻			
Baseline Profile	Local Limits		To get information show	t
Drive 1 Profile	Analog Ranges		the AC controller erros	
Drive 2 Profile	Gains		uic AC controller erros	
Voltage Cutback	Battery Limits			
121 Cutback	Steering			
Driver Pipeline				
PMAC Max Sp Volt Limit	PMAC motor parameters			
Local IO Monitor				

Fig. 13. AC controller home screen with the "DVTC Helper".

It is also from this screen that the configuration modes are switched:

- 1) GREEN: "Go Operational" to resume normal drive operation. The line contactor (power relay) must close;
- 2) RED: "Go Preoperational" to switch to drive configuration mode: the power relay is disabled and the motor cannot operate.

General information:

- IMPORTANT: the CAN node number must be checked if several controllers are available.
- When starting when the drive is in "Pre-operational" mode, the "External LED" error light does not light up. It is necessary to switch to "Operational" mode for the indicator to light up.
- When first receiving a SEVCON GEN4 drive, it may be prudent to save the initial drive configuration BEFORE changing it. To do this, refer to section to save the DCF file of the controller parameters.

2.4 The "Input/Output" Tab – Definition of Inputs/Outputs

Most of the settings in this tab will only be taken into account if the controller is in "Preoperational" mode (RED button: "Go Preoperational").

This tab allows you to define the functions available on the 13 digital inputs, the 5 analog inputs and the 3 digital power outputs.

In the minimum version, the controller requires the following functions:

3 digital inputs:

- 1) a Forward Switch on pin 18;
- 2) a Reverse Switch on pin 30;
- 3) a Foot Switch ("FS1") accelerator sensor on pin 19.

<u>1 analog input</u>:

1) a "Throttle" accelerator potentiometer on pin 22, the power supply being between pin 34 "Pot 1 Power Supply" and terminal B- of the controller.

2 digital power outputs:

- 1) the power relay coil between "Cont1" N°3 and "Cont1 Supply" N°4;
- 2) an external indicator between pins "Cont3" N°11 and "Cont3 Supply" N°12.



Fig. 14. Input/Output tab aimed at defining digital and analog inputs and power outputs.

The "Load Values" RED button is used to send the values to the AC controller. It takes a few seconds for all parameters to be sent.	Load Values
The "Read Values" BLUE button is used to read the values from the AC controller: this action verifies that the controller's programming has been taken into account.	Read Values

The AC controller can use more analog and digital inputs as long as the number of inputs used is changed to "# of inputs". Otherwise, the functions defined on these new entries will not be taken into account.

The digital power outputs used to supply the power contactors are at least 3; in minimum, only the "Contactor 1" output is used for the line contactor (on the "Cont1" N°3 and "Cont1 Supply" N°4 pins).

It may be interesting to have the flashing information of the green LED of the inverter on the dashboard of the vehicle. To do this, output 3 is configured in this direction by setting "External LED" in the "Contactor 3" field (see Figure 15).

The outputs for "Contactor 2" are not used, so the field "Contactor 2" is set to "Not Mapped": this output is reserved for example for an electric brake magnet ("Electro Brake") or for a STOP light.

# of Outputs:	3	÷
Contactor 1:	Line contactor	-
Contactor 2:	Not Mapped	-
Contactor 3:	External LED	-

Fig. 15. "Input/Output" tab for defining digital power outputs.

2.5 The "Tree" Tab – Function Settings

Most of the settings in this tab will only be taken into account if the controller is in "Preoperational" mode (RED button: "Go Preoperational").



Fig. 16. The "Tree" tab in the "Helper" window.

2.5.1 The « Search » Button

The "Helper" script only manages and displays the main "useful" commands for setting the AC controller.

All registers are accessible via the "Search" button in the "Tree" tab.



Fig. 17. Example of using the "Search" button.

2.5.2 Setting of the Line Contactor

Whatever the nominal voltage of the batteries, it is interesting to install a power contactor with a single nominal voltage of 24 V. The SEVCON GEN4 AC controller reduces the supply voltage to the nominal voltage of the line contactor coil.

This possibility can be configured in the menu:

- the "Tree" tab;
- "Configuration" menu;
- "Contactor" menu;
- red line "Voltages".

It must be checked that the "Pull-In Voltage" voltage reduction equals 24 V (nominal voltage of the power relay coil). After the "Pull-in Time" time, here 1 second, the voltage at the relay terminals is reduced to the 18 V value specified in "Hold-In Voltage".



Fig. 18. Menu "Tree structure - Configuration - Contactor - Voltages".

The "Line Contactor" power relay is used to isolate the power section of the three-phase inverter from the inverter's battery voltage in the event of a problem. It is activated when the controller considers that there is no longer any problem for the motor to operate.

Application Note EK016 - Use of the DVTC Software Tool for the SEVCON GEN4 AC Controllers - September 2019

in Tree Input / Output TPDO / RPDO		Line Cor	ntactor Dropout Paramet	ters	
Search		Line contactor drop out	Disabled	•	
- Motor		ine contactor drop out timer	0.0	Second	s
Foctorake Foctorake Foctorake Foctoractor Precharge Level Min Cap. Volts for Contactor to Close Max Cap. Volts Diff for Contactor to C Voltages Control Enables Hold Enables Hold Enables Fore Control Braking Drive Profiles Foregrature Control	lose				

Fig. 19. Setting the "Line Contactor Dropout" function.

When the "Line contactor drop out" parameter is activated, "Enabled" is activated, the relay power supply can be switched off if the controller (and therefore the motor) is not active. This reduces the power consumption on the batteries and reduces the heating of the power relay.

The value indicated in "Line contactor drop out timer" corresponds to the idle time at which the contactor will be opened again.

The "Line contactor options" option must be set to "Enabled" so that the controller can detect a fault if the power relay remains permanently closed "Line Contactor Welded Fault".

2.5.3 A Few Words about Voltage Reduction

The voltage reduction to +24 V for the power relay is also interesting when using +24 V signal lights such as XB4-BVB3.

The voltage reduction and the "Hold-In Voltage" value are the same for all 3 power outputs. However, it is possible to activate or not these options for the different functions that can be used as outputs.



Fig. 20. The XB4-BVB3 24 V signal light

n Tree Input / Output TPDO / RPDO		Volta	ge Control Enable		
Search		Voltage Control Enable for Contactor Drives 18	Line Contactor	On	-
Mater			Pump Contactor	On	•
r Configuration			Power Steer Contactor	On	•
- Throttle			Electromechanical Brate	On	•
- Footbrake			External LED	On	•
T Contactor			Traction Motor Cooling Fan	On	
- Precharge Level			Buzzer	On	•
Min Cap. Volts for Contactor to Close			Hom	On	
Voltages	c	Voltage Control Enable for Contactor Drives 916	Lights	On	-
Control Enables			Service	On	
Hold Enables			Motor Isolation	On	*
- Speed Control			Precharge Output	On	
Braking			Belt Electromechanical Brate	On	
Drive Profiles Temperature Control			Belt ChangeOver Contactor	On	
- Battery Control			Electro-mechanical Park brate	On	
- Status - Other		· · · · · · · · · · · · · · · · · · ·			

Fig. 21. Menu named "Tree structure - Configuration - Contactor - Control activation".

The "Control Enables" menu is configured here to activate voltage reduction on all output functions of the SEVCON GEN4 AC controller.



Fig. 22. Example of voltage reduction at the terminals of the indicator. Case of a 72 V power supply and a 24 V configuration.

Iain Tree Input / Output TPDO / RPDO	Reduce to Ho	Id Level Enable		
Search Configuration Throttle Footbrake	Reduce to Hold Level Enable for Contactor Drives 18	Line Contactor Pump Contactor Power Steer Contactor Electromechanical Brake External LED	0n 0ff 0ff 0ff 0ff	•
Encoder Contactor Precharge Level Min Cap. Volts for Contactor to Close Max Cap. Volts Diffor Contactor to Close		Traction Motor Cooling Fan Buzzer Horn	0ff 0ff	•
Voltages Control Enables Hold Enables Line Contactor Speed Control	Reduce to Hold Level Enable for Contactor Drives 9.16	Lights Service Motor Isolation Prechame Output	Off Off Off	•
Braking Drive Profiles Temperature Control Persecutive Control		Belt Electromechanical Brake Belt ChangeOver Contactor	Off Off	•

Fig. 23. Menu named "Tree – Configuration – Contactor – Hold Enables".

The "Hold Enables" menu specifies here that only the "Line Contactor" output will change to +18 V after one second.

2.5.4 Accelerator Pedal Settings

<u>IMPORTANT</u>: this setting is often a source of problems when receiving the controller. The configuration is carried out in "factory" on a specific test bench, with an acceleration potentiometer different from the one installed on the vehicle.

The first step is to measure the voltage range of your accelerator. After setting the controller to "Preoperational" mode (RED button: "Go Preoperational") so that the motor does not operate, it is possible to "read" the voltage measured on analog input N°1 through the "Status / Raw Analog Inputs" menu.

The minimum and maximum value of the accelerator tension must then be determined by operating the accelerator pedal.



Fig. 24. Menu named "Tree – Status – Raw Analog Inputs".

Comment:

The fifth analog input corresponds to the temperature sensor of the PTC motor, here a KTY84 sensor connected to the -BAT. The voltage of 3.035 V corresponds to an ambient temperature of 21 °C.

The adjustment of the useful range of the accelerator can be configured in the "Tree" tab, "Configuration / Throttle" menu.

	NOUC ID 1				
n Tree Input / Output TPDO / RPDO		a	Throtile parameters		
Sauch		Throttle Flags	Proportional Braking	Yes	
Jearch		Control Policy In Control	Directional Throttle	No	-
 Motor Configuration 	â l		Speed Limit Mode	Fixed at maximum	-
- Throttle			Braking Directional Throttle	No	-
Footbrake			Reverse Speed Limit Encoding	No	
Encoder			Handbrake Fault	Enabled	
Speed Control			Preportional Speed Limit in Braking	Enabled	
H Braking		C	Driveability profile gereration style (some builds only)	Use lowest values	
Drive Profiles Temperature Control			Allow step change in steerangle	No	
Battery Control			Virtual FS1	Disabled	
Status			Absolute Steer Angle in single traction	Disabled	
Other			Separate Seat Regen Braking settings	Disabled	
			Save Left Motor Speed Inversion	Disabled	
			Bake Light when Neutral Baking	Disabled	-
			Inching functionality	Generic	-
			Pronortional Sneed Limit in Drive	Enabled	-
		L.	noportoniai opeco cana morre		-
	Throttle	input characteristic		Linear	-
	Thr	nttia Start V/nitana 1		0.09785825	
		_			
'ing Node	Node ID 1 -	es		LOar	0 11
ing Node	Node ID 1	es	Throttla parameters	Load	d va
ing Node] ain Tree Input / Output TPDO / RPDO	Node ID 1	e	Throttle parameters	Loar	
ing Node ain Tree Input / Output TPDO / RPDO Search	Node ID 1	input characteristic	Throttle parameters	inear	- V
ing Node ain Tree Input / Output TPDO / RPDO Search	Node ID 1	input characteristic ottile Start Voltage 1	Throttla parameters	inear	
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration	Node ID 1 Throttle Thr	input characteristic ottie Start Voltage 1 hrottie Start Value 1	Throttla parameters	inear	•
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Throttle Footbrake	Node ID 1	input characterisiic ottle Start Volage 1 hrottle Start Value 1 rottle End Volage 1	Throttle parameters	inear	•
ing Node ain Tree Input / Output TPDO / RPDO Search Search Motor Configuration Throttle Footbrake Encoder Encoder	Node ID 1	input characterisiic ottle Start Voltage 1 hrottle Start Value 1 rottle End Voltage 1 Fhrottle End Value 1	Throttle parameters	inear	•
ing Node ain Tree Input / Output TPDO / RPDO Search Search Configuration Throttle Footbrake Encoder Contactor Sead Control	Node ID 1	input characterisio ottle Start Votage 1 hrottle Start Value 1 rottle End Votage 1 firottle End Value 1 ottle Start Votage 2	Throttle parameters	Inear 2 0.09765625 0.0 9.59765625 0.9999694814905242 0.0	-
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Throttle Footbrake Encoder Contactor Braking Braking	Node ID 1	input characteristic ottle Start Volkage 1 hrottle Start Volkage 1 Inrottle End Volkage 1 Inrottle End Volkage 2 hrottle Start Volkage 2	Throttla parameters	Inear 2 0.09765625 0.0 9.59765625 0.999994814905242 0.0 0.0	
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Frootbrake Encoder Contactor Contactor Encoder Drive Profiles Drive Profiles Drive Profiles	Node ID 1	input characteristic ottle Start Voltage 1 hrottle Start Voltage 1 hrottle End Voltage 1 hrottle End Voltage 1 ottle Start Voltage 2 hrottle End Voltage 2	Throttla parameters		•
ing Node ain Tree Input / Output TPDO / RPDO Search Gonfiguration Footbrake Footbrake Contactor Speed Control Braking Drive Profiles Drive Profiles Brakiny Control	Node ID 1	input characteristic ottile Start Voltage 1 nrottile Start Value 1 rottile End Voltage 1 Ihrottile End Voltage 1 ottile Start Voltage 2 hrottile Start Voltage 2 Throttile End Voltage 2	Throttla parameters		
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Footbrake Encoder Contactor Speed Control Braking Drive Profiles Temperature Control Battery Control Status	Node ID 1	input characteristic ottile Start Voltage 1 hrottile Start Voltage 1 Frottile End Voltage 1 Frottile End Voltage 2 hrottile Start Voltage 2 hrottile End Voltage 2 Frottile End Voltage 2	Throttla parameters		
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Throttle Fotobrake Encoder Contactor Braking Drive Profiles Temperature Control Battery Control Status Other	Node ID 1	input characterisic ottie Start Voltage 1 hrottie Start Voltage 1 frottie End Voltage 1 frottie End Voltage 2 hrottie Start Voltage 2 orttie End Voltage 2 frottie End Voltage 2 d Char Pt 1 Voltage ed Char Pt 1 Voltage	Throttla parameters	Lear 0.09765625 0.0 9.59765625 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	
ing Node ain Tree Input / Output TPDO / RPDO Search Gonfiguration Throttle Footbake Encoder Contactor Speed Control Braking Drive Profiles Temperature Control Battery Control Battery Control Other	Node ID 1	input characterisic ottle Start Volue 1 rottle Start Volue 1 rottle End Voltage 1 finottle End Voltage 2 hrottle Start Volue 2 rottle End Voltage 2 rottle End Voltage 2 finottle End Voltage 2 d Char Pt 1 Voltage end Char Pt 1 Voltage	Throttle parameters	Inear 2 0.09765625 0.0 9.59765625 0.9999694814905242 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	
ing Node ain Tree Input / Output TPDO / RPDO Search Gonfiguration Forotbrake Encoder Contactor Braking Drive Profiles Temperature Control Battery Control Battery Control Contactor Cont	Node ID 1	input characteristic ottie Start Voltage 1 hrottie Start Voltage 1 frottie End Voltage 1 frortile End Voltage 2 hrottie Start Voltage 2 orttie End Voltage 2 mrottie End Voltage 2 di Char Pt 1 Voltage end Char Pt 1 Voltage end Char Pt 2 Voltage end Char Pt 2 Voltage	Throttla parameters	Inear 2 0.09765625 0.0 9.59765625 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	
ing Node lain Tree Input / Output TPDO / RPDO Search Genfiguration Throttle Footbrake Encoder Contactor Braking Drive Profiles Temperature Control Battery Control Battery Control Battery Control Conference Throttle Drive Profiles Temperature Control Battery Control Drive Profiles Temperature Control Drive Profiles Temperature Control Drive Profiles Temperature Control Drive Profiles Temperature Control Drive Profiles Temperature Control Drive Profiles Temperature Control	Node ID 1	Input characteristic ottle Start Voltage 1 hrottle Start Voltage 1 hrottle End Voltage 1 hrottle End Voltage 1 hrottle Start Voltage 2 hrottle End Voltage 2 hrottle End Voltage 2 d Char Pt 1 Voltage ned Char Pt 1 Voltage ned Char Pt 2 Voltage ned Char Pt 2 Voltage	Throttla parameters	Inear 2 0.09765625 0.0 0.5099694814905242 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	
ing Node lain Tree Input / Output TPDO / RPDO Search Genfiguration Footbrake Encoder Contactor Speed Control Braking Drive Profiles Temperature Control Battery Control Battery Control Battery Control Battery Control	Node ID 1	Input characterisic ottle Start Voltage 1 nrottle Start Voltage 1 rrottle End Voltage 1 Throttle End Voltage 1 ottle End Voltage 2 rrottle End Voltage 2 Inrottle End Voltage 2 Inrottl	Throttla parameters	Inear I 0.09765625 0.0 9.59765625 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Footbrake Encoder Contactor Braking Drive Profiles Temperature Control Battery Control Battery Control Drive Profiles Other	Node ID 1	input characteristic ottile Start Voltage 1 nrottile Start Voltage 1 nrottile Start Voltage 1 nrottile End Voltage 1 ottile Start Voltage 2 nrottile End Voltage 2 nrottile Start Voltage 2 chrottile Start Voltage 2 chrottile End Voltage 2 chrottile End Voltage 2 char Pt 1 Voltage ned Char Pt 1 Voltage ned Char Pt 2 Voltage ned Char Pt 2 Voltage ned Char Pt 3 Voltage	Throttla parameters		
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Throttle Fotobrake Encoder Contactor Braking Drive Profiles Temperature Control Battery Control Status Other	Node ID 1	input characterisio ottle Start Voltage 1 hrottle Start Value 1 rottle Start Value 1 fortelle End Value 1 ottle Start Value 2 rottle End Value 2 d Char Pt 1 Voltage and Char Pt 2 Voltage ned Char Pt 2 Voltage ned Char Pt 3 Voltage ned Char Pt 3 Voltage med Char Pt 3 Voltage ned Char Pt 3 Voltage	Throttlə parameters	Linear 2 0.09765625 0.0 9.59765625 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	
ing Node ain Tree Input / Output TPDO / RPDO Search Configuration Twottle Footbrake Encoder Speed Control Braking Dir Profiles Temperature Control Battery Control Status Other	Node ID 1	input characteristic ottle Start Voltage 1 hrottle Start Voltage 1 hrottle End Voltage 2 hrottle Start Voltage 2 hrottle Start Voltage 2 crottle End Voltage 2 d Char Pt 1 Voltage d Char Pt 1 Voltage d Char Pt 2 Voltage end Char Pt 2 Voltage ned Char Pt 2 Voltage ned Char Pt 3 Voltage hed Char Pt 3 Voltage hed Char Pt 3 Voltage	Throttlə parameters	Inear 2 0.09765625 0.0 9.59765625 0.9999694814905242 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	

Fig. 25. Menu named "Tree – Configuration – Throttle".

In the "Throttle parameters" window, it is then possible to configure:

- "Throttle Start Voltage 1": it is the minimum voltage value that will be taken into account for the acceleration set point. It is recommended to create a dead band of operation by adding 0.1 V-0.2 V to the measured value.
- "Throttle Start Value 1": this value is always 0 (0%). If this value is 1, the minimum voltage "Throttle Start Voltage 1" corresponds to the MAXIMUM set point value. In this case, put 0 in "Throttle End Value 1".
- "Throttle End Voltage 1": it is the maximum voltage value that will be taken into account for the acceleration set point. It is recommended to create a dead band of operation by subtracting 0.2 V from the measured value for this maximum voltage.
- "Throttle End Value 1": this value is always 1 (100%). If this value is 0, the maximum voltage "Throttle End Voltage 1" corresponds to the MINIMUM set point value. In this case, you must put 1 in "Throttle Start Value 1".

2.5.5 Parameter Setting of the Motor Temperature Sensor

This setting is important for the thermal protection of the motor. It can be configured in the menu:

- the "Tree" tab; _
- the "Configuration" menu;
- the "Temperature Control" menu;
- the "Sensor Config" line in red.

Figure 26 gives an example with a temperature sensor of type KTY84. Default values for high and low voltages are provided by SEVCON.

Main Tree Input / Output TPDO / RPDO			Motor Temperatu	ire 1 (Measured - T1)	
Search		Mode F	тс	•	
De Motor	- Hig	h Temperature Voltage (PTC)	7.5	v	
ET Configuration	-0	w Temperature Voltage (PTC)	6.0	v	
Throttle		Switch source	0x00		
Encoder		PTC type	CTY84	•	
Contactor Speed Control		Failure torque cutback rate	120.0	5	
Braking		Failure torque recovery rate	5.0	5	
Temperature Control Sensor Configuration User defined cutback map User defined PTC map Control Configuration Sattery Control Sattery Control					
de- Gine	R	ead Values			Load Values

Fig. 26. Menu named "Tree – Configuration – Temperature Control – Sensor Configuration".

Comment:

The analog input N°5 corresponds to the temperature sensor of the PTC motor, here a KTY84 sensor connected to the -BAT. The voltage of 3.035 V corresponds to an ambient temperature of 20 °C. For this temperature the resistance is given by the following table.

Température	KTY84/150	KTY84 typ.	KTY84/150
	Min.		Max.
0 °C	464 Ω	498 Ω	532 Ω
20 °C	544 Ω	581 Ω	618 Ω
100 °C	950 Ω	1,000 Ω	1,050 Ω

Table 1. Resistance value of the KTY84 temperature sensor.

The measurement of the voltage of analog input N°5 and the motor temperature via the PTC probe KYT84 by replacing the current probe by a variable resistance allows to validate the correct functioning of the motor temperature measurement with this probe KTY84 (see measurement table AN-EK016.xlsx).

The "High Temperature Voltage (PTC)" = 7.5 V and "Low Temperature Voltage (PTC)" = 6.0 V voltages are only used for a temperature sensor other than the KTY84.

- ▶ High Temperature Voltage (for external PTC only # KTY84 !). This is the voltage at the input when the temperature is 100 °C.
- ▶ Low Temperature Voltage (for external PTC only # KTY84 !). This is the voltage at the input when the temperature is 0 °C.

2.5.6 Voltage Limits of the Battery

There are 2 characteristics concerning the voltage limits of the battery:

- 1. The "app_cutback" YELLOW curve is set by "Battery Overvolt Protection" and "Battery Undervolt Protection". This limit concerns the value of the voltage read between pin key N°1 "Keyswitch" and terminal B-.
- 2. The "motor_cutback" BLUE curve is set by "Voltage Cutback". This limit concerns the voltage between terminals B+ and B- of the GEN4 AC controller.

The EXCEL file named "SEVCON-GEN4-Calculs-voltages.xlsx" provides the correct setting values of the 2 curves for the different models of SEVCON GEN4-series.



Fig. 27. Menu named "Main –Battery Limits" – Default settings.

2.5.6.1 The Limits of the "app_cutback" Battery

The "Tree - Configuration - Battery Control" menu is used to define the nominal battery voltage and its high and low limits.

The "start cutback" limits define a threshold where the engine torque will be reduced.

Beyond the "Over voltage limit" and "Under voltage limit" limits, the motor will be stopped.

This limit concerns the value of the voltage read between pin key $N^{\circ}1$ "Keyswitch" and terminal B-. This voltage may be slightly different from the instantaneous value of the voltage between terminals B+ and B- of the GEN4-series controllers.

This limit is important when using the electric motor brake. Indeed, the current re-injected into the battery causes the battery voltage to increase.

Commonly, the values of the two tables named "app_cutback" and "motor_cutback" can be superimposed. In order to best protect the controller, the "motor_cutback" values must be less than or equal to the "app_cutback" values, the voltage between B+ and B- being higher and faster than that between pin N°1 "Keyswitch" and terminal B-.



Fig. 28. Menu named "Tree – Configuration – Battery Control".

2.5.6.2 Limiting Voltages of the "motor_cutback" Application

The "Voltage cutback" menu defines a function with thresholds beyond which the motor torque will be reduced or even zero.

This limit concerns the voltage between terminals B+ and B- of the GEN4 controller. This voltage may be slightly different from the instantaneous value of the voltage between pin 1 "Key switch" and terminal B-.

This limit is important when using the electric motor brake. Indeed, the current re-injected into the battery increases the voltage across the GEN4 controller's filtering capacities (before the fuse, power relay and cables connecting to the battery).

Commonly, the values of the two tables "app_cutback" and "motor_cutback" can be superimposed. In order to best protect the controller, the "motor_cutback" values must be less than or equal to the "app_cutback" values, the voltage between B^+ and B^- being higher and faster than that between pin N°1 "Key switch" and terminal B-.

Ping Node Node ID 1 Main Tree Input / Output TPDO / RPDO Search Image: Configuration Throttle Footbrake Image: Contactor Speed Control Braking Image: Drive Profiles Image: Control Braking Image: Drive Profiles Image: Control Braking Image: Drive Profiles Image: Drive Profiles <th>Pt 1Votage 0.0 Pt 2Votage 31.1875 Pt 3Votage 40.75 Pt 4Votage 64.75 Pt 5Votage 69.0625 Pt 6Votage 69.0625 Pt 7Votage 69.0625 Pt 8Votage 69.0625 Pt 9Votage 69.0625</th> <th>Voltage Toique-Cutback Map V Pt 1 Voltage Cutback Gain 0.0 V Pt 2 Voltage Cutback Gain 0.0 V Pt 3 Voltage Cutback Gain 0.9998779288684 V Pt 4 Voltage Cutback Gain 0.9998779288684 V Pt 5 Voltage Cutback Gain 0.0 V Pt 6 Voltage Cutback Gain 0.0 V Pt 7 Voltage Cutback Gain 0.0 V Pt 7 Voltage Cutback Gain 0.0 V Pt 7 Voltage Cutback Gain 0.0 V Pt 9 Voltage Cutback Gain 0.0</th> <th></th>	Pt 1Votage 0.0 Pt 2Votage 31.1875 Pt 3Votage 40.75 Pt 4Votage 64.75 Pt 5Votage 69.0625 Pt 6Votage 69.0625 Pt 7Votage 69.0625 Pt 8Votage 69.0625 Pt 9Votage 69.0625	Voltage Toique-Cutback Map V Pt 1 Voltage Cutback Gain 0.0 V Pt 2 Voltage Cutback Gain 0.0 V Pt 3 Voltage Cutback Gain 0.9998779288684 V Pt 4 Voltage Cutback Gain 0.9998779288684 V Pt 5 Voltage Cutback Gain 0.0 V Pt 6 Voltage Cutback Gain 0.0 V Pt 7 Voltage Cutback Gain 0.0 V Pt 7 Voltage Cutback Gain 0.0 V Pt 7 Voltage Cutback Gain 0.0 V Pt 9 Voltage Cutback Gain 0.0	
Otherse Contack Battery Nominal Voltage Battery Vorvolt Protection Battery Undervolt Protection Status Other	Red Values		Load Values

Fig. 29. Menu named "Tree – Configuration – Battery Control – Voltage cutback" 1/2.



Fig. 30. Menu named "Tree – Configuration – Battery Control – Voltage cutback" 2/2.



Fig. 31. Menu named "Main –Battery Limits" – Correct values.

2.5.6.3 Limiting Voltages of the SEVCON GEN4 AC Controller

The different limits must be compared with the absolute limits of the controller:

	24V only (Size 2 24V)	24/36V controllers	36/48V controllers	72/80V controllers	96/110V controller
Conventional working voltage range	16.8V to 28.8V	16.8V to 43.2V	25.2V to 57.6V	50.4V to 96V	67V to 132V
(Note 1)					
Working voltage limits (Note 2)	12.7V to 34.8V	12.7V to 52.2V	19.3 V to 69.6 V	39.1 V to 120 V	48V to 150V
Non- operational overvoltage limits:	39.6V	59.4V	79.2 V	132 V	150V

Fig. 32. Limiting voltages of the SEVCON GEN4 AC controller.

2.5.7 Motor Torque-Speed Characteristic

In the "Main" tab of the "Helper" script, the "Torque Maps" drop-down menu gives access to the setting of the "TorqueMap1 0x4611". This menu allows you to set the curve giving the evolution of the maximum torque in the motor (in Nm) according to its rotation speed (in rpm).

The "Peak Motor Torque" (about 3 times the nominal torque) and the "Max Stator Current" are the values indicated in the "Tree - Motor - Motor Data" menu.

The control law also indicates the maximum value of the torque that can be obtained as a function of the stator current "PMAC Torque Limit By Stator Current".

The YELLOW curve can be compared to 2 interesting curves (in RED):

- > either a power limit calculated from a maximum current in the battery: $P_{max} = U_{bat} \times I_{bat}$;
- → or a power limit given by "Power Limit". At constant power, the torque is given by a hyperbolic function: $\Gamma_{max}(Nm) = \frac{P_{max}(W)}{\Omega(rd/s)}$.



Fig. 33. Maximum torque (Nm) depending on motor speed (rpm).

2.5.7.1 Setting the Motor Limits: the "Profiles"

3 profiles are available in the SEVCON GEN4 AC controller:

- 1) The "Baseline Profile": this is the default profile enabled when other profiles are not used. It is the profile that must contain the largest settings (higher than the two other profiles).
- The "Driveability Select 1 Profile" profile is a profile that can be activated by a logic input (digital input 6, pin N°9). This profile must contain the lowest parameter values than the "Baseline Profile".
- 3) The "Driveability Select 2 Profile" profile is a profile that can be activated by a logic input (digital input 7, pin N°32). This profile must contain the lowest parameter values than the "Baseline Profile".

By default, if several profiles are activated simultaneously, the controller will use the lowest parameter value of the 3 profiles.

The parameter settings in the various "Profiles" can be made in "Operational" mode and are taken into account immediately after applying the values in the controller. By the "Load Values" button.

When the controller is in "Torque Mode" ([4] "Vehicle performance configuration", section 6-16, page 82), only the values "Speed limit ramp up rate when in torque mode" and "Speed limit ramp down rate when in torque mode" are used. The other ramp values in "%/s" are not used.

2.5.7.2 "Traction Baseline Profile"

The maximum torque and speed limits, as well as the acceleration and braking ramps, can be configured in the "Main" tab and the "Baseline Profile" button. The values are also available in the "Tree" tab, "Configuration - Drive Profiles - Baseline Profile" menu ([4] section 6-24 page 90).

<u>BE CAREFUL</u>: do not exceed the maximum speed of the motor!

An absolute limit of the motor speed is specified in the "Tree" tab, menu "Configuration - Speed Control - Overspeed").

n Tree Input / Outpu	ut TPDO / RPDO	Traction baseline p	rofile	
Cat Cantan II.	- Information	Maximum Torque applied during drive 10.0	%	
Get Controlle	a information	Maximum Torque applied during a direction change 5.0	%	
Get Fault I	nformation	Maximum Torque applied when neutral braking 5.0	%	
Go Operational	Go Preoperational	Maximum Torque applied when footbraking 5.0	%	
		Maximum Speed in forward direction 5000.0	rpm	
PMAC Encoder		Maximum Speed in reverse direction 1500.0	rpm	
ontrol Mode	Tomus Mans -	Ramp up rate during drive 200.0	%/s	
ontionmode	rorque maps	Ramp up rate during direction change braking 200.0	%/s	
Baseline Profile	Local Limits	Ramp up rate during neutral braking 200.0	%/s	
		Ramp up rate during footbraking 200.0	%/s	
Drive 1 Profile	Analog Ranges	Ramp down rate during drive 200.0	%/s	
Drive 2 Profile	Gains	Ramp down rate during direction change braking 200.0	%/s	
		Ramp down rate during neutral braking 200.0	%/s	
Voltage Cutback	Battery Limits	Ramp down rate during footbraking 200.0	%/s	
121 Cuthack	Steering	Speed limit ramp up rate when in torque mode 500.0	rpm/s	
121 COLDBCK	scering	Speed limit ramp down rate when in torque mode 500.0	rpm/s	
Driver Pipeline		Pead Values		LandVa
MAC Max Sp Volt Limit	PMAC motor parameters	Incod velocs		Load va

Fig. 34. Setting the operating limits of the motor in the "Baseline Profile" configuration.

2.5.7.3 "Driveability Select 1 Profile"

The "Driveability Select 1 Profile" profile can be activated by the sixth digital input (pin N°9). This profile can define a "Normal" or "Kids" mode compared to a "Sport" mode defined by the parameters of the "Baseline Profile".

The maximum torque and speed limits, as well as the acceleration and braking ramps, can be configured in the "Main" tab and the "Drive 1 Profile" button. The values are also available in the "Tree" tab, "Configuration - Drive Profiles - Drive Profile 1" menu.

Tree Input / Outp	out TPDO/RPDO	Driveability Select 1	Profile
		Maximum Torque applied during drive 5.0	Nm
Get Control	ler Information	Maximum Torque applied during a direction change 5.0	Nm
Get Fault	Information	Maximum Torque appled when neutral braking 5.0	Nm
Go Operational	Go Presserational	Maximum Torque applied when footbraking 5.0	Nm
do operacionar	ou Preoperational	Maximum Speed in forward direction 1000.0	rpm
PMAC Encoder		Maximum Speed in reverse direction 1000.0	rpm
		Ramp up rate during drive 200.0	Nm/s
ontrol Mode	Forque Maps	Ramp up rate during direction change braking 200.0	Nm/s
Baseline Profile	Local Limits	Ramp up rate during neutral braking 200.0	Nm/s
		Ramp up rate during footbraking 200.0	Nm/s
Drive 1 Profile	Analog Ranges	Ramp down rate during drive 200.0	Nm/s
Drive 2 Profile	Gains	Ramp down rate during direction change braking 200.0	Nm/s
erre e rrene		Ramp down rate during neutral braking 200.0	Nm/s
Voltage Cutback	Battery Limits	Ramp down rate during footbraking 200.0	Nm/s
DTCabad	Churing]	Speed limit ramp up rate when in torque mode 500.0	rpm/s
121 Cutback	steering	Speed limit ramp down rate when in torque mode 500.0	rpm/s
Driver Pipeline			

Fig. 35. Setting the operating limits of the "Driveability Select 1 Profile" motor.

2.5.7.4 "Driveability Select 2 Profile"

The "Driveability Select 2 Profile" can be activated by the seventh digital input (pin N°32). This profile is generally used to define a "Free Wheel" mode when the mechanical brake pedal is depressed. With zero speed set points, the GEN4 controller will try to slow the motor (programmable electric brake) when trying to stop the vehicle.

The maximum torque and speed limits, as well as the acceleration and braking ramps, can be configured in the "Main" tab and the "Drive 1 Profile" button. The values are also available in the "Tree" tab, "Configuration - Drive Profiles - Drive Profile 1" menu ([4] section 6-24 page 90).

Tree Input / Outp	out TPDO / RPDO	Driveability Select 2	Profile
		Maximum Torque applied during drive 0.0	%
Get Control	ler Information	Maximum Torque applied during a direction change 10.0	%
Get Fault	Information	Maximum Torque appled when neutral braking 10.0	%
Go Operational	Go Pressperational	Maximum Torque applied when footbraking 10.0	%
oo operational	ou Preoperational	Maximum Speed in forward direction 0.0	rpm
PMAC Encoder		Maximum Speed in reverse direction 0.0	rpm
		Ramp up rate during drive 200.0	%/s
ontrol Mode	Forque Maps	Ramp up rate during direction change braking 200.0	%/s
Baseline Profile	Local Limits	Ramp up rate during neutral braking 200.0	%/s
		Ramp up rate during footbraking 200.0	%/s
Drive 1 Profile	Analog Ranges	Ramp down rate during drive 200.0	%/s
Drive 2 Profile	Gains	Ramp down rate during direction change braking 200.0	%/s
		Ramp down rate during neutral braking 200.0	%/s
Voltage Cutback	Battery Limits	Ramp down rate during footbraking 200.0	%/s
DT Cuthack	Staaring	Speed limit ramp up rate when in torque mode 500.0	rpm/s
121 COLDOCK	Jeening	Speed limit ramp down rate when in torque mode 500.0	/pm/s
Driver Pipeline			

Fig. 36. Setting the operating limits of the "Driveability Select 2 Profile" motor.

2.6 Managing DCF Configuration Files

The different configuration values of a SEVCON GEN4 AC controller can be stored in a "Device Configuration File" with the extension "DCF".

<u>IMPORTANT</u>: it is recommended to create a DCF file as soon as the controller is received with the initial configuration. This configuration has been tested on a test bench, it will be used as a reference and can be recharged if necessary.

<u>IMPORTANT</u>: as soon as a configuration seems "acceptable", it is recommended to create a DCF file with a different file name, corresponding to the different settings made.

2.6.1 The "Save DCF" menu

Saving a DCF file is accessible from the menu:

- in the "Helper" script window;
- the "Settings" menu;
- the "Save DCF" menu.

It is not necessary to be in the "PreOp" mode to save the controller configuration in a DCF file. The operation takes a few minutes: the process must not be interrupted before the end and the power supply to the controller must not be cut off.

File Software S	ettings MACKOS Tuning CAN	Help	
Ping Node Main Tree 1	Save DCF Save Partial DCF Send DCF to Unit Compare DCFs	Node ID 1	•
	Create EDS Find Range Error		
Go Oper	Copy Baseline to Drive Profile 1	D	
PMAC E	Copy Baseline to Drive Profile 2 Copy Baseline to Drive Profile 3		
Control Mode	Copy Baseline to Drive Profile 4	ŀ	

Fig. 37. The "Save DCF" menu in the "Helper" script window.

2.6.2 File Naming

The multiplication of controller configurations likely to produce a DCF file requires rigorous naming of configuration files.

File names are also used to sort them in the same directory: there are therefore several sorting options, by date or by controllers.

The file name will then be composed of:

- "2018-03-31": the date in reverse format (here March 31, 2018) to sort by year, then by month, then by day;
- > "**PMS100**": the type of motor;
- "0705-0012": the version of the software used (here software for synchronous motor, version 0705.0012);
- ▶ "48V": the controller supply voltage (battery voltage);
- ▶ "S2": the type of controller: "size 2", "size 4" or "size 6";
- > "37A4": an identification of the final customer (here the number of the kart);
- > "17h22": the backup time;
- > "config-a-vide": a comment on the function of the configuration.

2018-03-31-PMS100-0705-0012-48V-SIZE2-37A4-17h22-config-a-vide.dcf

The files will be stored in a different directory from the "DVTC" script not to be deleted when the software is updated:

C:\SEVCON-GEN4\DCF



Fig. 38. The naming of the "DCF" files in the "C:\SEVCON-GEN4\DCF" directory.

2.6.3 The "Send DCF to Unit" Menu

This menu allows you to load a configuration into a controller.

<u>BE CAREFUL</u> the DCF file must have been generated with a controller having the same "hardware" (same "Part" number, see \S 8) and the same "software" (see \S 2.3).

Loading a DCF file into a controller is accessible from the menu:

- in the "Helper" script window;
- the "Settings" menu;
- the "Send DCF To Unit" menu.

IMPORTANT: it is necessary to be in the "PreOp" mode (RED button: "Go Preoperational") (so that the motor does not work) to be able to load a new configuration into the controller. The operation takes a few minutes and is **VERY CRITICAL**: the process must not be interrupted before the end and the power supply to the controller must not be cut off. In case of problems during transfer, the controller must return to the factory and may be unrecoverable.

At the end of the transfer, a window appears asking you to turn off the power to the controller and turn it back on ("Power Recycle"). It is only when the power is restored that the parameters of the new DCF file will be taken into account by the GEN4 AC controller.

Ping Node	Save DCF		
	Save Partial DCF	Node ID 1	•
Main Tree	Send DCF to Unit Compare DCFs		_
	Create EDS	<u> </u>	
	Find Range Error		
Go Oper	Copy Baseline to Drive Profile 1	D	
PMAC E	Copy Baseline to Drive Profile 2 Copy Baseline to Drive Profile 3		
Control Mode	Copy Baseline to Drive Profile 4	1	

Fig. 39. The "Send DCF To Unit" menu in the "Helper" window.

3 The "Helper" Script – Advanced Functions

3.1 Changing the Access Level

In the "DVTC" script window, in the online command area, it is necessary to check the access level to the controller with the command "lg 1? ». It is possible to change this access level by using the "lg 1 4" command. Example:

```
dvt(9) % lg 1 ?
Access Level: 0x00
0x00
dvt(10) % lg 1 4
OK
dvt(11) % lg 1 ?
Access Level: 0x04
0x04
```

3.2 Changing the Nominal Voltage and Current Values

It is possible to adapt a DCF file to a controller with different voltage and current ratings with the command: "configure_voltage_items nodeid voltage block_rating". The access level must be 4, here is an example of a 72 V, 550 A switch with the control:

dvt(12) % configure_voltage_items 1 72 550

set 0x2c00 0 to 0x0480	set 0x4612 7 to 0x0613
set 0x2c01 1 to 0x0566	set 0x4612 9 to 0x067a
set 0x2c01 2 to 0x061e	set 0x4612 11 to 0x067a
set 0x2c02 1 to 0x0326	set 0x4612 13 to 0x067a
set 0x2c02 2 to 0x02ec	set 0x4612 15 to 0x067a
set 0x2C30 6 to 0x24	set 0x4612 17 to 0x067a
set 0x4612 1 to 0x0000	set 0x6075 0 to 0x00086470
set 0x4612 3 to 0x02ec	set 0x4641 2 to 0x0226
set 0x4612 5 to 0x03d3	set 0x4641 12 to 0x0480
invalid baroword "Abort"	

```
invalid bareword "Abort"
in expression "Abort 0x06020000 / pow(2,6)";
should be "$Abort" or "{Abort}" or "Abort(...)" or ...
dvt(13) %
```

This macro control modifies the parameters related to the direct voltage of the battery and the RMS current in the motor phases. The file named "SEVCON-GEN4-Calculs-voltages.xlsx" summarizes the changes made:

	HEX	DEC	x 0,0625	
set 0x2c00 0 to 0x0480	0480	1152	72,00	V
set 0x2c01 1 to 0x0566	0566	1382	86,38	V
set 0x2c01 2 to 0x061e	061e	1566	97,88	V
set 0x2c02 1 to 0x0326	0326	806	50,38	V
set 0x2c02 2 to 0x02ec	02ec	748	46,75	V
set 0x2C30 6 to 0x24	24	36	72	V
set 0x4612 1 to 0x0000	0000	0	0,00	V
set 0x4612 3 to 0x02ec	02ec	748	46,75	V
set 0x4612 5 to 0x03d3	03d3	979	61,19	V
set 0x4612 7 to 0x0613	0613	1555	97,19	V
set 0x46129 to 0x067a	067a	1658	103,63	V
set 0x4612 11 to 0x067a	067a	1658	103,63	V
set 0x4612 13 to 0x067a	067a	1658	103,63	V
set 0x4612 15 to 0x067a	067a	1658	103,63	V
set 0x4612 17 to 0x067a	067a	1658	103,63	V
set 0x6075 0 to 0x00086470	00086470	550 000	mA	
set 0x4641 2 to 0x0226	0226	550	А	
set 0x4641 12 to 0x0480	0480	1152	72,00	V

Fig. 40. Switch to 72V 550A with the command: "configure_voltage_items 1 72 550".

The parameters at addresses "0x2c00" correspond to the menu "Battery Control", "Battery Nominal Voltage/Overvolt/Undervolt protection".

The parameter at address "0x2c30" corresponds to the menu "Battery Control - BDI Parameters", number of cells of the "Cell count" lead battery, at a rate of 2.00V per cell.

The settings at addresses "0x4612" correspond to the "Torque-Cutback Map Voltage" limitation of the "Battery Control - Voltage Cutback" menu.

The parameter at address "0x6075" corresponds to the maximum controller current in the "Main - Motor - Current Limit" menu. This current corresponds to the nominal current of the GEN4 controller.

The parameter at address "0x4641 sub 2" corresponds to the maximum current in the stator of the "Main - Motor - Motor Data" motor.

The parameter at address "0x4641 sub 2" corresponds to the nominal battery voltage defined in "Main - Motor - Motor Data". This value is identical to the one defined at address "0x2c00 sub 0".

3.3 Loading a "Software DLD" File into the Controller

The DLD file corresponds to the "Software" software of the controller and depends on the type of motor used: synchronous motor or asynchronous motor (induction motor).

The DLD files are provided by SEVCON and are located in the following directory:

C:\SEVCON-GEN4\DLD

There are 2 types of software in the directory:

- 1) The software named "0703_0017.dld" modified 09/11/2017: this is the latest version of the software for asynchronous motors;
- 2) The software named "0705_0013.dld" modified 10/08/2018: this is the latest version of the software for synchronous motors.

3.3.1 Saving the Controller Configuration

Before updating the "software" of a controller, it is essential to save its configuration in a DCF file (see 2.6.1 The "Save DCF" Menu). This configuration file will be reused after the update to make the controller operational with its motor.

It is also necessary to make a copy of the file "Master Database.edsdb" in the following directory:

C:\DVTC\common\program\EDS

It may be interesting to delete all the "*.eds" files in order to force the DVTC software to create a new "*.eds" file based on the new "*.edsdb" file.

3.3.2 The "Software" menu

Loading a DLD file into a controller is accessible from the "Helper" script window in the "Software" menu.

File	Software Settings	MACROS	Tuning	CAN	Help	
Dim	Enter Bootloader N	lode			Neda ID 1	
Ping	Program Unit				NOGE ID 1	
Mair	Exit Bootloader Mo	de p	O / RPDO]		
					_	
	Get Control	ler Inform	ation			
	Get Control Get Fault	ler Inform Informati	ation on			

Fig. 41. The "Software" menu to load a "DLD" file.

<u>IMPORTANT</u>: it is necessary to be in the "Preoperationnal" mode (RED button: "Go Preoperational"), so that the motor does not work, to be able to load a new configuration into the controller.

The operation takes a few minutes and is <u>VERY_CRITICAL</u>: the process must not be interrupted before the end and the power supply to the controller must not be cut off. If there are any problems during transfer, the controller must be returned to the factory and may be unrecoverable.

The operation is carried out in 3 steps.

3.3.3 Switching to the "Bootloader" mode

The first step is to switch to "Bootloader" mode, by using the "Enter Bootloader Mode" command from the "Software" menu (first line).

The controller LED flashes quickly and then goes out.

3.3.4 Programming a New "Software"

The second step consists in selecting the correct DLD file and programming the GEN4 drive with the "Program Unit" command from the "Software" menu (second line).

During the software update, the controller switches to boot loader mode: the green LED flashes quickly.

IMPORTANT: The transfer takes a few minutes and is **VERY CRITICAL**: the process should not be interrupted before the end and the power supply to the controller should not be cut off. In case of problems during transfer, the controller must return to the factory and may be unrecoverable.

```
Information
Node 1 fault (0x4681, Preop) set at 17:53:10, 03/07/17. Data (0x00 0x00 0x00). CANopen Error Code: 0x1000
found 1 memory ranges in C:/DVTC-DCF-DLD/DLD/0705_0012.dld (modified 01/22/2016 - 12:35:10):
            ...dsp-zeffer
programming dsp-zeffer on node 1
                                                       .....OK
block checksum 0x012dd800
Node 1 fault (0x5043, Param fixed range) set at 17:54:50, 03/07/17. Data (0x00 0x00 0x00). CANopen Error Code: 0x6300
Node 1 fault (0x5044, Param dyn range) set at 17:54:50, 03/07/17. Data (0x00 0x00 0x00). CANopen Error Code: 0x6300
Node 1 fault (0x4F41, Internal) set at 17:54:50, 03/07/17. Data (0x00 0x00 0x00). CANopen Error Code: 0x6100
Node 1 fault (0x5043 Davam fived range) set at 17:54:50, 03/07/17 Data (0x00 0x00 0x00). CENopen Error Code: 0x6300
4
ACCESS LEVEI: UXU4
                -operational
   ready in pr
Node 1 status:
Traction State: OFF
Already logged in at a higher level
Already logged in at a higher level
Access Level: 0x04
   ready in pre-ope
Node 1 status:
Traction State: OFF
Already logged in at a higher level
{646 502970} {668 668} {678 502961}
Bootloader: Gen4 (D0701.0001). EEPROM read limited to 1 byte: FALSE
attempting to exit bootloader properly with 55296
```

Fig. 42. Transfer of the current software to the "DVT" window.

During the transfer of the new program, a series of dots appears in the "Information" window following the text "programming dsp-zeffer on node 1".

At the end of the transfer, the message "OK" appears in the control window. It is important to exit the "boot loader" mode.

3.3.5 Exiting the "Bootloader" Mode

At the end of the transfer, when the message "OK" appears in the command window, you must exit "boot loader mode" by using the command "Exit Bootloader Mode" from the "Software" menu (third line).

At this point, the green LED on the GEN4 controller starts flashing again. <u>BE CAREFUL</u>: the controller is in "Preoperationnal" mode.

It is necessary to cut off the power supply to the controller, wait a few seconds and turn the controller back on "Power Recycle". It is also necessary to close the DVTC software and restart it.

By clicking on the "H" button, the "Helper" script will check the consistency of the EDS file available on the computer's hard disk with the new software and request the creation of a new file if necessary.

3.3.6 In Case of Problems

In case of problems during the transfer, do not exit the "boot loader" mode. It is necessary to cut off the power supply to the controller, turn it back on "Power Recycle" and restart loading the DLD file with the "Program Unit" command from the "Software" menu (second line).

3.3.7 After Updating a New "Software"

Once the new "software" is installed, the new variables that are declared must be correctly initialized. To do this, simply load the "generic" DCF file corresponding to this "Software":

ME0907_0705.0013_G4865_default_configuration_2_start_with.dcf

Then, it is necessary to reload the initial configuration file that was saved BEFORE the update of the "Software".

<u>Note</u>: After each software update step (DLD, DCF) and when the operation has gone well, it is important to remember to disconnect the power supply to the controller and restart it ("Power Recycle") and close and restart the DVTC software.

3.4 The "TPDO/RPDO" Tab

Reference [4] (section 6-4, page 70) gives some explanations about objects communicating via the CAN bus, such as "SDO: Service Data Object" and "PDO: Process Data Object".

PDOs are used by connected nodes (*e.g.*, in a two-drive configuration) to exchange real-time data during operation. PDOs allow up to 8 bytes of data to be transmitted in a CAN message.

They use the producer-consumer communication model, where the producer node creates and transmits the PDO for all connected consumer nodes configured to receive data. The transmitted PDOs are referred to as TPDOs and PDOs received, called RPDOs.

3.4.1 Some References on this Topic

The following documents have not been fully exploited:

- Adding PDOs.pdf
- PDOs training.pdf
- > App Note Controlling AC via CAN.pdf
- App Note Multi Node Setup.pdf
- App Note PDO Fundamentals.pdf
- > App Note Vehicle CAN wiring recommendations.pdf
- NT20100501-01 SEVCON Comment lire les objets CANopen avec un protocole CAN quelconque.pdf
- http://www.canopensolutions.com/english/about_canopen/device_configuration_cano pen.shtml
- http://www.canopensolutions.com/english/about_canopen/pdo.shtml

3.4.2 Configuration of "RPDOs"

When using a single controller, the "RPDO" registers are not used and must be empty. If this is not the case, the controller will generate an error message corresponding to waiting for data on the CAN bus and the controller will be in fault.

3.4.3 Configuration of "TPDOs"

5 "TPDO" modules are available on the GEN4 AC controller. They allow real-time data to be transmitted on the CAN bus.

🚯 DVT Helper				-		
<u>File</u> Software	S <u>e</u> ttings	MACROS	Tuning	<u>C</u> AN	<u>H</u> elp	
Ping Node					Node ID 1	•
Main Tree In	nput / Ou	tput TPDO	O / RPDO]		
Sync	Period					
Setup TPDO 1	Setup	RPDO 1				
Setup TPDO 2	Setup	RPDO 2				
Setup TPDO 3	Setup	RPDO 3				
Setup TPDO 4	Setup	RPDO 4				
Setup TPDO 5	Setup	RPDO 5				
Set Default	PMAC TP	DOs				

Fig. 43. The "TPDO/RPDO" tab of the "Helper" script.

The default configuration allows data to be sent continuously over the CAN bus.



Fig. 44. The data transmitted by the "TPDOs".

Application Note EK016 - Use of the DVTC Software Tool for the SEVCON GEN4 AC Controllers - September 2019

TP	PDO 1
Cob-ID for this PDO:	0x00000351
Syncs Per Transmit:	1
Bits: 16 Adr: 0x4600,5 Target Id Bits: 16 Adr: 0x4600,6 Target Iq Bits: 16 Adr: 0x4600,7 Id (f) Bits: 16 Adr: 0x4600,8 Iq (la)	(II) (Ia)
Bits Used: Bits Left:	64
Remove Item	Add Item
Move Item Up	Move Item Down

Fig. 45. The data transmitted by the "TPDO1".

TPDO 2						
Cob-ID for this PDO:	0x00000427					
Syncs Per Transmit:	1					
Bits: 16 Adr: 0x4600,9 Ud (Uf) Bits: 16 Adr: 0x4600,10 Uq (Ua) Bits: 16 Adr: 0x4600,11 Voltage Bits: 16 Adr: 0x4602,29 Measure	modulation ed inductance					
Bits Used:	64					
Bits Left:	0					

Fig. 46. The data transmitted by the "TPDO2".

T	IPDO 3
Cob-ID for this PDO:	0×00000457
Syncs Per Transmit:	1
Bits: 16 Adr: 0x4602,31 Voltag Bits: 16 Adr: 0x4602,32 Maxin Bits: 16 Adr: 0x4602,33 Maxin Bits: 16 Adr: 0x4600,3 Mctor	ge limit circle magnitude num fluxing current num iq allowed Temperature 1 (Measured - T1)
Bits Used:	64
Bits Left:	0

Fig. 47. The data transmitted by the "TPDO3".

TPDO 4			
Cob-ID for this PDO:	0x0000023	3	
Syncs Per Transmit:	1		
Bits: 16 Adr: 0x5100,3 Capacitor Voltage Bits: 8 Adr: 0x5100,4 Heatsink Temperature Bits: 16 Adr: 0x5100,2 Battery Current Bits: 16 Adr: 0x5100,1 Battery Voltage Bits: 8 Adr: 0x2790,1 BDI remaining charge			
Bits Used:		64	
Bits Left:		0	

Fig. 48. The data transmitted by the "TPDO4".

TPE	00 5
Cob-ID for this PDO:	0x00000458
Syncs Per Transmit:	1
Bits: 32 Adr: 0x2020,3 Target velo Bits: 32 Adr: 0x606c,0 Velocity	scity - left motor
Bits Used:	64
Bits Left:	0

Fig. 49. The data transmitted by the "TPDO5".

3.5 The "Change Baud Rate" Menu

To change the communication speed of the CAN bus:

- 1- Launch DVT.
- 2- Open the "Helper" with the menu "H".
- 3- In the "Helper" script window, click on the "CAN" menu.
- 4- Then choose "Change Baud Rate" (first line).

ile Software Settings M	MACROS Tuning	CAN Help
Ping Node		Change Baud Rate
Main Tree Input / Output	ut TPDO / RPDO	Change Node ID TPDO Rates
Get Controlle	er Information	Setup Display
Cat Fault I	afarmation -	Clear Comms Settings
Get Fault I	nromation	Multinode Control
Go Operational	Go Preoperatio	Heartbeat Producer Setup
PMAC Encoder		Heartbeat Consumer Setup

Fig. 50. The "Change Baud Rate" menu from the "DVT Helper".

Then simply select the new communication speed of the CAN bus.

<u>CAUTION 1</u>: It is essential to switch off the controller and recharge it with "Power Recycle" so that the new configuration can be taken into account. Similarly for the "DVT" script, it is necessary to close the software, then re-open it and search for the new communication speed.

<u>CAUTION 2</u>: the controller has entered "Pre Operational" mode. You will need to select "Go Operational" in green to be able to use the controller again.

🚷 dvt_can 🗖 🗖 💌 🗶
Change Baud Rate
Procedure: 1) Select desired rate. 2) Cycle power on unit. 3) Select same rate in DVT. 4) Type 'fpo' to go OP.
10kHz
20kHz
50kHz
100kHz
125kHz
250kHz
500kHz
1MHz

Fig. 51. Changing the speed of the CAN bus, menu "CAN" of the "Helper".

3.6 Definition of the Motor Characteristics

In the "Tree" tab of the "Helper" script, the first "Motor" menu gives access to the various motor parameters in the "Motor Data" submenu.

Ping Node Node ID 1				
Main Tree Input / Output TPDO / RPDO	AC Moto	or data (manufactu	rer specific)	
Search	Maximum Stator Current (Is_max)	270.0	A(RMS)	*
Pr Notor	Minimum Magnetizing Current (Im_min)	-270.0	A(RMS)	
Motor Data	Number of Pole Pairs (np)	4.0		
Peak Torque	Rated Stator Current	73.0	A(RMS)	
Current Limit	Stator Inductance (Ls)	39.99471664428709	uH	_
Configuration	Nominal battery voltage	48.0	v	_
Other	Current control propertional gain (Kp)	3.828125		
	lq max headroom (G-Mode IQM)	92.999267578125	%	E
	Current controlintegral gain (Ki)	0.0023(037109375		_
	Voltage Constant (Ke)	0.010498046875	V/rads (line, rms, elec_frq)	_
	Openloop start FW%	99.9969482421875	%	_
	Frequency/Mod index control Kp	0.012451171875		_
	Frequency/Mod index control Ki	0.1249:896484375		
	Max drive mod index	89.990234375	%	
	Max brake mod index	89.990234375	%	
	D-axis current controller proportional gain	0.0		
	D-axis current controller integral gai	n 0.0		
	Percentage minimum allowed saturation of L	s 45.098876953125	%	*
	Read Values			Load Values

Fig. 52. The motor parameters "AC Motor Data (manufacturer specific).

There are motor specific parameters such as:

- the maximum stator current "Maximum Stator Current Is_max" (often equal to the maximum current of the GEN4 AC controller);
- ➤ the minimum magnetizing current "Minimum Magnetizing Current Im_min" (?);
- the number of pole pairs;
- the "Rated Stator Current";
- the "Stator Inductance Ls";
- > the "Voltage Constant Ke" in V/rad/s. This constant is the ratio between the effective voltage between phases ("line to line rms") and the electric pulse ("elec_frq") (*stator rd/s*) = $2\pi \cdot f(stator Hz)$, *i.e.*:

$$Ke = \frac{U(entre\ phase\ eff)}{\omega(stator\ rd/s)}$$

But there are also controller-specific parameters such as the maximum value of the "Max controller mod index" and the proportional and integral gains of the various control loops.

4 The "Vehicle Interface" Script

4.1 Introduction

The many variables of the controller can be recorded over time using this script [5]. The "Vehicle Interface" script intercepts the data sent by the controller using the "TPDO" and interprets it using the "EDS" object dictionary. The "**CROSS**" button allows the launch of the "Vehicle Interface" script window from the "DVT Customer" window.



Fig. 53. Execution button of the "Vehicle Interface" script.

4.2 Data Display

le UUT Help		
📓 📰 🍡 Current Contfol 🜗 🕨 🔯 👘	Control b	uttons
Watch		
1, Target Id (If) (0.0625)	0.0	A
1, Target Iq (Ia) (0.0625)	0.0	A
1, Id (If) (0.0625)	-0.375	A
1, Iq (Ia) (0.0625)	-0.125	A
1, Ud (Uf) (0.0625)	0.0	V
1, Uq (Ua) (0.0625)	0.0	V
1, Voltage modulation (0.3922)	0.0	%
1, Measured inductance (0.0596)	39.994716644	l2 uH
1, Voltage limit circle magnitude (1.0000)	32212	А
1, Maximum fluxing current (1.0000)	151	Α
1, Maximum iq allowed (1.0000)	268	A
1, Motor Temperature 1 (Measured - T1) (1.0000)	35	DegC
1, Capacitor Voltage (0.0625)	10.0	V
1, Heatsink Temperature (1.0000)	18	DegC
1, Battery Current (0.0625)	0.0	A
1, Battery Voltage (0.0625)	52.125	V
1, BDI remaining charge (1.0000)	100	%
1, Target velocity - left motor (1.0000)	0	RPM
1, Velocity (1.0000)	0	RPM
Node Status		Output file
Node1 HBeat Op No f	aults set	Output me
Logging Options	1	
V Log to file Log Dir:	Filename:	
✓ Increment file name//common/veh_if_log	ME0913-TIPE	-1500-40

Fig. 54. The "Vehicle Interface" script window.

Note: the current Iq "1. Iq (Ia)" is an image of the motor torque.

4.2.1 The Output File

The "Vehicle interface" script saves the data in a text file in CSV format "Comma Separate Value": the values are separated by commas and the file is "readable" with a spreadsheet program.

The default directory for output files is:

C:\DVTC\common\veh_if_log

Before starting a recording, it is important to define the root of the output file name in the "Filename:" field, such as "PMS100". The "Vehicle interface" script adds the date and time of file creation. The final file will have the full final name:

PMS100_280418_192846.csv

For a field" "Filename = PMS100", dated 28 April 2018, at 19h28min46s.

4.2.2 The Control Buttons

The first button on the left resets the absolute time that will be used in the output file. The central "Play" button starts the data recording.

The last button on the right "Pause" stops recording and generates the output file.



Fig. 55. The control buttons of the "Vehicle Interface" script.

4.3 Data Processing Using EXCEL



Fig. 56. The Excel macro "Vehicle Interface Log Viewer.xlsm".

Thanks to an Excel macro called "Vehicle Interface Log Viewer.xlsm", the data recorded in CSV format will be put into a spreadsheet and a graph will be generated.

It is necessary to allow the execution of macros on this EXCEL file.

It is interesting to fill in the box "Default Log File Location:" with the directory where the CSV files are saved.

After clicking on the "GO" button and selecting the CSV file you want to use, the macro runs and an error appears: you must then click on "End".

Microsoft Visual Basic				
Erreur d'exécution '13':				
Incompatibilité de type				
Continuer Fin	1	Déboga	age	Aide
		-		

Fig. 57. The Excel macro "Vehicle Interface Log Viewer.xlsm" generates an error...

The proposed graph contains 2 error curves, "Time (s)" and here "BDI remaining charge % (1)", which are not displayed as a function of time in seconds, but as a function of their number of points. Simply select one by one the first 2 curves of the list and delete them.



Fig. 58. Result of the Excel macro "Vehicle Interface Log Viewer.xlsm" with 2 error curves.



Fig. 59. Result of the Excel macro "Vehicle Interface Log Viewer.xlsm" with the 2 error curves that have been deleted.

All that remains is to "sort" the curves because all the variables are represented with the same scale. For example, there is a data that evolves between +32212 and 0, the speed that evolves between +5000 rpm and -1500 rpm...

While on the curve tab, saving the EXCEL file will propose a modification of the file extension in".xlsx" format:

PMS100_280418_193823.xlsx

5 The "Editor" Script

5.1 Introduction

The "E" button allows the launch of the "Editor" script window from the "DVT Customer" window.

The "Editor" script window which is a graphical interface for reading and editing DCF files offline.



Fig. 60. Execution button of the "Editor" script.

After selecting the DCF file you want to study, an empty window appears. In the "Search Object" field, you must then enter the keywords of the variables you want to display. The area under the "Search Object" field contains a list of variables containing the requested keywords. By selecting a variable, the information related to this variable is displayed in the right-hand area.

😥 editor_top			×
File Setup TPDOs Setup RPDOs Local I/O Power Maps Saturatio	n Map Voltage Maps Macros		
Object Search	Motor data (manufacturer	specific)	
mates data	Maximum Stator Current (Is_max) 450.0	A(RMS)	
motor data	Minimum Magnetising Current (Im_min) 0.0	A(RMS)	
0x4641 ROOT (Motor data (manufacturer specific))	Number of Pole Pairs (np) 4.0		
	Rated Stator Current 89.0	A(RMS)	
	Stator Inductance (Ls) 29.265380584716783	uH	
	Nominal battery voltage 24.0	v	
	Current control proportional gain (Kp) 0.009979248046875		
	lq max headroom (G-Mode IQM) 98.999)234375	%	
	Current control integral gain 0.011993408203125		
	Voltage Constant (Ke) 0.009979248046875	V/rads	
	Openloop start FW% 0.0	%	
	Frequency control Kp 0.001556396484375		
	Frequency control Ki 0.000640869140625		
	Max drive mod index 99.9755859375		
	lq max modindex (PI-Mode IQM) 89.990234375		
	Percentage miniumum allowed saturation of Ls 98.9990234375	%	
· · · · · · · · · · · · · · · · · · ·			
Configure by Hex Address	Read Values		Load Values
C:/DVTC-DCF-DLD/DCF/PMS10	00/PMSL00RWB405-UK0319A44-24V-configavideOK-14032012-12h18	l.dcf	

Fig. 61. The "Editor" script window.

It is then possible to modify the values and save them in the DCF file with the "Load Values" button in red and/or to read the values of the DCF file with the "Read Values" button in blue. Variables can be searched by their address in hexadecimal in the format:

0x4641

and by clicking on "Configure by Hex Address".

6 References

- [1] Thierry LEQUEU, « AN-EK015-FR Installation du logiciel DVT pour les variateurs SEVCON GEN4 », 12 pages, janvier 2013, consulté le 21 septembre 2019 sur : <u>https://www.e-kart.fr/information/tutoriaux/678-an-ek015-fr-installation-du-logicieldvt-pour-les-variateurs-sevcon-gen4</u>
- [2] P. SHIPLEY, « Application Note DVT Installation (draft) », December 2nd, 2009, 6 pages.
- [3] Site web de la société SEVCON, <u>http://www.sevcon.com/</u>, consulté le 22 avril 2018.
- [4] SEVCON, «Gen4 Product Manual», version 3.4, de décembre 2015, 115 pages, 3256 Ko, consulté le 21 septembre 2019 sur : <u>https://www.e-kart.fr/information/notices-techniques/variateurs/1279-sevcon-gen4-product-manual-v3-4</u>
- [5] Arnaud SIVERT, «AN-EK005-FR Didacticiel pour variateur GEN4 SEVCON (moteur AC) V2 », 32 pages, avril 2010, consulté le 21 septembre 2019 sur : <u>https://www.e-kart.fr/information/tutoriaux/187-an-ek005-fr-didacticiel-pour-variateurgen4-sevcon-moteur-ac-v2</u>
- [6] Site web de la société IXXAT, <u>http://www.ixxat.com/</u>, consulté le 21 septembre 2019.
- [7] Société SEVCON, « SEVCON DVT Tutorial Using DVT with Gen4 Systems », 11 pages, consulté le 21 septembre 2019 sur : <u>https://www.e-kart.fr/21-articles-techniques/698-sevcon-dvt-tutorial-using-dvt-with-gen4-systems.htm</u>
- [8] Site web de la société ActiveState, <u>http://www.activestate.com/activetcl</u>, consulté le 21 septembre 2019.
- [9] H. SLATER, P. SHIPLEY, « SEVCON Setting up PMAC software », révision 14, du 18 mai 2018, 28 pages, 652 Ko, consulté le 21 septembre 2019 sur : <u>https://www.e-kart.fr/images/stories/technique/SEVCON/sevcon-app-note-pmac.pdf</u>
- [10] Thierry LEQUEU, « Exemple de câblage du circuit électrique d'un véhicule », consulté le 21 septembre 2019 sur : <u>https://www.e-kart.fr/information/trucs-astuces/279exemple-de-cablage-du-circuit-electrique-d-un-kart</u>

7 Appendix 1 – Checks Before the Launch of DVTC

7.1 The Controller Wiring – Power Part

The controller must be powered at its rated voltage and the power source must be able to provide the current required to operate the motor.

The motor power terminals must be connected to the controllers in the order indicated in the parameterization report and/or wiring diagram.

The protections must be installed and in particular the SD300 power relay, which is controlled by the controller. This relay is used to isolate the power section in the event of a fault on the controller. There is no need for a freewheel diode at the terminals of the relay coil because it is integrated in the controller.



Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10].

7.2 The Controller Wiring – Control Part

- The power supply to the controller via the 2 pins 1 and 6 must allow the controller to be supplied with a high starting current (a few A). The "I/O init" error occurs when the wiring of the controller power supply limits the voltage rise when the power is switched on (wire cross-section too small, wire length too long, source not powerful enough...).
- The motor position encoder must be connected to the controller, taking into account the isolation of the encoder ground "0V encoder" which is different from the power battery ground "B-" [4].
- ➤ A female DB9-pin connector will allow an easier connection of the configuration interface via the CAN bus.
- The green external light reproduces the flashes of the light on the SEVCON controller in the event of an error: it is convenient on the vehicle's dashboard!

The Forward/Stop/Reverse functions, the PB6 accelerator and its FS1 contact are the minimum inputs used with the default controller configuration.



Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10].

7.3 Checking the USB-to-CAN interface

The IXXAT USB-to-CAN interface has two LEDs, one for the USB bus and the other for the CAN bus. These indicators provide information on the status of the communication.



Fig. 64. The compact USB-to-CAN interface IXXAT [6].

- © If the USB light is green, communication with the compact USB-to-CAN interface via the USB port is possible.
- ☺ However, if the USB indicator is red, communication is not possible. In this case it will be necessary to check if you have installed VCI V3 correctly. In case of problems, the latest versions of the USB-to-CAN interface drivers can be downloaded from the IXXAT website at:

https://www.ixxat.com/support/file-and-documents-download/drivers

When the communication via the USB port is effective, you can then launch the "DVTC" software.

<u>BE CAREFUL</u>: The interface may be installed for a particular outlet on the computer and may require a new installation if the USB-to-CAN interface is connected to another USB outlet.



Fig. 65. The USB-to-CAN V2 IXXAT interface [6].

8 Appendix 2 – Numbering of SEVCON GEN4 AC Controllers

8.1 Product identification label

The identification label for SEVCON GEN4 controllers is located on the side of the controller (see Figure 67). It contains the following information:

- 1) Type: it is a summary of the main characteristics of the controller, here from the GEN4 family, the voltage level (here 36 V/48 V) and the motor current (here 275 A);
- 2) Part: it is the complete coding of the controller characteristics that is explained in the paragraph §8.2;
- 3) Serial: This is the unique serial number of the controller. The first 2 digits correspond to the year of manufacture.



Fig. 66. Product Identification Label for SEVCON GEN4 Controllers.



Size 2 modelsSize 4 modelsSize 6 modelsFig. 67. The 3 different sizes of SEVCON GEN4 AC controllers.

8.2 Numbering of SEVCON GEN4 AC Controllers

- 634A: GEN4 controller?
- 42: ??? size 2 4875
- 44: ??? : size 4 4845
- 101: A/B and U/V/W encoders for MAS asynchronous motor
- 201: A/B and U/V/W/ encoders for MS synchronous motor
- 203: sin/cos encoder for PERM synchronous motor: **<u>BE CAREFUL</u>**: This controller has a special design that modifies the role of the inputs/outputs

8.3 Glossary of Terms

EDS: Electronics Data Sheet: CAN object dictionary (without numerical values) File name: product code+ revision number:

GEN4_pc0X0705503_rev0x0010010.eds

Explained in the DSP306 eds specification

EDS: configuration parameter file

DCF: Device Configuration File: same as EDS with the values

SDO: Service Data Object

PDO: Process Data Object

CLI: ???

9 Appendix 3 – Online IT Orders

9.1 The Principle of Tcl/Tk Commands

The Tcl/Tk commands can be entered directly in the command prompt window, or written in a text file with the extension" *.tcl" [2], [8].

9.1.1 Displaying a Text

puts "Hello World"

9.1.2 Comments

The text line after the "#" symbol is ignored

9.1.3 Variables

set x "Green" puts "My favourite colour is \$x"

```
set p "10"
puts "The value of p is $p"
```

9.1.4 Calculations

expr (8 + 12) expr (5 / 2) expr (5.0 / 2.0) expr (0x08 + 0x04) expr (0x18 | 0x34)

The characters"[et]" must be used to insert commands that will be evaluated before being assigned to the variable.

set x [expr (4 + 5)]
puts "The value of x is \$x"
puts "Four squared is [expr (4 * 4)]"

9.1.5 Calculation loops

```
foreach n { 1 5 10 20 50 100 } {
puts "$n squared is [ expr ( $n * $n ) ]"
}
```

```
for { set p 1 } { $p <= 10 } { incr p } {
puts "$p cubed is [ expr ( $p * $p * $p ) ]"
}
```

9.1.6 Declaration of Procedures

```
proc add_four { num } {
set r [ expr ( $num + 4 ) ]
return $r
}
add_four 9
```

9.2 CANopen Commands of SEVCON GEN4 AC Controllers

9.2.1 Manual Loading of a DCF Configuration File

- 1- Launch the "DVT Customer" script.
- 2- Choose the right communication speed until the green LED on the IXXAT interface flashes on both sides.
- 3- In the "DVTC" command window, type the following lines and confirm each by pressing the "ENTER" key:

lg 1# Se connecter sur le nœud CAN N° 1 (« log on node 1 »)fpo 1 PRE# Mettre le variateur du nœud 1 en mode « PRE » (opérationnel).dl_dcf [tk_getOpenFile] 1# Chargement du fichier « DCF » dans le variateur

- # du nœud 1 après avoir sélectionner un fichier.
- 4- Select the "DCF" file to load via the Windows interface.
- 5- Wait a few moments for the file to be loaded into the controller.
- 6- Cut off the power supply of the controller and replace it ("recycle").

9.2.2 List of "Active Faults"

The "flts" command:

dvt(101) % flts + « ENTER »

will display the list of faults on the controller of CAN node 1, for example:

- 0: 0x5101 Line Contactor o/c
- 1: 0x4981 Throttle Fault
- 2: 0x45c1 BDI Warning
- 3: 0x45c2 BDI Cutout

9.2.3 Manual Loading of a DLD "Software" File

In the online command area of the "DVTC" software window, the GEN4 controller must first be set to "Preoperationnal" mode with the "fpo pre" command.

The online order to switch to boot loader mode is "bts 1".

During the software update, the controller switches to boot loader mode: the green LED flashes quickly and then REMAINS OFF.



Fig. 68. The command "enter boot loader mode" in the "DVT" window.

To load the file, use the command "load_dld 1": a file selection window opens to choose the DLD file to use.



Fig. 69. The command "load_dld 1" in the "DVT" window.

<u>IMPORTANT</u>: The transfer takes a few minutes and is <u>**VERY CRITICAL**</u>: the process should not be interrupted before the end and the power supply of the controller should not be cut off. In case of problems during transfer, the controller must return to the factory and may be unrecoverable!



Fig. 70. Transfer of the current software to the "DVT" window.

During the transfer of the new program, a series of dots appears in the "Information" window following the text "programming dsp-zeffer on node 1".

At the end of the transfer, the message "OK" appears in the control window.

It is important to exit the "boot loader" mode with the command "box 1".

At this point, the green LED on the GEN4 controller starts flashing again. CAUTION: the controller is in "Preoperationnal" mode.

It is necessary to cut off the power supply of the controller, wait a few seconds and turn the controller back on "Power Recycle". It is also necessary to close the DVTC software and restart it.

By clicking on the "H" button, the "Helper" script will check the consistency of the EDS file available on the computer's hard disk with the new software and request the creation of a new file if necessary.

In case of problems during the transfer, do not exit the "boot loader" mode. It is necessary to cut off the power supply of the controller, turn it back on ("**Power recycle**") and restart loading with the command "load_dld 1".

10 Appendix 4 – The Variables of the Motor

10.1 The "Save Partial DCF" Command in the "DVTC Helper"

Saving a partial DCF file is accessible from the menu:

- "Helper" script window;
- "Settings" menu;
- "Save Partial DCF" menu.

It is not necessary to be in the "PreOp" mode to save the controller configuration in a DCF file. The operation takes a few minutes: the process must not be interrupted before the end and the power supply of the controller must not be cut off.

OVT Helper		
File Software	Settings MACROS Juning CAN	N Help
Ding No.	Save DCF	Nede ID 1
Ping Node	Save Partial DCF	Node ID I
Main Tree	Send DCF to Unit	
	Compare DCFs	
	Create EDS	
	Find Range Error	
Go Oper	Copy Baseline to Drive Profile 1	
PMAC E	Copy Baseline to Drive Profile 2 Copy Baseline to Drive Profile 3	
Control Mode	Copy Baseline to Drive Profile 4	

Fig. 71. The "Save Partial DCF" menu in the "Helper" script window.

A new window opens and allows you to select the different variables to be extracted.

The "Add PMAC Motor Items" button allows you to directly select the characteristic variables corresponding to the motor parameters.

<u>Comments</u>: All sub-indexes of the selected variables will be fully saved.

The "Save Selected Items" button is used to generate a partial DCF file containing the variables that have been selected.



Fig. 72. The "Object Search" window of the "Save Partial DCF" menu.

10.2 List of Variables Provided by "Add PMAC Motor Items"

The "Add PMAC Motor Items" button allows you to directly select the characteristic variables corresponding to the motor parameters, *i.e.*:

- 0x4611 Motor power limit map
- 0x4615 Motor power limit map 2
- 0x4617 Programmable User Data
- 0x4620 Motor Temperature 1 (Measured T1)
- 0x4621 Motor Temperature Setup
- 0x4630 Encoder Configuration
- 0x4640 Motor Nameplate Data
- 0x4641 AC Motor data (manufacturer specific)
- 0x4650 Miscellaneous DSP configuration (Gen4)
- 0x6072 Maximum torque
- 0x6075 Current limit
- 0x6076 Peak torque
- 0x6090 Encoder resolution

😢 dvt_partial_dcf_search	🔞 dvt_partial_dcf_search
Object Search	Object Search
Add from search list Add PMAC Motor Items Add by Hex Address Add PDOs	Add from search list Add PMAC Motor Items Add by Hex Address Add PDOs
0x4611 0x4615 0x4617 0x4620 0x4621 0x4630 0x4630 0x4640 0x4641	0x4620 0x4621 0x4630 0x4640 0x4641 0x4650 0x6072 0x6075
Clear List	0x60/0 0x6090 Clear List Save All Other Turns

Fig. 73. Result of the "Add PMAC Motor Items" button.

10.2.1 Variable 0x4611 – Motor power limit map

0x4611	Motor power limit map
0x4611 sub 0	Number of entries = $0x12 = 18$
0x4611 sub 1	Pt 1 Max Torque
0x4611 sub 2	Pt 1 Speed

10.2.2 Variable 0x4615 – Motor power limit map 2

0x4615	Motor power limit map 2
0x4615 sub 0	Number of entries = $0x12 = 18$
0x4615 sub 1	Secondary Pt 1 Max Torque
0x4615 sub 2	Secondary Pt 1 Speed

10.2.3 Variable 0x4617 – Programmable User Data

0x4617	Programmable User Data
0x4617 sub 0	Number of entries $= 4$
0x4617 sub 1	Data = 0xfffffffffff
0x4617 sub 2	Description of data
0x4617 sub 3	Version of Data
0x4617 sub 4	Checksum of Data

10.2.4 Variable 0x4620 – Motor Temperature 1 (Measured - T1)

0x4620	Motor Temperature 1 (Measured - T1)
0x4620 sub 0	Number of entries $= 7$
0x4620 sub 1	Mode = 1
0x4620 sub 2	High Temperature Voltage (PTC)
0x4620 sub 3	Low Temperature Voltage (PTC)
0x4620 sub 4	Switch source
0x4620 sub 5	PTC type
0x4620 sub 6	Failure torque cutback rate
0x4620 sub 7	Failure torque recovery rate

10.2.5 Variable 0x4621 – Motor Temperature Setup

0x4621	Motor Temperature Setup
0x4621 sub 0	Number of entries $= 7$
0x4621 sub 1	Motor temperature estimate current constant
0x4621 sub 2	Motor temperature estimate discretization
0x4621 sub 3	Maximum allowable motor temperature
0x4621 sub 4	Resistance variation hot temperature
0x4621 sub 5	Resistance variation cold temperature
0x4621 sub 6	Resistance variation hot factor
0x4621 sub 7	Resistance variation cold factor

10.2.6 Variable 0x4620 – Encoder Configuration

0x4630	Encoder Configuration
0x4630 sub 0	Number of entries = $0x15 = 21$
0x4630 sub 1	Encoder Pull Up

0x4630 sub 2	Encoder Supply
0x4630 sub 3	Encoder Type
0x4630 sub 4	Encoder Offset
0x4630 sub 5	Sin input minimum (trough) voltage
0x4630 sub 6	Sin input maximum (peak) voltage
0x4630 sub 7	Cos input minimum (trough) voltage
0x4630 sub 8	Cos input maximum (peak) voltage
0x4630 sub 9	Actual sin minimum (trough) voltage
0x4630 sub A	Actual sin maximum (peak) voltage
0x4630 sub B	Actual cos minimum (trough) voltage
0x4630 sub C	Actual cos maximum (peak) voltage
0x4630 sub E	Multipole Sin-cos / Resolver waves per mechanical rotation
0x4630 sub 10	Encoder offset
0x4630 sub 12	Sin-cos/UVW latency select
0x4630 sub 13	Sin-cos/UVW latency fine adjust
0x4630 sub 14	Sin-cos min warning voltage
0x4630 sub 15	Sin-cos max warning voltage

10.2.7 Variable 0x4640 – Motor Nameplate Data

These data are not present in the PMS100 motor DCF...

0x4640	Motor Nameplate Data
0x4640 sub 0	Number of entries
0x4640 sub 1	Rated line voltage
0x4640 sub 2	Rated phase current
0x4640 sub 3	Rated mechanical speed
0x4640 sub 4	Rated frequency
0x4640 sub 5	Rated power
0x4640 sub 6	Power factor

10.2.8 Variable 0x4041 – AC Motor data (manufacturer specific)

0x4641	AC Motor data (manufacturer specific)
0x4641 sub 0	Number of entries = $0x2b = 43$
0x4641 sub 1	Commit
0x4641 sub 2	Maximum Stator Current (Is_max)
0x4641 sub 3	Minimum Magnetizing Current (Im_min)
0x4641 sub 4	
0x4641 sub 5	Number of Pole Pairs (np)
0x4641 sub 6	
0x4641 sub 7	Rated Stator Current
0x4641 sub 8	
0x4641 sub 9	
0x4641 sub A	Stator Inductance (Ls)
0x4641 sub B	
0x4641 sub C	Nominal battery voltage
0x4641 sub D	Current control proportional gain (Kp)
0x4641 sub E	Iq max headroom (G-Mode IQM)
0x4641 sub F	Current control integral gain (Ki)
0x4641 sub 10	

0x4641 sub 11	
0x4641 sub 12	Voltage Constant (Ke) V/rads (line, rms, elec_frq)
0x4641 sub 13	
0x4641 sub 14	
0x4641 sub 15	
0x4641 sub 16	Openloop start FW%
0x4641 sub 17	
0x4641 sub 18	
0x4641 sub 19	Frequency/Mod index control Kp
0x4641 sub 1A	Frequency/Mod index control Ki
0x4641 sub 1B	
0x4641 sub 1C	
0x4641 sub 1D	
0x4641 sub 1E	Max drive mod index
0x4641 sub 1F	Max brake mod index
0x4641 sub 20	
0x4641 sub 21	D-axis current controller proportional gain
0x4641 sub 22	D-axis current controller integral gain
0x4641 sub 23	
0x4641 sub 24	
0x4641 sub 25	
0x4641 sub 26	
0x4641 sub 27	
0x4641 sub 28	
0x4641 sub 2A	
0x4641 sub 2B	Percentage minimum allowed saturation of Ls

10.2.9 0x4650 Variable – Miscellaneous DSP Configuration (Gen4)

There are 2 groups of 16 bits of "All or Nothing" information coded on each bit by "0" or "1".

0x4650	Miscellaneous DSP configuration (Gen4)
0x4650 sub 0	Number of entries $= 2$
0x4650 sub 1	Miscellaneous DSP configuration 1 (Gen4) (16 bits)
0x4650 sub 2	Miscellaneous DSP configuration 2 (Gen4) (16 bits)

10.2.10 0x6072, 0x6075 and 0x6076 Variables

0x6072	Maximum torque
0x6075	Current limit
0x6076	Peak torque

10.2.11 0x6090 Variable – Encoder Resolution

This is the definition of the encoder resolution.

0x6090	Encoder resolution
0x6090 sub 0	Number of entries $= 2$
0x6090 sub 1	Pulses per revolution
0x6090 sub 2	Motor revolutions per second

11 Appendix 5 – Tips for Adjusting Correctors

11.1 Speed Loop

11.2 Current Loop

List of Figures:

Fig. 1. The IXXAT USB-to-CAN interface [6].	5
Fig. 2. Shortcut for the execution of the DVTC software tool (version 2018)	5
Fig. 3. Information windows of the DVTC software tool (i.e., version 13.9)	6
Fig. 4. The CAN menu of the DVTC tool	6
Fig. 5. The "Info Window" menu	7
Fig. 6. The "Information" window.	7
Fig. 7. The online command window of the DVTC software tool	7
Fig. 8. Choice of the CAN bus speed and launch of the "Helper"	
Fig. 9. Execution button of the "Vehicle Interface" script.	
Fig. 10. Execution button of the "Helper" script	
Fig. 11. Execution button of the "Editor" script	
Fig. 12. AC controller home screen with the "DVT Helper"	9
Fig. 13. AC controller home screen with the "DVTC Helper".	10
Fig. 14. Input/Output tab aimed at defining digital and analog inputs and power output	ıts11
Fig. 15. "Input/Output" tab for defining digital power outputs	12
Fig. 16. The "Tree" tab in the "Helper" window	13
Fig. 17. Example of using the "Search" button.	13
Fig. 18. Menu "Tree structure - Configuration - Contactor - Voltages"	14
Fig. 19. Setting the "Line Contactor Dropout" function.	15
Fig. 20. The XB4-BVB3 24 V signal light	15
Fig. 21. Menu named "Tree structure - Configuration - Contactor - Control activation	
Fig. 22. Example of voltage reduction at the terminals of the indicator. Case of a 72 V	/ power
supply and a 24 V configuration.	
Fig. 23. Menu named "Tree - Configuration - Contactor - Hold Enables"	16
Fig. 24. Menu named "Tree - Status - Raw Analog Inputs"	17
Fig. 25. Menu named "Tree - Configuration - Throttle"	
Fig. 26. Menu named "Tree - Configuration - Temperature Control - Sensor Configu	uration".
	19
Fig. 27. Menu named "Main –Battery Limits" – Default settings	
Fig. 28. Menu named "Tree – Configuration – Battery Control"	21
Fig. 29. Menu named "Tree – Configuration – Battery Control – Voltage cutback" 1/2	2 21
Fig. 30. Menu named "Tree – Configuration – Battery Control – Voltage cutback" 2/2	2 22
Fig. 31. Menu named "Main –Battery Limits" – Correct values.	
Fig. 32. Limiting voltages of the SEVCON GEN4 AC controller	
Fig. 33. Maximum torque (Nm) depending on motor speed (rpm)	23
Fig. 34. Setting the operating limits of the motor in the "Baseline Profile" configurati	on24
Fig. 35. Setting the operating limits of the "Driveability Select 1 Profile" motor	25
Fig. 36. Setting the operating limits of the "Driveability Select 2 Profile" motor	25
Fig. 37. The "Save DCF" menu in the "Helper" script window	
Fig. 38. The naming of the "DCF" files in the "C:\SEVCON-GEN4\DCF" directory	27
Fig. 39. The "Send DCF To Unit" menu in the "Helper" window	
Fig. 40. Switch to 72V 550A with the command: "configure_voltage_items 1 72 550"	' 30
Fig. 41. The "Software" menu to load a "DLD" file	
Fig. 42. Transfer of the current software to the "DVT" window.	
Fig. 43. The "TPDO/RPDO" tab of the "Helper" script	
Fig. 44. The data transmitted by the "TPDOs"	
Fig. 45. The data transmitted by the "TPDO1".	

Fig. 46. The data transmitted by the "TPDO2".	36
Fig. 47. The data transmitted by the "TPDO3".	36
Fig. 48. The data transmitted by the "TPDO4".	37
Fig. 49. The data transmitted by the "TPDO5".	37
Fig. 50. The "Change Baud Rate" menu from the "DVT Helper"	37
Fig. 51. Changing the speed of the CAN bus, menu "CAN" of the "Helper"	38
Fig. 52. The motor parameters "AC Motor Data (manufacturer specific)	39
Fig. 53. Execution button of the "Vehicle Interface" script.	40
Fig. 54. The "Vehicle Interface" script window	40
Fig. 55. The control buttons of the "Vehicle Interface" script.	41
Fig. 56. The Excel macro "Vehicle Interface Log Viewer.xlsm".	41
Fig. 57. The Excel macro "Vehicle Interface Log Viewer.xlsm" generates an error	42
Fig. 58. Result of the Excel macro "Vehicle Interface Log Viewer.xlsm" with 2 error curve	es.
	42
Fig. 50 Result of the Excel macro "Vehicle Interface Log Viewer vism" with the 2 error	
rig. 57. Result of the Excer macro vehicle interface Log viewer. Aisin with the 2 ciror	
curves that have been deleted.	43
curves that have been deleted Fig. 60. Execution button of the "Editor" script	43 44
curves that have been deleted Fig. 60. Execution button of the "Editor" script Fig. 61. The "Editor" script window.	43 44 44
 Fig. 59. Result of the Excer macro "venicle interface Log viewer.xisin" with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10] 	43 44 44 46
Fig. 60. Execution button of the "Editor" script Fig. 61. The "Editor" script window Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10] Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10]	43 44 44 46 47
 Fig. 59. Result of the Excer matrix "venicle interface Log viewer.xish" with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script. Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10]. Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10]. Fig. 64. The compact USB-to-CAN interface IXXAT [6]. 	43 44 44 46 47 47
 Fig. 59. Result of the Excer matrix vehicle interface Log viewer.xisin with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10] Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10] Fig. 64. The compact USB-to-CAN interface IXXAT [6] Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. 	43 44 44 46 47 47 48
 Fig. 59. Result of the Excer macro "venicle interface Log viewer.xisin" with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script. Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10]. Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10]. Fig. 64. The compact USB-to-CAN interface IXXAT [6]. Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. Fig. 66. Product Identification Label for SEVCON GEN4 Controllers. 	43 44 44 46 47 47 48 49
 Fig. 59. Result of the Excer matrix vehicle interface Log viewer.xisin with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script. Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10]. Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10]. Fig. 64. The compact USB-to-CAN interface IXXAT [6]. Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. Fig. 66. Product Identification Label for SEVCON GEN4 AC controllers. Fig. 67. The 3 different sizes of SEVCON GEN4 AC controllers. 	43 44 46 47 47 48 49 49
 Fig. 59. Result of the Excer matrix vehicle interface Log viewer.xisin with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10] Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10] Fig. 64. The compact USB-to-CAN interface IXXAT [6]. Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. Fig. 66. Product Identification Label for SEVCON GEN4 AC controllers. Fig. 67. The 3 different sizes of SEVCON GEN4 AC controllers. Fig. 68. The command "enter boot loader mode" in the "DVT" window. 	43 44 46 47 47 47 48 49 49 52
 Fig. 59. Result of the Excer filter of vehicle interface Log viewer.xisin with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script. Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10]. Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10]. Fig. 64. The compact USB-to-CAN interface IXXAT [6]. Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. Fig. 66. Product Identification Label for SEVCON GEN4 Controllers. Fig. 67. The 3 different sizes of SEVCON GEN4 AC controllers. Fig. 68. The command "enter boot loader mode" in the "DVT" window. 	43 44 44 46 47 47 47 48 49 52 53
 Fig. 59. Result of the Excer filteror "venicle interface Log viewer.xish" with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script. Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10]. Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10]. Fig. 64. The compact USB-to-CAN interface IXXAT [6]. Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. Fig. 66. Product Identification Label for SEVCON GEN4 Controllers. Fig. 67. The 3 different sizes of SEVCON GEN4 AC controllers. Fig. 68. The command "enter boot loader mode" in the "DVT" window. Fig. 69. The command "load_dld 1" in the "DVT" window. 	43 44 44 46 47 47 47 47 49 49 52 53 53
 Fig. 59. Result of the Excer matrix vehicle interface Log viewer.xisin with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10] Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10] Fig. 64. The compact USB-to-CAN interface IXXAT [6] Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. Fig. 66. Product Identification Label for SEVCON GEN4 Controllers. Fig. 67. The 3 different sizes of SEVCON GEN4 AC controllers. Fig. 68. The command "enter boot loader mode" in the "DVT" window. Fig. 70. Transfer of the current software to the "DVT" window. Fig. 71. The "Save Partial DCF" menu in the "Helper" script window. 	43 44 44 46 47 47 47 48 49 49 52 53 53 54
 Fig. 59. Result of the Exect matter vehicle interface Eog viewer. Anshill with the 2 error curves that have been deleted. Fig. 60. Execution button of the "Editor" script Fig. 61. The "Editor" script window. Fig. 62. Example of wiring the power section of a SEVCON GEN4 AC controller [10] Fig. 63. Example of wiring the control section of a SEVCON GEN4 AC controller [10] Fig. 64. The compact USB-to-CAN interface IXXAT [6]. Fig. 65. The USB-to-CAN V2 IXXAT interface [6]. Fig. 66. Product Identification Label for SEVCON GEN4 AC controllers. Fig. 67. The 3 different sizes of SEVCON GEN4 AC controllers. Fig. 68. The command "enter boot loader mode" in the "DVT" window. Fig. 70. Transfer of the current software to the "DVT" window. Fig. 71. The "Save Partial DCF" menu in the "Helper" script window. 	43 44 44 46 47 47 47 47 47 49 52 53 53 54 54

List of Tables:

 Table 1. Resistance value of the KTY84 temperature sensor.
 19