

# DC Shield TLE9562-3QX

## About this document

#### Scope and purpose

This user manual describes the BLDC shield with the TLE9562-3QX. This document provides detailed information on the board's content, layout and use. It should be used in conjunction with the TLE9562-3QX datasheet, which contains full technical details on the device specification and operation.

#### **Intended audience**

This document is intended for users who develop applications with the TLE956x family.

### **Table of contents**

Abou	t this document	
Table	e of contents	1
1	Introduction	1
2	Hardware description	
2.1	Hardware	
2.2	Schematic	7
2.3	Layers	
2.4	Bill of Material of the TLE9562-3QX	
3	Start and uIO stick programmation	13
3.1	Download the Graphic User Interface for the uIO stick	
3.1.1	Download from MyICP	
3.1.2	Download from the Infineon Toolbox	
3.2	Configuration Wizard for TLE9562-3QX	
4	Config Wizard - Control tabs	15
4.1	SBC	
4.2	Bridge Driver	
5	Revision history	21

#### **1** Introduction

2 The TLE9652-3QX evalutaion board is intended to provide a simple and easy-to-use tool for getting familiar with the device features and for first application tests. The evaluation board consists of a uIO-stick,

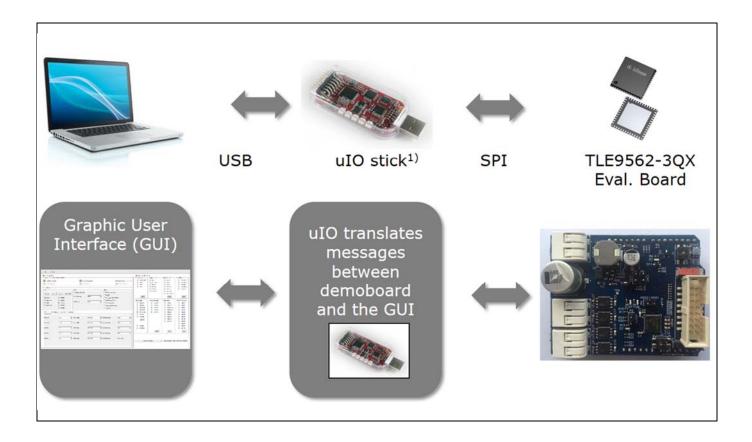
a TLE9652-3QX board.

3 The uIO-stick is the interface between the PC and the application board such as the TLE9562-3QX. The TLE9562-3QX SPI communication is emulated by the uIO-stick, which is controlled by the PC software.



4 The board of the TLE9562-3QX has a connector for the uIO-stick, connectors for the power supply, three connector for the motor output. And an active reverse battery protection with IPZ40N4S5L-2R8.

Figure 1 TLE9562-3QX evaluation Board concept



<sup>1)</sup> The uIO stick must be ordered separately – SP001215532 Details about the uIO stick can be found hear: <u>www.hitex.com/uIO</u>

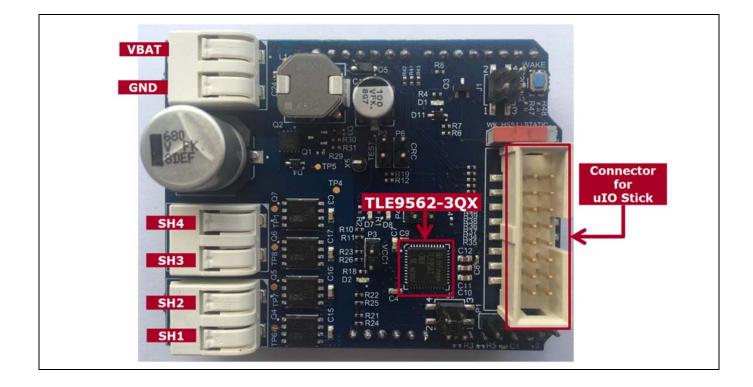


# 2 Hardware description

### 2.1 Hardware

The TLE9562-3QX evaluation board is designed to be compatible with the uIO-stick. The uIO-stick plugs into the TLE9562-3QX main board via a 16-pin header, and allows an easy interface to the microcontroller via USB for SPI communication.

#### Figure 2 TLE9562-3QX evaluation board





#### Figure 3 TLE9562-3QX evaluation board

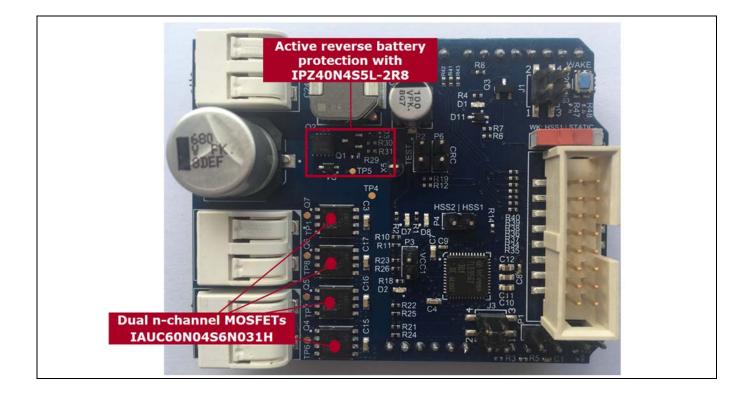
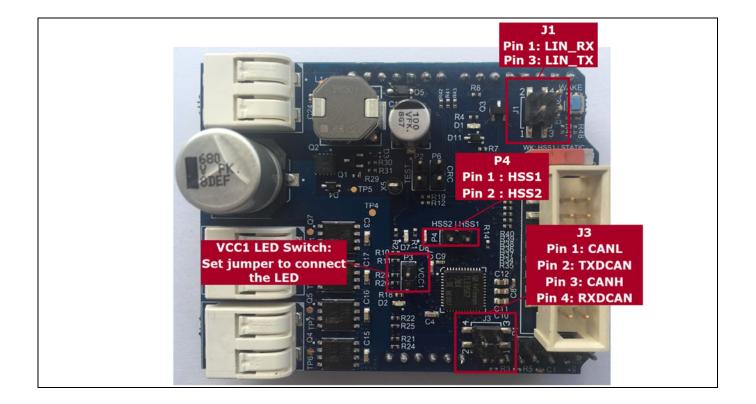
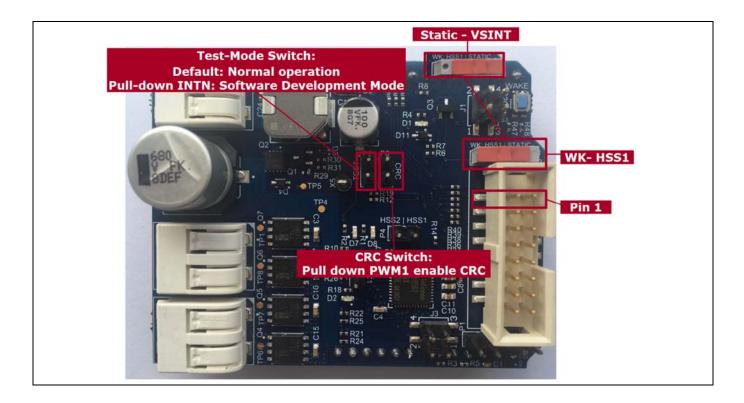


Figure 4 TLE9562-3QX evaluation board: Jumper settings





#### Figure 5 TLE9562-3QX evaluation board: Jumper setttings and switches



- Test-Mode Switch: Software Development Mode is a dedicated SBC configuration especially useful for software development. The Watchdog is enabled in Software Development Mode as default state.
- CRC: The SPI interface includes also 8 Bits used for Cyclic Redundancy Check (CRC) to ensure data integrity on sent or received SPI command.



#### Figure 6 TLE9562-3QX evaluation board: Arduino connectors 1/2

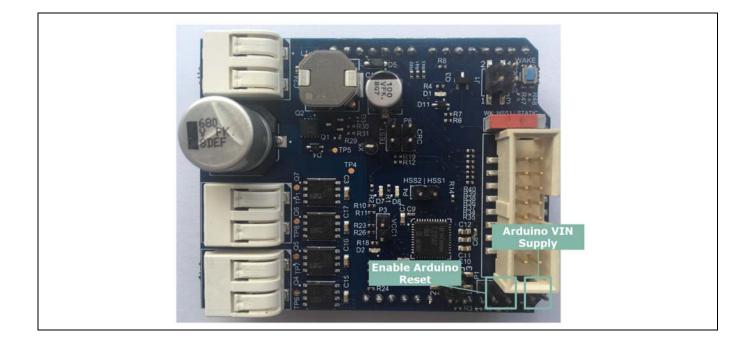
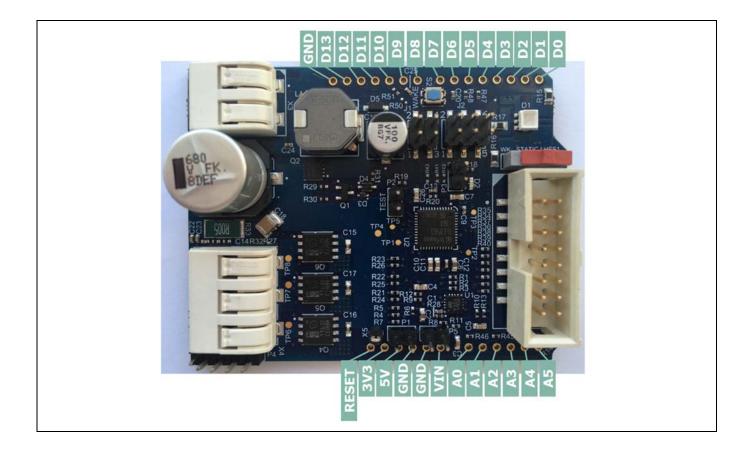


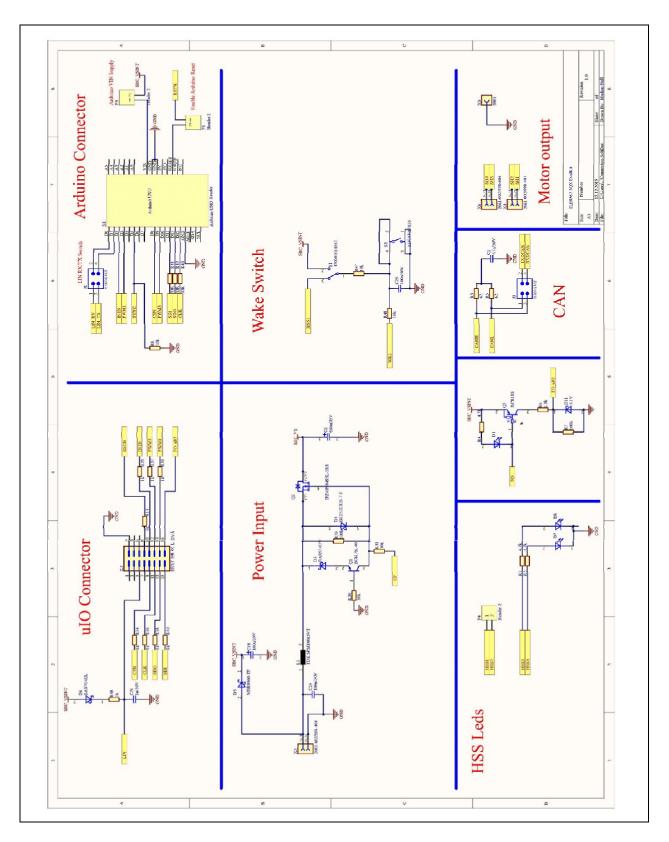
Figure 7 TLE9562-3QX evaluation board: Arduino connectors 2/2





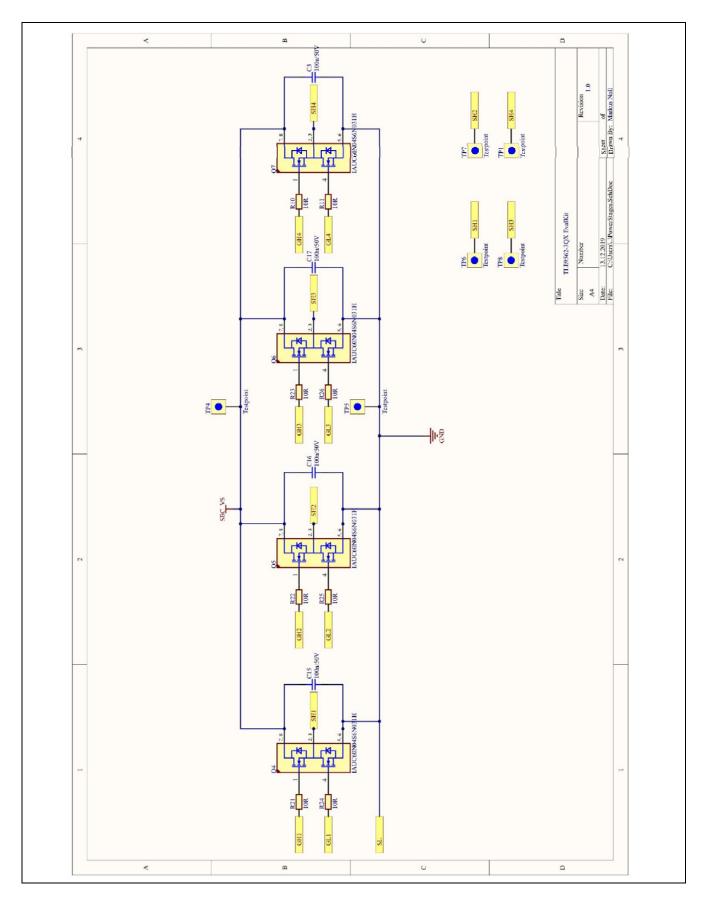
# 2.2 Schematic





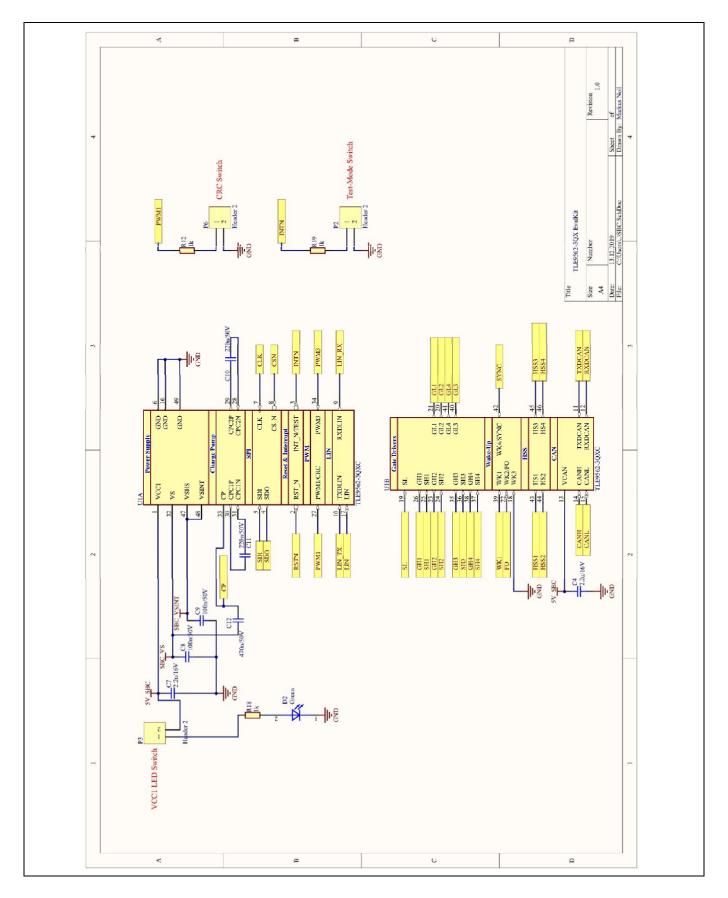


# Figure 9 Schematic 2/3





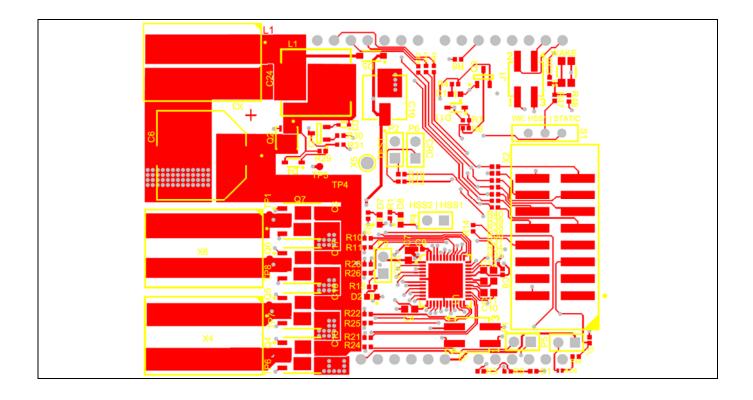
## Figure 10 Schematic 3/3





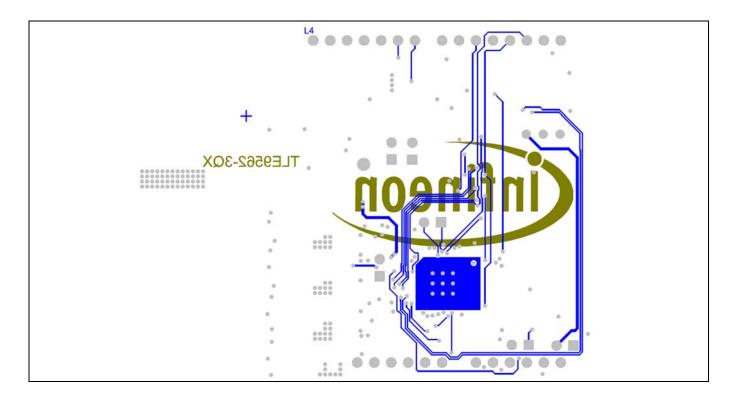
# 2.3 Layers

## Figure 11 Top layer with overlay

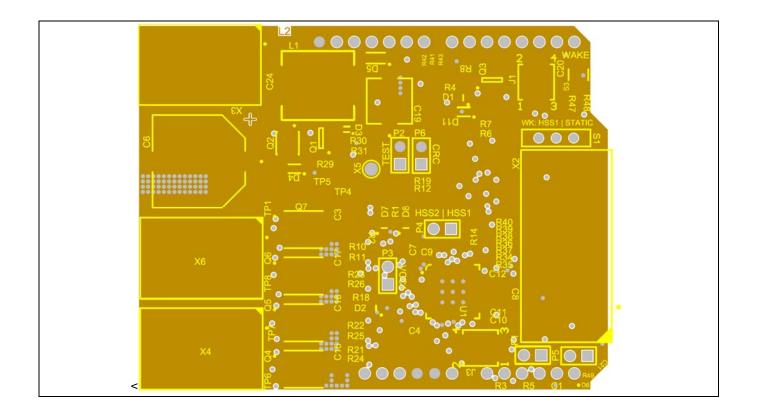




#### Figure 12 Bottom layer with overlay



#### Figure 13 Inner layer - GND





# 2.4 Bill of Material of the TLE9562-3QX

### Figure 14 TLE9562-3QX - Section of Bill of Material (BOM)

Designator	Comment	Manufacturer	Description	Quantity				
J1, J3	61000421121		SMT Vertical Pin Header WR-PHD, Pitch 2.54 mm, Dual Row,					
	TOK COMMONSCRIT		4 pins					
11	TDK SPM10065VT							
P1, P2, P3, P4, P5, P6	Header 2		Header, 2-Pin					
51	450301014042	WS-SLTV THT Mini Slide Switch, Opposite Side Connection, SPDT		1				
\$3	434153017835		WS-TASV J-Bend SMT Tact Switch 3.5x2.9mm, height 1.7mm, 350gf					
TP1, TP4, TP5, TP6,	<b>*</b>							
TP7, TP8	Testpoint			6				
C3, C15, C16, C17	100n/50V	AVX	Surface Mount Ceramic Capacitor Automotive Grade	4				
D4	BZT52C12S-7-F	Diodes Incorporated	Surface Mount Zener Diode	1				
D3	BASS2-02V	Infineon Technologies	Silicon Schottky Diode	1				
D6	BAS70-02L	Infineon Technologies	Silicon Schottky Diode	1				
Q1	BC817K-40	Infineon Technologies	NPN Silicon AF Transistor	1				
02	10740104551 200	Informa Taskastation	OptiMOS-5 N-Channel Enhancement Mode Power-					
Q2	IPZ40N04S5L-2R8	Infineon Technologies	Transistor, VDS 40V, ID 40A	1				
Q3	bjt_pnp_1b2e3c_3p_10k	Infineon Technologies	PNP Silicon Digital Transistor	1				
Q4, Q5, Q6, Q7	IAUC60N04S6N031H	Infineon Technologies		4				
U1	TLE9562-3QXC	Infineon Technologies	Bridge SBC Family, PLGM					
X5	5001	Keystone Electronics Corp.	Test Point THT, Black					
DS	MBR0560-TP	Micro Commercial Components	Schottky Rectifier, 0.5A/60V					
D1, D7, D8	d_led_a	OSRAM Opto Semiconductors	Surface Mount LED, Super Red, 630nm					
D2	Green	OSRAM Opto Semiconductors	Surface Mount LED, Green, 570nm					
C6	680u/35V	Panasonic	Aluminum Electrolytic Capacitors					
C19	100u/35V	Panasonic	Surface Mount Aluminium Electrolytic Capacitor					
			SMT, .025" Shrouded SQ POST IDC Headers , 2.54mm pitch,	-				
X2	HTST-108-01-L-DVÂ	Samtec	16-pin Vertical, Double row	1				
C1	4.7n/50V	TDK Corporation	Chip Multilayer Ceramic Capacitor for General Purpose	1				
C4, C7	2.2u/16V	TDK Corporation	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination					
C8, C9, C20, C24	100n/50V	TDK Corporation	Chip Multilayer Ceramic Capacitor for General Purpose					
C10, C11	220n/50V	TDK Corporation	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft					
			Termination Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft					
C12	470n/50V	TDK Corporation	Termination	1				
C21	1n/50V	TDK Corporation	Chip Multilayer Ceramic Capacitor for General Purpose	1				
R1, R2, R4	4.7k	Vishay	Standard Thick Film Chip Resistor	3				
R3, R5	62	Vishay	Standard Thick Film Chip Resistor	2				
R6	1.3k	Vishay	Standard Thick Film Chip Resistor	1				
R7, R29	100k	Vishay	Standard Thick Film Chip Resistor					
R8, R30, R31, R47, R48	10k	Vishay	Standard Thick Film Chip Resistor					
R10, R11, R21, R22,				-				
R23, R24, R25, R26	10R	Vishay	Standard Thick Film Chip Resistor	8				
R12, R14, R18, R19,	80							
R34, R35, R36, R37,	1k	Vishay	Standard Thick Film Chip Resistor	12				
R41, R42, R43	33R	Vishay	Standard Thick Film Chip Resistor					
D11	5.1V	Vishay General Semiconductor	Small Signal Zener Diode, GDZ-G-Series / 5.1V					
		in a seneral seneral seneral seneral	SMD PCB Terminal block with Push-Buttons, with 6mm Pin	· · · ·				
X3, X4, X6	2061-602/998-404	WAGO	Spacing, 2-pole					



# **3** Start and uIO stick programmation

The uIO stick requires a firmware supporting the GUI (Graphic user interface)

### 3.1 Download the Graphic User Interface for the uIO stick

The TLE9210x gate driver setting tool can be either downloaded from Infineons's MyICP upon access request or from the Infinon Tool Box (not yet possible by the generation of the user manual).

### 3.1.1 Download from MyICP

The GUI for the Motor System IC can be downloaded upon request to <u>Motorcontrolsolutions@infineon.com</u> Once the .zip file is locally extracted, start: **ConfigWizard.exe** (in the application subfolder) and click on the icon for **TLE9562.** 

#### Figure 15 Start of the GUI after download from MyICP

🦲 imageformats	19.05.2020 16:10	File folder	
📜 platforms	19.05.2020 16:10	File folder	
📕 scripts	26.05.2020 14:05	File folder	
uIO-Stick_Firmware	19.05.2020 16:10	File folder	
ConfigWizard.exe	13.04.2020 14:12	Application	2.999 KB
Disclaimer.txt	13.04.2020 14:12	Text Document	2 KB
HIDLibrary.dll	13.04.2020 14:12	Application extens	14 KB
ICW.xsd	13.04.2020 14:12	XSD File	3 KB
ICW_Types.xsd	13.04.2020 14:12	XSD File	27 KB
Smsvcp140.dll	13.04.2020 14:12	Application extens	430 KB
Qt5Core.dll	13.04.2020 14:12	Application extens	4.968 KB

### 3.1.2 Download from the Infineon Toolbox

The GUI is installed the Infineon Toolbox following the steps below:

- 1. Go to: www.infineon.com/toolbox
- 2. Follow the instructions provided on the toolbox installation webpage. Also see the "Download Getting Started Infineon Toolbox Guide" link for des additional user information
- 3. Launch the Infineon Toolbox on your PC:
- 4. Select Manage Tools
- 5. Search and install the tool: Config Wizard for Motor System IC
- 6. Start the Config Wizard for Motor System IC
- 7. Click on TLE9562



### 3.2 Configuration Wizard for TLE9562-3QX

- The first utilization of the uIO stick in combination of the GUI for the TLE9562 requires the programmation of the uIO stick:
- 1. Connect the uIO stick to the USB port
- 2. Menu Extra
- 3. Update uIO
- 4. Click Yes (refer Figure 16)

#### Figure 16 Updating the uIO



**5.** Select uIO.V222.hex and open (the valid version at the creation time of the document)

### 3.2 Load TLE9562 presettings

Presettings for the gate driver can be loaded:

#### $File \rightarrow Load \rightarrow TLE9562\_ConfigWizard\_Presettings\_2020\_06\_25\_1.icwp$

- The charge pump is activated
- The active gate control and the postcharge are activated
- The gate driver currents for the active and freewheeling MOSFETs are pre-configured



# 4 Config Wizard - Control tabs

#### Figure 17 The two main tabs SBC, Bridge Driver

- Bridge Driv	or	
Bridge Driv	cı.	
C Bridge Driver		
connection Status / Signalisation Pin Status		
ulO Stick connected	Target IC accessable	uIO Fimware Version: 2 . 2 . 2
RO Pin activated		

### 4.1 SBC

#### Figure 18 Connection Status/ Signaling Pin Status

	<ul> <li>Green LED: Communication between the uIO stick and the TLE9562- and is working</li> <li>Target IC accessible:</li> <li>Firmware version of the connected uIO</li> <li>RO Pin activated:</li> </ul>	3QX is connected
Connection Stat	pe Driver Status / Signalisation Pin Status Stick connected Pin activated	ulO Fimware Version: 2 . 2 . 2



#### Figure 19 Overview of the SBC tab

<ul> <li>Connection Status / Sig</li> <li>Control Function</li> </ul>	naling Pin Status
→ Wake-up (WK)	
Normal         Discourse         Normal         TLESSOL           Steps (P5         TLESSOL         OV Recotion         Normal           State (P1)         TLESSOL         OV Recotion         Normal	peried by Suft Reset.         CLEAR         CLEAR           0 WK TypeX.         Downs Status.         Wate Load Status.         Wide Status.         Wide Status.           New X-Inva         Occ STAT         Wide Und.         Wide Clear Status.         Wide Clear Status.           New Zimes         Occ STAT         Wide Und.         Wide Clear Status.         Wide Clear Status.
PMM         Premist 1988 (* 200 Hz)         Premist 1986 (* 200 Hz)	Series     Series

### Figure 20 SBC: Control functions

Mode: For example: "Sle	eep/Fs" -> "Normal" check uIO	connection and press "NORMAL"
Product identifier		
Control Function Mode NORMAL SLEEP STOP Soft Reset Normal TLE9560 Sleep /FS TLE9561 Stop TLE9562 Soft Reset TLE9563 TLE9564	Image: CC1       Image: High Act. Peak Thr.       Reset Threshold       VRT1       OV Recation   None	Others TSD2 min wait 64sec FOx_EN RO triggered by Soft Reset WK2/FO as WK Input Reset Delay 2ms Sample and Hold Disable VS_OV 30V

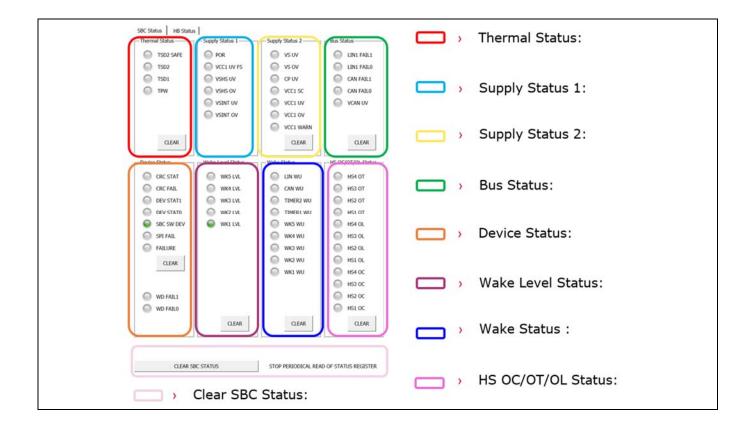


#### Figure 21 SBC: Wake-up, PWM/Interrupt, HS1 – HS4, Timer /BUS

WK1 Filter	16us	▼ WK1Enable	WK1 ON	VK1 Pul	Device None	-	>	Wa	ake-up
WK2 Filter	16us	▼ WK2 Enable	WK2 ON	• WK2 Pul	Device None	-			i.
WC3 Filter	16us	• WK3 Enable	WK3 ON	• WK3 Pul	Device None	•			
VK4 Filter	16us	• WK4Enable	WK4 ON	• WK4Pul	Device None	-			
NKS Filter	16us	WKS Enable	WKS ON	VKS Pul	Device Pull-up fixed				
	PWM2Fi PWM3Fi	PMM(brienupt )HS1- eq (# 100 Hz (* 200 Hz eq (# 100 Hz (* 200 Hz eq (# 100 Hz (* 200 Hz eq (# 100 Hz (* 200 Hz	PMMIDC PWM2DC PWM3DC PWM4DC	0.0 % 작 0.0 % 작 0.0 % 작 0.0 % 작	Interrupt Mask Control			A	PWM/Interrupt
ke-up PWM/Intern 1 - H54 SW Recovery H51 af SW Recovery H52 af SW Recovery H53 af SW Recovery H54 af SW Recovery after U Individual Shutdown	ter OV ter OV ter OV ter OV N	「Shutdown disable 「Shutdown disable 「Shutdown disable 「Shutdown disable 「Shutdown disable	HS2 OV HS3 OV HS4 OV ed on supply OV in Stop	H51 H52 H53 H54	off off off	* * *			HS1 – HS4
	Wake up - Timer 1 Per Timer 1 Per Timer 2 Per Timer 2 Per Timer 2 On Cyclic Wake	Time lod Time	I mer, flus	• • •	805 Configuration CAN IDM1 IDM TOD Time-Out IDM TOD Time-Out IDM Stope control inactive	[CPP	*		> Time/BUS



#### Figure 22 SBC Status



#### Figure 23 Half-Bridge (HB) Status

PWM Ch.4 63	39.6ns 39.6ns	639.6ns 639.6ns	Ons Ons	Ons Ons Ons	Ons Ons Ons	Ons Ons Ons		>	GEN Status
0	HB4VOUT HB3VOUT HB2VOUT	ID REG	IPDCHG4 S IPDCHG3 S IPDCHG2 S	T T	0	CSA OC VSINTOOVBRAKE ST		>	TD REG
000	HB1VOUT PWM6STAT PWM5STAT PWM9STAT	000	IPDCHG1 S IPCHG4 ST IPCHG3 ST IPCHG2 ST	T	0000	LS4DSOV BRK LS3DSOV BRK LS2DSOV BRK LS1DSOV BRK	8	>	DSOV
0	PWM3STAT PWM2STAT PWM1STAT	0000	IPCHG1 ST TDREG4 TDREG3 TDREG2 TDREG1		000	LS4DSOV HS4DSOV LS3DSOV HS3DSOV LS2DSOV	3	>	Clear Diagnostic Bridge Driver (BD) Status
	CLEAR		CLEAR		000	HS2DSOV LS1DSOV HS1DSOV CLEAR			



# 4.2 Bridge Driver

#### Figure 24 Bridge Driver: 1<sup>st</sup> Tab – General control, VDS Monitoring (Mon.)

SBC Bridge Driver					1	
General / VDS Mon Blank/CCP time / HBMODE / On-Board PVVM Generator	Brake / TDON/TDOFF   Mosfet Drive Currents   General bridge Control	CS/HS Drain Current -				
F = 20 kHz	BD Freq C 18.75 MHz @ 37.5 MHz	LS Filter Time	lus	•		
PWM1Enable 🔽	PWM1 mapped to HB1	LS1 OV Threshold	0.20V	•		On-Board PWM Generators
PWM1Duty Cyde 0 % 🛨	PWM3 mapped to HB3 💌	LS2 OV Threshold	0.20V	•		
PWM3 Enable		LS3 OV Threshold	0.20V	<u> </u>		General Bridge Control
PWM3 Duty Cyde 0 % 🛨	CPUV Threshold 1	LS4 OV Threshold	0.20V	•		
F = 400 Hz	ext. MOSFET Normal Level 💌	Deep adaptation e	enable			LS/HS Drain-Source
SYNC 0	BRDV recover from OV     Steps adaption of precharge/predischarge current	HS1 OV Threshold	0.20V	J		monitoring
1010: 0-10 for (0% - 100%)	Adaptive Gate Control 2:Active	HS2 OV Threshold	0.20V	•		
	Charge Pump Enable     Postcharge dsable	HS3 OV Threshold	0.20V	•		
	Filter adaptive gate control     Detection of active/FW Mosfet	HS4 OV Threshold	0.20V	-		
	Hold Current					
	Frequency Modulation enable					
		1				

Figure 25 Bridge Driver: 2<sup>nd</sup> Tab – Blank/ CCp time, HBMODE, Brake, TDON/ TDOFF Timing

Seneral / CSA / VDS Mon Blank/O Blank time / CCP time	HBMODE / Precharge Predischarge time	Brake	TDON / TDOFF	Timing				
TBLANK ACTIVE_HB1 2.45us	HB1 Mode Passive Off 💌	LS1 Disable in SLAM	EDON HE1	0.64 us	•	_		
TCCP ACTIVE_HB1 2.45us	Act. Freewheeling HB1	LS2 Disable in SLAM     LS3 Disable in SLAM					>	Blank time/ CCP time
TBLANK ACTIVE_HB2 2.45us		C LS4 Disable in SLAM	IDON HE2	0.64 us	-			
CCP ACTIVE_HB2 2.45us	HB2 Mode Passive Off 💌	SLAM Active	EDON HE3	0.64 us	•			
	Act. Freewheeling HB2	VDS OV Brake LS1-4 🗭 800 mV 🦵 220 mV		A	_		>	HBMODE / Pre-charge time;
BLANK ACTIVE_HB3 2.45us		and the second second second	IDON HE4	0.64 us	*			Pre-discharge time
COP ACTIVE_H83 2.45us	HB3 Mode Passive Off 💌	Blank Time Brake 🦳 7 us 🔎 11 us	1DOFF HB1	0.64 us	•			r e abenarge ante
BLANK ACTIVE_HB4 2.45us	Act. Freewheeling HB3 PWM HB3	Parking Brake enable	Dorriot	10.0100	-			
CCP ACTIVE_H84 2.45us		OV Brake enable	tDOFF HB2	0.64 us	•		>	Brake
BLANK ACTIVE_FW1 2.45us	HB4 Mode Passive Off 💌	OV Brake Hysteresis Hyster 1 💌						
COP ACTIVE_FW1 2.45us	Act. Freewheeling HB4		tDOFF HB3	0.64 us	-			
COP ACTIVE_PW1 (2.4505	F PWM H64	OV Brake Threshold 27 V 💌	tDOFF HB4	0.64 us	•		>	TDON timing/ TDOFF Timing
BLANK ACTIVE_FW2 2.45us	Precharge Time HB1 110ns 💌							
TCCP ACTIVE_FW2 2.45us	Precharge Time HB2 110ns							
BLANK ACTIVE_FW3 2.45us	Precharge Time HB3 110ns   Precharge Time HB4 110ns							
CCP ACTIVE_FW3 2.45us	Predischarge Time HB1 110ns							
	Predscharge Time HB2 110ns 💌							
BLANK ACTIVE_FW4 2.45us	Predischarge Time HB3 110ns 💌							
TCCP ACTIVE_FW4 2.45us	redischarge Time HB4 110ns 💌							



## Figure 26Bridge Driver: 3rd Tab – MOSFET Drive Currents

General / VDS Mon Blank/CCP time / HBMODE / B Static charge/discharge current		Precharge / Predischarg	sfet Drive Currents je INIT	PWM charge/discharge	current		Static charge current/		
Format: charge / discharge current		Precharge HB1 Init	10.2 mA	PWM charge Active MO	SFET		static discharge current		
r onnine: enarge	, / under na gle current	Precharge Hb1 Init	110.2 ma	Charge HB1 Active	6.5 mA	-	statie alsenarge earrene		
H81	40.1 mA / 39.4 mA	Predischarge HB1 Init	31.2 mA	Charge HB2 Active	6.5 mA	-			
				Charge HB3 Active	6.5 mA	i 🛑	Pre-charge initial/		
HB2	40.1 mA / 39.4 mA 💌	Precharge HB2 Init	10.2 mA 💌	Charge HB4 Active	6.5 mA	·	pre-discharge initial		
нвз	40.1mA/39.4mA 💌	100 B		PWM discharge Active N	IOSFET				
183	40,1ma/39,4ma 🔄	Predischarge HB2 Init	31.2 mA 💌	Discharge HB1 Active	8.2 mA	J 💭	PWM charge current/		
HB4	40.1 mA / 39.4 mA 💌			Discharge HB2 Active	8.2 mA	-	PWM discharge current		
no-	190.1 mg/ 32.1 mg	Precharge HB3 Init	10.2 mA 👱	Discharge HB3 Active	8.2 mA	-	<ol> <li>Prostania - International contraction of the statement of the</li></ol>		
PWM max pred	harge/predischarge			Discharge HB4 Active	8.2 mA	<u> </u>			
Format: charge	e / discharge current	Predischarge HB3 Init	31.2 mA	I			PWM max. Pre-charge/		
HB1	00 mA / 100 mA			FW MOSFET; Format: d	harge/discharge current		PWM max. Pre-discharge		
HB2	100 mA / 100 mA 💌	Precharge HB4 Init	10.2 mA	Charge/Discharge HB1 F	FW 40.1 mA / 39.4 mA	<b>_</b>	i minimuxi i re disendi ge		
HB3	100 mA / 100 mA 💌			Charge/Discharge HB2 F	FW 40.1 mA / 39.4 mA	-			
HB4	100 mA / 100 mA 💌	Predischarge HB4 Init	31.2 mA	Charge/Discharge HB3 I	FW 40.1 mA / 39.4 mA		Maximum prechage and pre		
	ste pull-down ste pull-down			Charge/Discharge H84 P	FW 40.1 mA / 39.4 mA	•	discharge currents		
HB3 off-sta	ste pull-down								



# 5 Revision history

Document version	Date of release	Description of changes
V 1.0	2020-07-16	Initial version

#### Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

Edition 2020-07-16

Published by

Infineon Technologies AG

81726 Munich, Germany

© 2020 Infineon Technologies AG. All Rights Reserved.

Do you have a question about this document? Email: erratum@infineon.com

Document reference AppNote Number

#### IMPORTANT NOTICE

The information contained in this application note is given as a hint for the implementation of the product only and shall in no event be regarded as a description or warranty of a certain functionality, condition or quality of the product. Before implementation of the product, the recipient of this application note must verify any function and other technical information given herein in the real application. Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind (including without limitation warranties of noninfringement of intellectual property rights of any third party) with respect to any and all information given in this application note.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application. For further information on the product, technology delivery terms and conditions and prices please contact your nearest Infineon Technologies office (www.infineon.com).

#### WARNINGS

Due to technical requirements products may contair dangerous substances. For information on the types in question please contact your nearest Infineor Technologies office.

Except as otherwise explicitly approved by Infineor Technologies in a written document signed by authorized representatives of Infineor Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof car reasonably be expected to result in personal injury.