

BLDC Shield TLE9563-3QX

About this document

Scope and purpose

This user manual describes the BLDC shield with the TLE9563-3QX. This document provides detailed information on the board's content, layout and use. It should be used in conjunction with the TLE9563-3QX 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	ut this document	1
Tabl	e of contents	1
1	Introduction	
2	Hardware description	
2.1	Hardware	3
2.2	Schematic	8
2.3	Layout	
2.4	Bill of Material	14
3	Start and uIO stick programmation	15
3.1	Download the Graphic User Interface for the uIO stick	
3.2	Configuration Wizard for TLE9563-3QX	15
4	Config Wizard - Control tabs	16
4.1	SBC	
4.2	Bridge Driver	
Revi	ision history	21

1 Introduction

The TLE9653-3QX evaluation 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 can be used wither with a uIO-stick, or with an Arduino Uno.

The uIO-stick is the interface between the PC and the application board such as the TLE9563-3QX. The TLE9563-3QX SPI communication is emulated by the uIO-stick, which is controlled by the PC software.

The board of the TLE9563-3QX 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 TLE9563-3QX Eval. Board concept



¹⁾ 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 TLE9563-3QX evaluation board is designed to be compatible with the uIO-stick. The uIO-stick plugs into the TLE9563-3QX main board via a 16-pin header, and allows an easy interface to the microcontroller via USB for SPI communication.

Figure 2 TLE9563-3QX evaluation board: Overview





Figure 3 TLE9563-3QX evaluation board



Figure 4 TLE9563-3QX evaluation board





Figure 5 TLE9563-3QX evaluation board: Jumper settings 1/3



- Test-Mode jumper: Software Development Mode is a dedicated SBC configuration especially useful for software development. When the jumper is set, the watchdog is disabled.
- Attention: The uIO stick does not refresh the watchdog. Therefore, for a correct operation with the uIO stick, the Jumper for Test Mode must be placed in order to enable the software development mode and to deactivate the watchdog



Figure 6 TLE9563-3QX evaluation board: Jumper settings 2/3



Figure 7 TLE9563-3QX evaluation board





Figure 8 TLE9563-3QX evaluation board: Arduino connectors





2.2 Schematic

Figure 9 Schematics 1/4





Figure 10 Schematics 2/4





Figure 11 Schematics 3/4







Figure 12 Schematics 4/4





2.3 Layout

Figure 13 Top layer with overlay



Figure 14 Bottom layer with overlay





Figure 15 Inner layer - GND





2.4 Bill of Material

Figure 16 Bill of Material

Designator	Value	Manufacturer	Description	Quantity
U2	TLE9563	Infineon Technologies	Motor System IC - BLDC CAN	1
03		Infineen Technologies	OptiMOS-5 N-Channel Enhancement Mode	4
Q2	1P240IN0455L-2R8	Infineon rechnologies	Power-Transistor, VDS 40V, ID 40A	1
Q4, Q5, Q6	IAUC60N04S6N031H	Infineon Technologies		3
L1	TDK SPM10065VT	TDK Corporation	1 μH inductor, Isat20 = 27 A	1
U1	LM339QT		Quad comparator	1
D4	BZT52C12S-7-F		Surface Mount Zener Diode	1
D3	BAS52-02V	Infineon Technologies	Silicon Schottky Diode	1
Q1	BC817K-40	Infineon Technologies	NPN Silicon AF Transistor	1
C18	10/50./		Surface Mount Ceramic Capacitor,	1
C10	100/500		Commercial Grade, 10 uF	1
X5	5001		Test Point THT, Black	1
R33	5mR/2W		Shunt resistor 0.005R/2W/1%	1
D5	MBR0560-TP		Schottky Rectifier, 0.5A/60V	1
C13	2.2n/16V		Chip Monolithic Ceramic Capacitor	1
C14	1.5n/16V		Chip Monolithic Ceramic Capacitor	1
C22, C23	22n/16V		Chip Monolithic Ceramic Capacitor	2
C6	680u/35V		Aluminum Electrolytic Capacitors	1
C19	100/251/		Surface Mount Aluminium Electrolytic	1
C19	1000/337		Capacitor	1
R28	OR		0R/50V	1
C2 C12	470p/50V	TDK Corporation	Multilayer Ceramic Chip Capacitor,	2
C2, C12	4701/300	TDK Corporation	Automotive Grade, Soft Termination	2
C3 C4 C5	68p/50V	TDK Corporation	Multilayer Ceramic Chip Capacitor,	0
63, 64, 65	001/ 500	TDK Colporation	Automotive Grade, Soft Termination	5
C7 C25	2 20/16	TDK Corporation	Multilayer Ceramic Chip Capacitor,	2
c7, c20	2.20/100	TDK Colporation	Automotive Grade, Soft Termination	
C10 C11	220p/50V	TDK Corporation	Multilayer Ceramic Chip Capacitor,	2
(10, (11	22011/301	TER Corporation	Automotive Grade, Soft Termination	
C25	4.7p/50V	TDK Corporation	Chip Multilayer Ceramic Capacitor for	1
	4.711/001	TER Corporation	General Purpose	-
			Chip Multilayer Ceramic Capacitor for	
C1, C8, C9, C15, C16, C17, C20,	100n/50V	TDK Corporation	General Purpose, Surface Mount Ceramic	8
C24			Capacitor Automotive Grade	
R1, R2, R3, R4, R5, R7, R8, R9,				
R10, R11, R12, R13, R30, R31,	10k		Standard Thick Film Chip Resistor	19
R44, R45, R46, R47, R48				
R6	3.3k		Standard Thick Film Chip Resistor	1
R14, R19, R34, R35, R36, R37,	1k		Standard Thick Film Chip Resistor	9
R38, R39, R40				-
R15, R16, R17	330R/0.5W	_	Standard Thick Film Chip Resistor	3
R18	470R		Standard Thick Film Chip Resistor	1
R20	49.9R		Standard Thick Film Chip Resistor	1
R21, R22, R23, R24, R25, R26	10R		Standard Thick Film Chip Resistor	6
R27, R32	4.7R	_	Standard Thick Film Chip Resistor	2
R29	100k		Standard Thick Film Chip Resistor	1
R41, R42, R43	33R		Standard Thick Film Chip Resistor	3
R50, R51	62		Standard Thick Film Chip Resistor	2
<u>\$1</u>	450301014042		10x2.5mm THT WS-SLTV	1
S2	434153017835		3.5x2.9mm SMD J-Bend WS-TASV, height 1.7	1
			mm, 350 gf	_



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 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 TLE9563

3.2 Configuration Wizard for TLE9563-3QX

The first utilization of the uIO stick in combination of the GUI for the TLE9563 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 17)

Figure 17 Updating the uIO



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



4 Config Wizard - Control tabs

Figure 18 The two main tabs SBC, Bridge Driver

SBC: Overview	- Selected in this view	
- Bridge Driver:		
SBC Bridge Driver Bridge Driver United Bridge Driver Bridge Dridge Driver Bridge Driver Bridge Driver Bridge Driver Bridge Drive	Target IC accessable	uIO Fimware Version: 2 . 2 . 2

4.1 SBC

Figure 19 Connection Status/ Signaling Pin Status

	 Green LED: Communication between the uIO stick and the TLE950 and is working Target IC accessible: Firmware version of the connected uIO RO Pin activated: 	63-QX is connected
SBC Bridge D Connection State UIO Stice RO Pin a	Driver us / Signalisation Pin Status ck connected activated	uIO Fimware Version: 2 . 2 . 2

Figure 20 Overview of the SBC tab



 Connection Status / Signaling Pin State Control Function 1. Wake-up (WK) 2. PWM/Interrupt 3 	atus 3. HS1-HS3 4. Timer/BUS
SBC Status	SEC Status HB Status Supply Status 1 Bus Status TSV Status Supply Status 1 Over Supply Status 2 Bus Status TSV2 FOR Over Supply Status 1 Over Supply Status 2 Bus Status TSV2 FOR Over Supply Status 1 Over Supply Status 2 CAN FAIL1 TSV2 VCL UV FS Over Supply Status 2 Over Supply Status 2 Over Supply Status 2 TSV2 VCL UV FS Over Supply Status 2 Over Supply Status 2 Over Supply Status 2
VCCL Others NORMAL SEEP STOP Soft Reset T 150 At Reset T 150 At Reset T 150 At Reset Normal T 159561 T 159561 OV Receton Roset Delay Zms Reset Delay Zms Soft Reset T 159502 OV Receton None Serge and Notable	ПРИ УзЯБ ОУ УССІ 5С УЗЯТ ГУ УССІ 5С УЗЯТ ГУ УССІ 5С УССІ 100 УССІ 100 ОССІ 100 УССІ 100 ОССІ 100 УКАВ 100 ОССІ 100
TLSS64 T V5_0V 30V • Weightermark 161 - 163 Timer/R0/5 • Wale up (W0) • W64 Enable W64 Enable WW4 Fiber 16us • W64 Enable W64 Pull Device Rone	OC FAR. THRR: WU H62 0T OC FAR. WKH WU H63 0T OC FAR. WKH WU H63 0T OF RES TATE WKH WU H63 0T OF RES TATE WKH WU H63 0T OF RES TATE H63 0C H63 0C WO FAILI H63 0C H63 0C WO FAILI CLAR CLAR
	CLEAR SRC STATUS STOP PERIODICAL READ OF STATUS REGISTER

Figure 21 SBC: Control function

→ Mode For e	: xample: "Sleep	o/Fs" -> "Noi	rmal″ chec	k uIO connection and	press "NORMAL"
- Control Function	uct identifier				
- Mode		-VCC1		Others-	
NORMAL SLEEP	STOP Soft Reset	High Act. Peak Thr.		TSD2 min wait 64sec	
Normal	TLE9560	Reset Threshold	VRT1 •	R0 triggered by Soft Reset	
Sleep / FS Stop Soft Reset	 TLE9561 TLE9562 TLE9563 TLE9564 	OV Recation	None	Reset Delay 2ms Sample and Hold Disable VS_OV 30V	

Figure 22 SBC: Wake-up, PWM/Interrupt, HS1 – HS3, Timer /BUS



Wale-up PWW/Interrupt HSL-HGS Wale-up (WA) WK4 Filter 1664	Timer/BUS WK4 Enable VK4 ON	WK4 Pull Device	tione 💌	> Wa	ake-up
Wide-op PVMM/Interrupt HS PVM1 PVM1 PVM1 PVM1 PVM1 PVM2 PVM1 PVM2 PVM1 PVm2 PVM2 PVM2 PVM1 PVm2 PVm2 PVm2 PVM1 PVm2 PVm2 PVm2 PVM1 PVm2 PVm2 PVm2	51 - HS3 Timer,BUS OHz PVM1DC 0.0 %	Interrupt Mask Control Period DITN enable With deabled in SDM With O deabled in SDM With 0 in SDM DIT enable SI STAT INT enable BUS STAT DIT enable BUS STAT DIT enable TOPP STAT DIT enable F SUPPLY STAT DIT enable SUPPLY STAT DIT enable		,	PWM/Interrupt
Wake-up PWM/Interrupt H51- H51 - H53 SW Recovery H51 after OV SW Recovery H53 after OV SW Recovery H53 after OV SW Recovery H53 after OV SW Recovery H53 after OV Individual Shutdown at OT	HS3 Timer/BUS	ISI OV S2 OV S3 OV on supply OV in Stop or Sleep on supply UV	HS1 Off HS2 Off HS3 Off	v v v	> HS1 – HS3
	Walesco PMM/Interrupt H51-H53 Timer 1 Period [Timer 1 On-Time [Timer 2 Period [Timer 2 On-Time [Cyclic Wale [Tmer/BUS 10 ms OFF 10 ms OFF OFF OFF	EUS Configuration	OP₽	> Timer/BUS

Figure 23 SBC Status

SBC Status HB Status Thermal Status Supply Status 1 Status Supply Status 1 TSD2 SAFE POR VS UV	bus Status: → Thermal Status:
TSD2 TSD2 SOV TSD1 TSD1 TPW SVSOV VSOV VSOV	CAN FALLO → VCAN UV → Supply Status 1:
	> Supply Status 2:
Device Status CRC STAT CRC FAIL DEV STATI	HS OCTOTIOL Status
OEV STATO SRC SW DEV SPI FAIL FAILURE	HS3 04 HS2 04 HS2 04 HS1 04 HS3 04 HS3 05
UEAR WID FALLI WID FALLO UEAR	HS2 OC HS1 OC CEAR
CLEAR SBC STATUS STOP PERIODICAL	READ OF STATUS REGISTER > Wake Status :
Clear SBC Status:	HS OC/OT/OL Status:

Figure 24 Half-Bridge (HB) Status



SBC Status HB Status PWM Switching Characterist	is-		> PWM Switching Characteristics:
Config. TDON PWM Ch.1 639.6ns PWM Ch.2 639.6ns PWM Ch.3 639.6ns	Config. TDOFF Eff. TDON Eff. TDOFF Eff. TTRISE Eff. TTRISE 639.6ns 0ns 0ns 0ns 0ns 0ns 639.6ns 0ns 0ns 0ns 0ns 0ns 639.6ns 0ns 0ns 0ns 0ns 0ns 639.6ns 0ns 0ns 0ns 0ns 0ns		> Current Sense Amplifier (CSA)
Current Sense Amp. (CSA) - Current Vscox = RSHUNT Calc. Current:	2.5V 5.00 mOhm		> GEN Status
GEN Status HB3VOUT HB2VOUT	ID REG IPDCHG3 ST IPDCHG2 ST IPDCHG2 ST IPDCHG2 ST) ,	> TD REG
HB1VOUT PWM6STAT PWMSSTAT PWMSSTAT PWM4STAT	IPOCHGI ST VSOVBRAKE ST IPOCHGI ST IPCHGI ST IPCHGI ST IPCHGI ST ISJDSOV BRK		DSOV
PWM3STAT PWM2STAT PWM2STAT PWM1STAT	TDREG3 LS3050V TDREG2 TDREG1 LS2050V LS2050V		
CLEAR	LSDSOV HSDSOV		
CLEAR DIAGNOSTI	C ED STATUS STOP PERIODICAL READ OF STATUS REGISTER)	
CLEAR DIAGNOST	c BD STATUS STOP PERIODICAL READ OF STATUS REGISTER	(BD) Status	s

4.2 Bridge Driver

Figure 25Bridge Driver: 1st Tab - General, CSA, VDS Monitoring (Mon)

Sac Biolog Driver			_	
General / CSA / VOS Mon Blank/COTone / HBMCDE / Brake / TDON/TDOFF Mosfet Drive Cut Ext. PWM Generation via uIO-Stick General Bridge Control	CSA control	LS/HS Drain Current		
□ PWM 1 Duty C. 50 % 📩 BD Freq 🛈 18.75 MHz C 37.5 MHz	PWM Inputs 3 PWM 💌	LS Filter Time 0. Sus 💌		On-Board PWM Generator
□ PWM 3 Duty C. 50 % 📩 CPUV Threshold 1 💌	CSA ouput cap max. 400pF 💌	LS1 OV Threshold 0.20V 💌		
	CS Direction Bidrectional	LS2 OV Threshold 0.20V		General Bridge Control
PWM S Duty C. 50 % 🖆 ext. MOSFET Logic Level 💌		LS3 OV Threshold 0.20V		-
Frequency 20000 Hz == Fingle/suto CP auto switch over	CS OV Filter Time 6us			
2 steps adaption of precharge/predischarge current	CSA disabled	Deep adaptation enable		CSA Control
AdaptiveGate Control Disabled	OC Threshold of CS TH1	HS1 OV Threshold 0.20V	· · · ·	
Charge Pump Enable	Gain of Current Sensor 10V/V	HS2 OV Threshold 0.20V 💌		
Filter adaptive gate control	C shutdown enabled	HS3 OV Threshold 0.20V		LS/HS Drain Current
1 Detection of active/FW Mosfet				
Hold Current TH1				
Prequency Modulation enable				
		L J		
]	

Figure 26 Bridge Driver: 2nd Tab – Blank/ CCP time, HBMODE, Brake, TDON/ TDOFF Timing



HBIX bink (CD time TBLANK ACTIVE_FIEI [2.45us ↓ TOCP ACTIVE_FIEI [2.45us ↓ TOCP ACTIVE_FIEI [2.45us ↓ TBLANK ACTIVE_FIEI	DON / DOA / HE2 DON / HE3 DOA / HE3 DOA / HE3 DOA / HE3 DOA / HE3	(0.64 us 0.64 us 0.64 us 0.64 us 0.64 us 0.64 us 0.64 us	-	>	Blank time/ CCP time HBMODE / Pre-charge time; Pre-discharge time
ICOP ACTIVE_PE1 2.45x8 Image: Figure Fi	IDON HE2 IDON HE3 IDOFF HE1 IDOFF HE2 IDOFF HE3	0.64us 0.64us 0.64us 0.64us	1	>	HBMODE / Pre-charge time; Pre-discharge time
H82 Mode Passive Off TCOP ACTIVE_JH83 2.45us TBLANK ACTIVE_JH83 2.45us TCOP ACTIVE_JH83 2.45us TCOP ACTIVE_JH83 2.45us TCOP ACTIVE_JH83 2.45us TCOP ACTIVE_JH83 2.45us TBLANK ACTIVE_JH83 2.45us TCOP ACTIVE_JH83 2.45us TBLANK ACTIVE_JW1 2.45us TCOP ACTIVE_JW1 2.45us TREANK ACTIVE_JW2 2.45us TREANK ACTIVE_FW2 2.45us TREANK ACTIVE_FW3	IDON HES IDOFF HE1 IDOFF HE2 IDOFF HE3	0.64 us	1	>	HBMODE / Pre-charge time; Pre-discharge time
TBLANK ACTIVE_FW3 2.45us ▼ TOCP ACTIVE_FW3 2.45us ▼ H63 Mode Pasave Off ▼ V V V TBLANK ACTIVE_FW1 2.45us ▼ TBLANK ACTIVE_FW2 2.45us ▼ Precharge Time H81 110ns ▼ TBLANK ACTIVE_FW3 2.45us ▼ Precharge Time H81 110ns ▼ TBLANK ACTIVE_FW3 2.45us ▼ Precharge Time H81 110ns ▼ TBLANK ACTIVE_FW3 2.45us ▼ Predscharge Time H81 110ns ▼ TBLANK ACTIVE_FW3 2.45us ▼ Predscharge Time H81 110ns ▼	EDOFF HB2 EDOFF HB3	0.64 us	-		
W Act. Presideding HB3 OV Brake Hystersis Implement in the implemen	1DOFF HB3	0.64 us			
TCCP ACTIVE_FW1 2.45us Precharge Time H81 110ms III TBLANK ACTIVE_FW2 2.45us Precharge Time H83 III III TCCP ACTIVE_FW2 2.45us Precharge Time H83 III III III TCCP ACTIVE_FW2 2.45us Precharge Time H83 IIII IIII IIII IIII IIII IIIII IIIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII			-)	Brake
TBLANK ACTIVE_PW2 2.45us Precharge Time HB3 110ns _ TCCP ACTIVE_PW2 2.45us Precharge Time HB3 110ns _ TBLANK ACTIVE_PW3 2.45us Predischarge Time HB3 110ns _ PREdischarge Time HB1 110ns _ _ _				>	TDON timing/ TDOFF timing
TBLANK ACTIVE_PW3 2.45us Predischarge Time HB1 110ms • Predischarge Time HB1 110ms • • •					
TCOP ACTIVE_FW3 2-45us Predischarge Time H83 110ns					

Figure 27Bridge Driver: 3rd Tab – MOSFET Drive Currents

SBC Bridge Dri General LGG L (M Static charge/disc HB1	ver 1.1.500 c.1.500 c.1.50	ve / TDangibore invisied precharge / Predischarge Precharge HB1 Init	DNT	WM charge/discharge curre Charge HB1 Active Charge HB2 Active	ent 12 mA 12 mA	•	>	Static charge current/ static discharge current
H82	16.6 mA / 14.1 mA 💌	Predischarge HB 1 Init Precharge HB 2 Init	15.1 mA 💌	Charge HB3 Active	12 mA	•	>	Pre-charge initial/ pre-discharge initial
HB3	16.6 mA / 14.1 mA	Predischarge H82 Init	15.1 mA	Discharge HB2 Active Discharge HB3 Active	15.1 mA	•)	PWM charge current/ PWM discharge current
HB1 HB2 HB3	32.1 mA / 29.8 mA ▼ 32.1 mA / 29.8 mA ▼ 32.1 mA / 29.8 mA ▼	Precharge HB3 Init Predischarge HB3 Init	12 mA 💌	Charge/Discharge HB1 FW Charge/Discharge HB2 FW Charge/Discharge HB3 FW	12 mA 12 mA 12 mA	•	> >	PWM max. Pre-charge/ PWM max. Pre-discharge
☐ HB1 off-state ☐ HB2 off-state ☐ HB3 off-state	pul-dewn Duil-dewn Duil-dewn						>	32.1 mA: Pre-charge/ 29.8 mA: Pre-discharge



Revision history

Document version	Date of release	Description of changes
V 1.0	2020-06-23	Initial version

Trademarks

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

Edition 2020-06-23

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.