

BLDC Shield TLE9563-3QX

User guide

Z8F80521104

About this document

Scope and purpose

This user guide introduces the *brushless direct current (BLDC)* shield with the TLE9563-3QX. This document provides detailed information on the content, layout and usage of the board. 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.

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Safety precautions

Safety precautions

Note: Please note the following warnings regarding the hazards associated with development systems.

Table 1 Safety precautions

	<p>Caution: The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.</p>
	<p>Caution: Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.</p>
	<p>Caution: The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.</p>
	<p>Caution: A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.</p>

Warnings

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

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1 The board at a glance

1 The board at a glance

The TLE9563-3QX *BLDC* shield 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 either with an uIO-Stick or stacked on an Arduino UNO board.

The uIO-Stick is the interface between the PC and the application board, such as the TLE9563-3QX.

The TLE9563-3QX *serial peripheral interface (SPI)* communication is emulated by the uIO-Stick, which is controlled by the *graphical user interface (GUI)*.

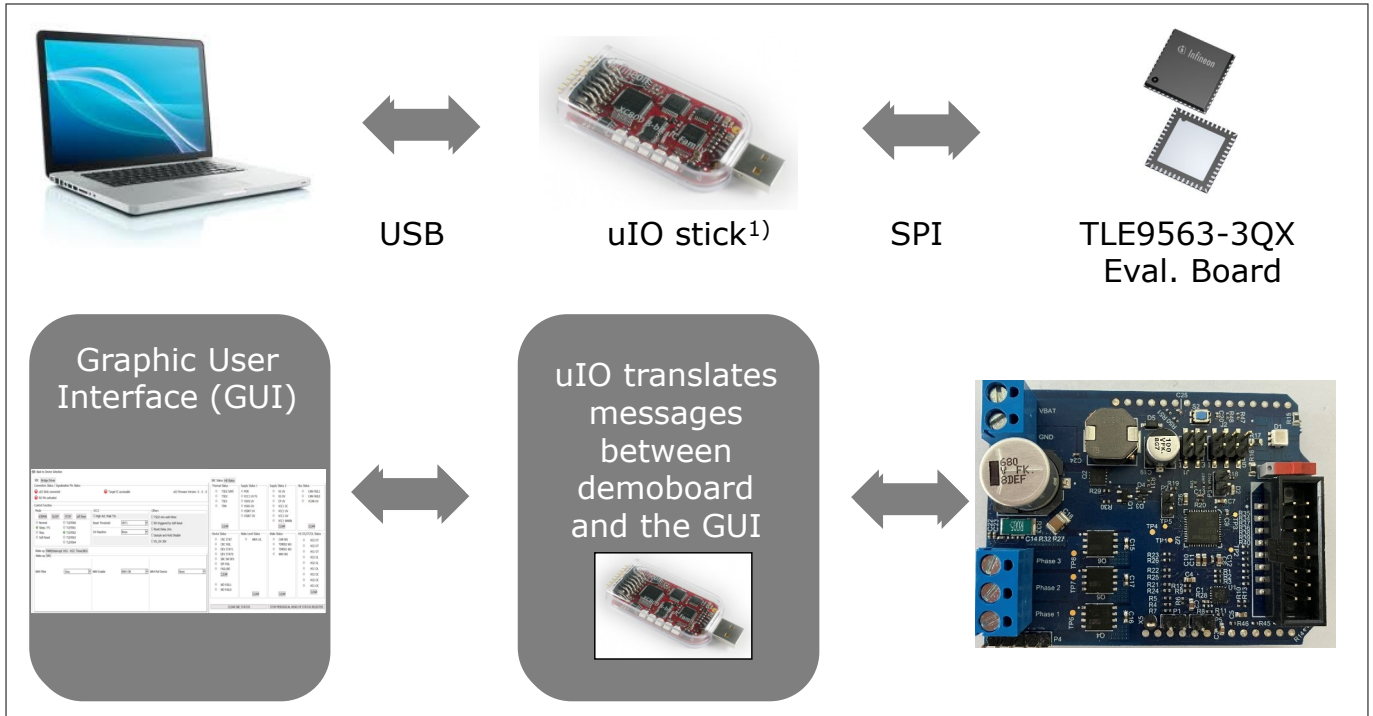


Figure 1 TLE9563-3QX Evaluation board with the uIO-Stick concept

1.1 Delivery content

The cardboard box includes one *BLDC* Shield TLE9563-3QX board. The Arduino UNO board and the uIO -Stick are not included and have to be ordered separately.

For further details about the uIO-Stick refer to: www.hitex.com/uIO

For further information about the Arduino UNO controller board refer to: Arduino - Home.

1 The board at a glance

1.2 Block diagram

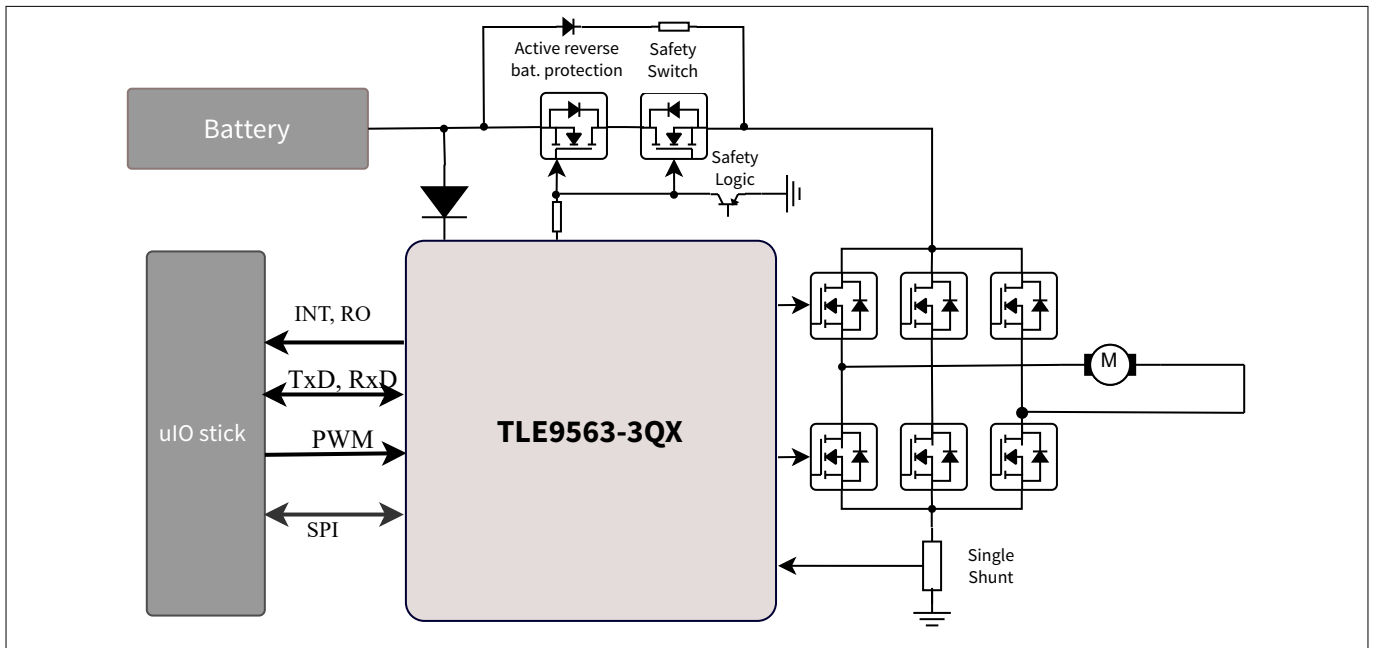


Figure 2 Application circuit for a bi-directional motor control with the TLE9563-3QX using a uIO-Stick

Note: Using the TLE9563 eval board with a uIO-Stick, is possible to spin only a BDC (bi-directional) motor. With the Configuration Wizard it is possible to access the TLE9563 registers but not send a pattern for the rotating field.

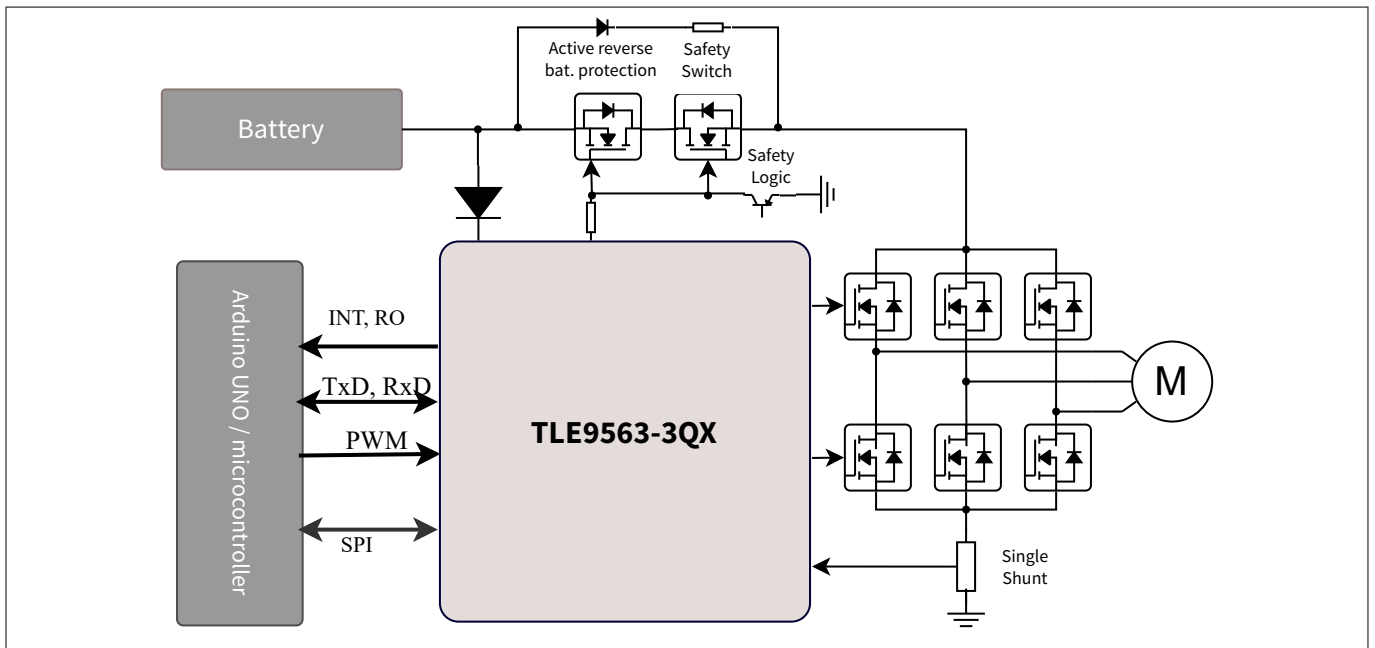


Figure 3 Application circuit for a BLDC motor control with the TLE9563-3QX using an Arduino UNO board

Note: Using the TLE9563 with the Arduino UNO board it is possible to spin a BLDC motor.

1 The board at a glance

1.3 Main features

The TLE9563 evaluation board includes:

- A MOTIX™ TLE9563-3QX
- A 16-pin connector for the uIO-Stick
- A placeholder for the pin header to stack the motor control shield directly on top of an Arduino UNO controller board¹⁾
- An active reverse battery protection circuitry with IPZ40N4S5L-2R8
- A back electro magnetic force (BEMF) comparator
- Three IAUC60N04S6N031H with dual N-channel MOSFETs
- Hall sensor connectors

Table 2 **Technical data**

Voltage supply	Maximum current
Typ. 12 V (max. 28 V)	16 A

¹⁾ Due to manufacturing mistake the holes are filled and they need to be cleaned before connecting the pin header.

2 Hardware description

2 Hardware description

The TLE9563-3QX *BLDC* Shield 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 *universal serial bus (USB)* for *SPI* communication.

2.1 Board overview and connectors

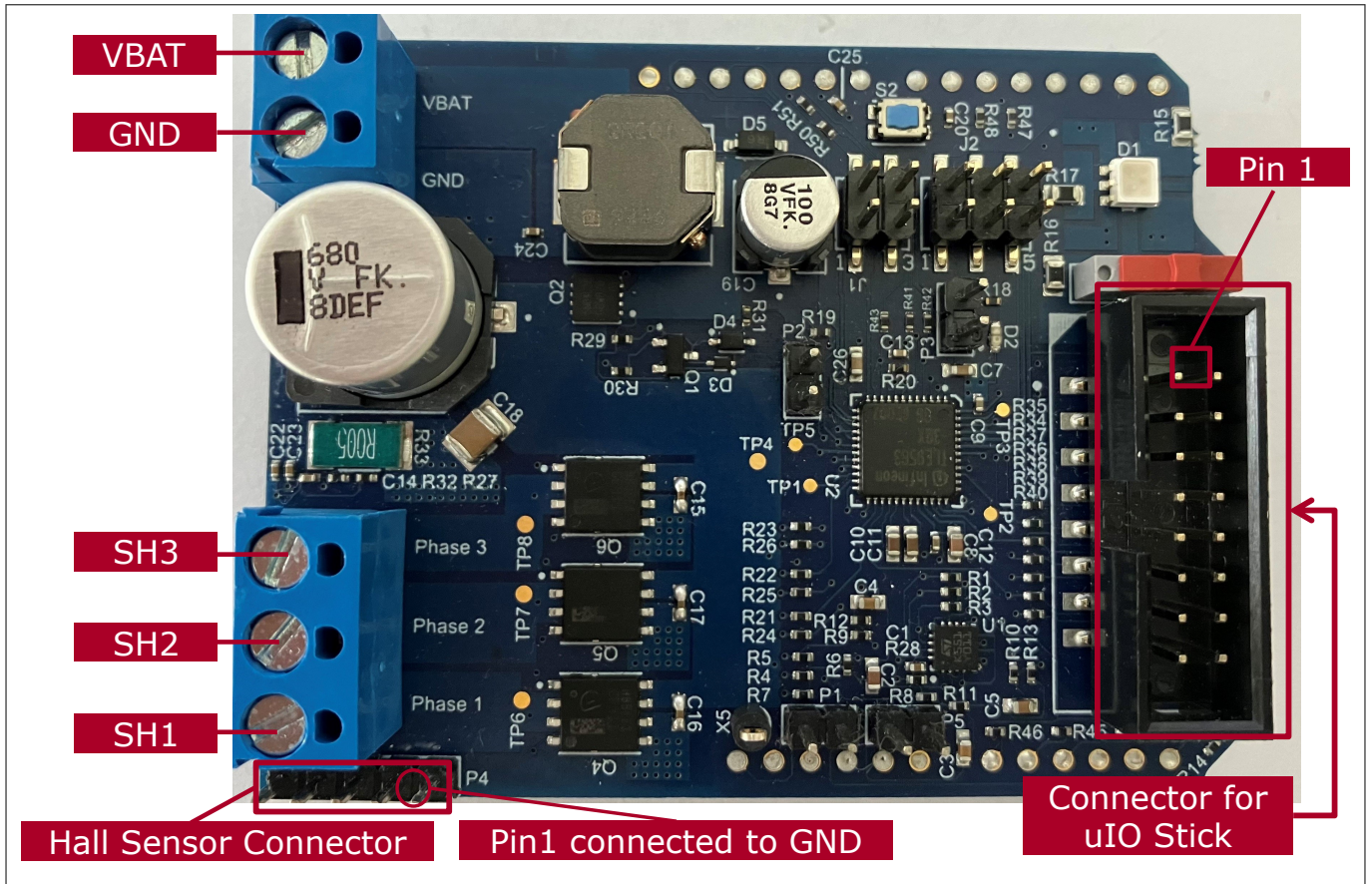


Figure 4 Evaluation board connectors

2 Hardware description

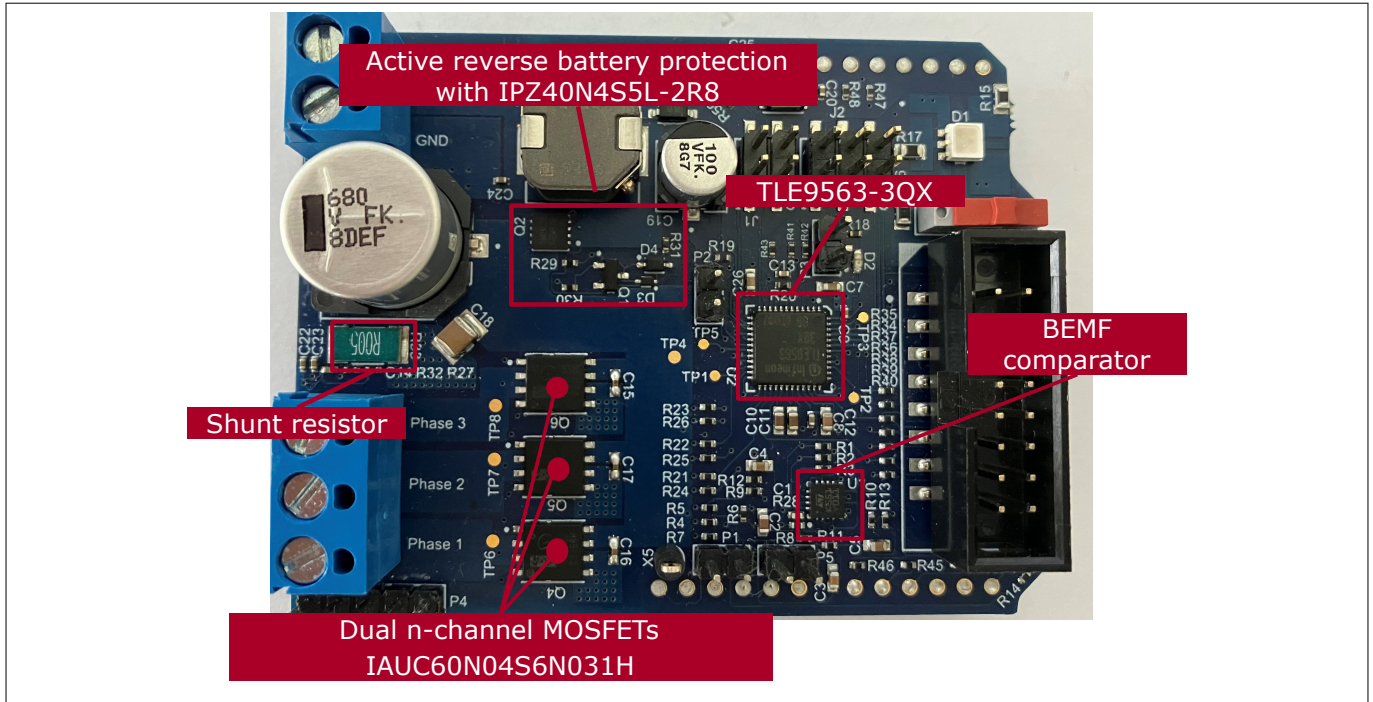


Figure 5 Board components overview 1

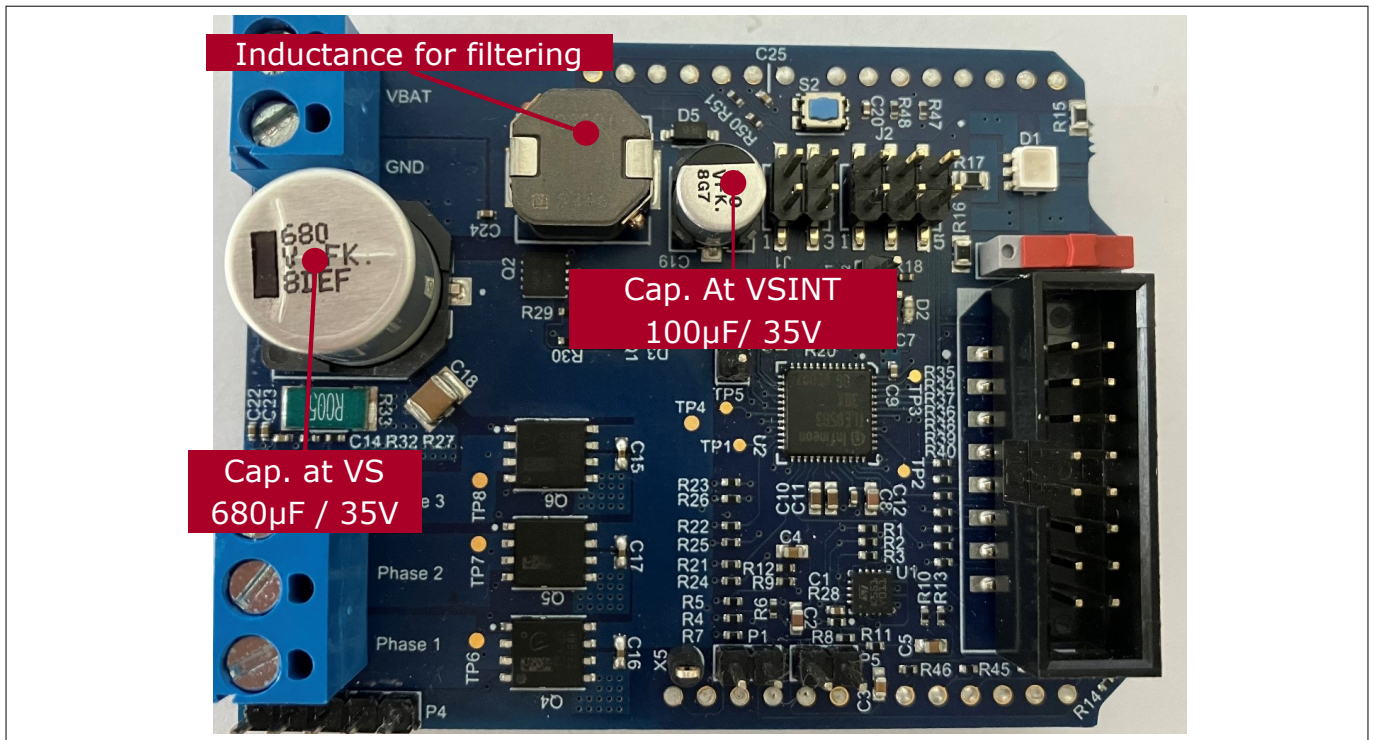


Figure 6 Board components overview 2

2 Hardware description

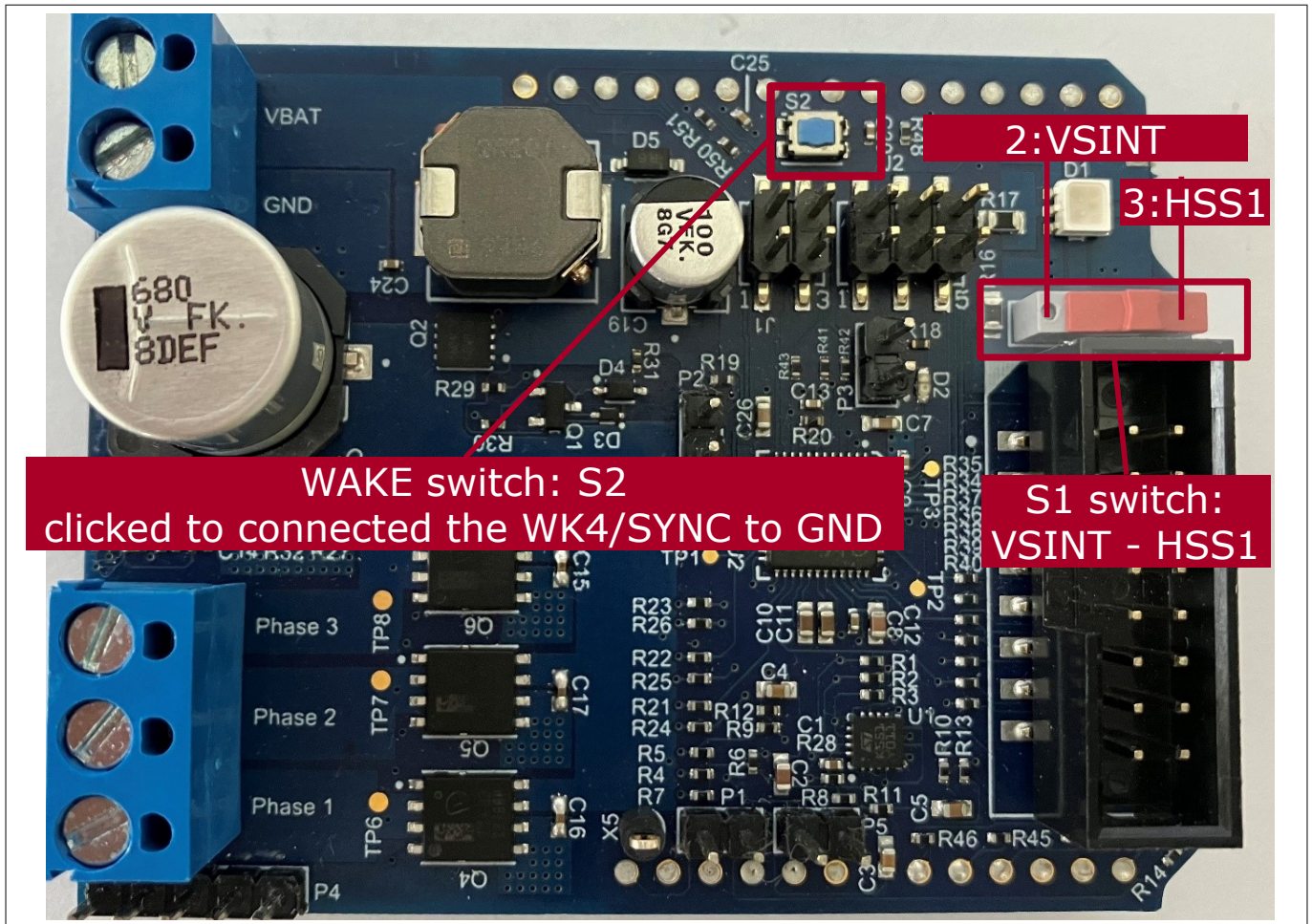


Figure 7 Board switches

Table 3 Switches and positions

Switches	Positions	Description
Wake switch S2	-	Wake the TLE9563-3QX up and exit the sleep mode
Switch S1	Position 2:VSINT	To use the interrupt function properly, ensure that the switch S1 is in position 2:VSINT. Otherwise the interrupt is bound to the <i>pulse-width modulation (PWM)</i> of HSS1 (HS1) and called periodically, if this HSS1 (HS1) is used.
	Position 3:HSS1	To use the cyclic sense feature set the switch S1 to position 3:HSS1 (HS1). One of the high-side drivers is switched on periodically and supplies some external circuits connected to the WK inputs (for more details refer to sub-chapter 5.7.1 of the datasheet).

2 Hardware description

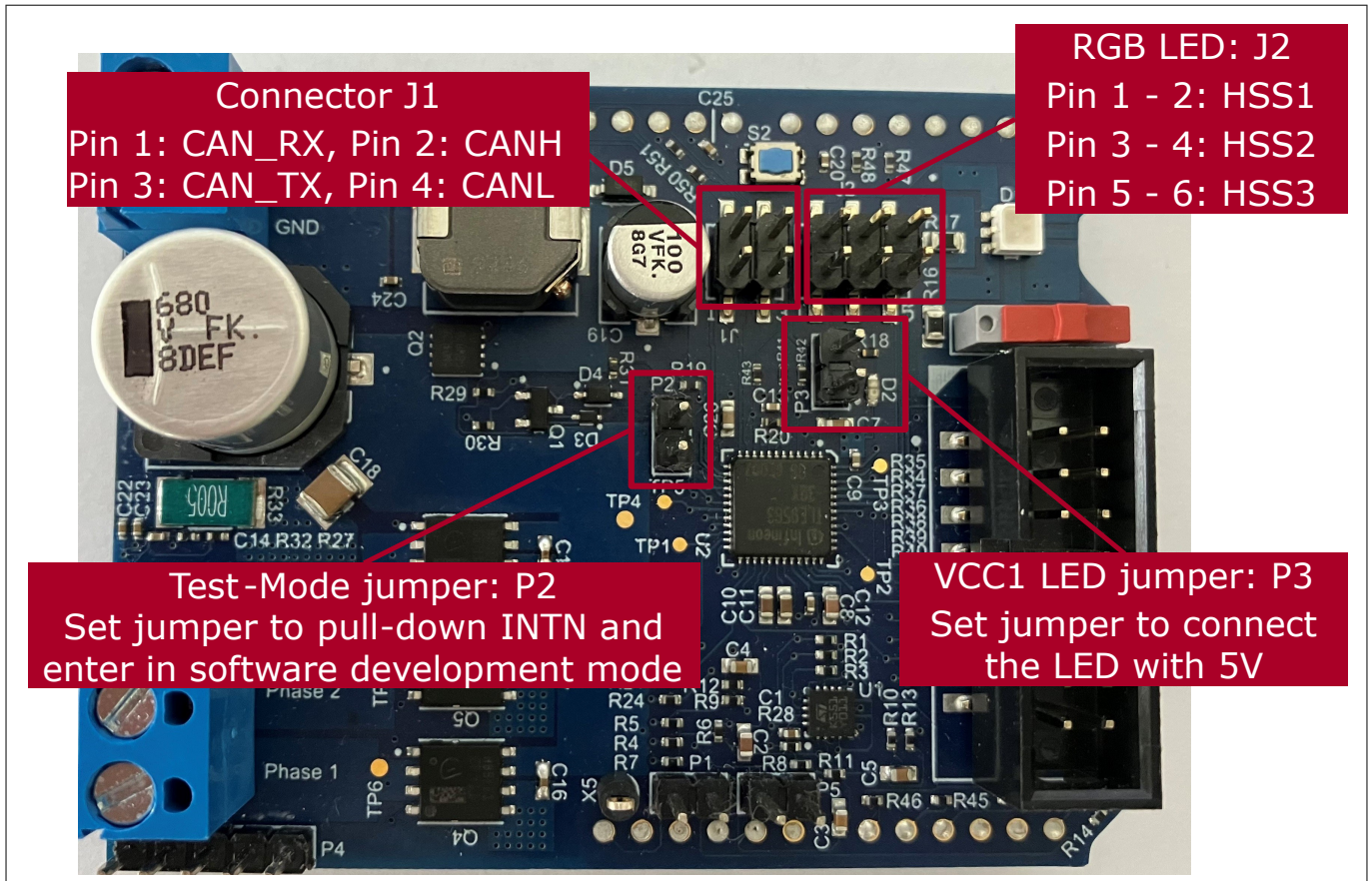


Figure 8 TLE9563 jumpers overview

Note: The software development mode is a dedicated SBC (system basis chip) configuration, which is useful for software development. To enter in this mode, the jumper P2 has to be set. In software development mode the watchdog is enabled, but will not trigger the transition to fail-safe mode or restart mode.

2 Hardware description

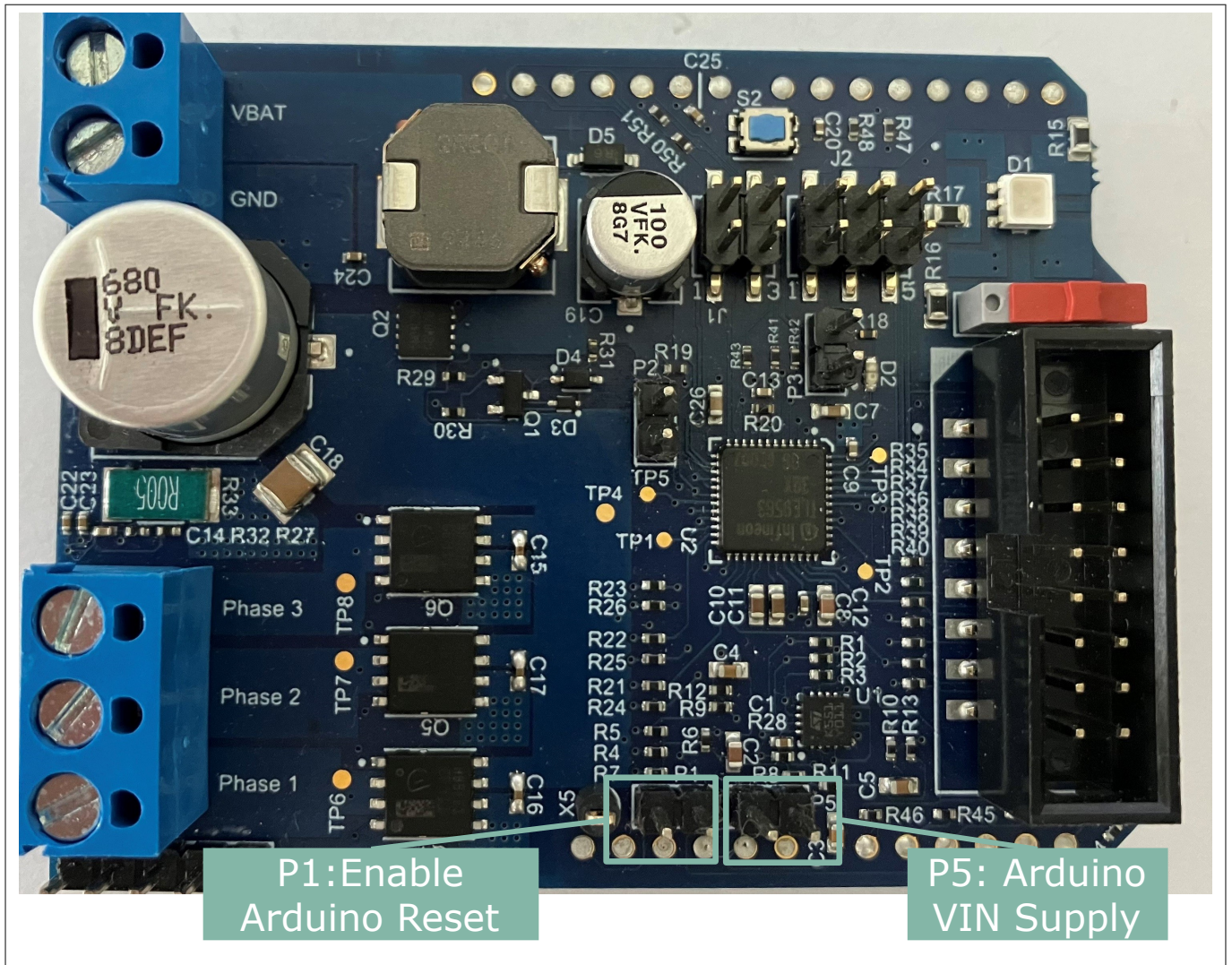


Figure 9 Arduino jumpers

Set the jumper P5 to connect VIN of Arduino with the 5 V regulator (VCC1) on the TLE9563 shield. For the Arduino jumper settings refer to [Jumper settings](#)

2 Hardware description

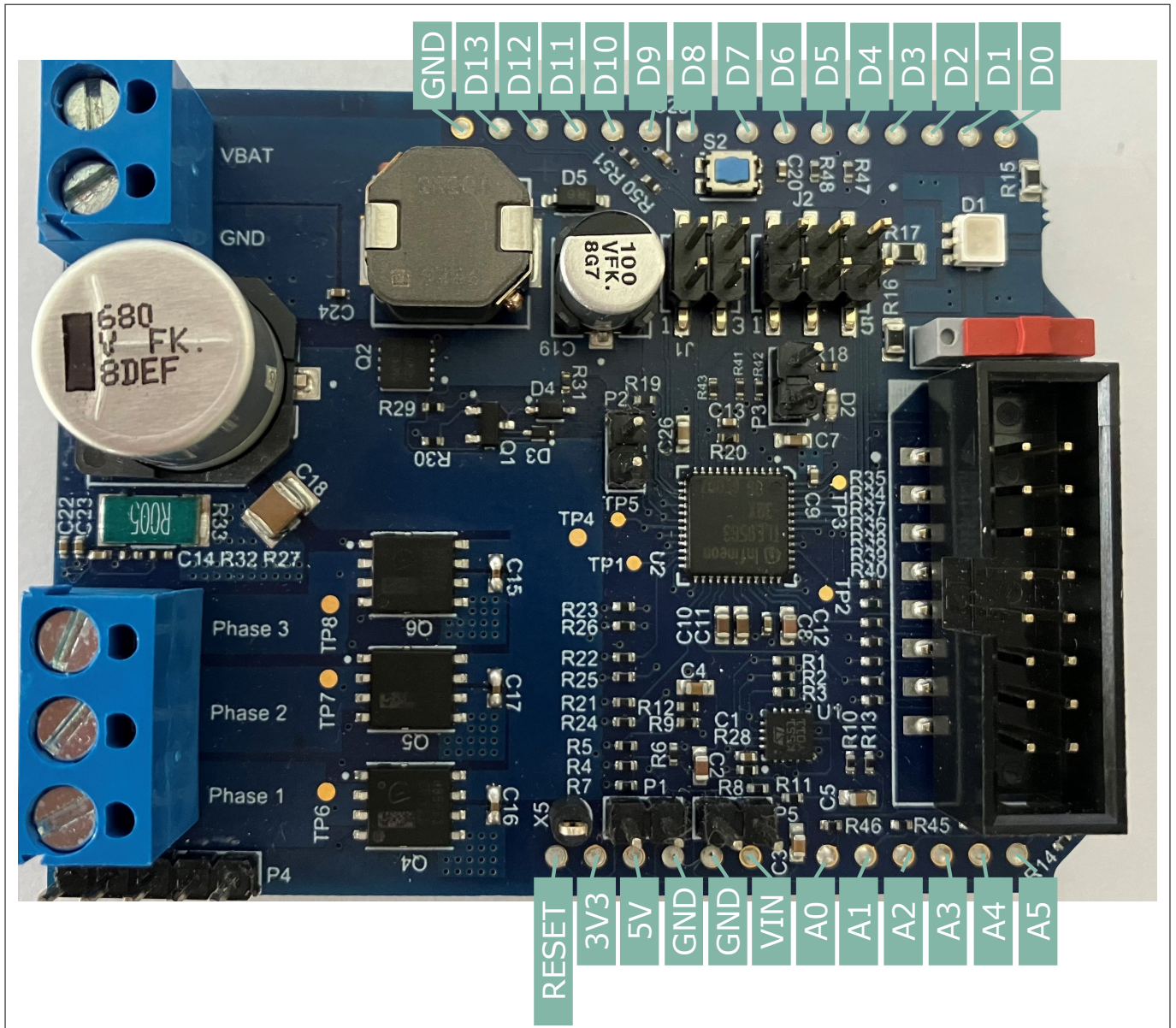


Figure 10 Arduino connectors
For the Arduino pins details refer to [Pin description](#).

2 Hardware description

2.2 Board design

2.2.1 Schematics

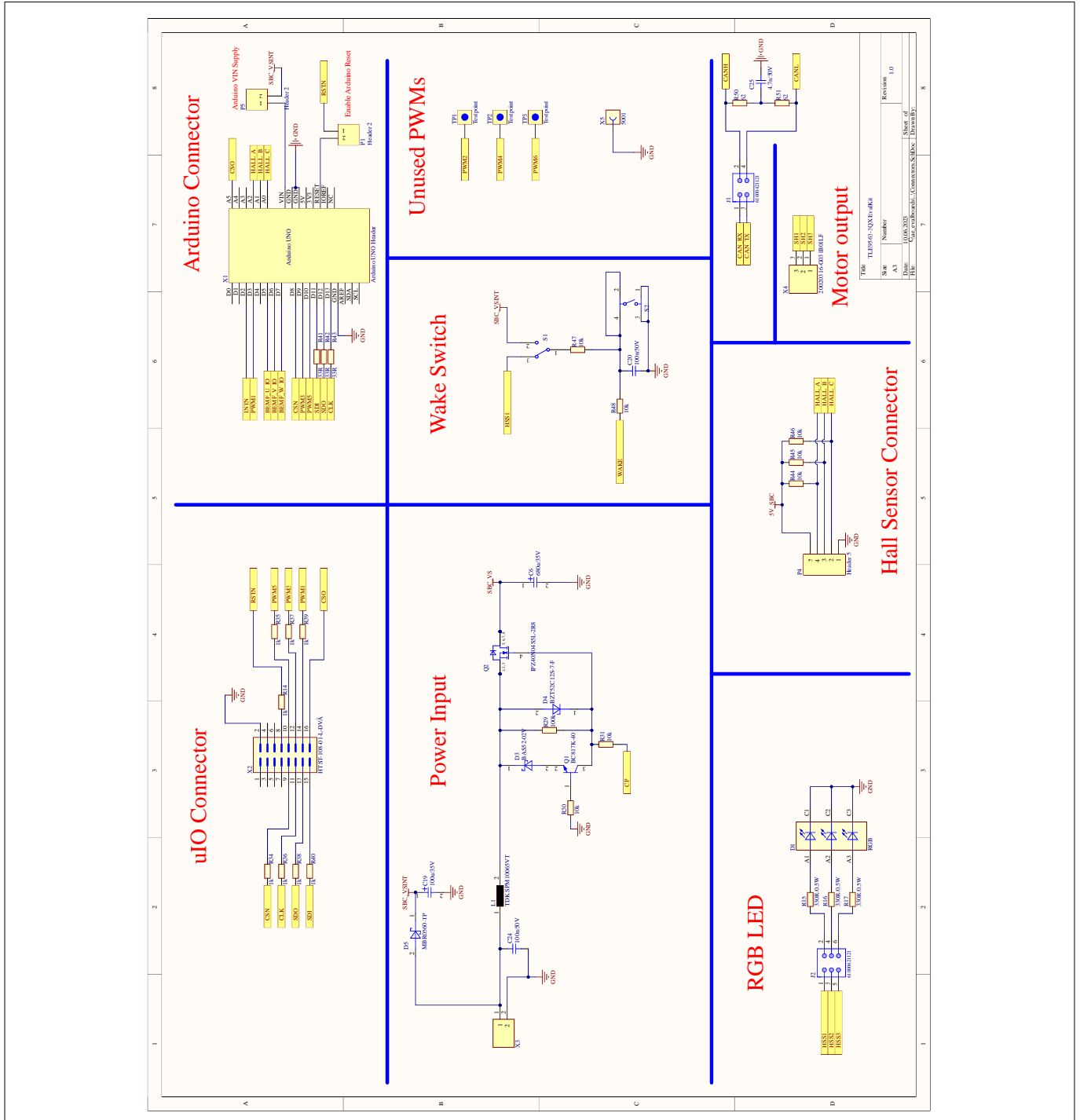


Figure 11 Schematic 1/4

2 Hardware description

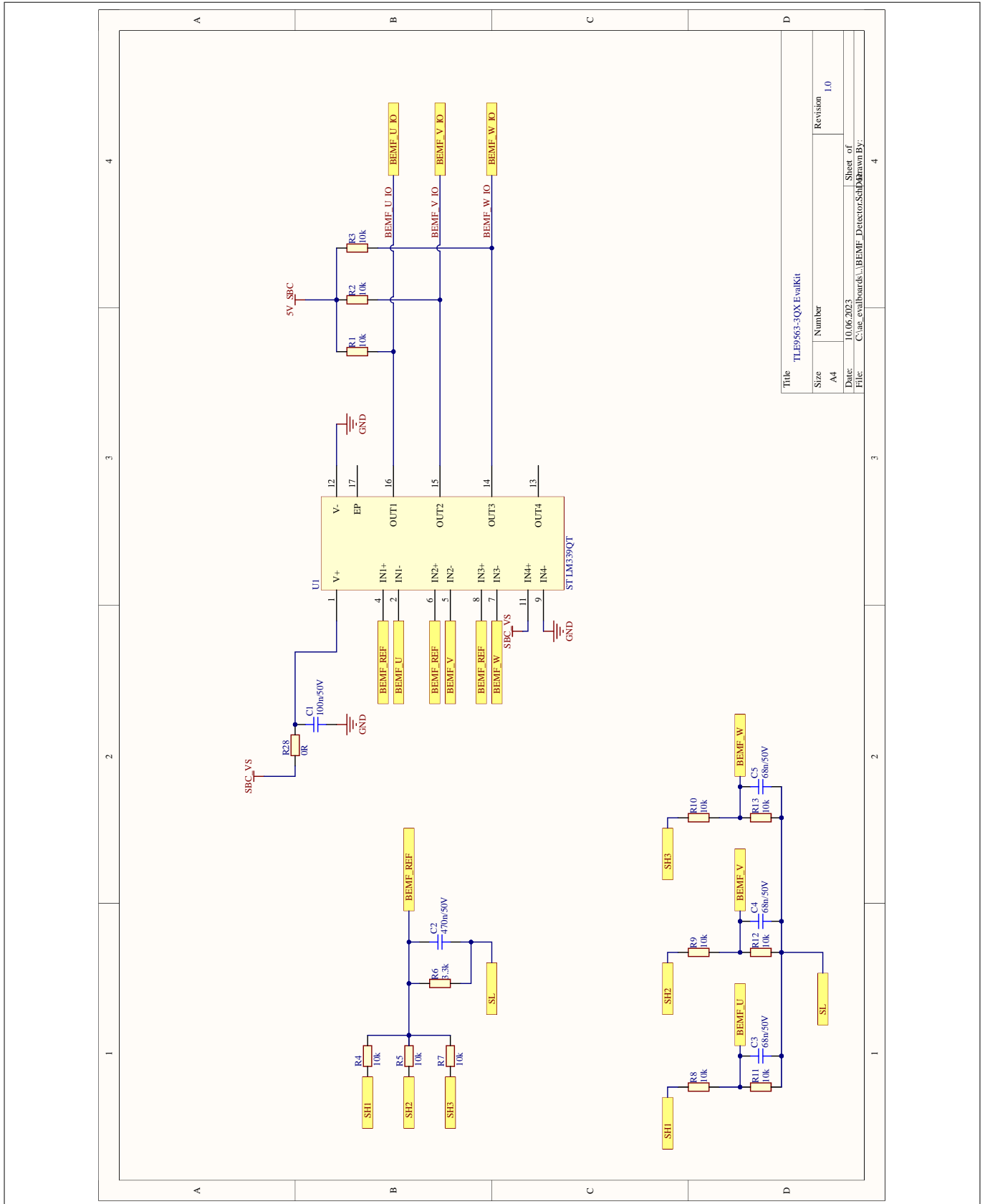


Figure 13 Schematic 3/4

2 Hardware description

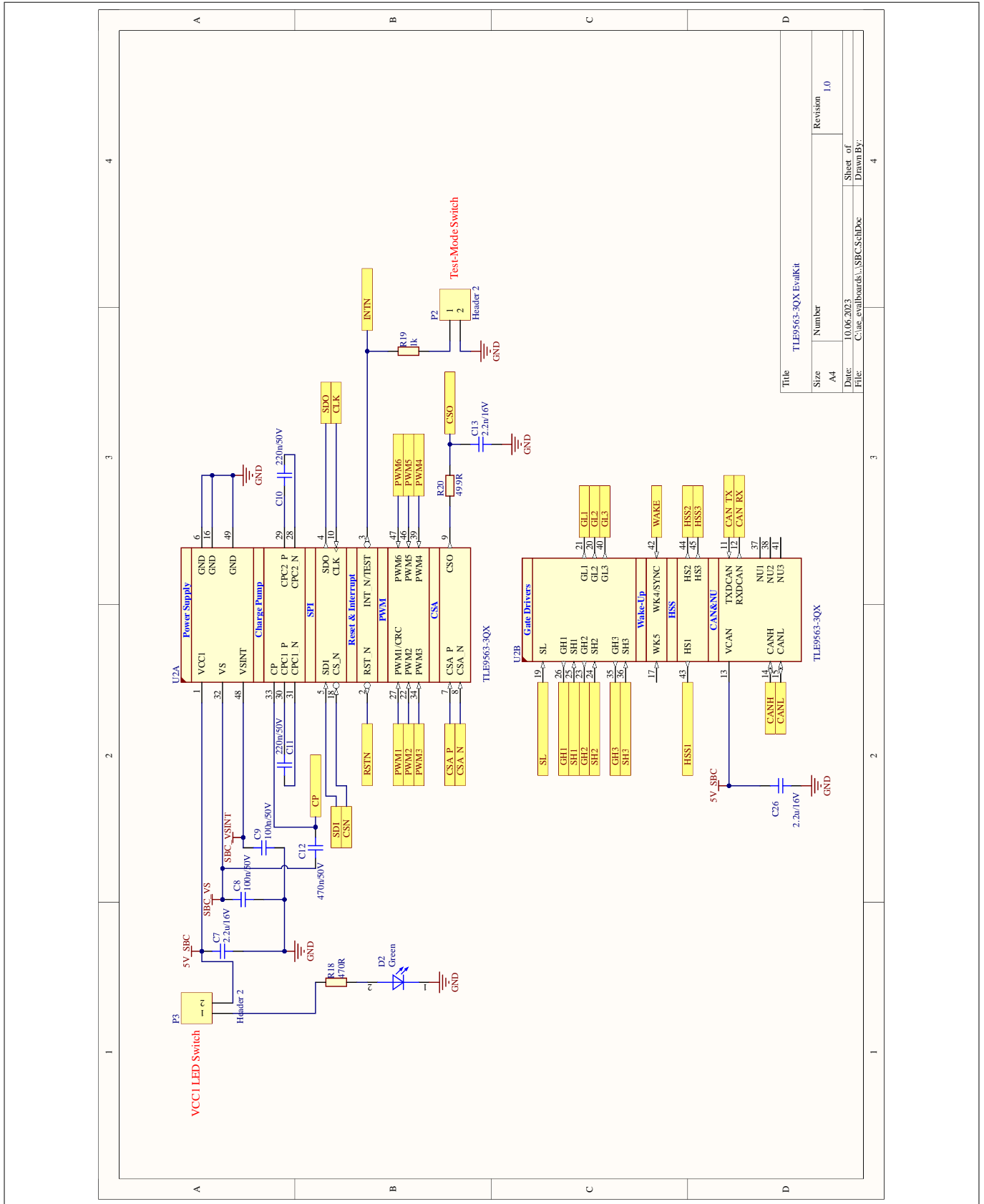


Figure 14 Schematic 4/4

2 Hardware description

2.2.2 Layout

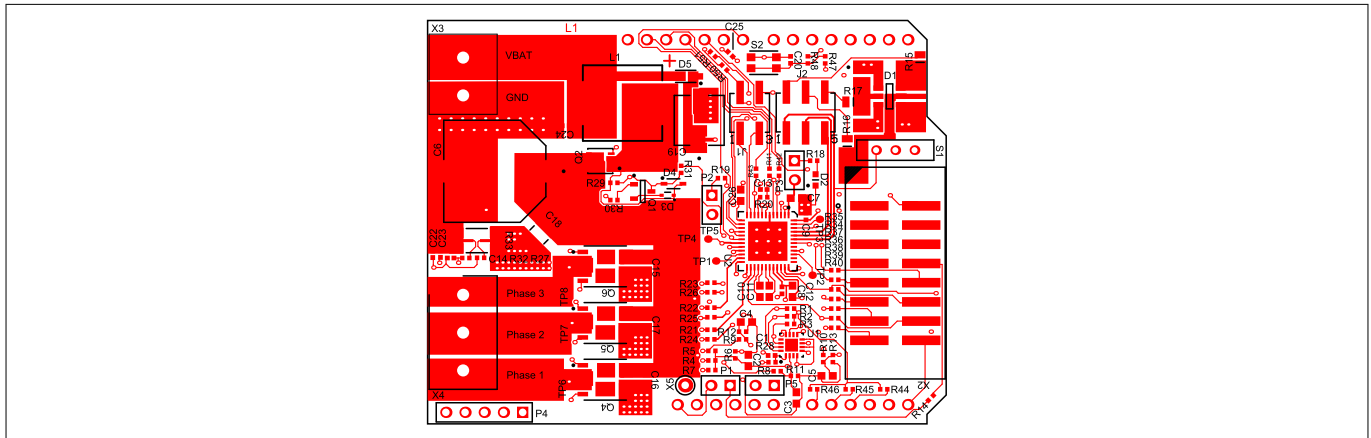


Figure 15 Top layer with overlay

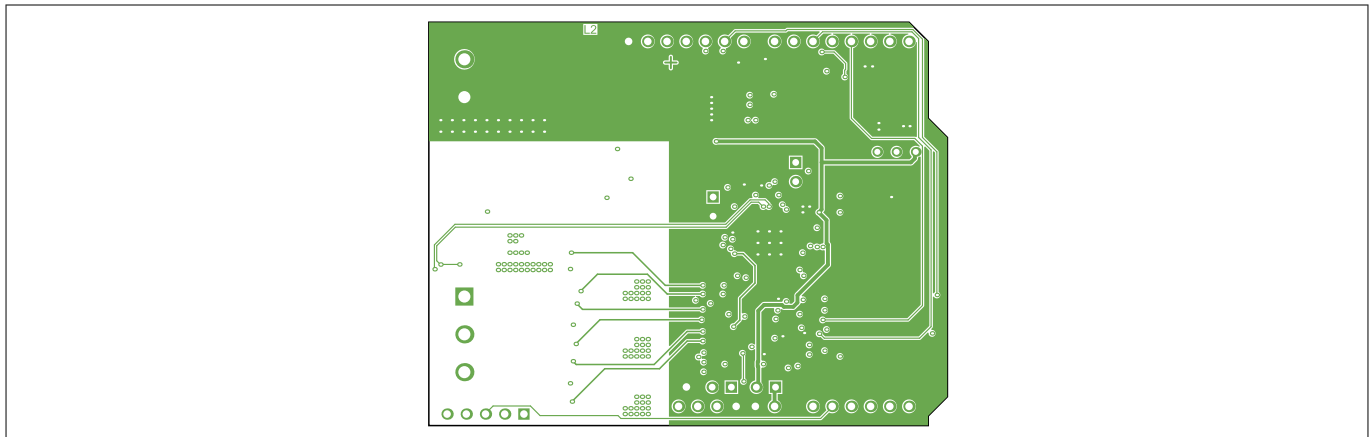


Figure 16 Inner layer 1

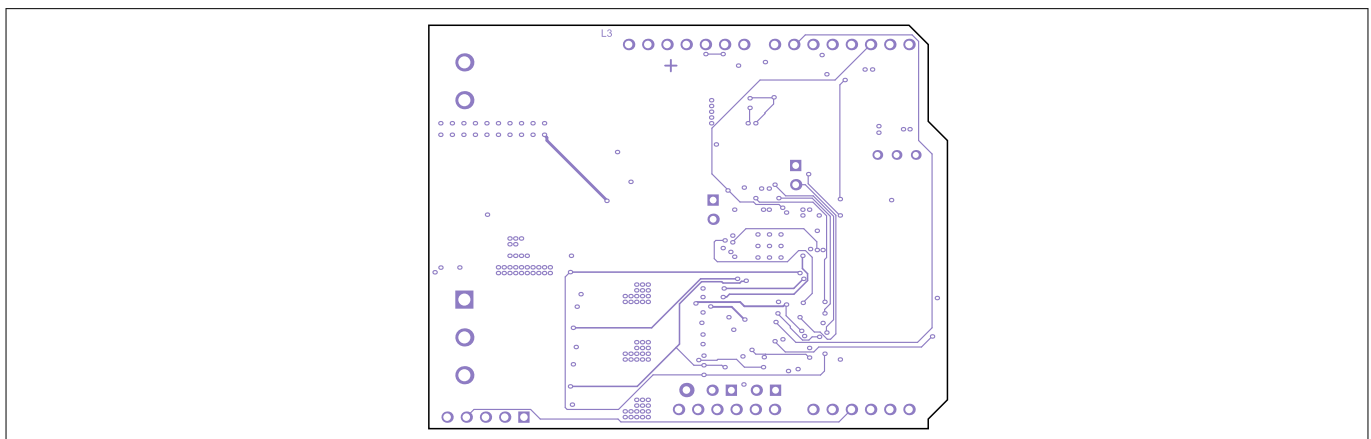


Figure 17 Inner layer 2

2 Hardware description

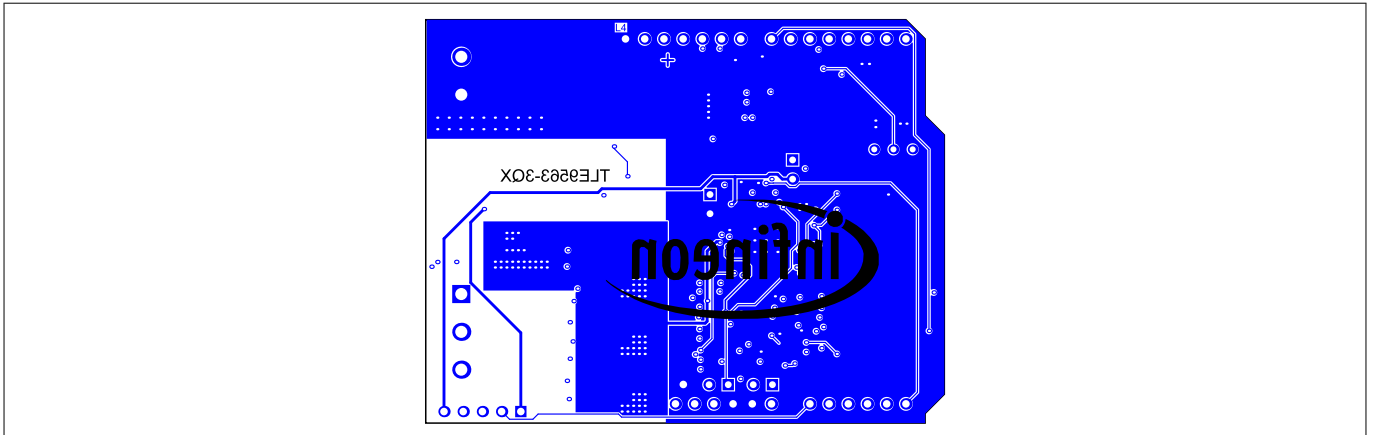


Figure 18 **Bottom layer with overlay**

2 Hardware description

2.2.3 Bill of material

Designator	Value	Qty	Description	Footprint	Manufacturer
C1, C8, C9, C20, C24	100nF/50V	5	Chip Multilayer Ceramic Capacitor for General Purpose	CAPC1005X60N	TDK Corporation
C2, C12	470nF/50V	2	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1708X95N	TDK Corporation
C3, C4, C5	68nF/50V	3	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1708X95N	TDK Corporation
C6	680uF/35V	1	Aluminum Electrolytic Capacitors	CAPAE1350X1400N	Panasonic
C7, C26	2.2uF/16V	2	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1708X95N	TDK Corporation
C10, C11	220nF/50V	2	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1708X95N	TDK Corporation
C13	2.2nF/16V	1	Chip Monolithic Ceramic Capacitor	CAPC1005X55N-0	MuRata
C14	1.5nF/16V	1	Chip Monolithic Ceramic Capacitor	CAPC1005X55N-0	MuRata
C15, C16, C17	100nF/50V	3	Surface Mount Ceramic Capacitor Automotive Grade	CAPC1608X90N	AVX
C18	10uF/50V	1	Surface Mount Ceramic Capacitor, Commercial Grade, 10 uF	CAPC3526X630N	Kemet
C19	100uF/35V	1	Surface Mount Aluminium Electrolytic Capacitor	CAPAE660X800N-2	Panasonic
C22, C23	22nF/16V	2	Chip Monolithic Ceramic Capacitor	CAPC1005X55N-0	MuRata
C25	4.7nF/50V	1	Chip Multilayer Ceramic Capacitor for General Purpose	CAPC1005X60N	TDK Corporation
D1	RGB	1	MULTILED, wavelength-625nm (red), 528nm (true green), 460nm (blue)	SOJ110P340X200-6 N-2-V	OSRAM Opto Semiconductors

2 Hardware description

Designator	Value	Qty	Description	Footprint	Manufacturer
D2	Green	1	Surface Mount LED, Green, 570nm	LED-SMD-LG L29K-XXXX-24	OSRAM Opto Semiconductors
D3	BAS52-02V	1	Silicon Schottky Diode	SODFL1608X59N	Infineon Technologies
D4	BZT52C12S-7-F	1	Surface Mount Zener Diode	SOD2513X120N	Diodes Incorporated
D5	MBR0560-TP	1	Schottky Rectifier, 0.5A/60V	SOD3716X135N-2	Micro Commercial Components
J1	61000421121	1	SMT Vertical Pin Header WR-PHD, Pitch 2.54 mm, Dual Row, 4 pins	61000421121	
J2	61000621121	1	SMT Vertical Pin Header WR-PHD, Pitch 2.54 mm, Dual Row, 6 pins	61000621121	
L1	1.5uH	1	SPM10065VT	SPM10065VT	TDK Corporation
P1, P2, P3, P5	Header 2	4	Header, 2-Pin	HDR1X2	
P4	Header 5	1	Header, 5-Pin	HDR1X5	
Q1	BC817K-40	1	NPN Silicon AF Transistor	SOT95P240X110-3N-1	NXP
Q2	IPZ40N04S5L-2 R8	1	OptiMOS-5 N-Channel Enhancement Mode Power-Transistor, VDS 40V, ID 40A	TSDSON-8-33-V	Infineon Technologies
Q4, Q5, Q6	IAUC60N04S6N 031H	3	OptiMOS-6 N-Channel	PG-TSON-8-56	Infineon Technologies
R1, R2, R3, R4, R5, R7, R8, R9, R10, R11, R12, R13, R30, R31, R44, R45, R46, R47, R48	10k	19	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R6	3.3k	1	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R14, R19, R34, R35, R36, R37, R38, R39, R40	1k	9	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R15, R16, R17	330R/0.5W	3	Standard Thick Film Chip Resistor	RESC2113X50N	Vishay
R18	470R	1	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R20	49.9R	1	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R21, R22, R23, R24, R25, R26	10R	6	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay

2 Hardware description

Designator	Value	Qty	Description	Footprint	Manufacturer
R27, R32	4.7R	2	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R28	0R	1	0R/50V	RESC1005X40N	Panasonic
R29	100k	1	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R33	5mR/2W	1	0.005R/2W/1%	RESC6432X85N_4p	KOA
R41, R42, R43	33R	3	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R50, R51	62	2	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
S1	450301014042	1	10x2.5mm THT WS-SLTV	450301014042	
S2	434153017835	1	3.5x2.9mm SMD J-Bend WS-TASV, height 1.7 mm, 350 gf	434153017835	
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	Testpoint	8		Testpoint	
U1	ST LM339QT	1	COMPARATOR 4 GEN PUR 16QFN	QFN 16 3x3	STMicroelectronics
U2	TLE9563-3QX	1	Bridge SBC Family	VQFN-48	Infineon Technologies
X2	HTST-108-01-L-DVÂ	1	SMT, .025" Shrouded SQ POST IDC Headers , 2.54mm pitch, 16-pin Vertical, Double row	CON-M-SMD-HTST-108-01-L-DV	Samtec
X3	20020316-G021B01LF	1	Connector	20020316G021B01LF	
X4	20020316-G031B01LF	1	Connector	SHDR3W100P0X500_1X3_1500X900X1350	
X5	5001	1	Test Point THT, Black	CON-THT-TP-5001	Keystone Electronics Corp.

3 Getting started

3 Getting started

There are two options to operate the TLE9563 *BLDC* shield:

- Stacked on an Arduino UNO board or compatible
- Config Wizard for MOTIX™ Motor System *integrated circuit (IC)*s with uIO-Stick

3.1 Arduino UNO controller board

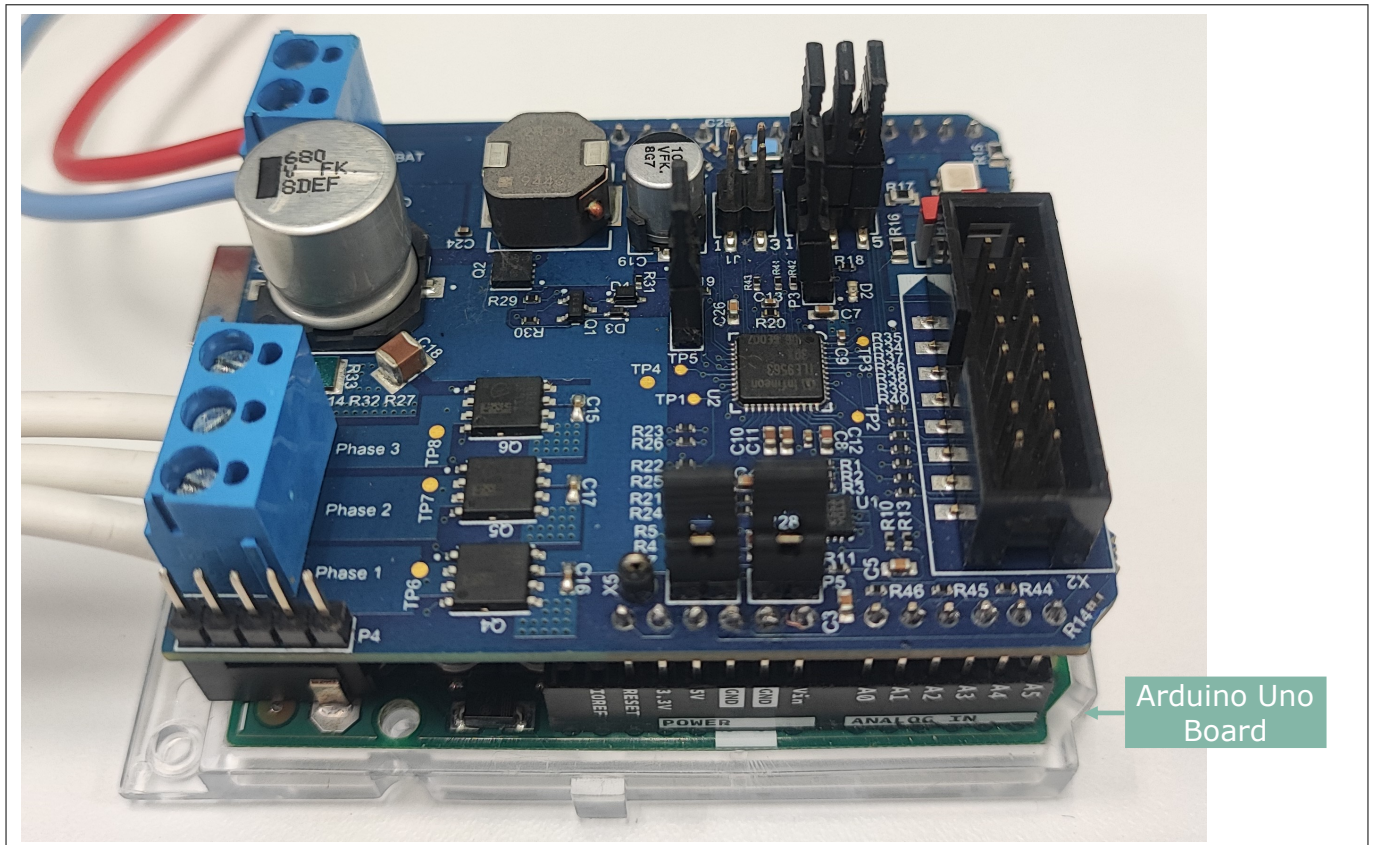


Figure 19 TLE9563 board stacked on an Arduino UNO board

Infineon offers the TLE9563 device driver to provide an *application programming interface (API)* to configure the devices.

TLE9563 device driver is available here: <https://www.infineon.com/cms/en/product/power/motor-control-ics/bldc-motor-control-ics/bldc-motor-system-ics/tle9563-3qx/>

Example codes to operate with an Arduino UNO board are available here: <https://github.com/Infineon/motor-system-ic-tle956x>

Before using the *BLDC* shield with an Arduino, refer to [Arduino getting started](#) for further information.

3 Getting started

3.2 Config Wizard for MOTIX™ Motor System ICs with the uIO-Stick

The Config Wizard for MOTIX™ Motor System ICs is a software tool running on a PC or laptop and providing a [GUI](#) to control the TLE9563-3QX on the board.

To interface the boards to the [USB](#) port of the PC or laptop an uIO-Stick is necessary.

3.2.1 Download the graphical user interface for the uIO-Stick

Config Wizard for MOTIX™ Motor System ICs allows easy configuration of Automotive Motor System IC products. The [GUI](#) can be installed from the Infineon development center following the steps below:

1. Go to [Infineon Developer Center Launcher](#)
2. Follow the instructions provided on the launcher web page
3. Launch the **Infineon Developer Center Launcher** on your computer
4. Select **Manage Tools**
5. Search and install **Config Wizard for MOTIX™ Motor System ICs**
6. After the installation click **Start** on the launch tool

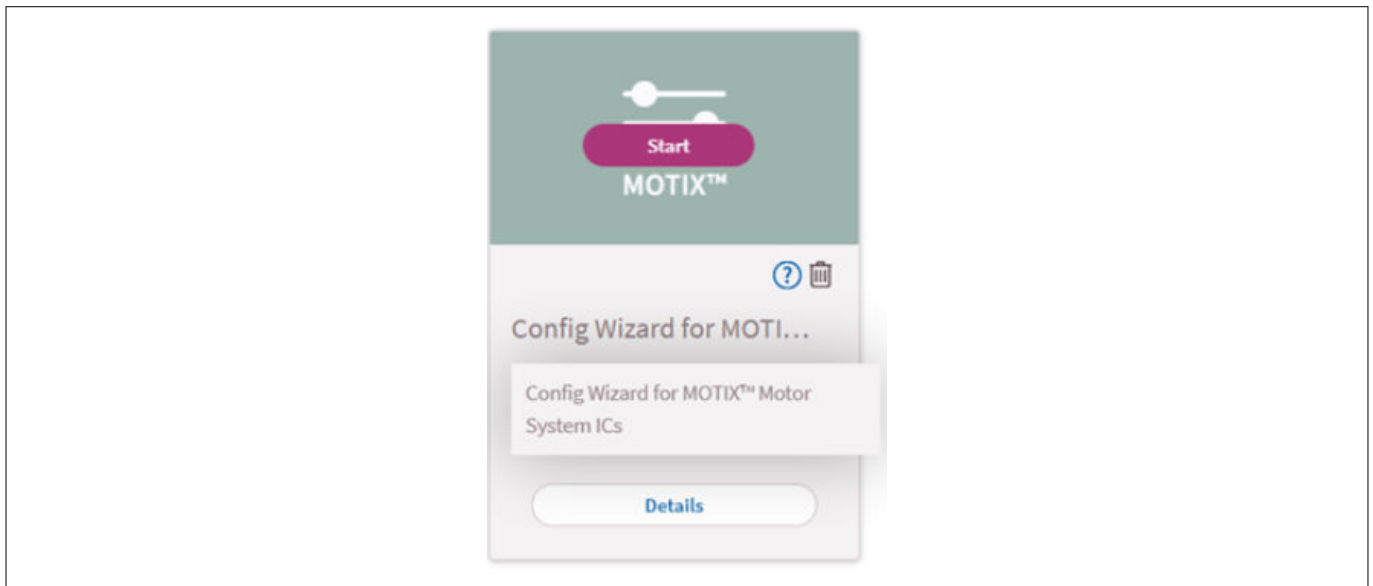


Figure 20 Starting the Config Wizard for MOTIX™ Motor System ICs

7. Click on the **TLE9563 SHIELD**

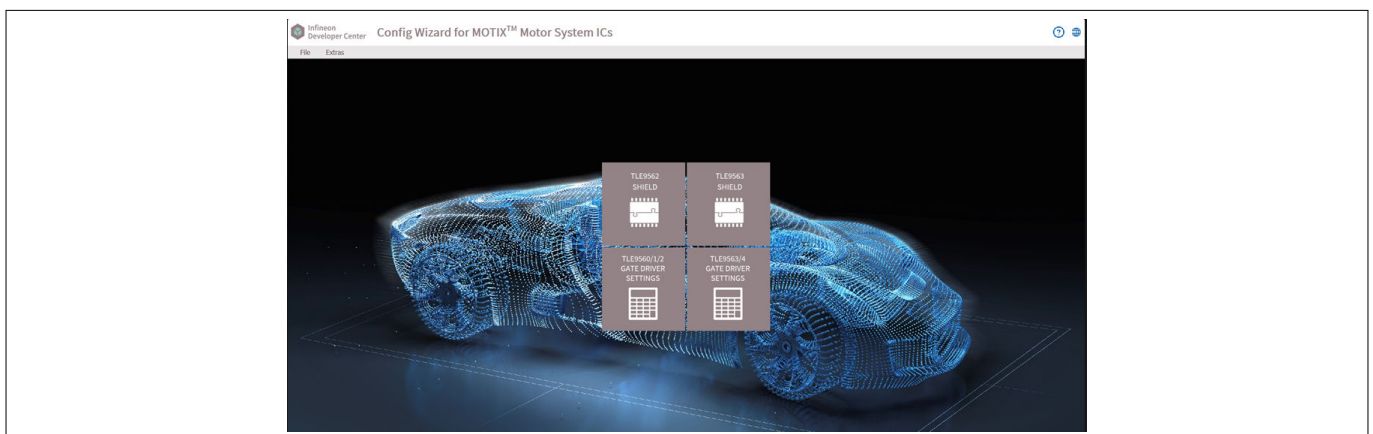


Figure 21 TLE9563 SHIELD selection

3 Getting started

3.2.2 Start the configuration Wizard for TLE9563-3QX

The uIO-Stick requires to be programmed when used for the first in combination with the Config Wizard to control the TLE9563-3QX.

To program the uIO-Stick and get started with the Config Wizard follow the steps listed below:

1. Set the Jumper P2 to pull down the INT/TEST pin and enable the device to enter in software development mode
2. Set the Jumper P3 to connect the LED to the LDO VCC1 (5 V regulator)
3. Connect the uIO-Stick to the *USB* port
4. Supply the board connecting the *voltage supply (VS)*
5. Start the **Config Wizard for Motor System IC**
6. Select the tab **Extras**
7. Select **Update uIO**

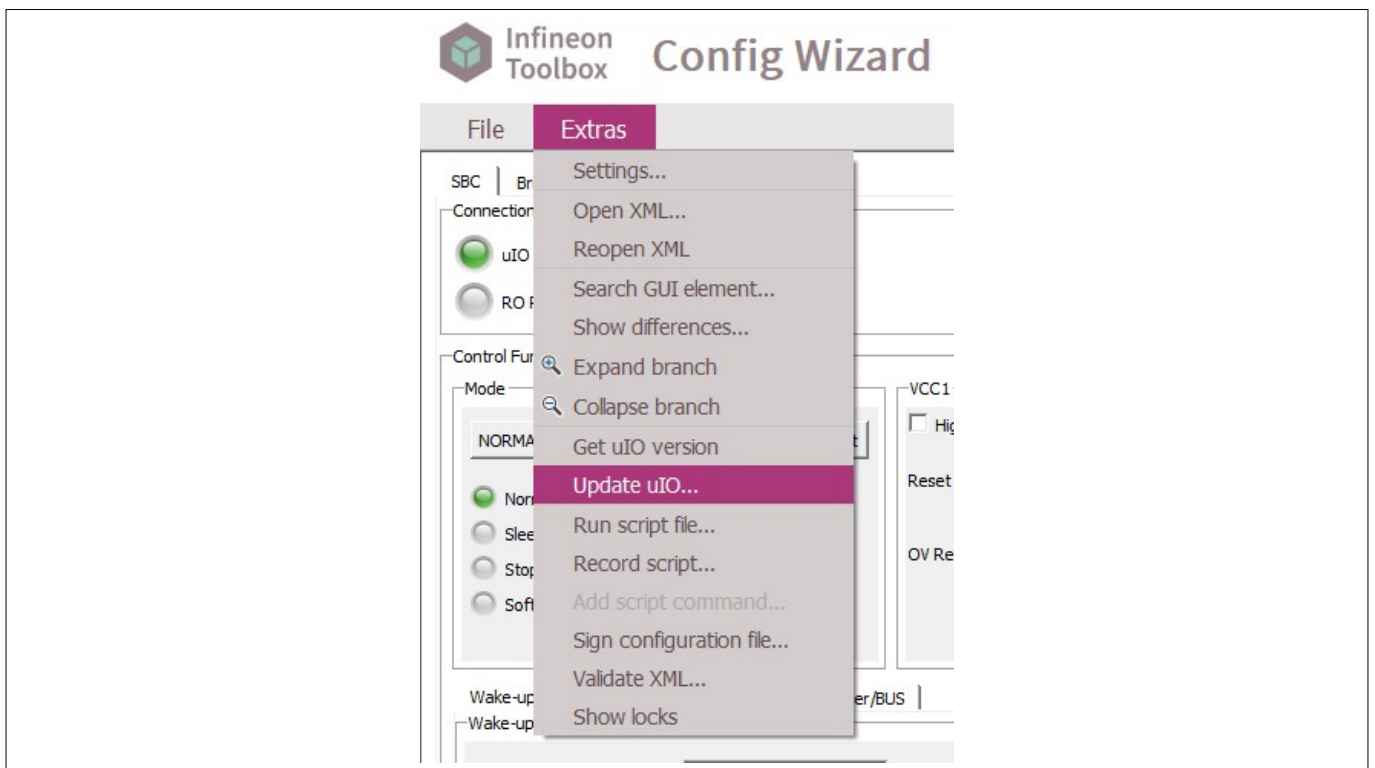


Figure 22 Update uIO

8. Click **Yes**

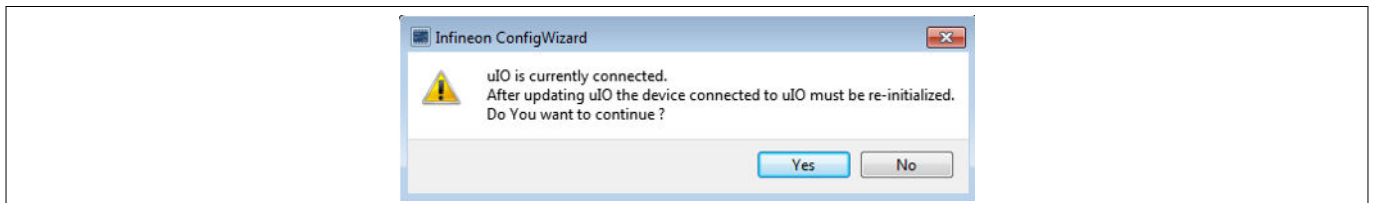


Figure 23 Pop-up window

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

4 Config Wizard for MOTIX™ Motor System ICs - control tab pages

4 Config Wizard for MOTIX™ Motor System ICs - control tab pages

4.1 SBC tab page

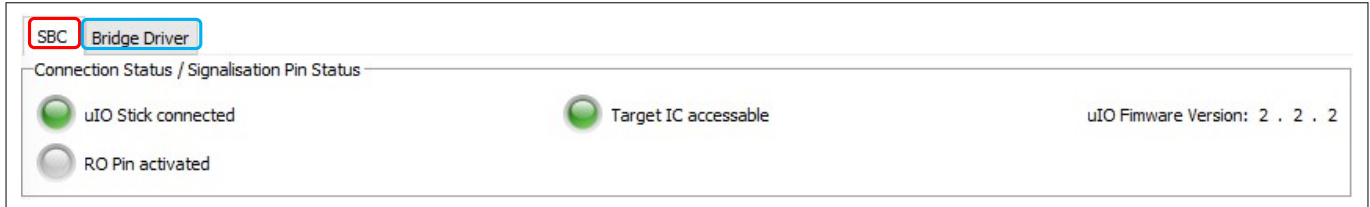


Figure 24 Two main tabs: SBC, Bridge Driver

Table 4 Legend

Color	Description
	SBC (system basic chip): Overview (selected in this view)
	Bridge Diver

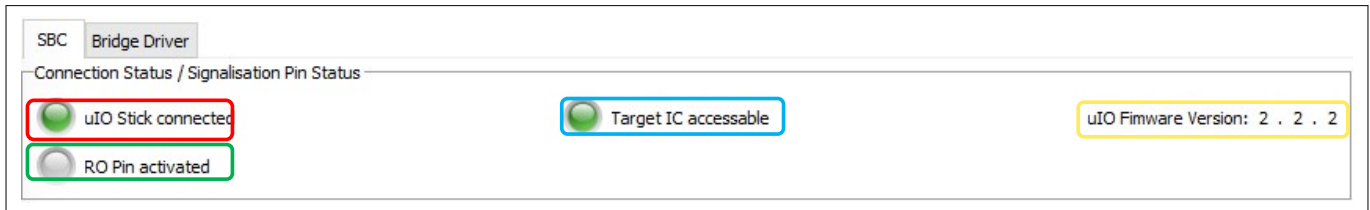


Figure 25 Connection Status, Signaling Pin Status

Table 5 Legend

Color	Status indicator	Description
	uIO stick connected	Communication between the uIO-Stick and the TLE9563QX/TLE9563QXV33 is connected and is working
	Target <i>IC</i> accessible	-
	uIO Firmware version	Firmware version of the connected uIO
	RO Pin activated	-

4 Config Wizard for MOTIX™ Motor System ICs - control tab pages

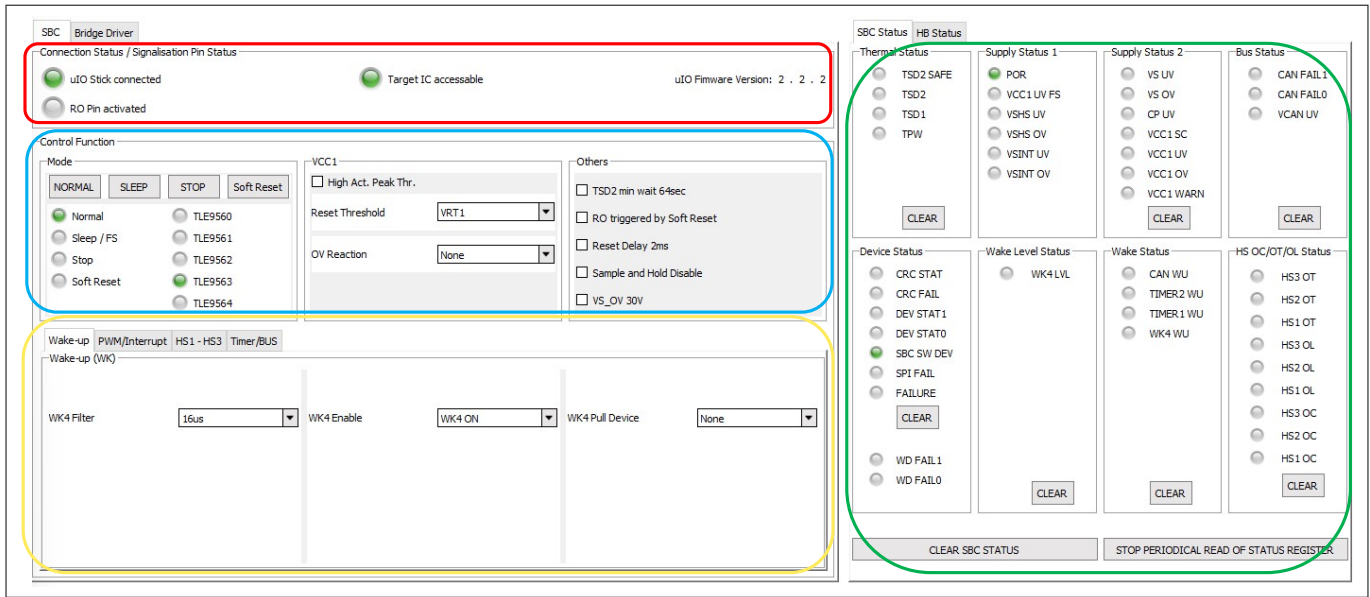


Figure 26 GUI – SBC overview

Table 6 Legend

Color	Description
	Connection status/Signaling pin status
	Control function
	Available tabs: <ul style="list-style-type: none"> Wake-up (WK) PWM/Interrupt HS1-HS3 Timer/BUS
	SBC (system basis chip) Status

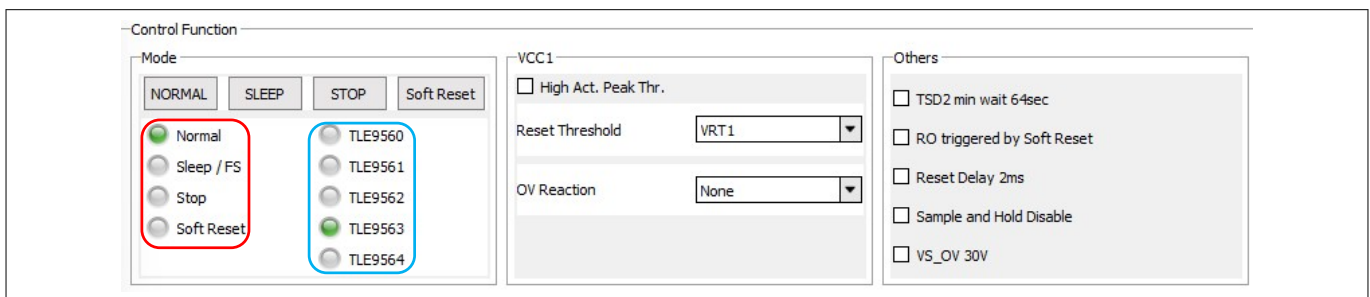


Figure 27 SBC: Control function

Table 7 Legend

Color	Description
	Mode, for example Sleep/Fs → Normal , check uIO connection and click on NORMAL
	Product identifier

4 Config Wizard for MOTIX™ Motor System ICs - control tab pages

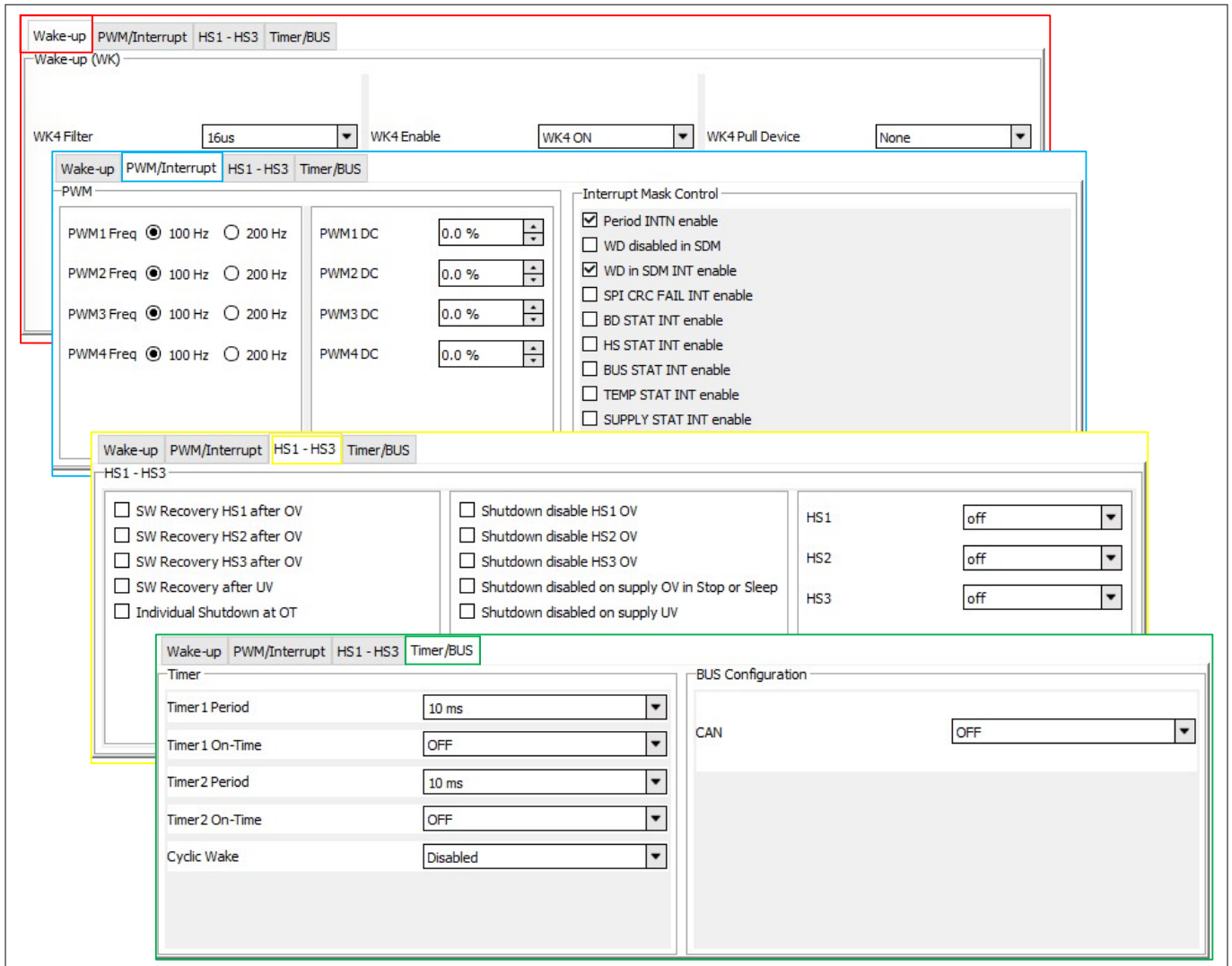


Figure 28 SBC: Wake-up, PWM/Interrupt, HS1-HS3, Timer/BUS

Table 8 Legend

Color	Description
	Wake-up
	PWM/Interrupt
	HS1 – HS3
	Timer/BUS

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Figure 29 SBC status

Table 9 Legend

Color	Description
	Thermal Status
	Supply Status 1
	Supply Status 3
	Bus Status
	Device Status
	Wake Level Status
	Wake Status
	HS OC/OT/OL Status
	Clear SBC Status

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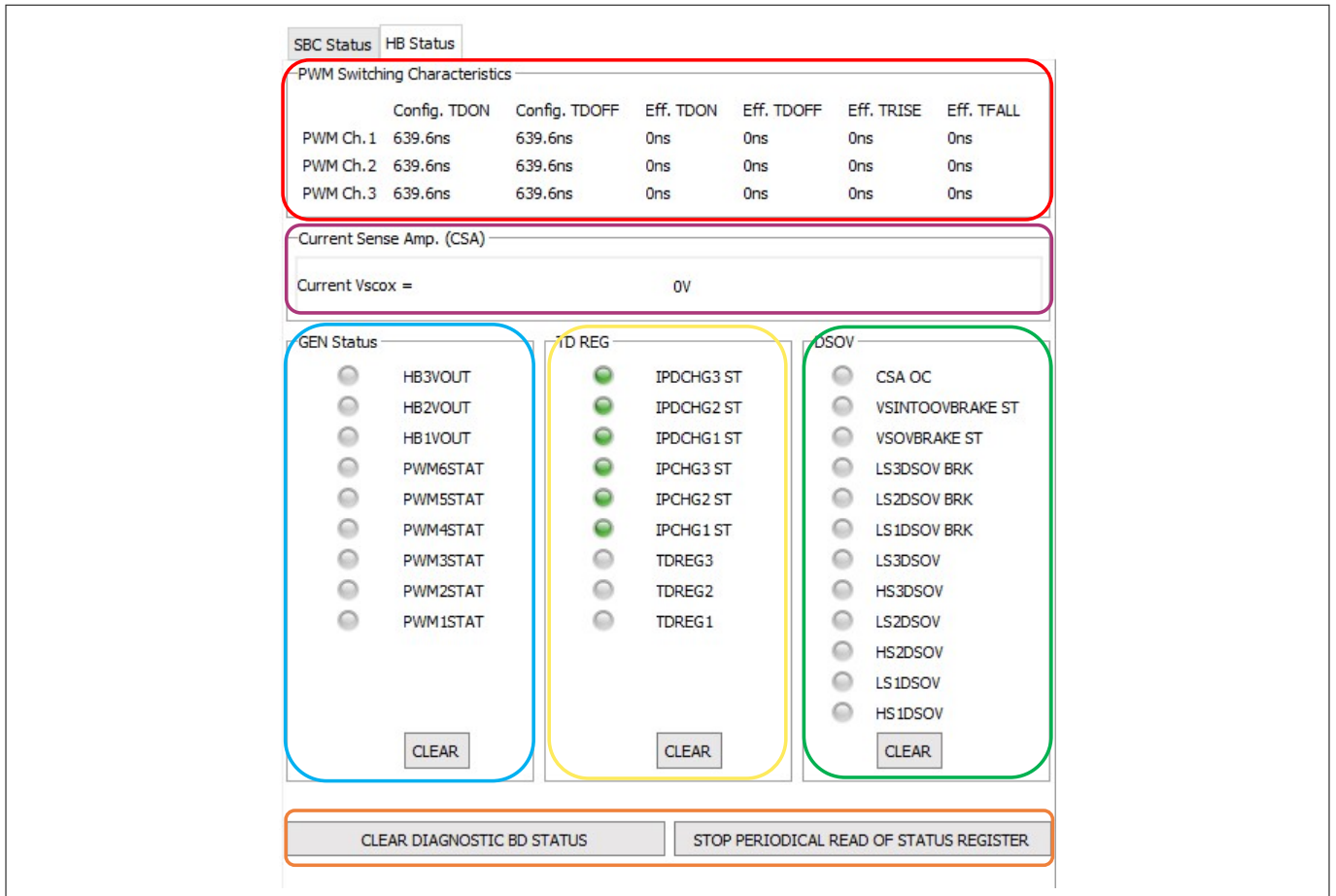


Figure 30 **Half-Bridge (HB) Status**

Table 10 **Legend**

Color	Description
	PWM Switching Characteristics
	GEN Status
	TD REG
	DSOV
	Clear Diagnostic Bridge Driver (BD) Status
	<i>current-sense amplifier (CSA)</i>

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4.2 Bridge driver tab page

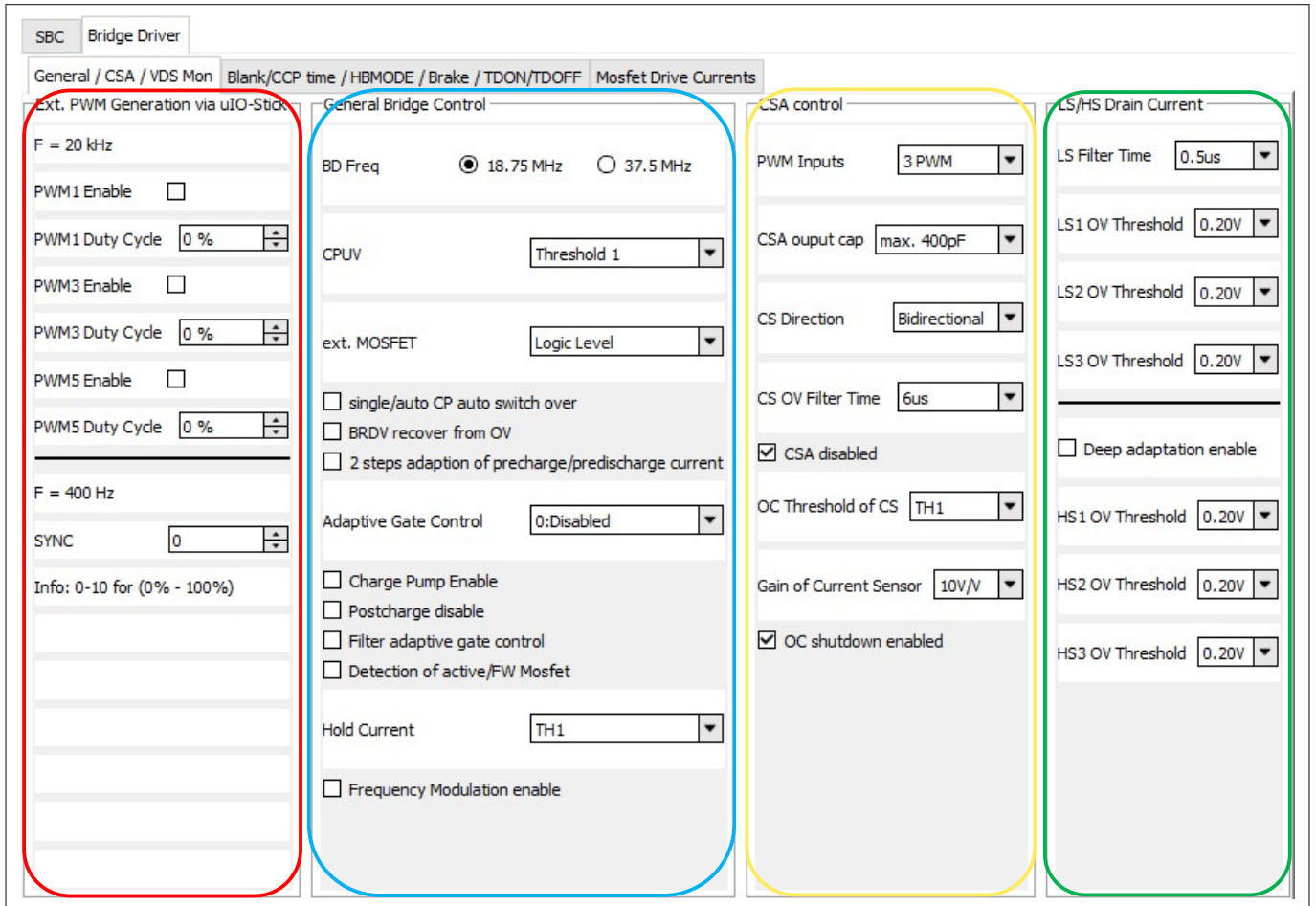






Figure 31 Bridge driver: General, CSA, VDS monitoring

Table 11 Legend

Color	Description
	On-Board <i>PWM</i> Generator
	General Bridge Control
	<i>CSA</i> Control
	LS/HS Drain Current

4 Config Wizard for MOTIX™ Motor System ICs - control tab pages

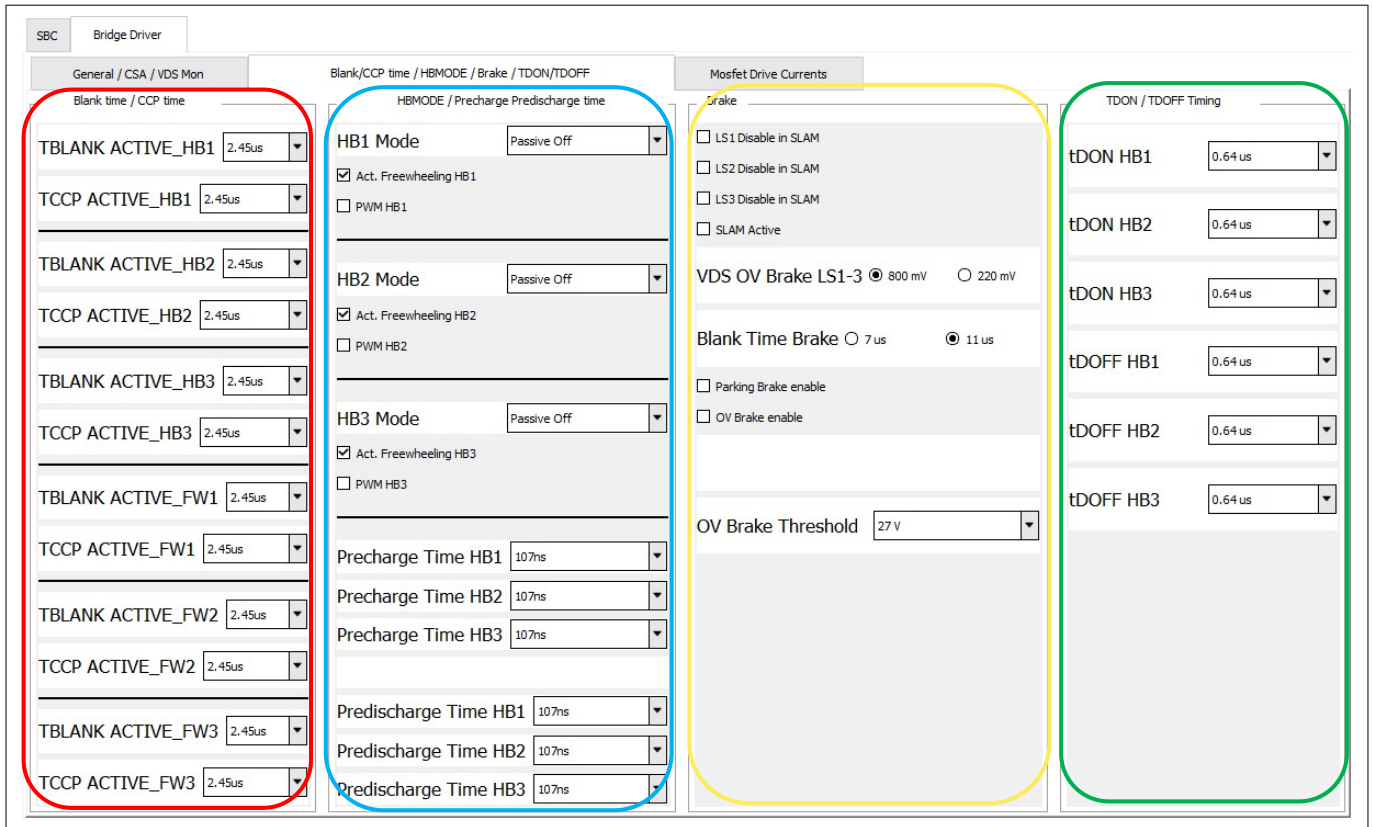






Figure 32 Blank/CCP time, HBMODE, Brake, TDON/TDOFF timing

Table 12 Legend

Color	Description
	Blank time/CCP time
	HBMODE/Pre-charge time; Pre-discharge time
	Brake
	TDON timing/TDOFF timing

4 Config Wizard for MOTIX™ Motor System ICs - control tab pages

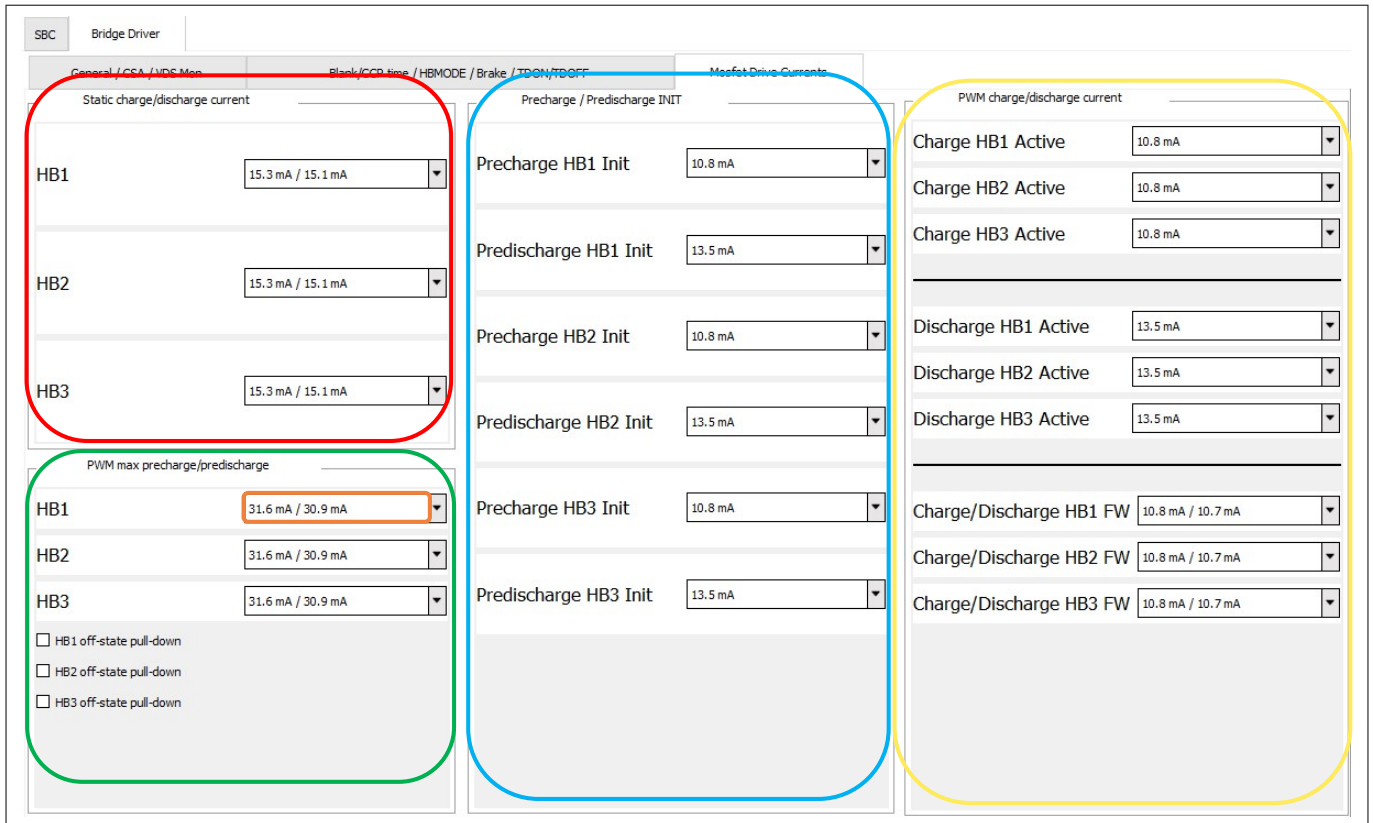







Figure 33 MOSFET Drive currents

Table 13 Legend

Color	Description
	Static charge current/static discharge current
	Pre-charge initial/pre-discharge initial
	PWM charge current/PWM discharge current
	PWM max. Pre-charge/PWM max. Pre-discharge
	32.1 mA: Pre-charge/29.8 mA: Pre-discharge

5 References and appendices

5.1 Glossary

API

application programming interface (API)

BLDC

brushless direct current (BLDC)

CSA

current-sense amplifier (CSA)

Special-purpose amplifiers that output a voltage proportional to the current flowing in a power rail. They utilize a "current-sense resistor" to convert the load current in the power rail to a small voltage, which is then amplified by the current-sense amplifiers.

GUI

graphical user interface (GUI)

A type of interface that allows users to interact with electronic devices via graphical icons and visual indicators.

IC

integrated circuit (IC)

A miniaturized electronic circuit that has been manufactured in the surface of a thin substrate of semiconductor material. An integrated circuit is also referred to as micro-circuit, microchip, silicon chip, or chip.

PWM

pulse-width modulation (PWM)

A technique to encode an analog value into the duty cycle of a pulsing signal with arbitrary amplitude.

SPI

serial peripheral interface (SPI)

A synchronous serial communication interface specification used for inter-chip communication, primarily in embedded systems.

USB

universal serial bus (USB)

An industry standard that defines cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices.

VS

voltage supply (VS)

5.2 References

References

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- [2] Infineon, *IAUC60N04S6N031H datasheet*: <https://www.infineon.com/cms/en/product/power/mosfet/automotive-mosfet/iauc60n04s6n031h/>
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- [4] *Arduino UNO board*: <https://www.arduino.cc/>
- [5] *C++ library for Infineon's motor system IC TLE956x family*: <https://github.com/Infineon/motor-system-ic-tle956x#motor-system-ic-tle956x-library>
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- [8] Infineon, *Multi Motor Evaluation Kit*: <https://www.infineon.com/cms/en/product/evaluation-boards/multi-motor-evalkit/>

Revision history

Document version	Date of release	Description of changes
Rev. 1.10	2023-11-17	<ul style="list-style-type: none">• Important notice and Safety precautions added• Document type corrected from User manual to User guide• Delivery content added• Block diagram added• Main features added• Arduino UNO controller board information added• Schematics and Layout updated• Images updated in SBC tab page and Bridge driver tab page• Glossary added• References added
Rev. 1.00	2020-06-23	<ul style="list-style-type: none">• Initial document release

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