DC Shield TLE9562-3QX

User guide

Z8F80648352

About this document

Scope and purpose

This user guide introduces the brushed *direct current (DC)* shield with the TLE9562-3QX. This document provides detailed information on the content, layout and usage of the board. Use it in conjunction with the TLE9562-3QX datasheet, which contains full technical details on the device specification and operation.

Intended audience

Users who develop applications with the TLE956x family.

Important notice

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Safety precautions

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

Table 1 Safety precautions

	**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.*
	**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.*
	**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.*
	**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.*

Warnings

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1 The board at a glance

The TLE9652-3QX brushed direct current shield is a simple and easy-to-use tool for getting familiar with the device features and for first application tests.

Use the evaluation board either with a 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 TLE9562-3QX.

The TLE9562-3QX *serial peripheral interface (SPI)* communication is emulated by the uIO-Stick, which you can control through the *graphical user interface (GUI)*.

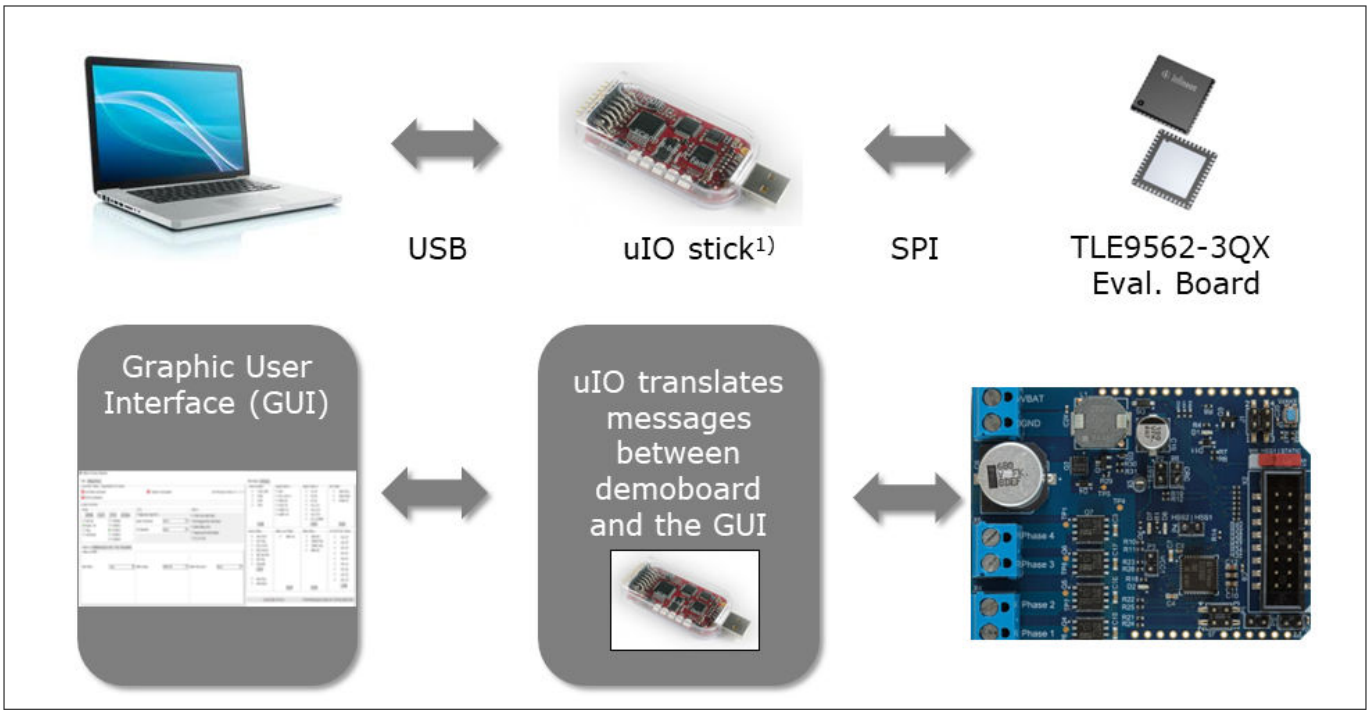

Figure 1 TLE9562-3QX Evaluation board with the uIO-Stick concept

1.1 Delivery content

The cardboard box includes one brushed direct current shield TLE9562-3QX board. The Arduino UNO board and the uIO -Stick are not included and you need to order them 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.

1.2 Block diagram

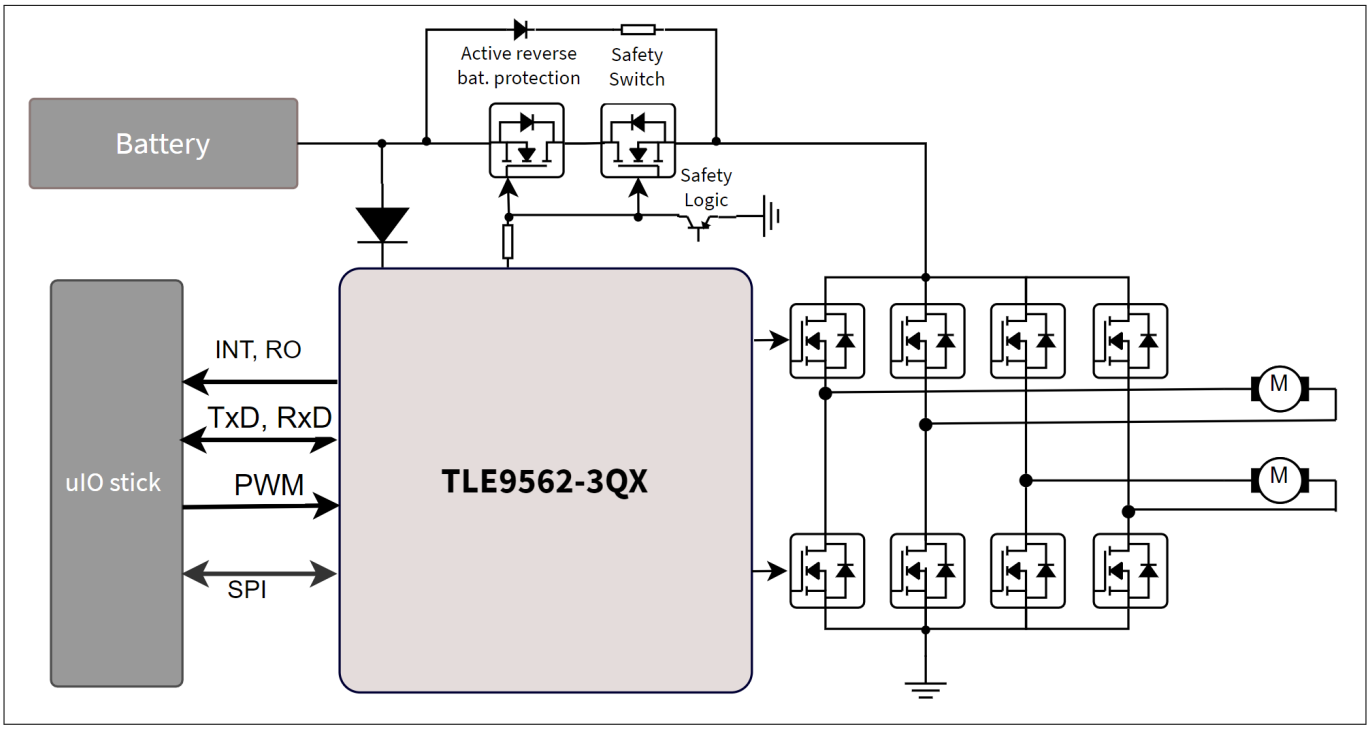

Figure 2 **Application circuit for a bi-directional motor control with the TLE9562-3QX using a uIO-Stick**

***Note**: Using the TLE9562 shield board with a uIO-Stick, you can spin a brushed direct current motor (bi-directional).*

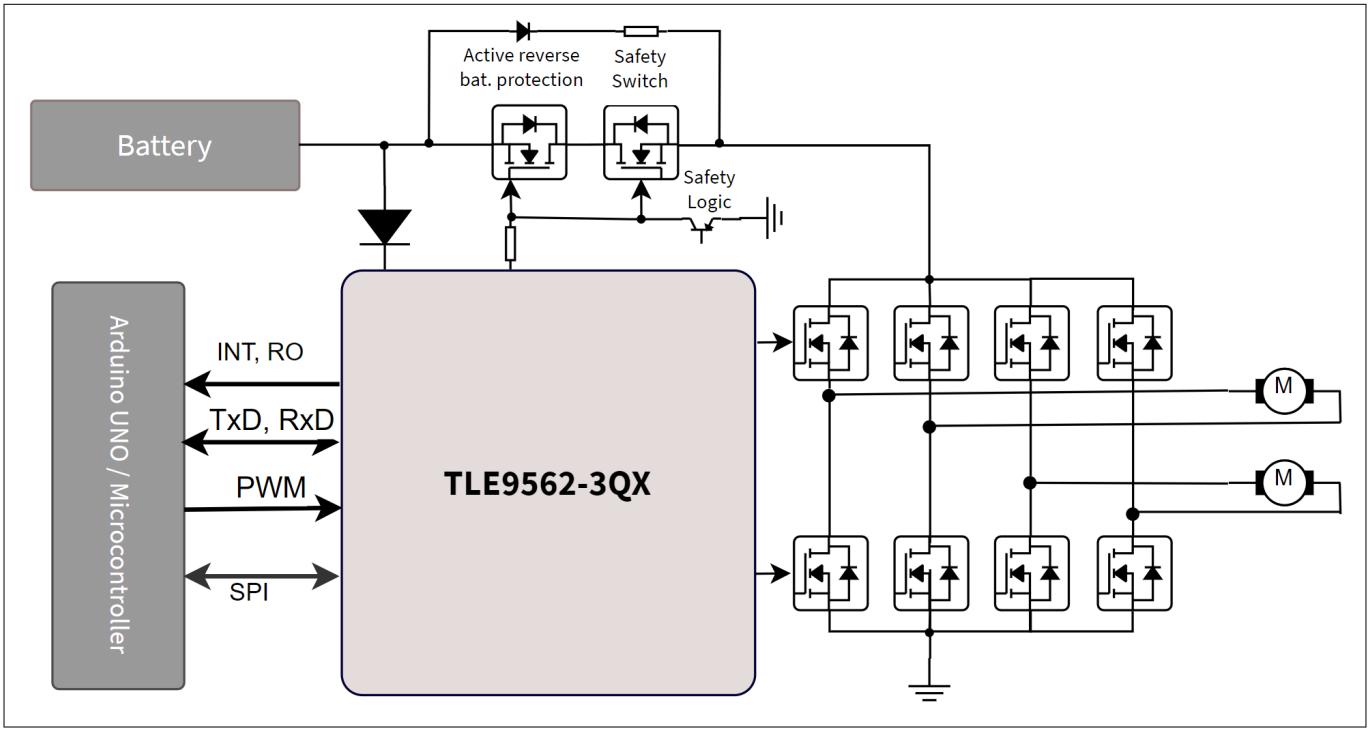

Figure 3 **Application circuit for a bi-directional motor control with the TLE9562-3QX using an Arduino UNO board**

***Note**: Using the TLE9562 shield board with the Arduino UNO board, you can spin a brushed direct current motor (bi-directional).*

1.3 Main features

The TLE9562 evaluation board includes:

- A MOTIX™ TLE9562-3QX
- 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 board[1)]
- An active reverse battery protection circuitry with IPZ40N4S5L-2R8
- Four 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

The TLE9562-3QX brushed direct current shield is compatible with the uIO-Stick. The uIO-Stick plugs into the TLE9562-3QX main board with a 16-pin header, and allows an easy interface to the microcontroller through *universal serial bus (USB)* for *SPI* communication.

2.1 Board overview and connectors

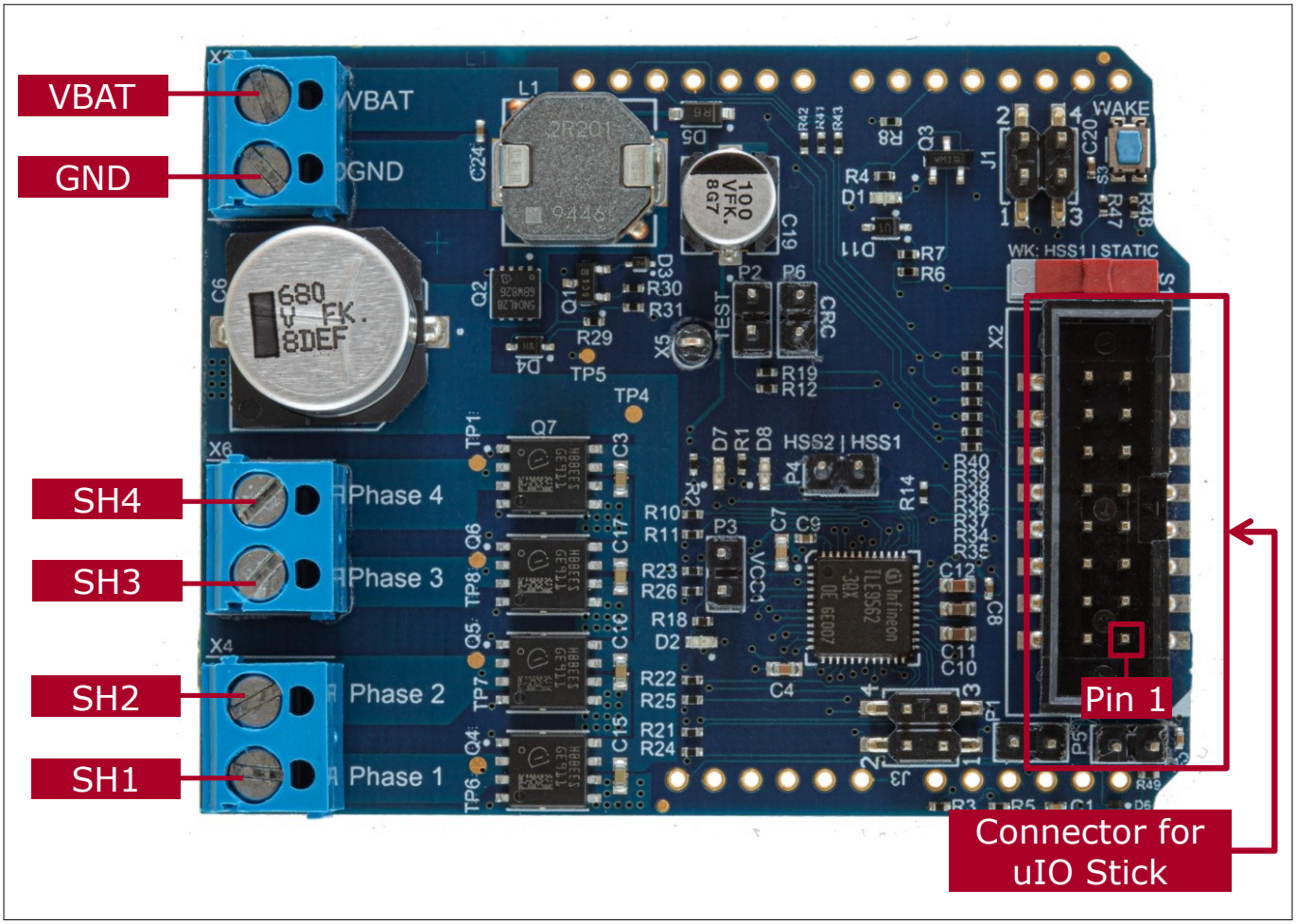

Figure 4 Evaluation board connectors

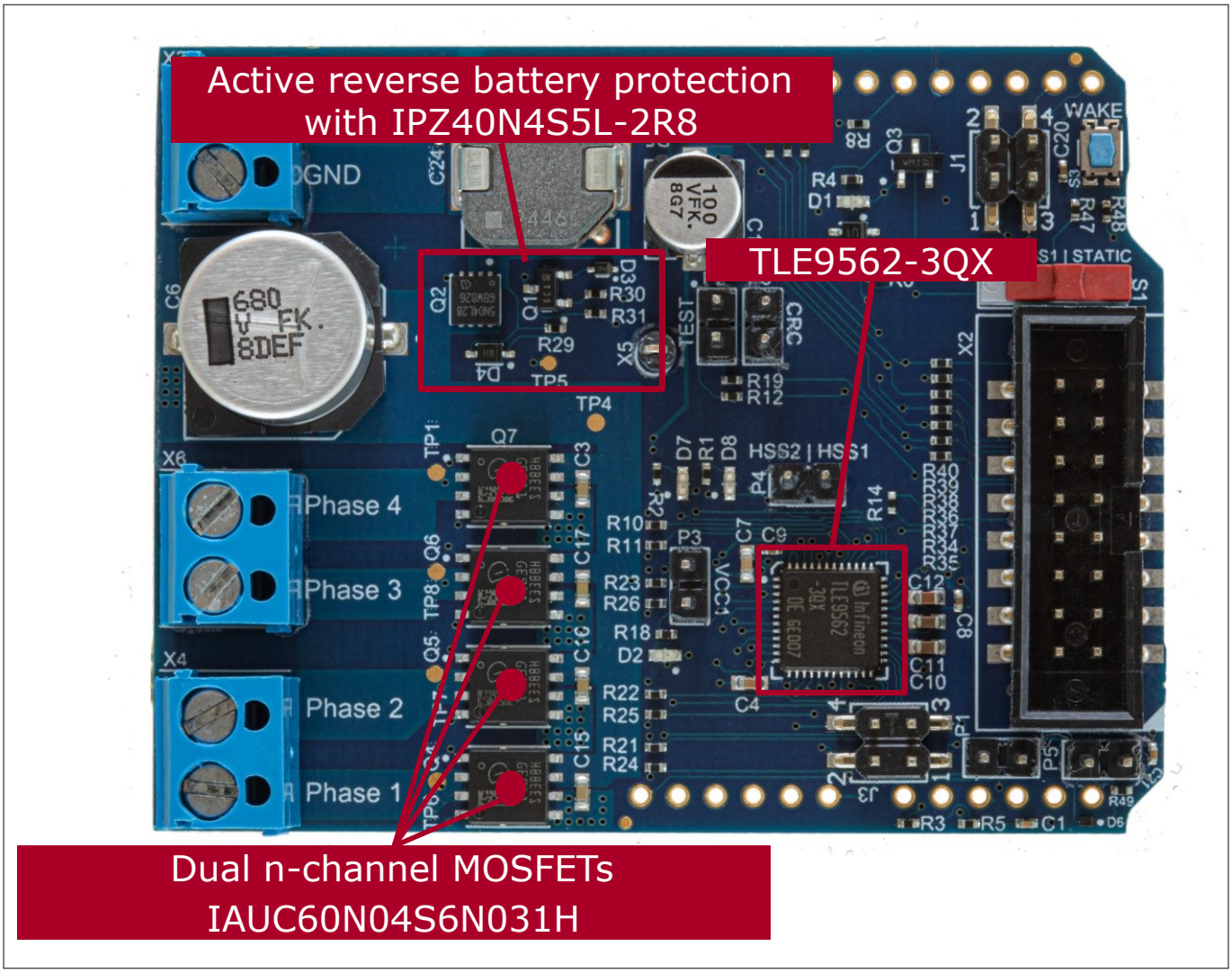

Figure 5 Board components overview 1

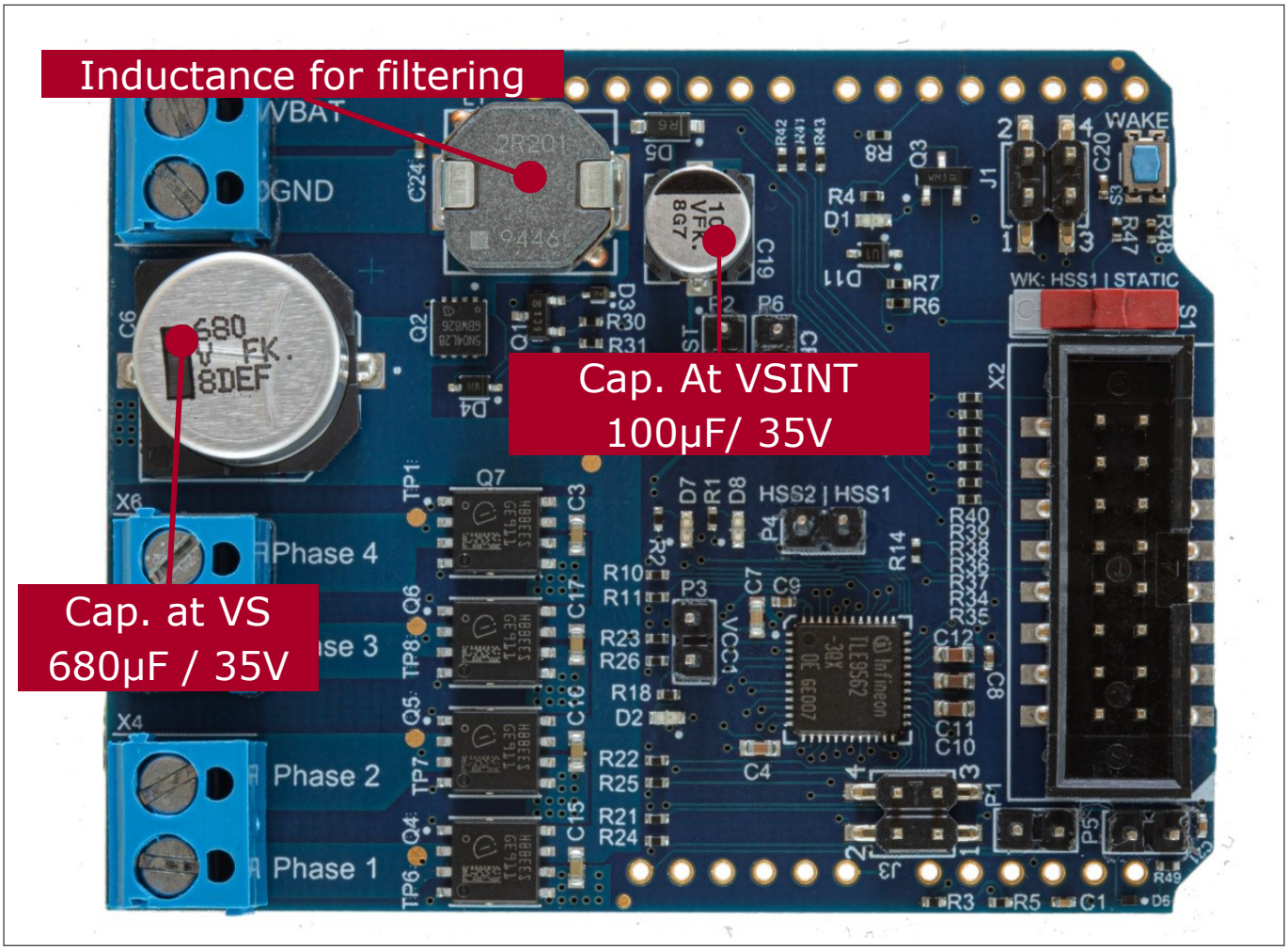

Figure 6 Board components overview 2

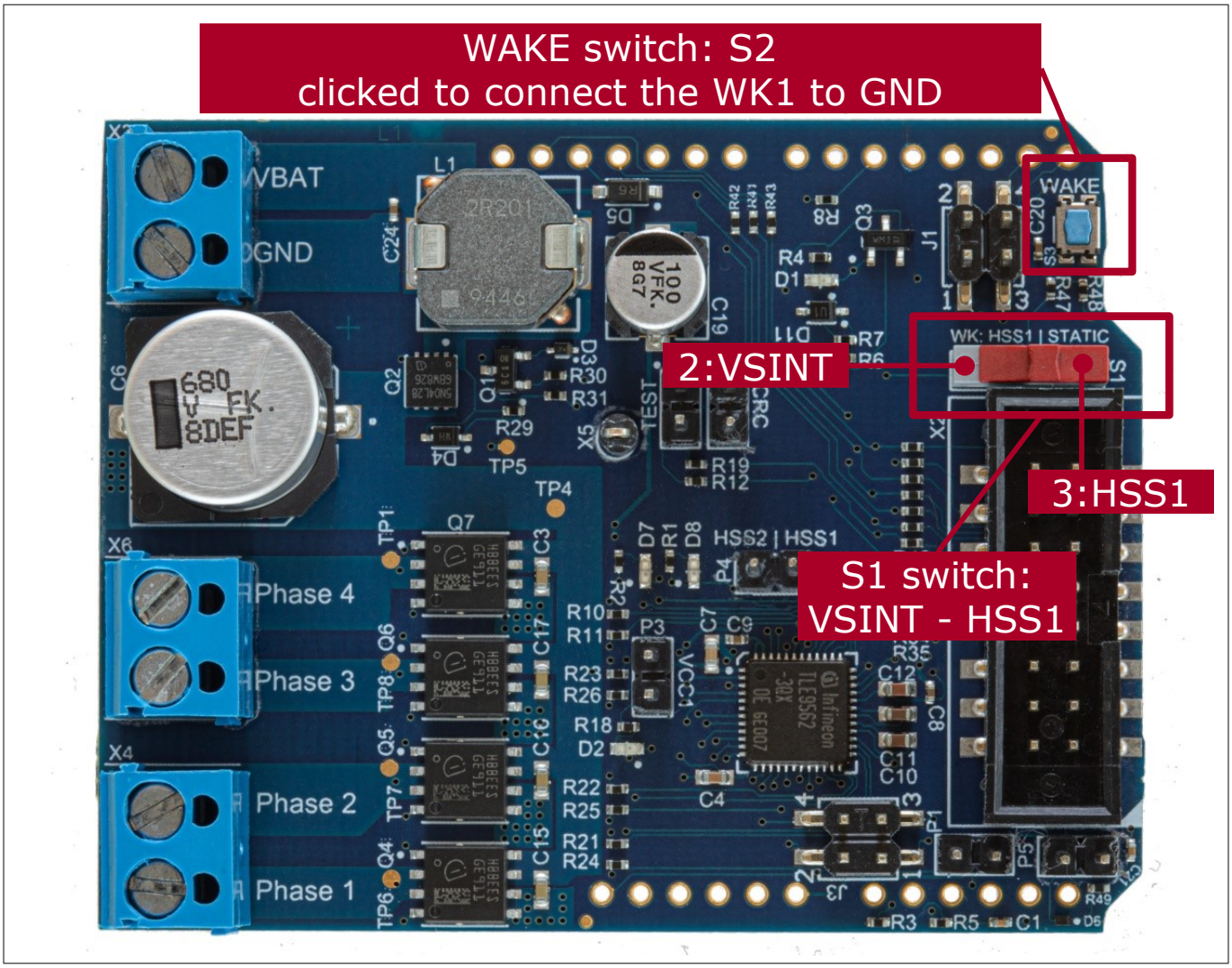

Figure 7 **Board switches**

Table 3 **Switches and positions**

Switches	Positions	Description
Wake switch S2	-	Wake the TLE9562-3QX up and exit 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 *pulse-width modulation (PWM)* 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 of the datasheet).

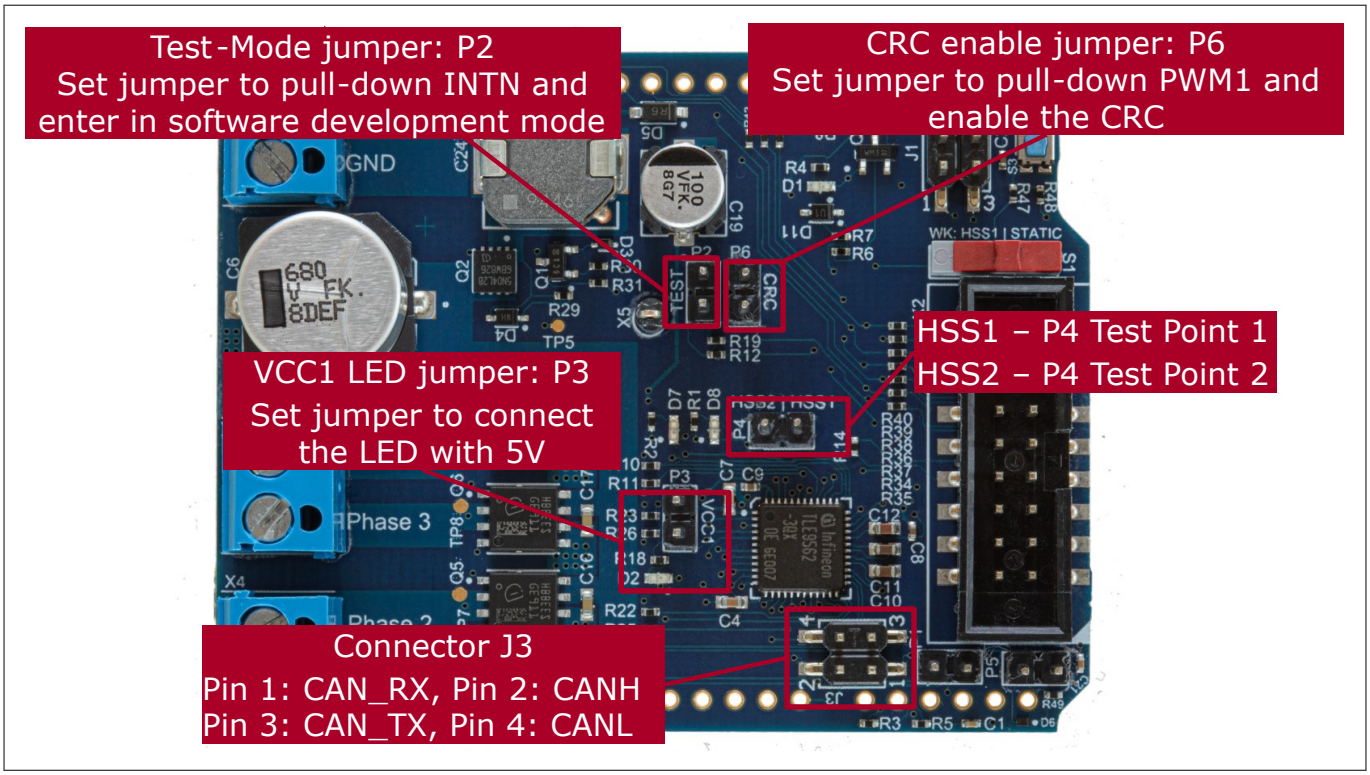

Figure 8 TLE9562 jumpers overview

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

***Note**: The SPI interface includes also 8 bits used for cyclic redundancy check (CRC) to ensure data integrity on sent or received SPI command. Set the jumper P6 to pull down the PWM1 pin to ground and enable the CRC.*

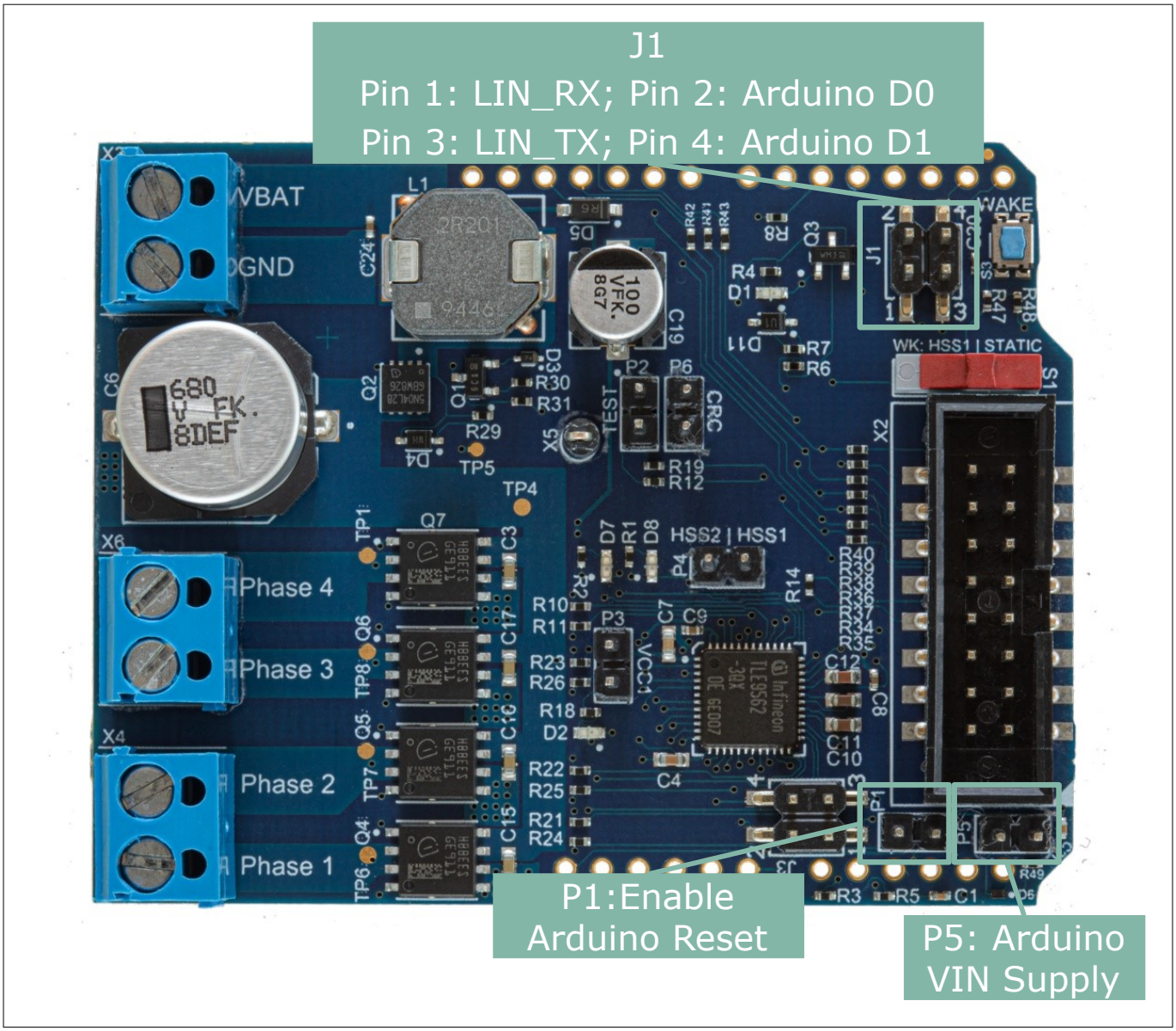

Figure 9 Arduino jumpers

Set the jumper P5 to connect VIN of Arduino with the 5 V regulator (VCC1) on the TLE9562 shield.

For the Arduino jumper settings refer to https://motor-system-ic-tle956x.readthedocs.io/en/latest/hardware-platforms.html#id4

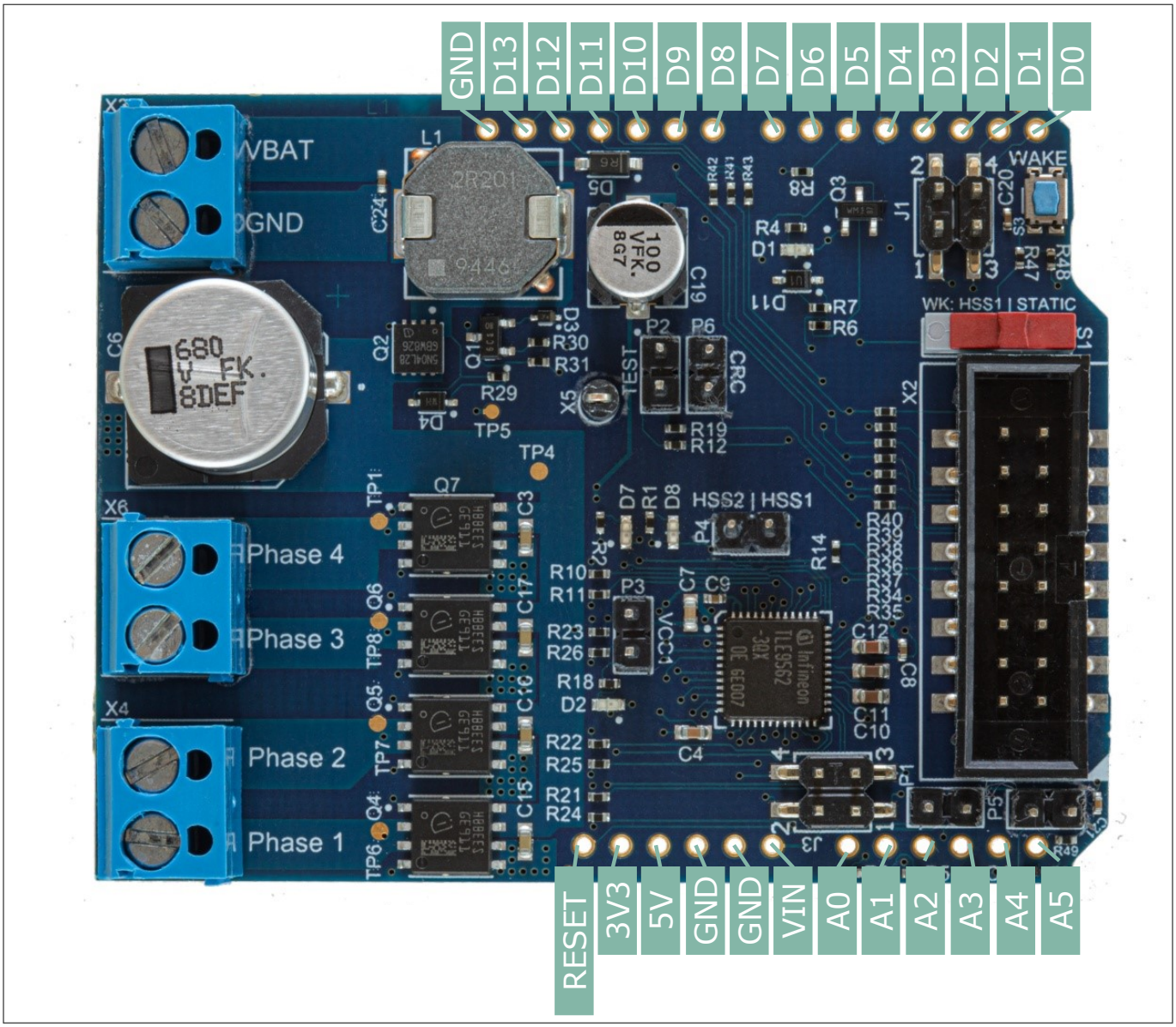

Figure 10 Arduino connectors

For the Arduino pins details refer to https://motor-system-ic-tle956x.readthedocs.io/en/latest/hardware-platforms.html#dc-motor-shield-with-tle9562.

2.1.1 Board design

2.1.1.1 Schematics

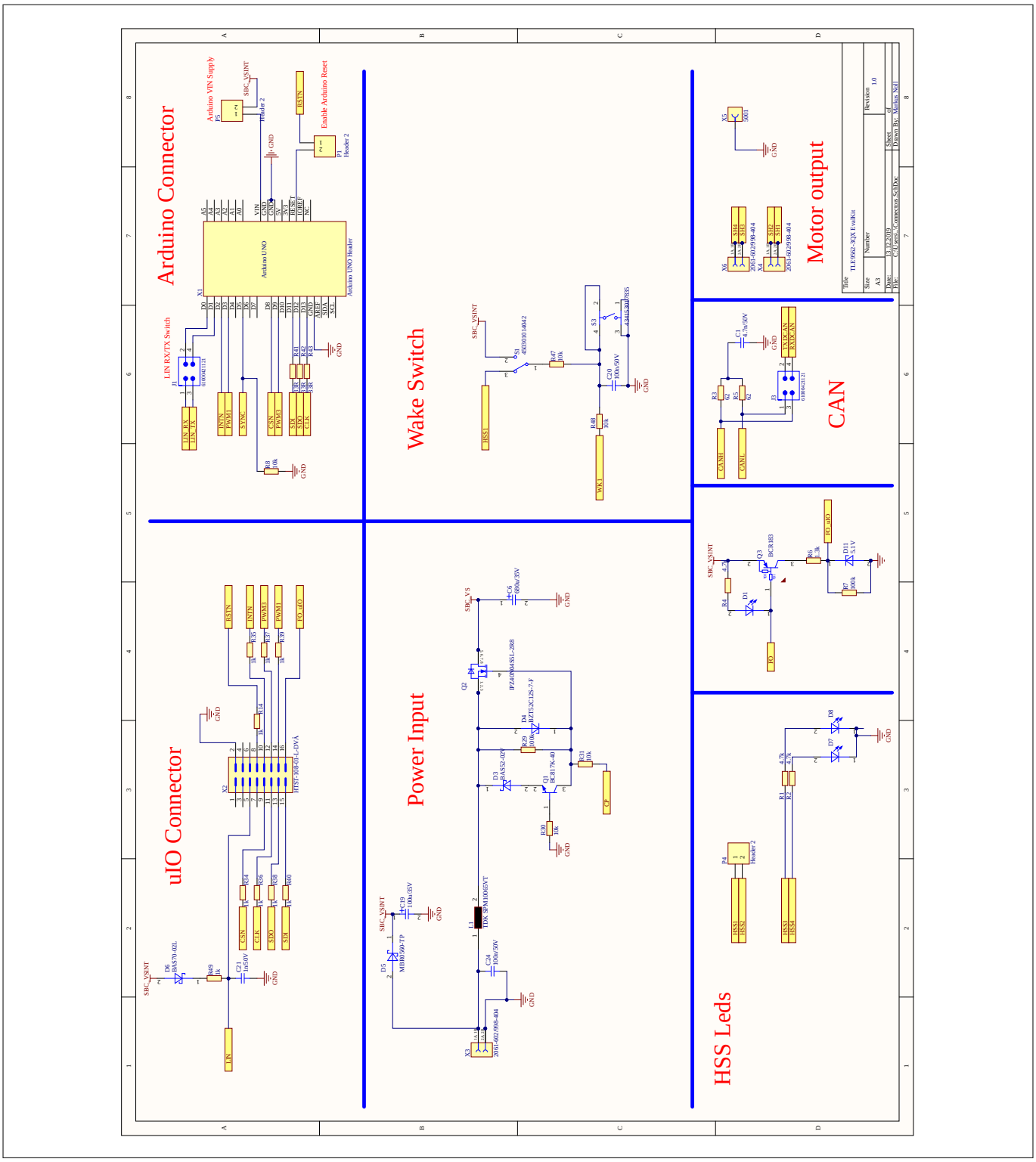

Figure 11 Schematic 1/3

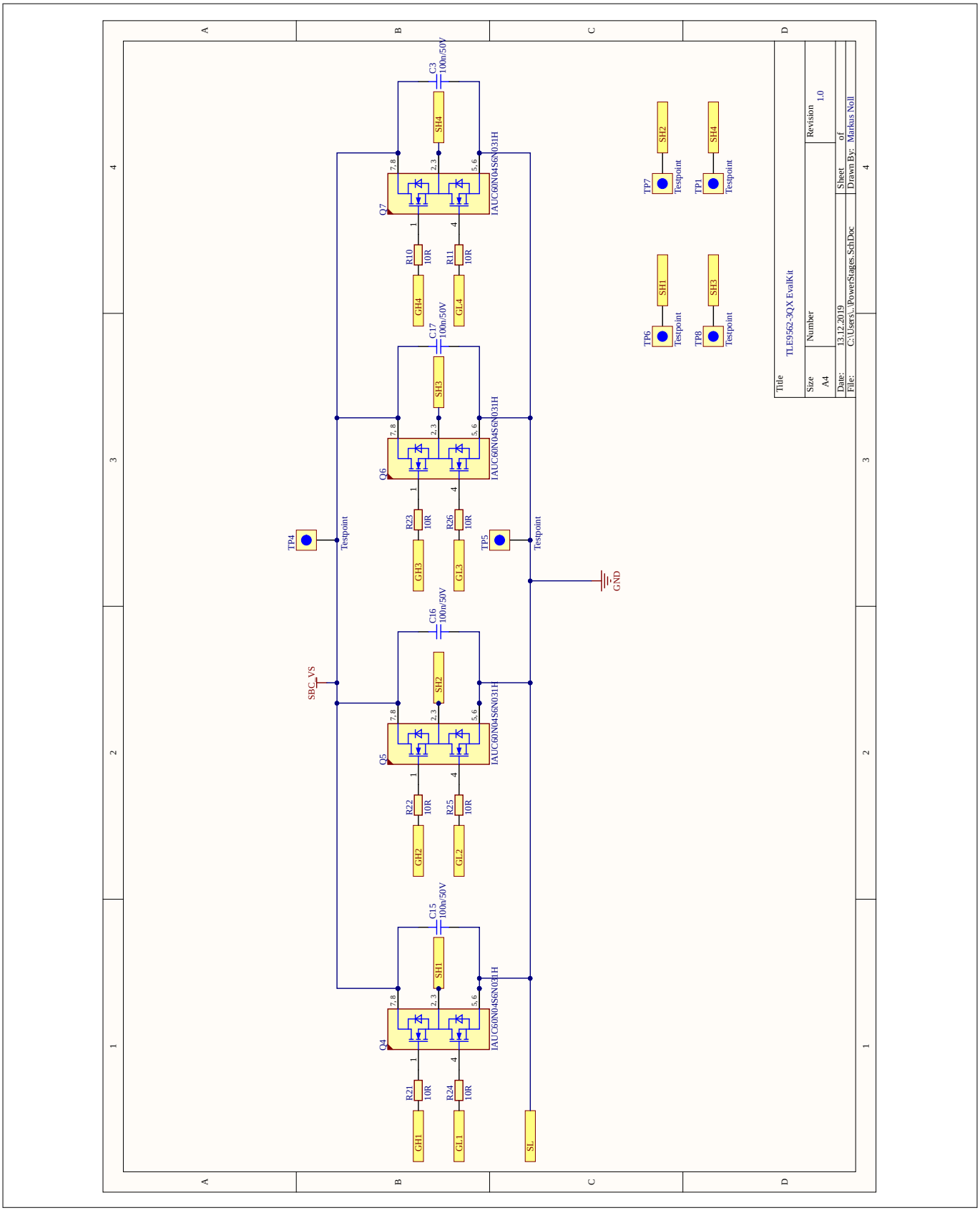

Figure 12 Schematic 2/3

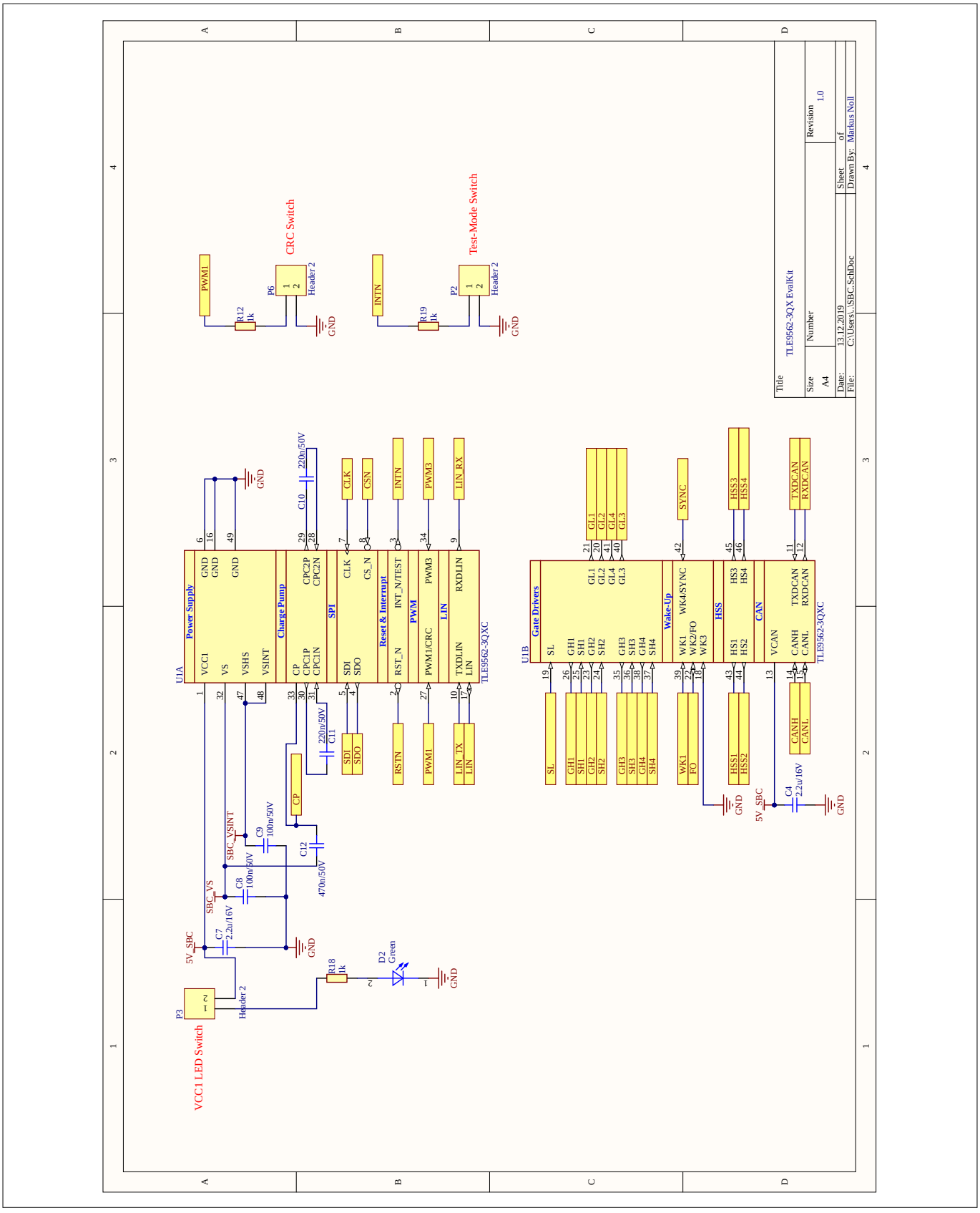

Figure 13 Schematic 3/3

2.1.1.2 Layout

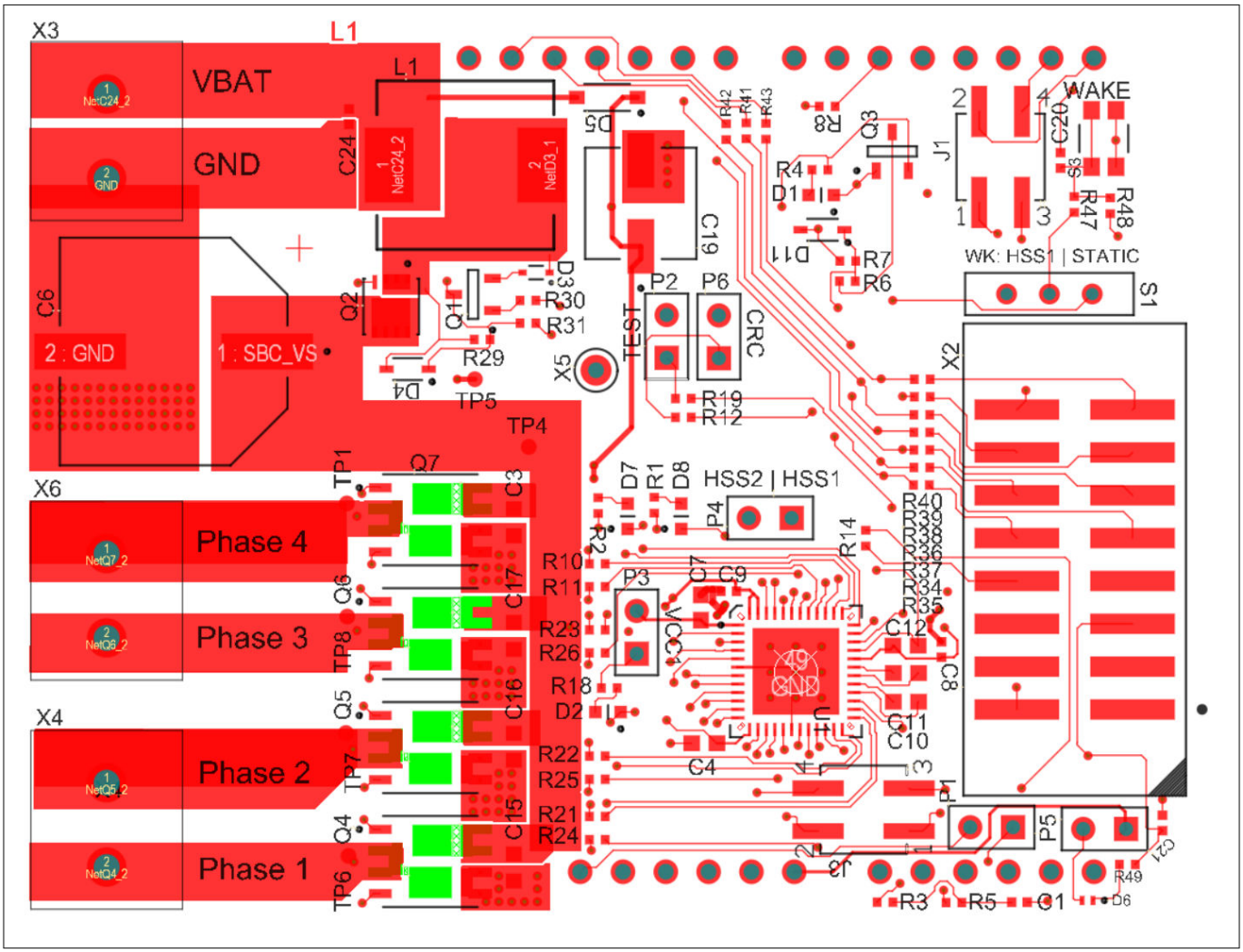

Figure 14 Top layer with overlay

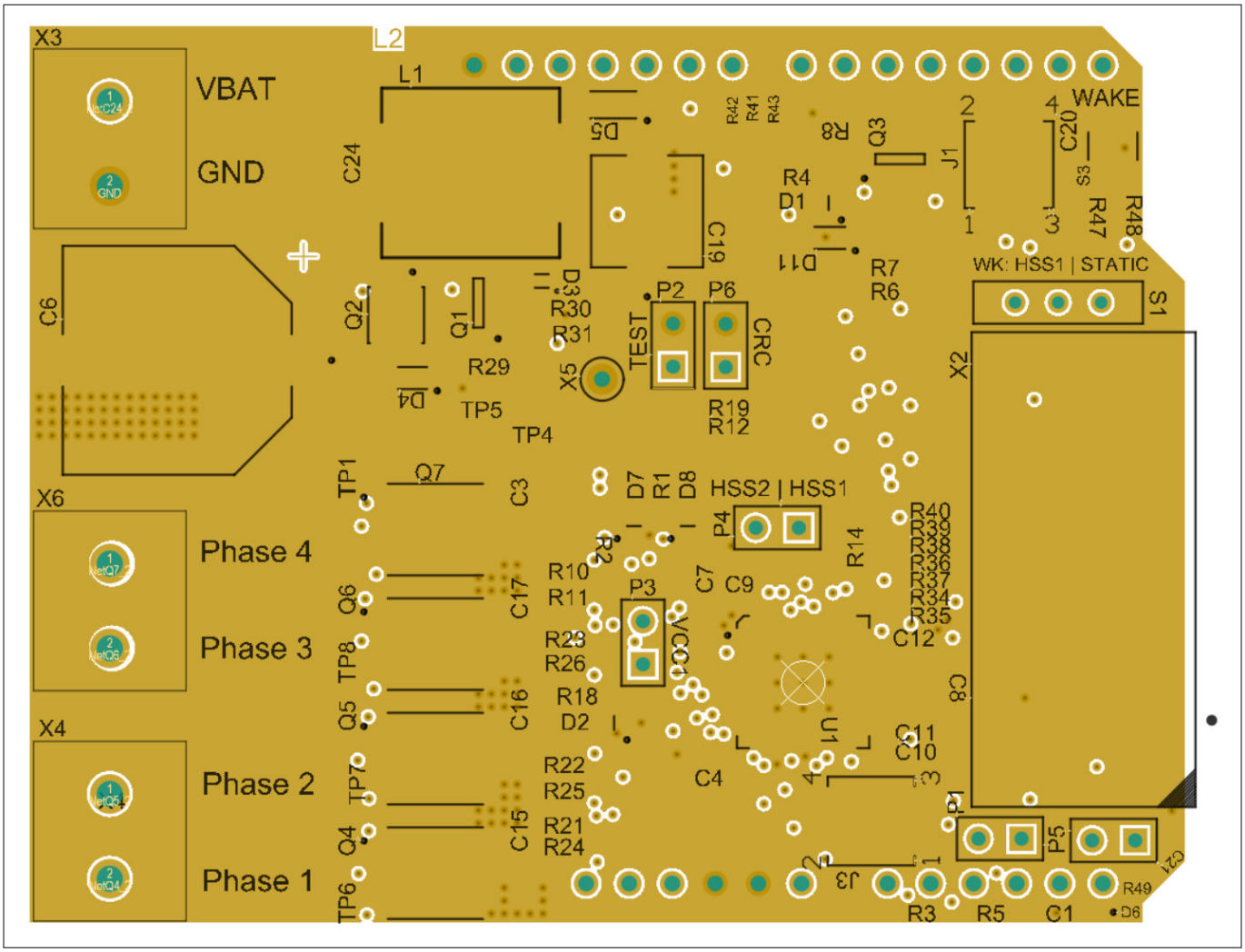

Figure 15 Inner layer 1

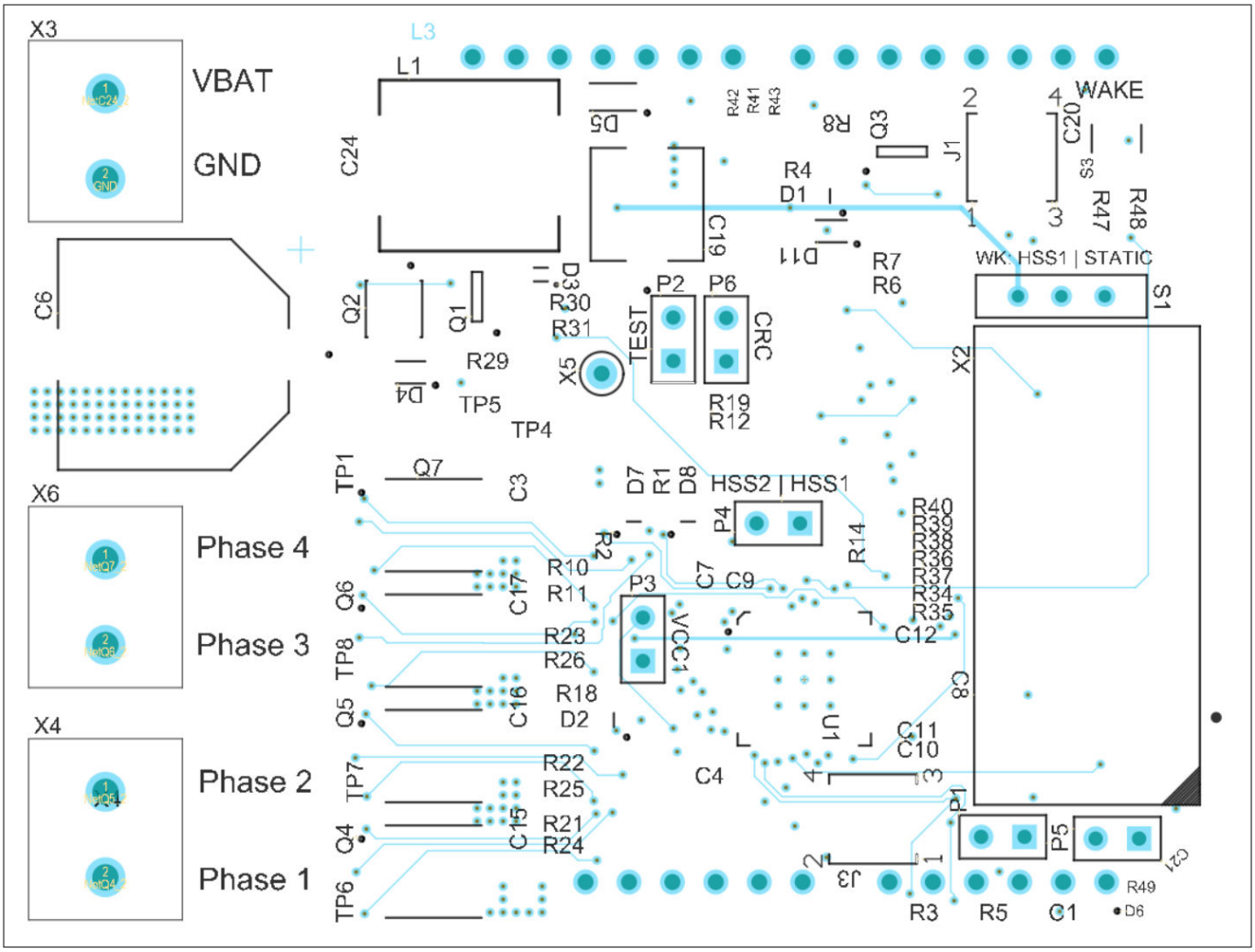

Figure 16 Inner layer 2

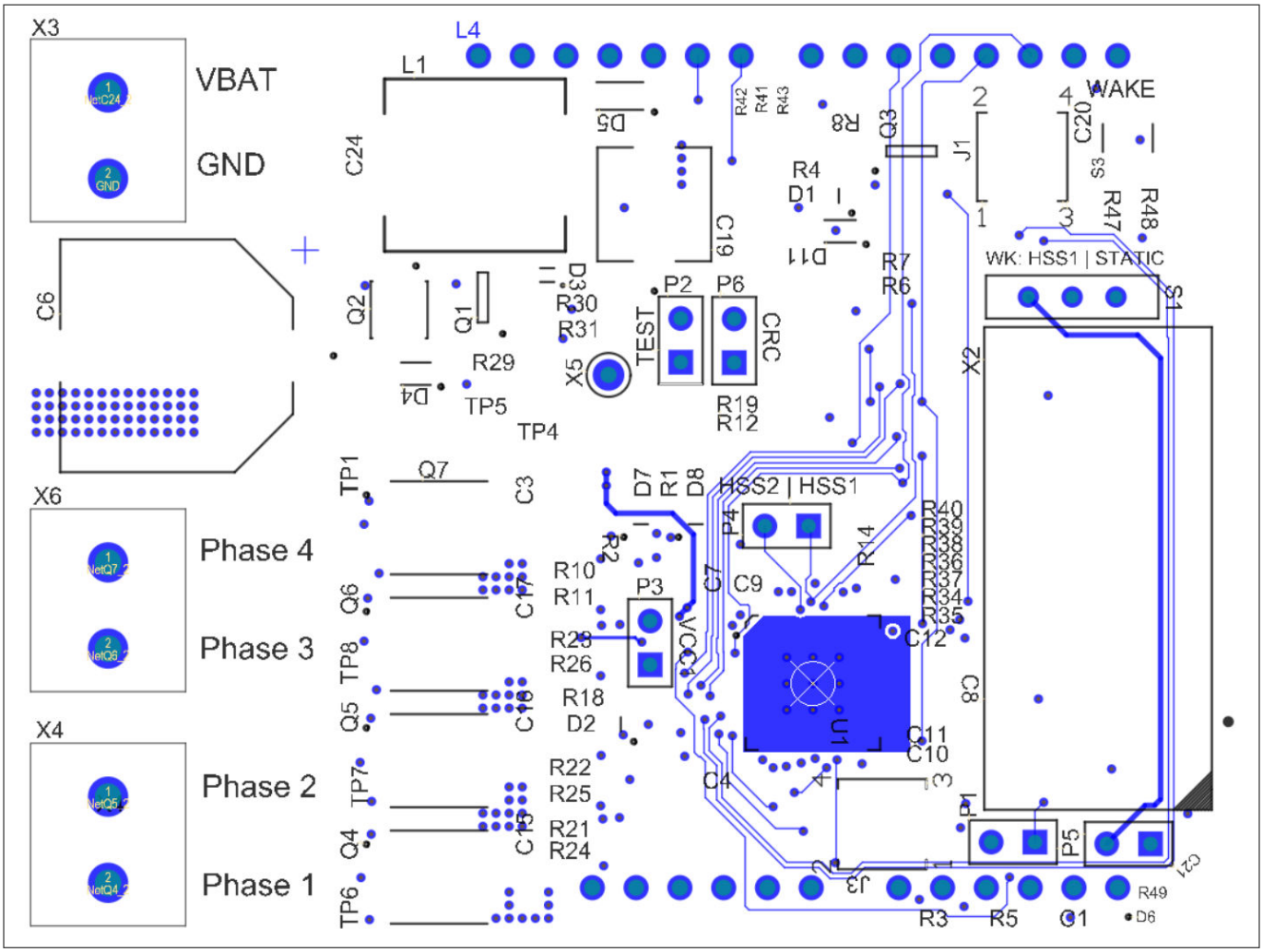

Figure 17 Bottom layer with overlay

2.1.1.3 Bill of material

Designator	Value	Qty	Description	Footprint	Manufacturer
C1	4.7 nF/50 V	1	Chip Multilayer Ceramic Capacitor for General Purpose	CAPC1005X60N	TDK Corporation
C3, C15, C16, C17	100 nF/50 V	4	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1608X90N	AVX
C4, C7	2.2 uF/50 V	2	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1708X95N	TDK Corporation
C6	680 uF/35 V	1	Aluminum Electrolytic Capacitors	CAPAE1350X1400N	Panasonic
C8, C9, C20, C24	100 nF/50 V	4	Chip Multilayer Ceramic Capacitor for General Purpose	CAPC1005X60N	TDK Corporation

Designator	Value	Qty	Description	Footprint	Manufacturer
C10, C11	220 nF/50 V	2	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1708X95N	TDK Corporation
C12	470 nF/50 V	2	Multilayer Ceramic Chip Capacitor, Automotive Grade, Soft Termination	CAPC1708X95N	TDK Corporation
C19	100 uF/35 V	1	Surface Mount Aluminium Electrolytic Capacitor	CAPAE660X800N-2	Panasonic
C21	1 nF/50 V	1	Chip Multilayer Ceramic Capacitor for General Purpose	CAPC1005X60N	TDK Corporation
D1, D7, D8	Red	1	Surface Mount LED, Super Red, 630nm	LED-SMD-LS L29K-XXXX-1	OSRAM Opto Semiconductors
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
D6	BAS70-02L	1	Schottky Rectifier, 0.5A/60V	DFN100X60X50-2N-V	Infineon Technologies
D11	5.1 V	1	Small Signal Zener Diode, GDZ-G-Series/5.1V	SOD2713X115N	Vishay General Semiconductor
J1, J3	61000421121	2	SMT Vertical Pin Header WR-PHD, Pitch 2.54 mm, Dual Row, 4 pins	61000421121	
L1	1.5 uH	1	SPM10065VT	SPM10065VT	TDK Corporation
P1, P2, P3, P4, P5, P6	Header 2	6	Header, 2-Pin	HDR1X2	
Q1	BC817K-40	1	NPN Silicon AF Transistor	SOT95P240X110-3N-1	NXP
Q2	IPZ40N04S5L-2R8	1	OptiMOS-5 N-Channel Enhancement Mode Power-Transistor, VDS 40V, ID 40A	TSDSON-8-33-V	Infineon Technologies
Q3		1	PNP Silicon Digital Transistor	SOT95P240X110-3N-1	Infineon Technologies
Q4, Q5, Q6, Q7	IAUC60N04S6N031H	4	OptiMOS-6 N-Channel	PG-TSON-8-56	Infineon Technologies

Designator	Value	Qty	Description	Footprint	Manufacturer
R1, R2, R4,	4.7 k	3	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R3, R5	62	2	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R6	3.3 k	1	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R7, R29	100 k	2	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R8, R30, R31, R47, R48	10 K	5	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R10, R11, R21, R22, R23, R24, R25, R26	10 R	8	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R12, R14, R18, R19, R34, R35, R36, R37, R38, R39, R40, R49	1 k	12	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
R41, R42, R43	33 R	3	Standard Thick Film Chip Resistor	RESC1005X40N	Vishay
S1	450301014042	1	10x2.5mm THT WS-SLTV	450301014042	
S3	434153017835	1	3.5x2.9mm SMD J-Bend WS-TASV, height 1.7 mm, 350 gf	434153017835	
TP1, TP4, TP5, TP6, TP7, TP8	Testpoint	6		Testpoint	
U1A, U1B	TLE9562-3QXC	1	Bridge SBC Family, PLGM	QFN50P700X700X90-49N-3-1	Infineon Technologies
X1	Arduino UNO Header	1		Arduino UNO Header	
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, X4, X6	20020316-G021B01LF	3	Connector	20020316G021B01LF	
X5	5001	1	Test Point THT, Black	CON-THT-TP-5001	Keystone Electronics Corp.

3 Getting started

There are two options to operate the TLE9562 brushed direct current 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

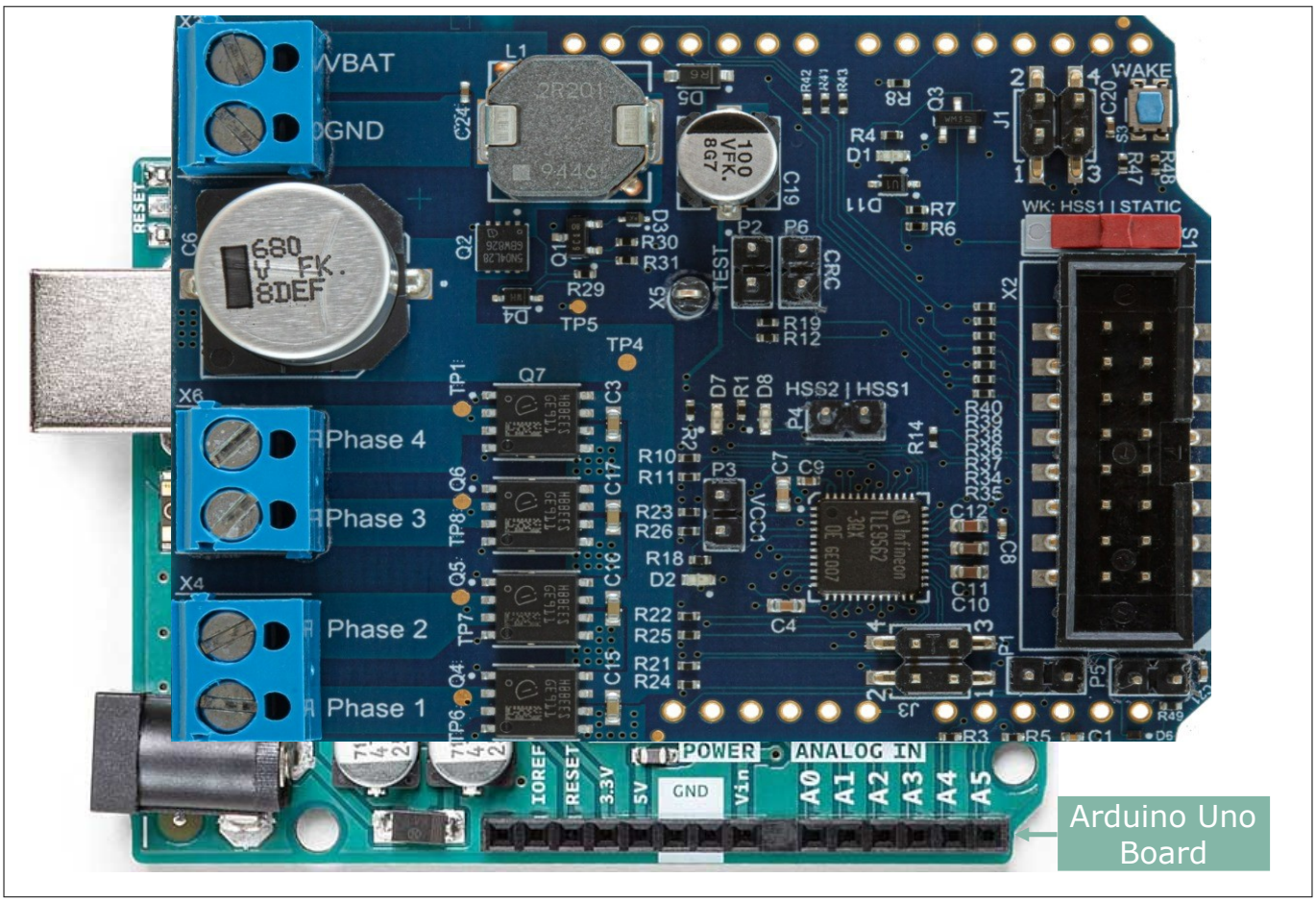

Figure 18 TLE9562 board stacked on an Arduino UNO board

Infineon offers the TLE9562 device driver to provide an *application programming interface (API)* to configure the devices.

TLE9562 device driver is available here: https://www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-control-ics/dc-motor-system-ics/tle9562-3qx/

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

Before using the brushed *DC* shield with an Arduino, refer to Arduino getting started for more information.

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

The Config Wizard for MOTIX™ Motor System *IC*s is a software tool running on a PC or laptop and providing a *GUI* to control the TLE9562-3QX on the board.

Use a uIO-Stick to interface the boards to the *USB* port of the PC or laptop.

3.2.1 Download the graphical user interface for the uIO-Stick

Config Wizard for MOTIX™ Motor System *IC*s allows easy configuration of Automotive Motor System IC products.
To install the *GUI* from the Infineon development center, follow 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

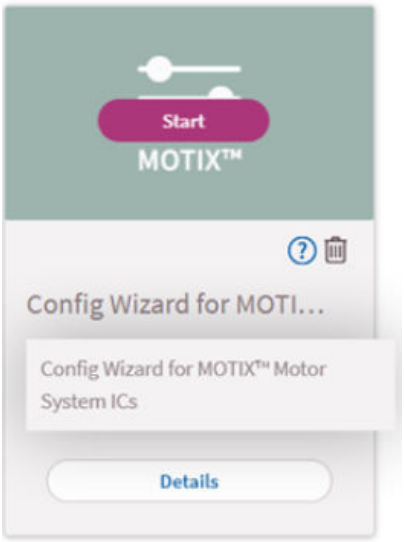

Figure 19 Starting the Config Wizard for MOTIX™ Motor System ICs

7. Click on the **TLE9562 SHIELD**

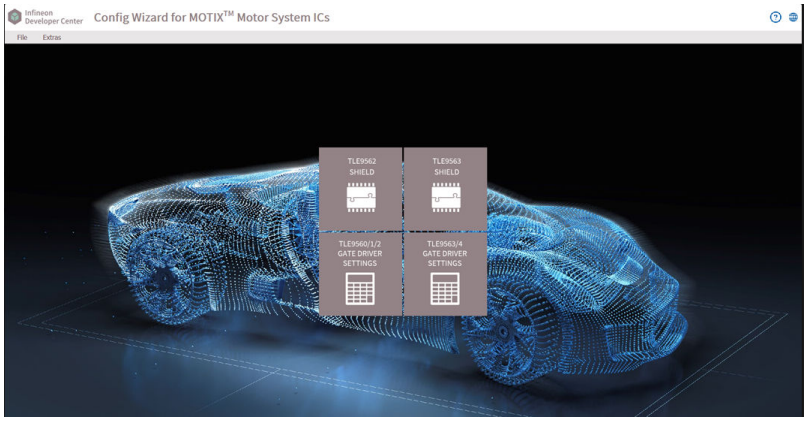

Figure 20 TLE9562 SHIELD selection

3.2.2 Start the configuration Wizard for TLE9562-3QX

The uIO-Stick requires to be programmed when first used in combination with the Config Wizard to control the TLE9562-3QX.

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 21 Update uIO

8. Click **Yes**

Figure 22 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

4.1 SBC tab page

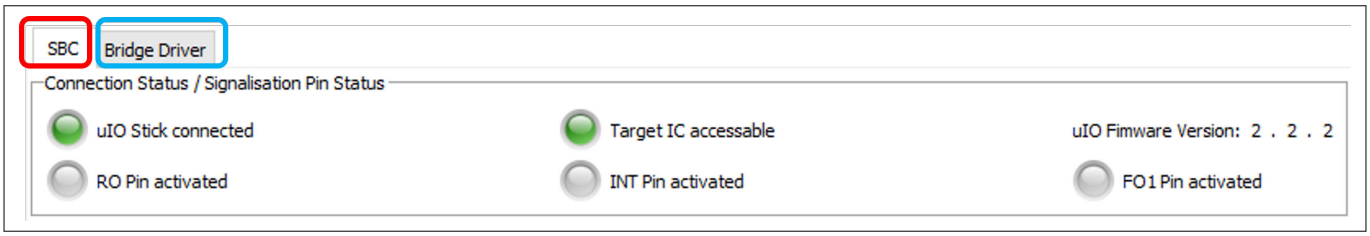

Figure 23 Two main tabs: SBC, Bridge Driver

Table 4 Legend

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

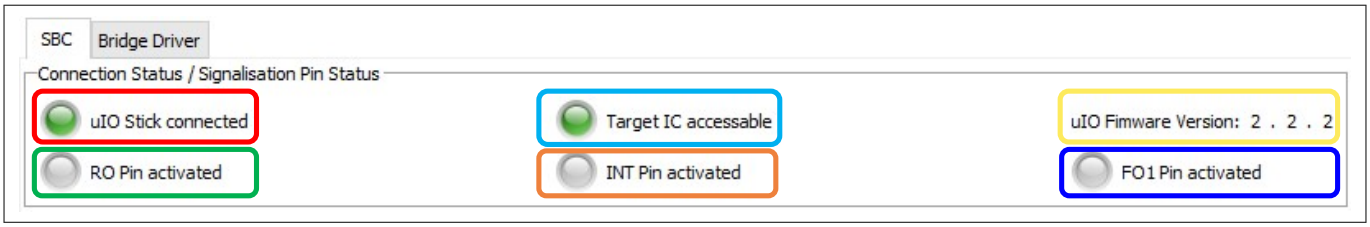

Figure 24 Connection Status, Signaling Pin Status

Table 5 Legend

Color	Status indicator	Description
	uIO stick connected	Communication between the uIO-Stick and the TLE9562-3QX is connected and is working
	Target *IC* accessible	-
	uIO Firmware version	Firmware version of the connected uIO
	RO Pin activated	-
	INT Pin activated	-
	Fail Output Pin activated	-

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

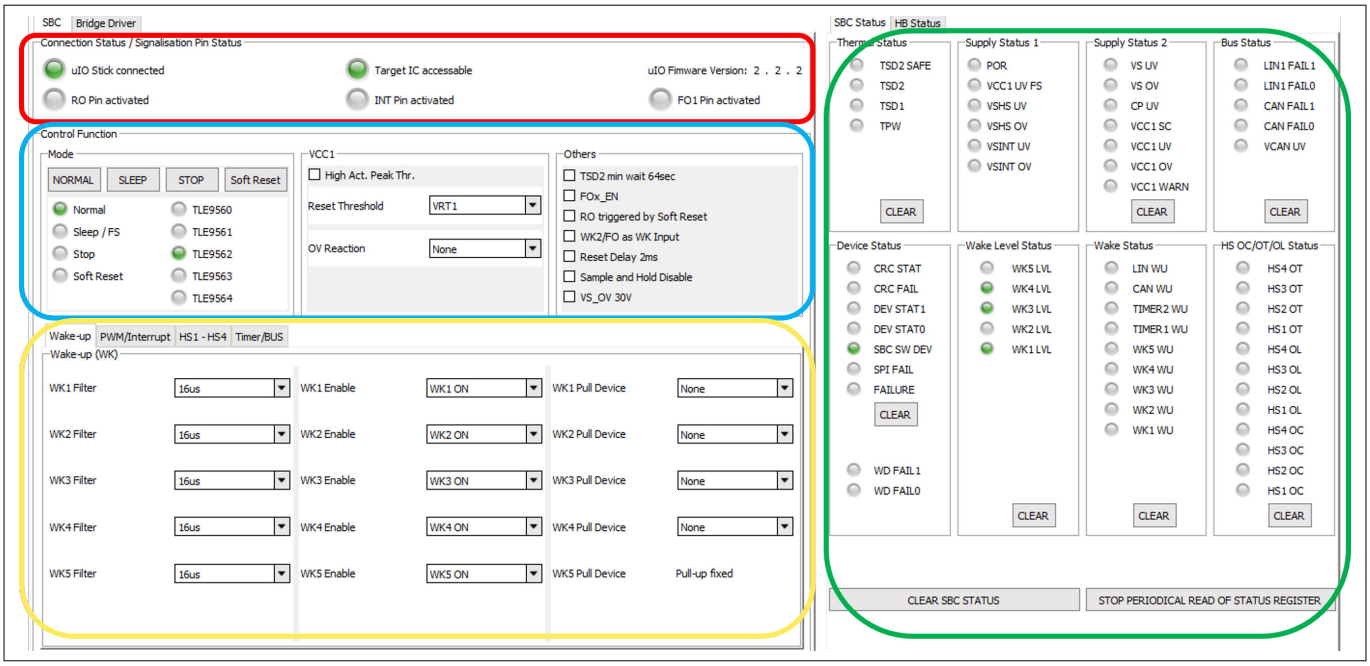

Figure 25 GUI – SBC overview

Table 6 Legend

Color	Description
	Connection status/Signalisation pin status
	Control function
	Available tabs: • Wake-up (WK) • *PWM*/Interrupt • HS1-HS4 • Timer/BUS
	SBC (system basis chip) Status

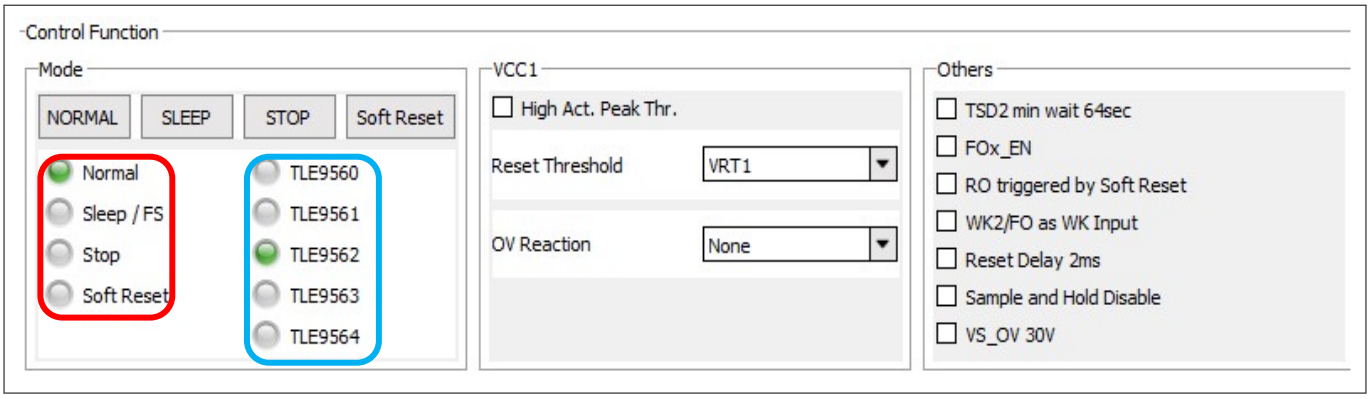

Figure 26 SBC: Control function

Table 7 Legend

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

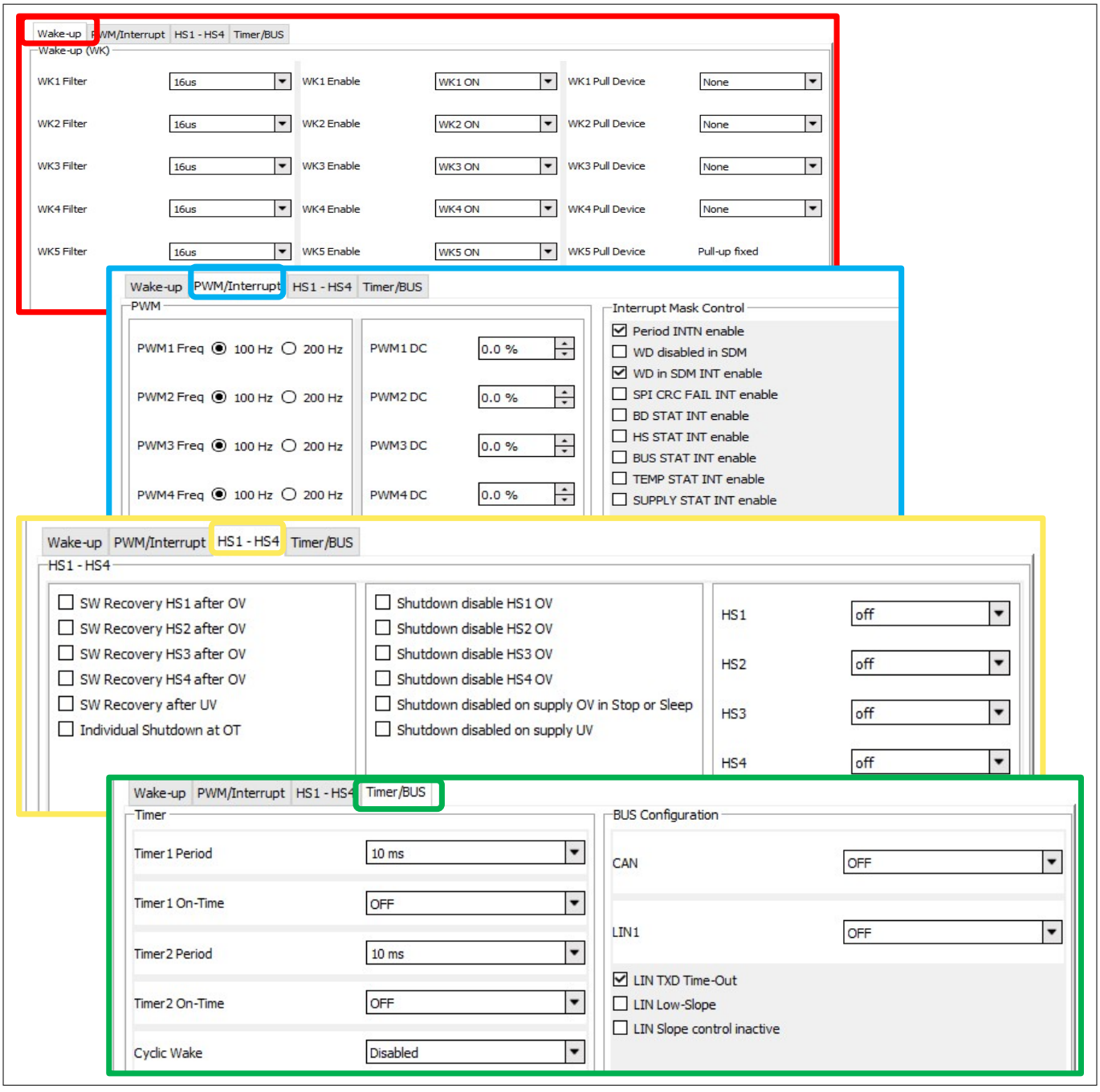

Figure 27 SBC: Wake-up, PWM/Interrupt, HS1-HS4, Timer/BUS

Table 8 Legend

Color	Description
	Wake-up
	PWM/Interrupt
	HS1 – HS4
	Timer/BUS

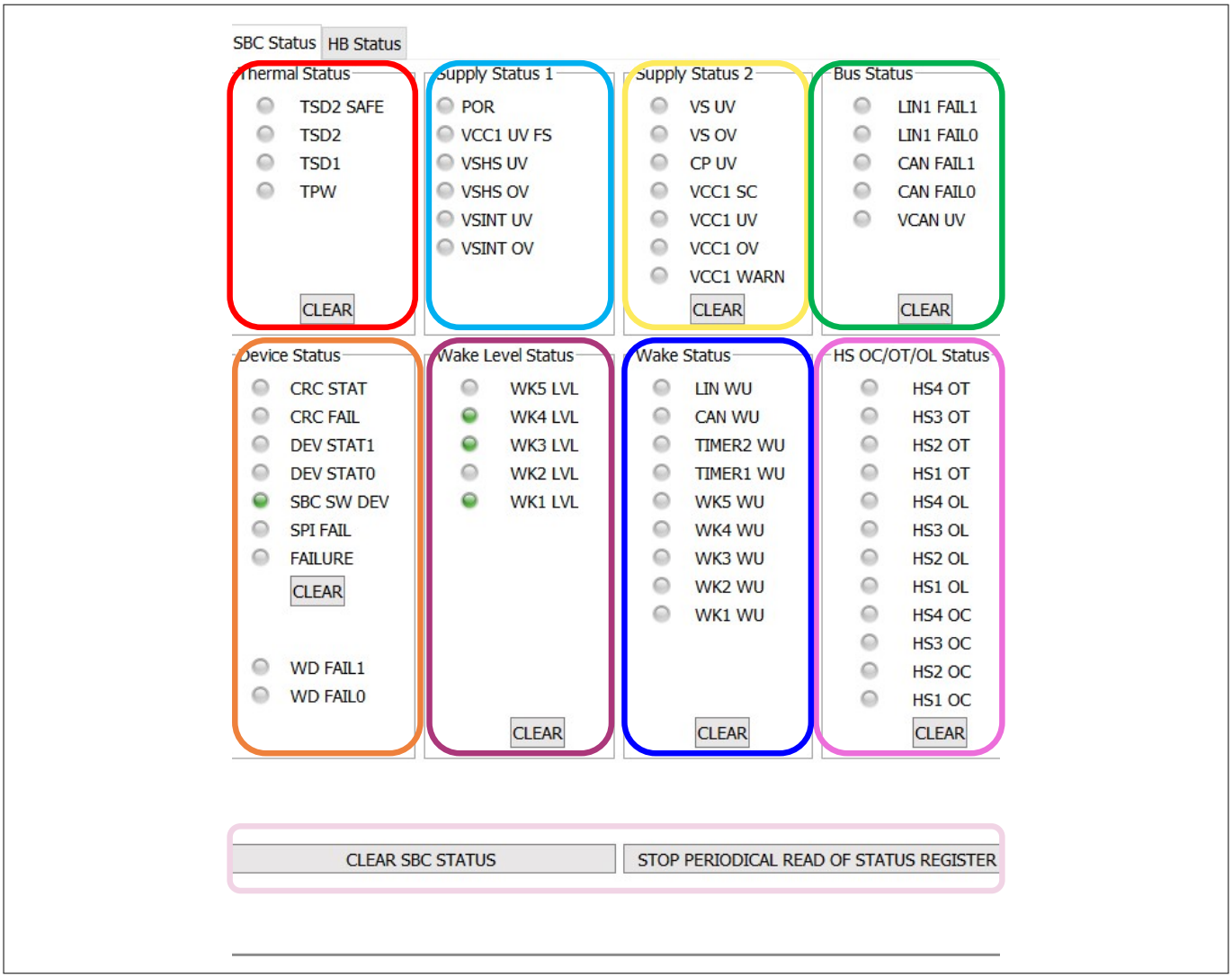

Figure 28 SBC status

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

Figure 29 Half-Bridge (HB) Status

Table 10 Legend

Color	Description
	PWM Switching Characteristics
	GEN Status
	TD REG
	DSOV
	Clear Diagnostic Bridge Driver (BD) Status

4.2 Bridge driver tab page

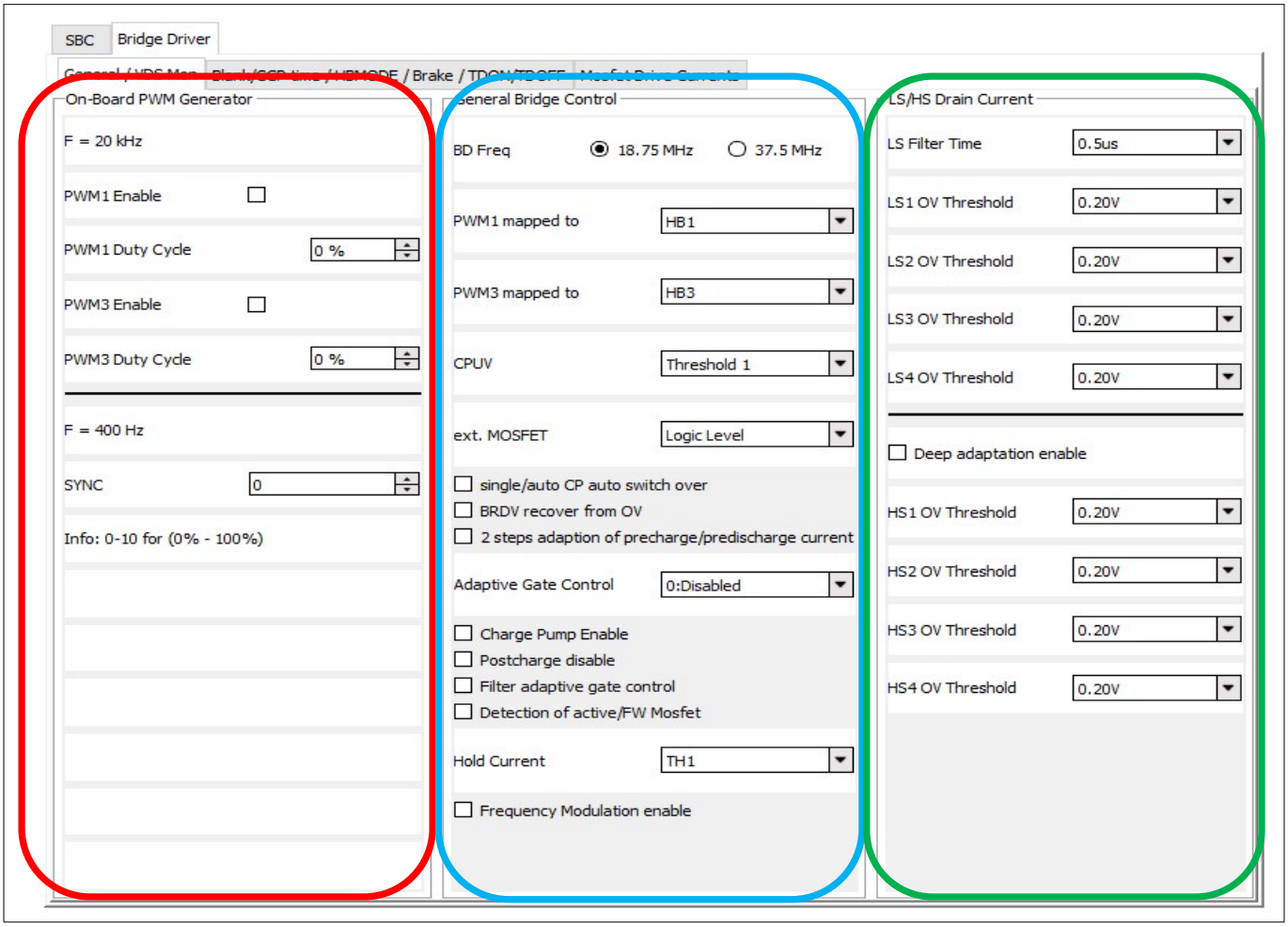

Figure 30 Bridge driver: General, VDS monitoring

Table 11 Legend

Color	Description
	On-Board *PWM* Generator
	General Bridge Control
	LS/HS Drain Current

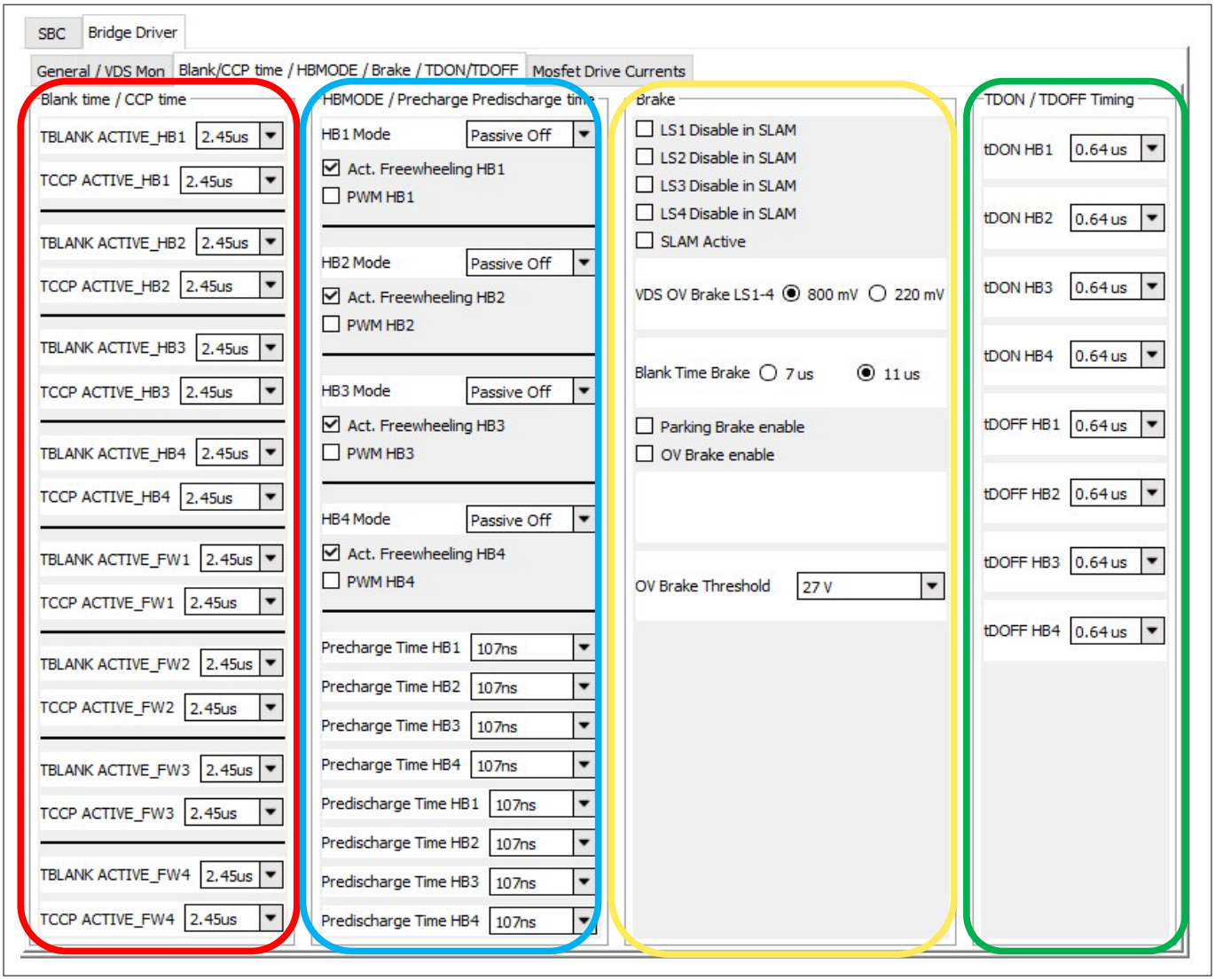

Figure 31 Blank/CCP time, HBMODE, Brake, TDON/TDOFF timing

Table 12 Legend

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

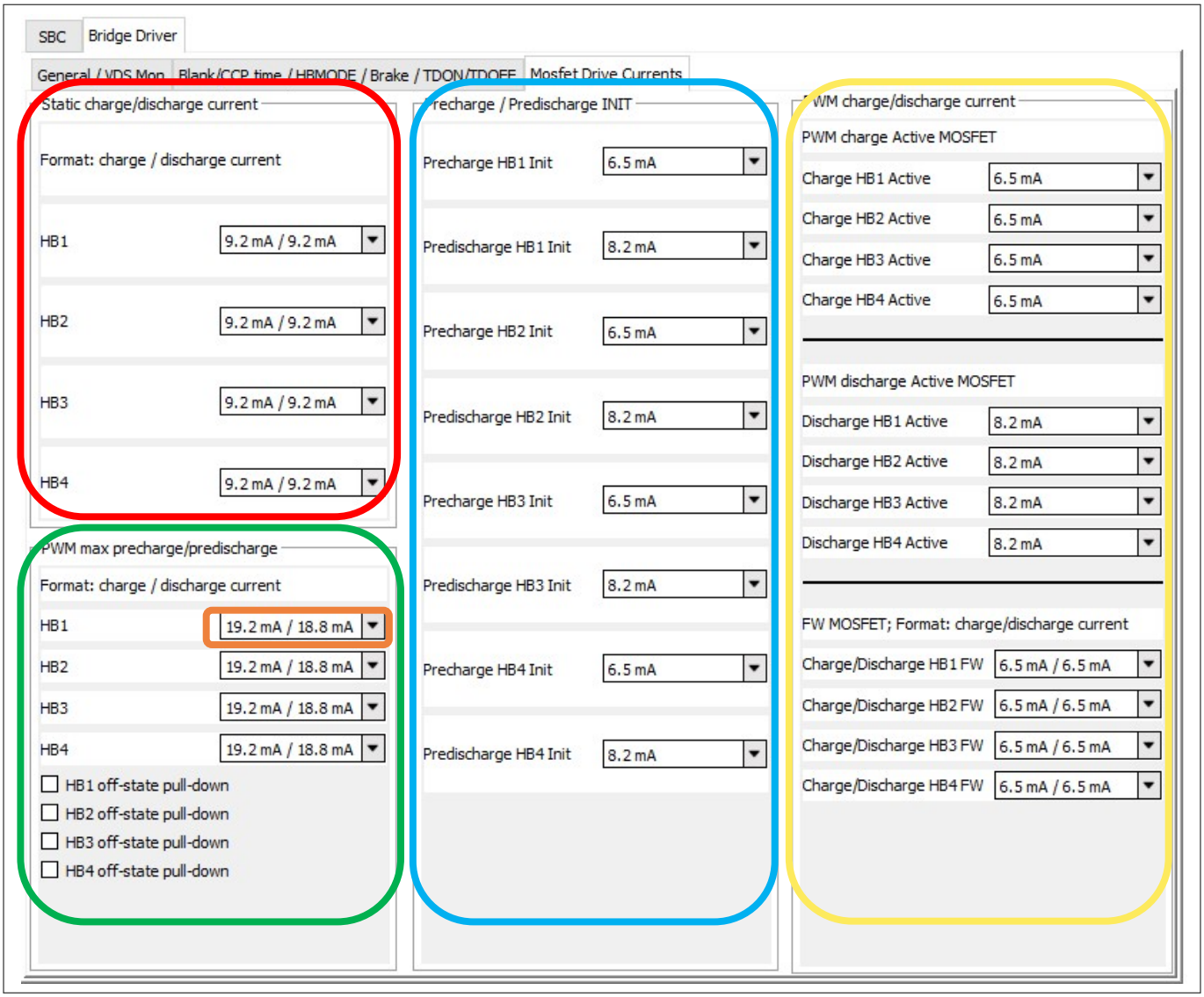

Figure 32 MOSFET Drive currents

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
	19.2 mA: Pre-charge/18.8 mA: Pre-discharge

5 References and appendices

5.1 Glossary

API

application programming interface (API)

A set of defined rules that enables various software components to communicate with each other.

CRC

cyclic redundancy check (CRC)

A procedure that uses a checksum to check the validity of a data transfer.

DC

direct current (DC)

One-directional flow of electric charge. An electrochemical cell is a prime example of DC power. Direct current may flow through a conductor such as a wire, but can also flow through semiconductors, insulators, or even through a vacuum as in electron or ion beams. The electric current flows in a constant direction, distinguishing it from alternating current (AC).

ESD

electrostatic discharge (ESD)

A sudden and momentary flow of electric current between two electrically charged objects caused by contact, an electrical short or dielectric breakdown.

GUI

graphical user interface (GUI)

An interface that enables users to interact with electronic devices through icons and visual indicators.

IC

integrated circuit (IC)

A miniature electronic circuit built on the surface of a thin substrate of a semiconductor material.

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 communication protocols used in a bus for connection, communication, and power supply between computers and electronic devices.

VS

voltage supply (VS)

5.2 References

[1] *Infineon, TLE9562-3QX datasheet :* https://www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-control-ics/dc-motor-system-ics/tle9562-3qx/

[2] *Infineon, IAUC60N04S6N031H datasheet:* https://www.infineon.com/cms/en/product/power/mosfet/automotive-mosfet/iauc60n04s6n031h/

[3] *Infineon, MOTIX™ SBC TLE9562 device driver:* https://softwaretools.infineon.com/tools/com.ifx.tb.tool.tle9562devicedriver

[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

[6] *Infineon, Arduino Getting started:* https://motor-system-ic-tle956x.readthedocs.io/en/latest/sw-frmwk/arduino/index.html

[7] *Infineon, Getting started with the evalkits DC/BLDCvideo:* https://www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-control-ics/dc-motor-system-ics/tle9562-3qx/#!videos

[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	2024-07-04	• Document type corrected from User manual to User guide • Important notice and Safety precautions added • Delivery content added • Block diagram added • Main features added • Arduino UNO controller board added • Schematics and Layout updated • Images updated in SBC tab page, Bridge driver tab page, and Board overview and connectors • Glossary and References added
Rev. 1.00	2020-07-16	• Initial document release

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