

BLDC Shield TLE9185QX/TLE9185QX V33

User guide

Z8F80304681

About this document

Scope and purpose

This user guide describes the BLDC Shield with the TLE9185QX/TLE9185QX V33. This guide provides detailed information on the board's content, layout, and use. The guide should be used in conjunction with the TLE9185QX/TLE9185QX V33 datasheet, which contains full technical details on the specification and operation of the device.

Intended audience

Hardware and software engineers that are familiar with motor control schemes and intend to evaluate the IC TLE9185QX and TLE9185QXV33

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1 Introduction

1 Introduction

The TLE9185QX/TLE9185QX V33 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 with a μ IO stick, or with an Arduino Uno.

The μ IO stick is the interface between the PC and the application board such as the TLE9185QX/TLE9185QX V33.

The TLE9185QX/TLE9185QX V33 SPI communication is emulated by the μ IO stick, which is controlled by the PC software.

The board of the TLE9185QX/TLE9185QX V33 has a connector for the μ IO stick, connectors for the power supply, and three connectors for the motor output. The board also has an active reverse battery protection with IPZ40N4S5L-2R8.

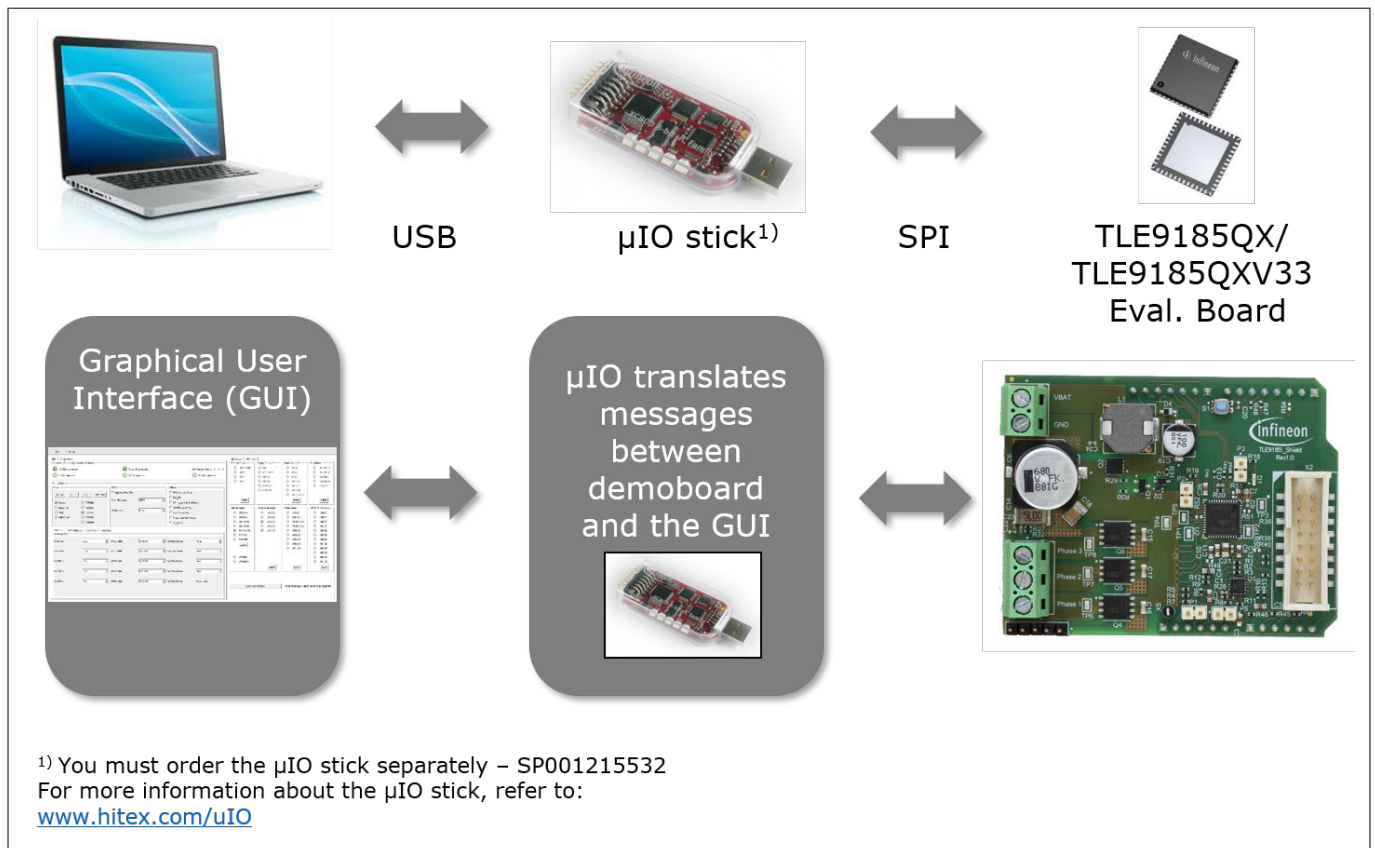


Figure 1 TLE9185QX/TLE9185QX V33 concept

2 Hardware description

2.1 Hardware

The TLE9185QX/TLE9185QX V33 evaluation board is designed to be compatible with the μ IO-stick. The μ IO-stick plugs into the TLE9185QX/TLE9185QX V33 main board via a 16-pin header, and enables an easy interface to the microcontroller via USB for SPI communication.

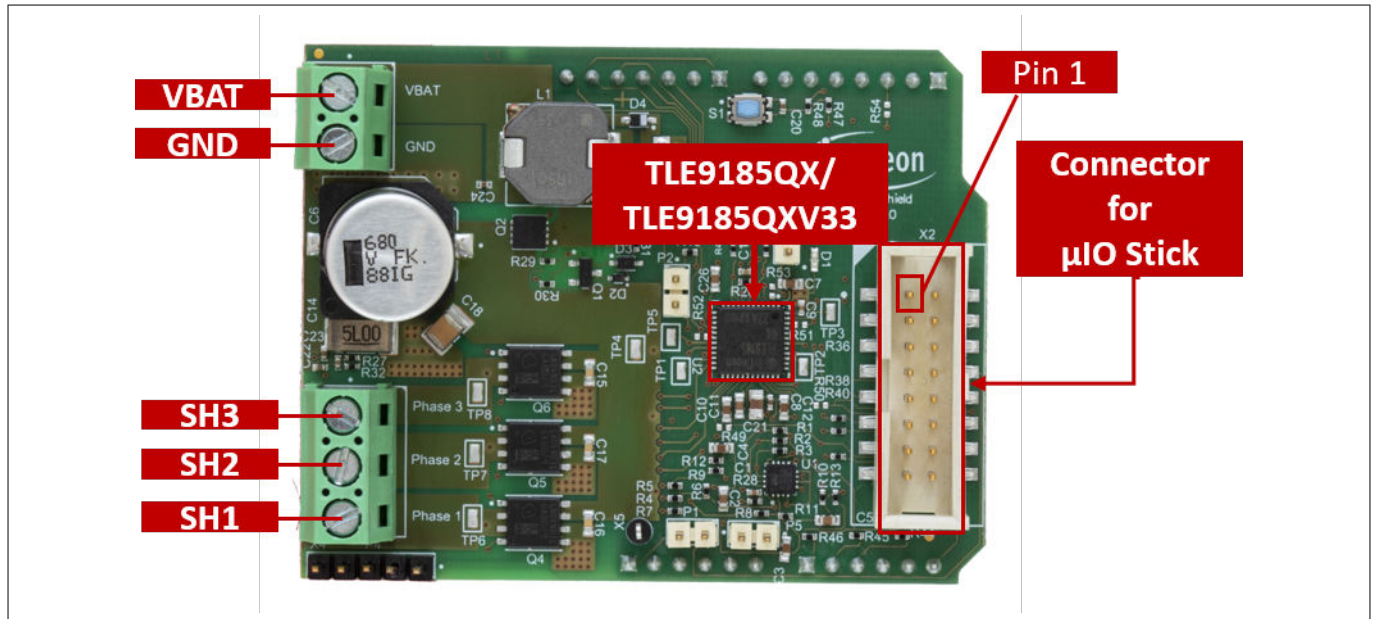


Figure 2 TLE9185QX/TLE9185QX V33 evaluation board: Overview 1

2 Hardware description

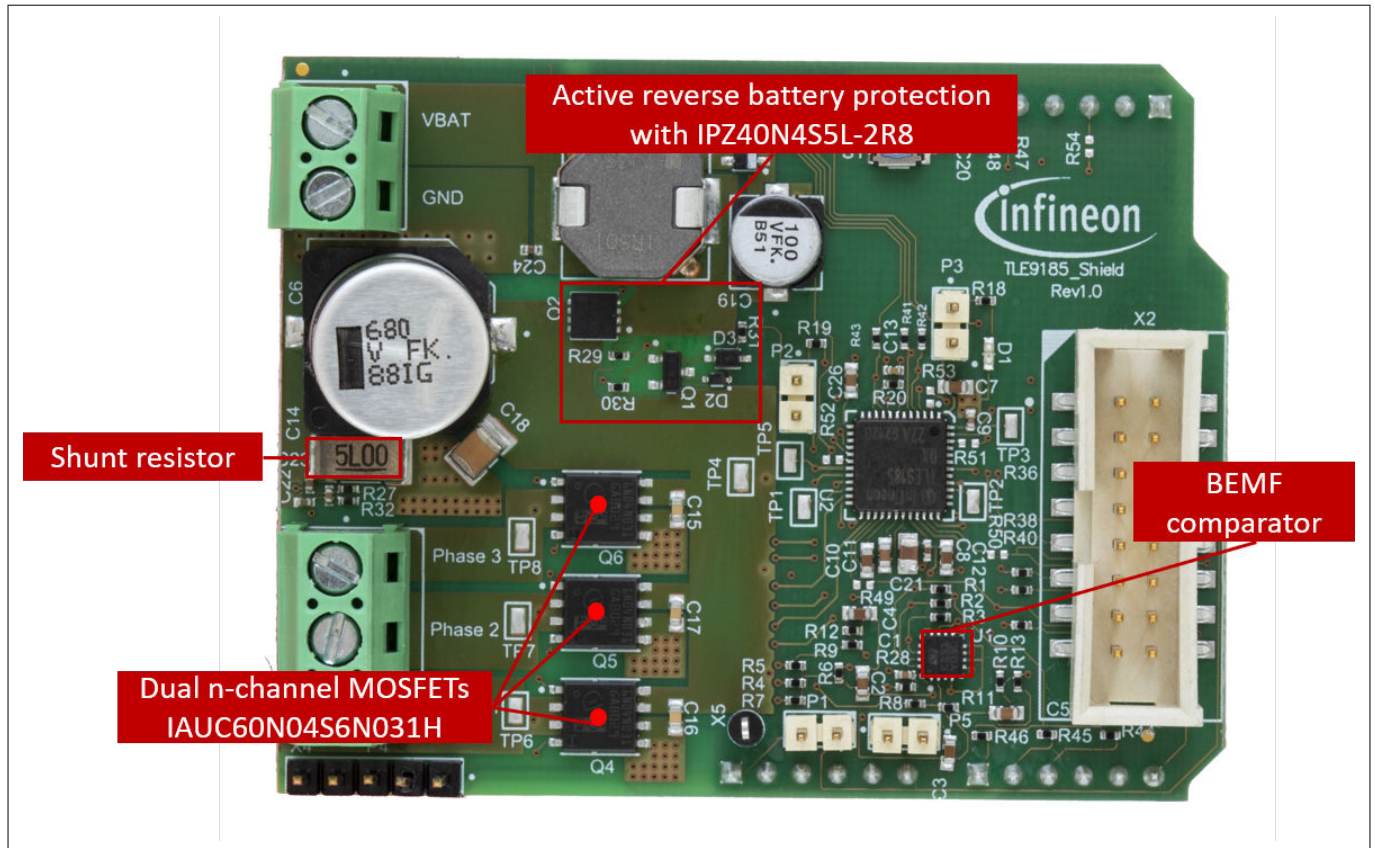


Figure 3 TLE9185QX/TLE9185QX V33 evaluation board: Overview 2

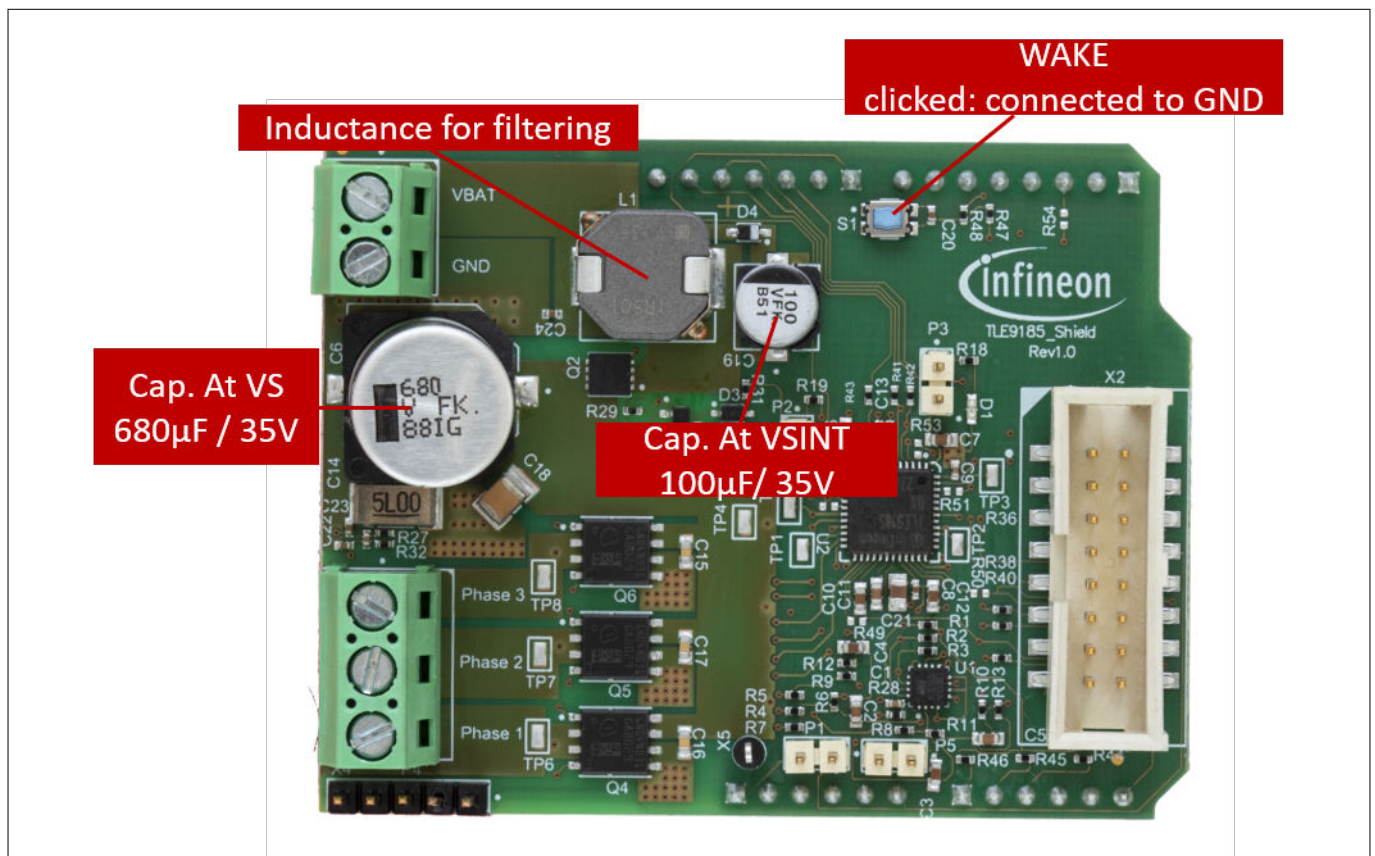


Figure 4 TLE9185QX/TLE9185QX V33 evaluation board: Overview 3

2 Hardware description

Wake push button: Push this button to exit sleep mode.

Note: Before sending the device into sleep mode, the wake-up source must be active.

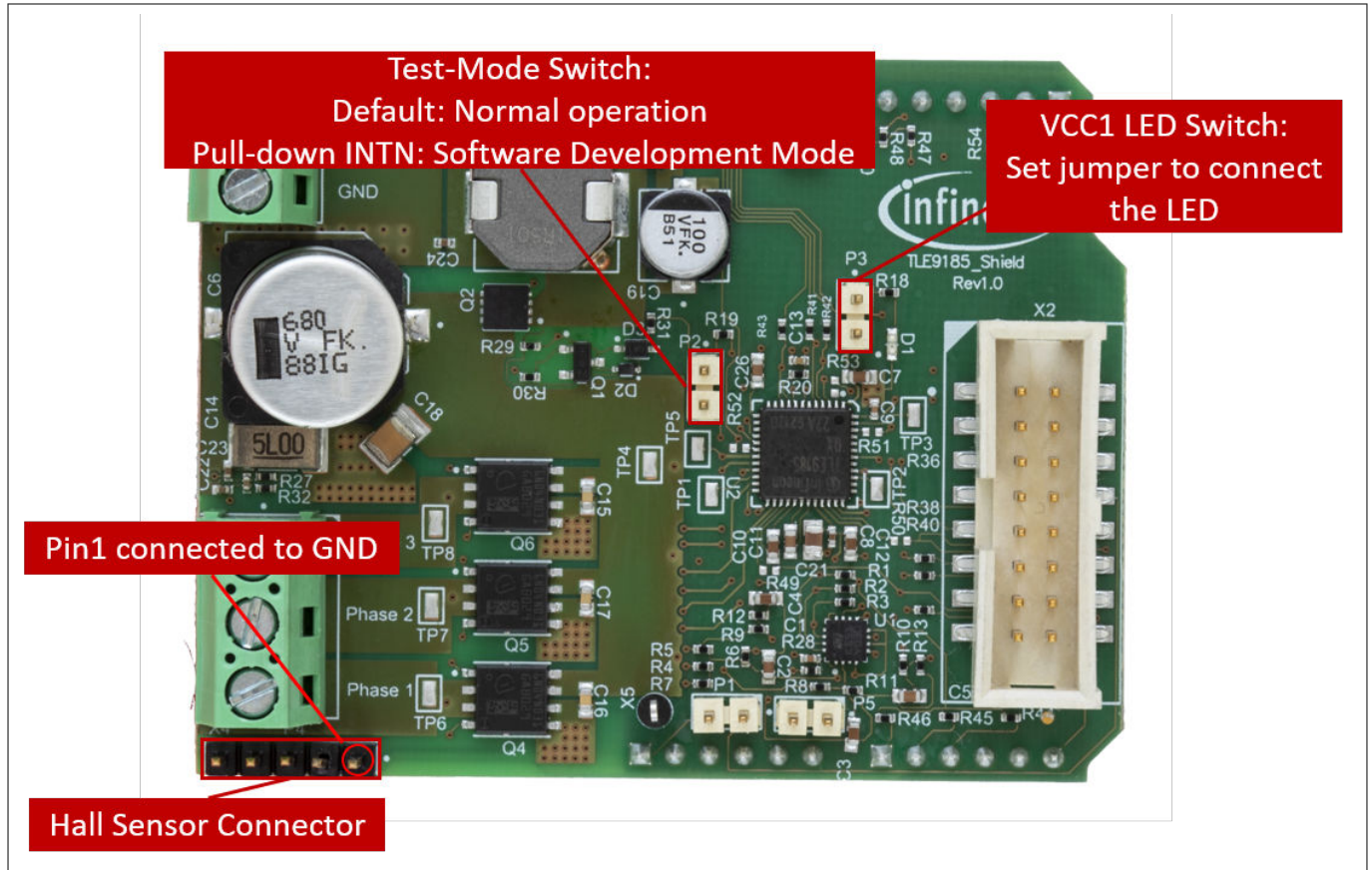


Figure 5 TLE9185QX/TLE9185QX V33 evaluation board: Jumper settings

Test-mode switch: Software development mode is a dedicated SBC configuration, which is especially useful for software development. In software development mode, the watchdog is enabled by default.

Cyclic redundancy check (CRC): The SPI interface also includes 8 bits used for the CRC to ensure data integrity of sent or received SPI commands.

2 Hardware description

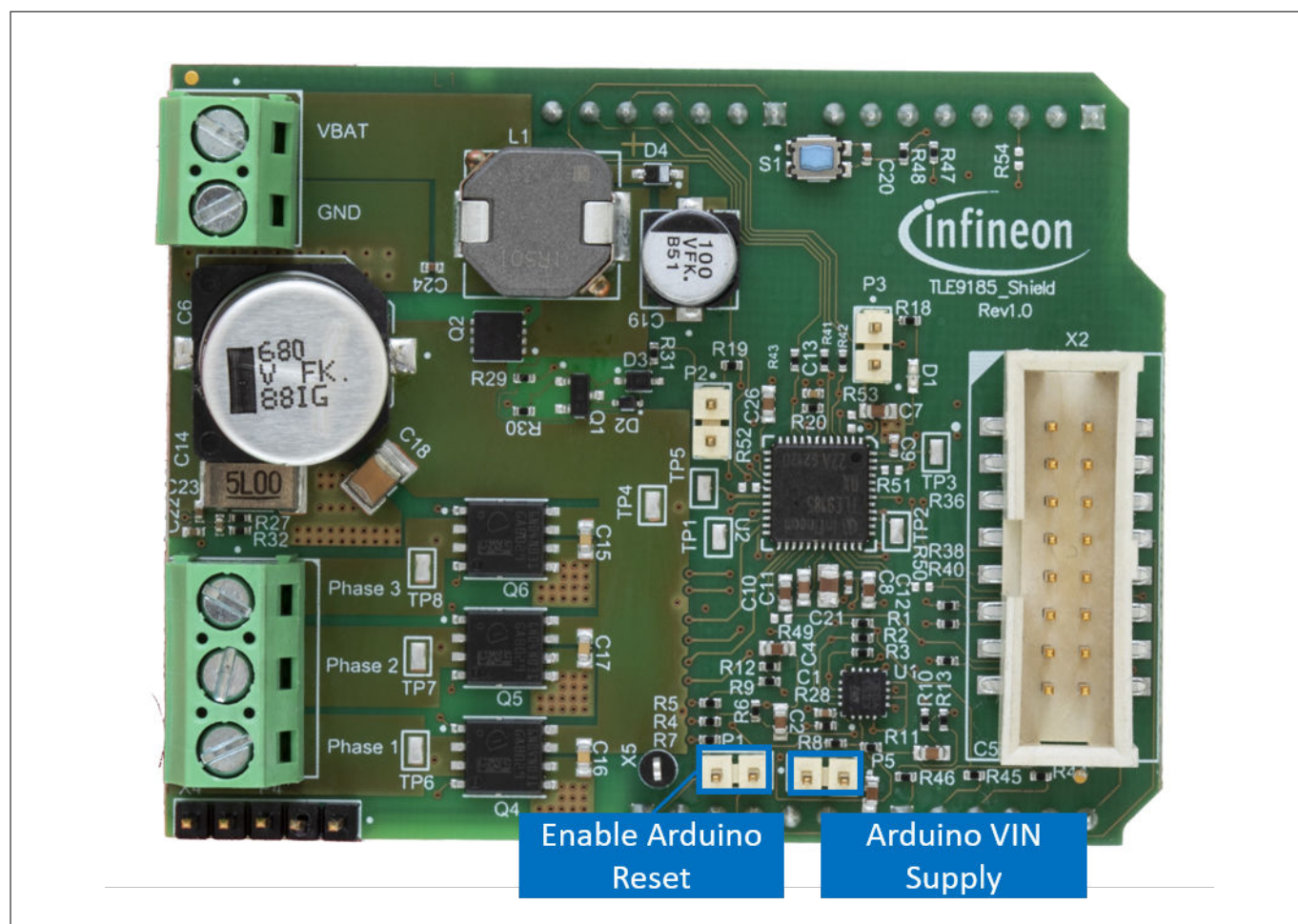


Figure 6 TLE9185QX/TLE9185QX V33 evaluation board: Arduino jumper settings

2 Hardware description

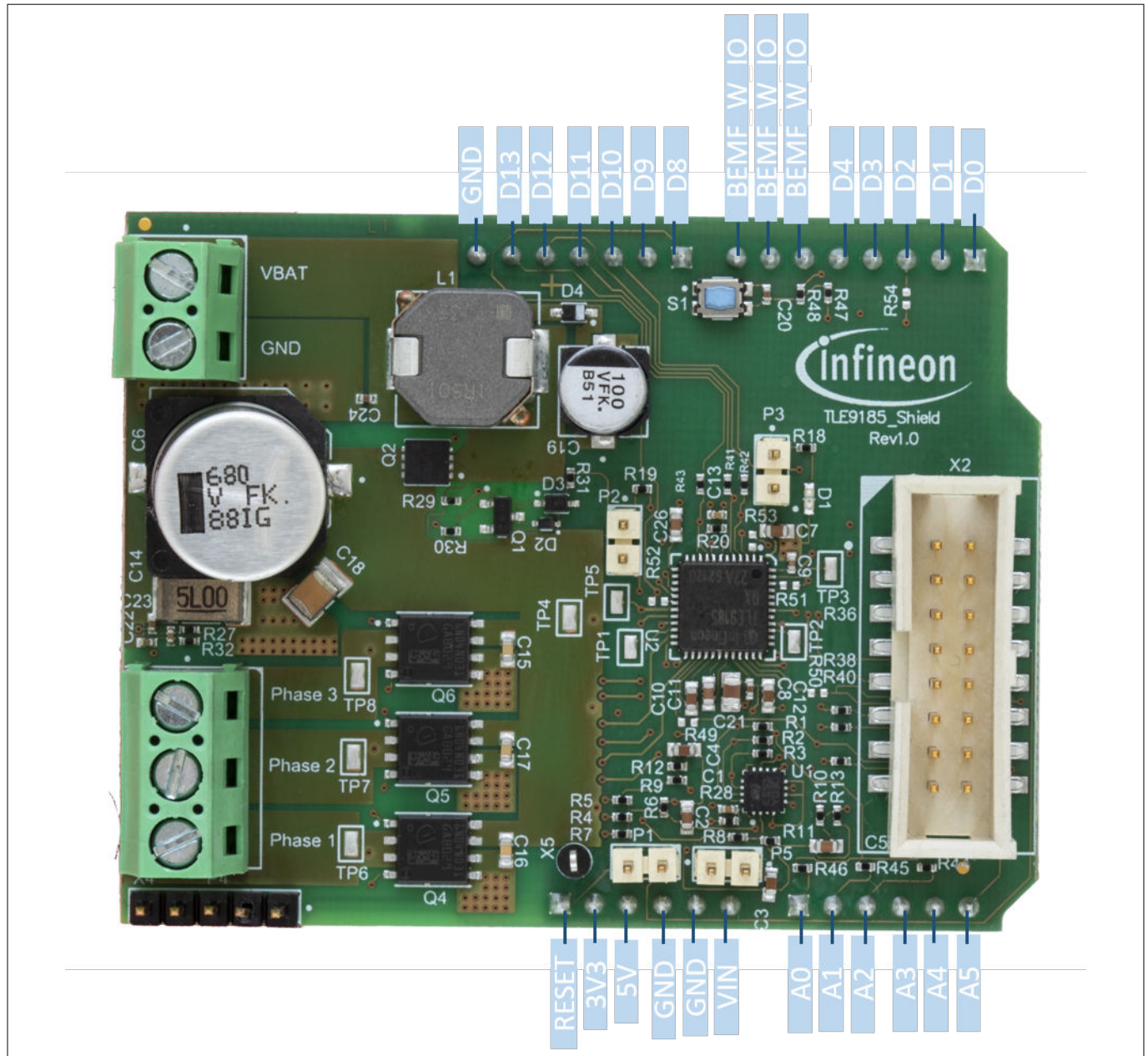


Figure 7 TLE9185QX/TLE9185QX V33 evaluation board: Arduino connectors

2.2 Schematics

Figure 8 Schematics: Connectors

2 Hardware description

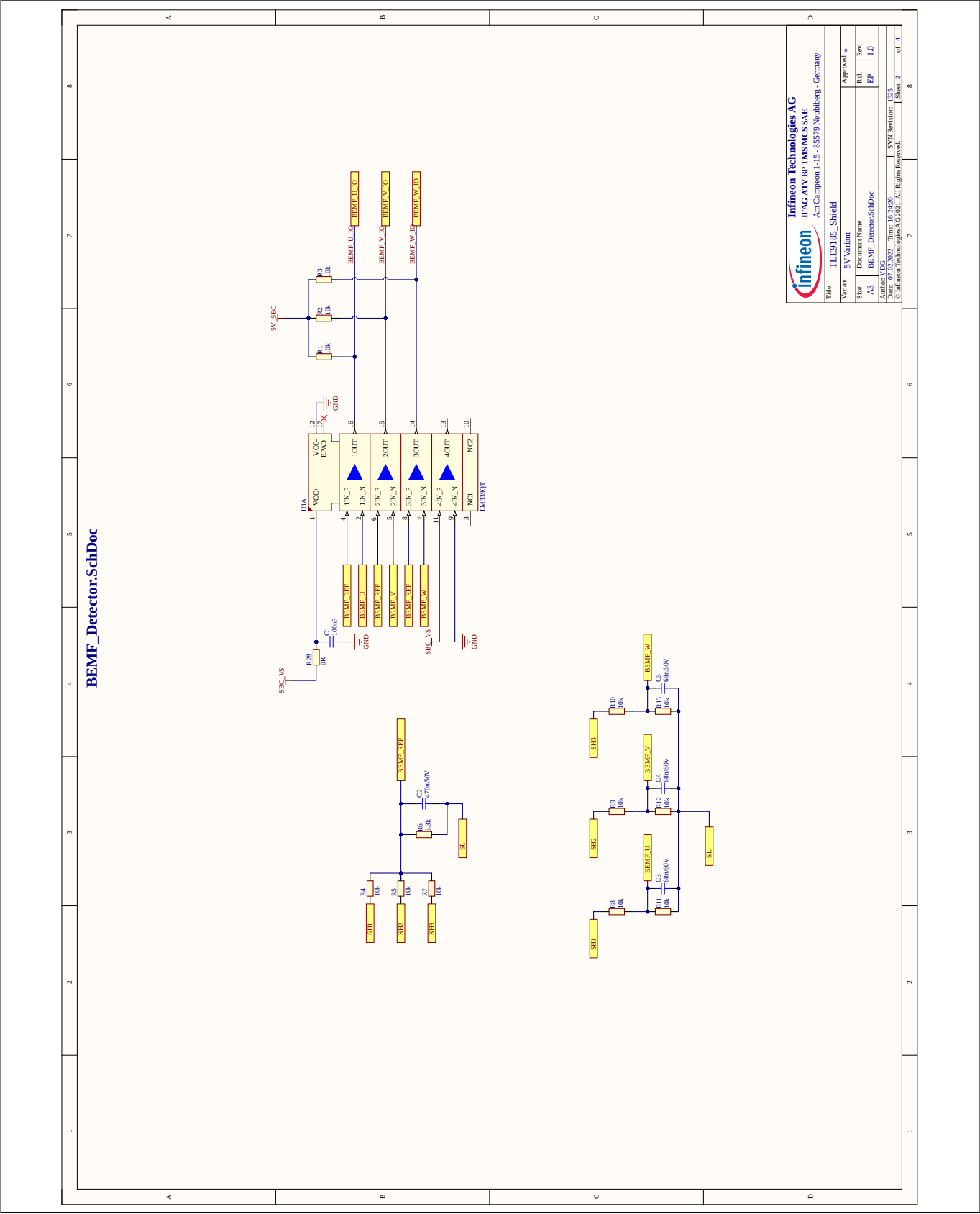
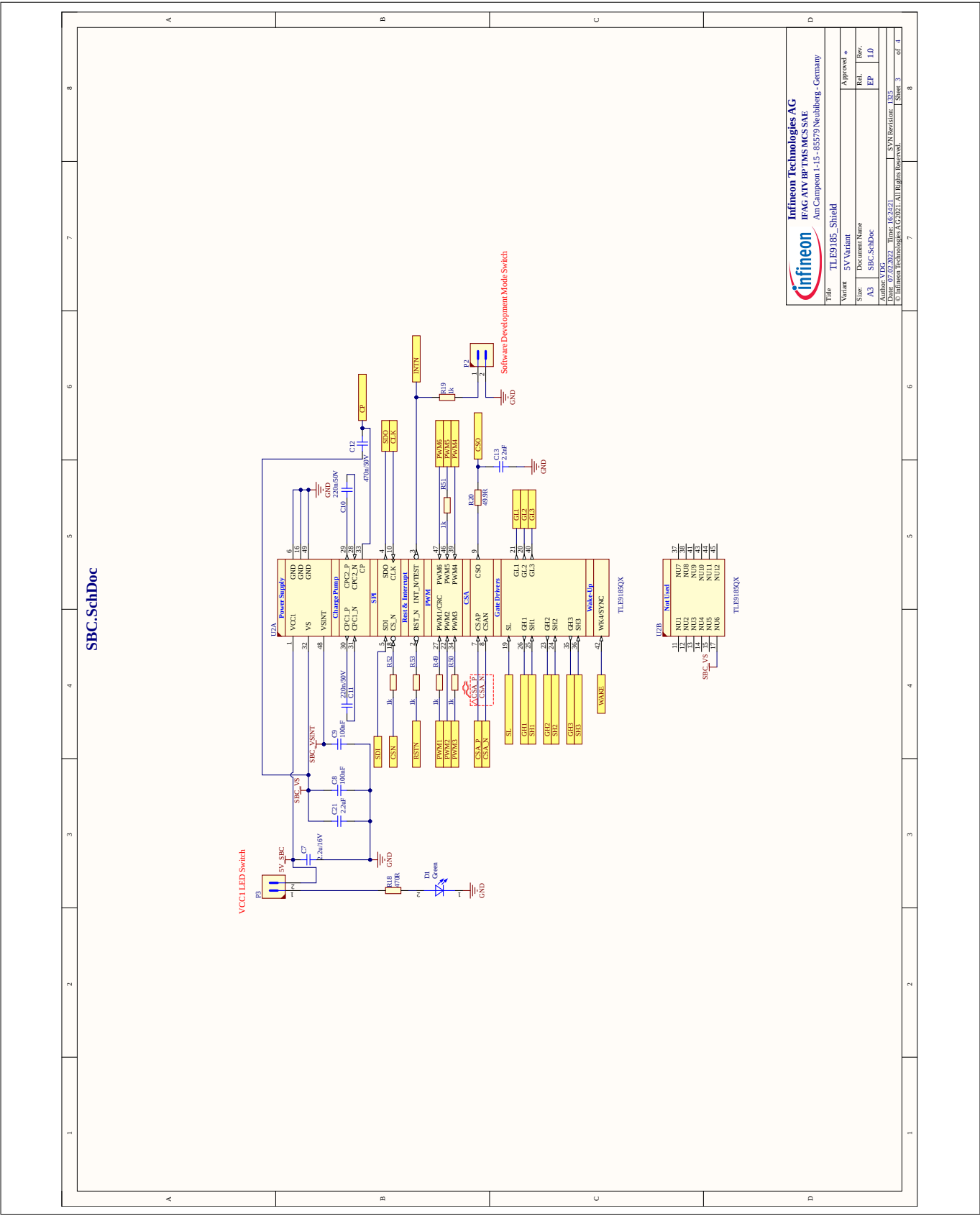


Figure 9 Schematics: BEMF detector



Figure 10 **Schematics: Power stages**

2 Hardware description



2 Hardware description

2.3 Layers

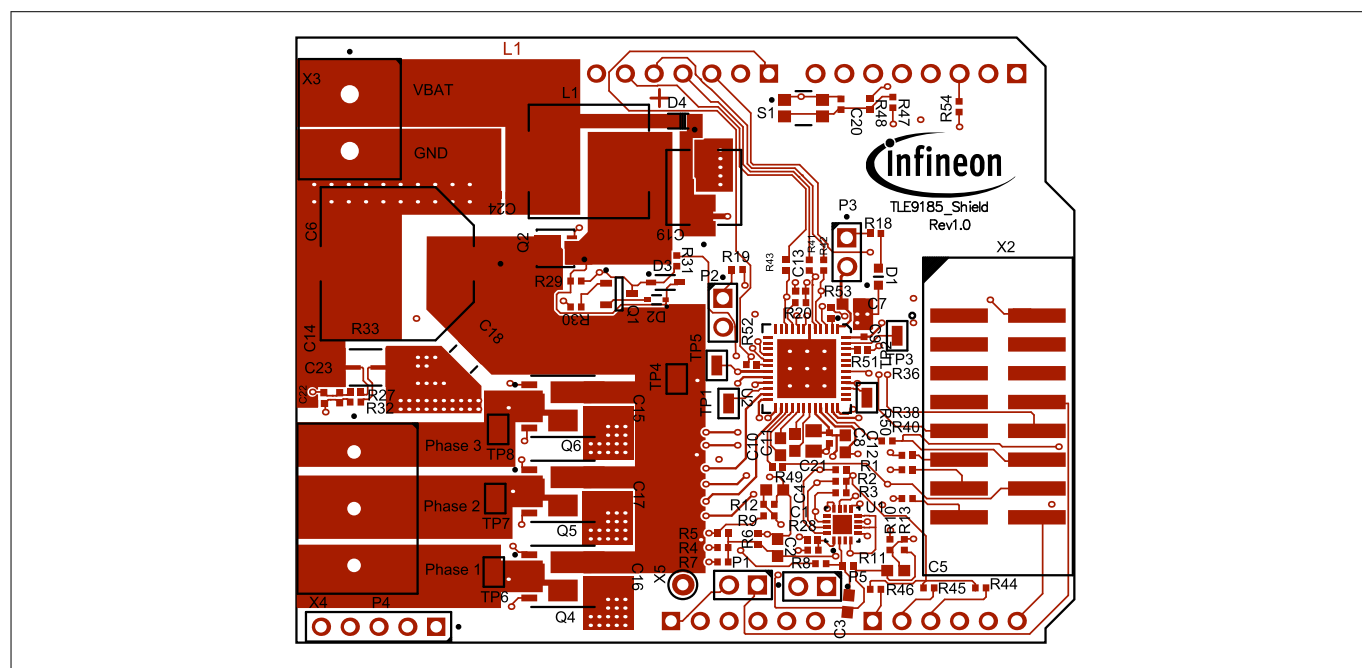


Figure 12 Top layer with overlay

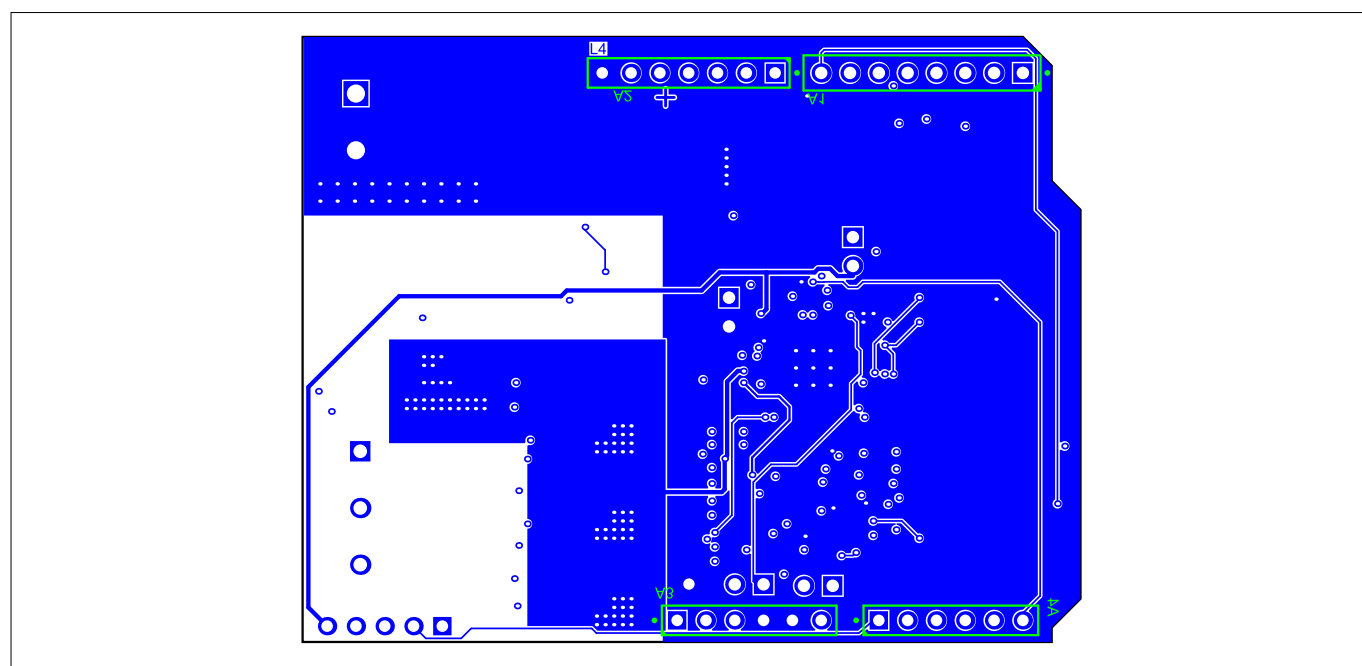


Figure 13 Bottom layer with overlay

2 Hardware description

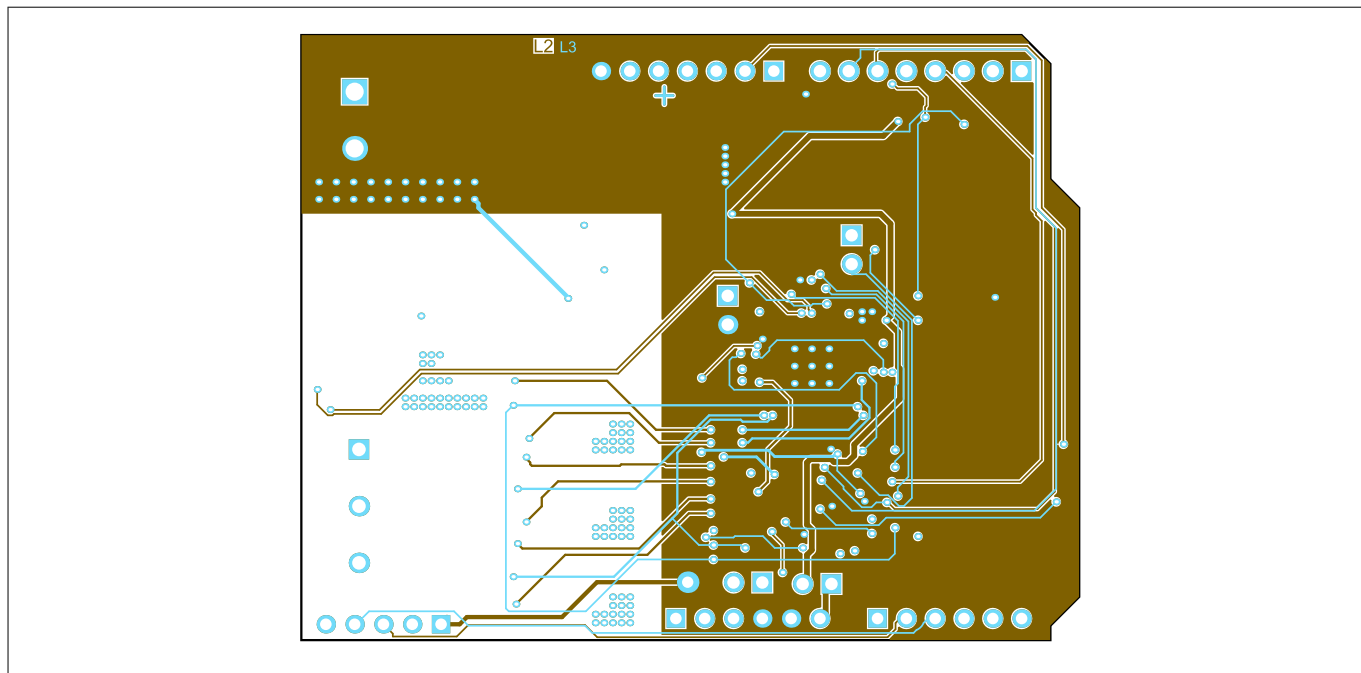


Figure 14 **Inner layer -GND**

2 Hardware description

2.4 Bill of material

Table 1 Bill of material

Designator	Quantity	Description	Manufacturer	Manufacturer order number
A1	1	Through-hole .025 SQ post header...	Samtec	TSW-108-23-F-S
A2	1	SQ post-terminal strip assembly	Samtec	TSW-107-23-F-S
A3, A4	2	SQ post-terminal strip assembly	Samtec	TSW-106-23-F-S
C1, C8, C9, C20, C24	5	CAP	TDK Corporation	CGA2B3X7R1H104K050BB
C2, C3, C4, C5, C7, C10, C11, C12	8	Multilayer ceramic chip capacitor	TDK Corporation	CGA3E3X7R1H474K080AE
C6	1	Aluminum electrolytic capacitors	Panasonic	EEEFK1V681AQ
C13	1	CAP	MuRata	GCM155R71H222KA37
C14	1	CAP	MuRata	GCM155R71H152KA37
C15, C16, C17	3	Surface-mount ceramic capacitor	AVX	06035C104K4Z2A
C18	1	Surface-mount ceramic capacitor	Kemet	C1210C106M5R2CAUTO
C19	1	Surface-mount aluminum electrolytic capacitor	Panasonic	EEE-FK1V101XV
C21	1	CAP	TDK Corporation	CGA4J3X7R1H225K125AB
C22, C23	2	CAP	MuRata	GCM155R71H223KA55
D1	1	Surface-mount LED	OSRAM Opto Semiconductors	LG L29K-G2J1-24
D2	1	Silicon Schottky diode	Infineon Technologies	BAS52-02V
D3	1	Zener diode	onsemi	SZMM3Z12VST1G
D4	1	Medium power AF Schottky diode	Infineon Technologies	BAT165
L1	1	IND	TDK Corporation	SPM10065VT-1R5M-D
P1, P2, P3, P5	4	Through-hole .025 SQ post-header	Samtec	HTSW-102-07-L-S

(table continues...)

2 Hardware description

Table 1 (continued) Bill of material

Designator	Quantity	Description	Manufacturer	Manufacturer order number
P4	1	SQ Post- terminal strip assembly	Samtec	TSW-105-23-F-S
Q1	1	NPN silicon AF transistor	Infineon Technologies	BC817K-40
Q2	1	OptiMOS-5 N-channel	Infineon Technologies	IPZ40N04S5L-2R8
Q4, Q5, Q6	3		Infineon Technologies	IAUC60N04S6N031H
R1, R2, R3, R4, R5, R7, R8, R9, R10, R11, R12, R13, R31, R44, R45, R46, R47, R48	18	Standard thick- film chip resistor	Vishay	CRCW040210K0FK
R6	1	Standard thick- film chip resistor	Vishay	CRCW04023K30FK
R18	1	Standard thick- film chip resistor	Vishay	CRCW0402470RFK
R19, R49, R50, R51, R52, R53, R54	7	RES	Vishay	CRCW04021K00FK
R20	1	Standard thick- film chip resistor	Vishay	CRCW040249R9FK
R27, R32	2	Standard thick-film chip resistor	Vishay	CRCW04024R70FK
R28	1	0R	Panasonic	ERJ2GE0R00X
R29	1	Standard thick- film chip resistor	Vishay	CRCW0402100KFK
R30	1	Standard thick- film chip resistor	Vishay	CRCW040247K0FK
R33	1	RES	KOA Speer Electronics Inc.	TLR3AWDTE5L00F75
R36, R38, R40, R41, R42, R43	6	RES	Vishay	CRCW0402330RFK
S1	1	Switch tactile Spst-	Würth Elektronik	434153017835
U1	1	Low-power quad voltage comparators	STMicroelectronics	LM339QT
U2	1	BLDC driver	Infineon Technologies	TLE9185QX
X2	1	SMT	Samtec	HTST-108-01-L-DVÂ
X3	1	Conn terminal	Amphenol	20020316-G021B01LF

(table continues...)

2 Hardware description

Table 1 (continued) **Bill of material**

Designator	Quantity	Description	Manufacturer	Manufacturer order number
X4	1	PCB terminal block	Phoenix Contact	1792876
X5	1	Test point THT	Keystone Electronics Corp.	5001

3 Getting started and programming the μ IO stick

3.1 Download the graphical user interface (GUI) for the μ IO stick

To install the GUI from the Infineon Developer Center, follow the steps below.

1. Go to www.infineon.com/toolbox
2. Follow the instructions provided on the Infineon Developer Center Launcher webpage
3. Launch the Infineon Developer Center on your PC
4. Click Manage Tools
5. Search and install the tool Config Wizard for MOTIX™ motor gate driver ICs
6. Start the Config Wizard for MOTIX™ motor gate driver ICs
7. Click TLE9185 SHIELD or TLE9185V33 SHIELD

3.2 Configuration wizard for the TLE9185QX/TLE9185 V33

Before using the μ IO stick in combination with the GUI for the TLE9185QX/TLE9185QX V33, you must program the μ IO stick:

1. Set the jumper P2 to pull down the INT/TEST pin, which places the device in software development mode
2. Set the jumper P3 to connect the LED to the VCC1 (5 V or 3.3 V regulator)
3. Connect the μ IO stick to the USB port
4. Supply the board connecting the VS
5. Start ConfigWizard.exe. Refer to the figure below

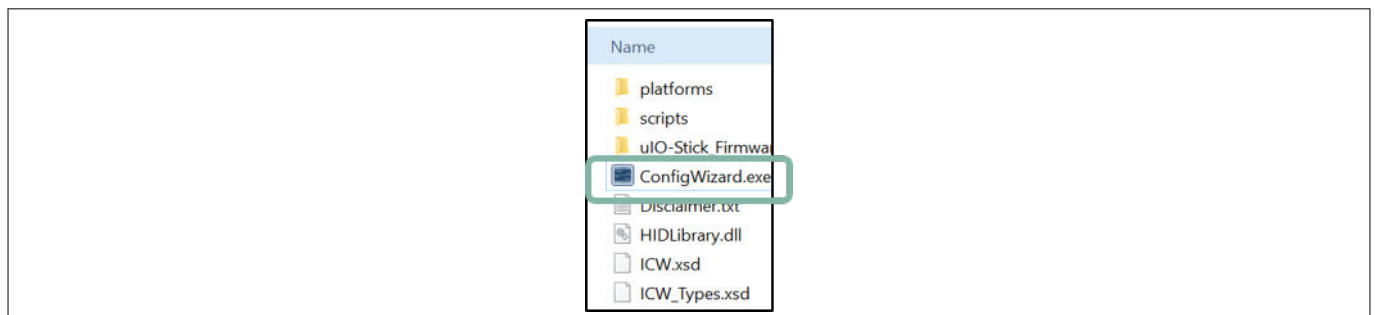


Figure 15 ConfigWizard.exe

6. Click the Extra tab
7. Click Update μ IO

3 Getting started and programming the μ IO stick

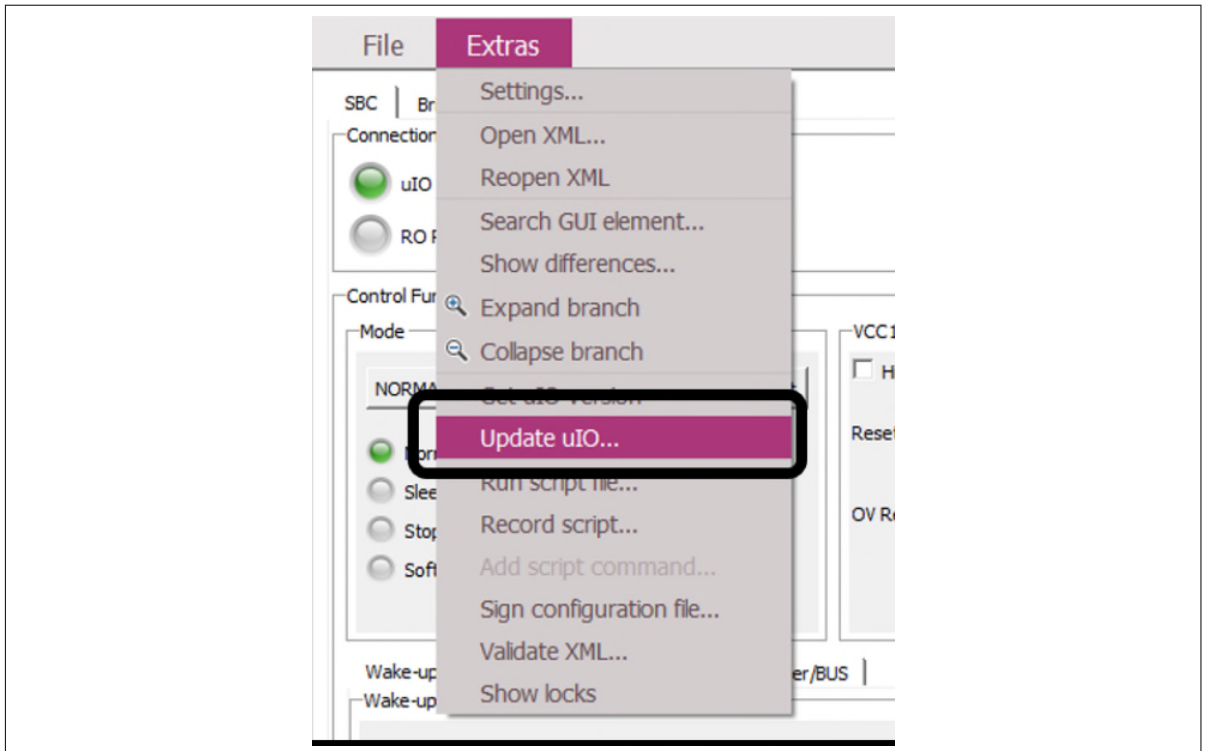


Figure 16 Update μ IO

8. Click yes, as shown in the figure below

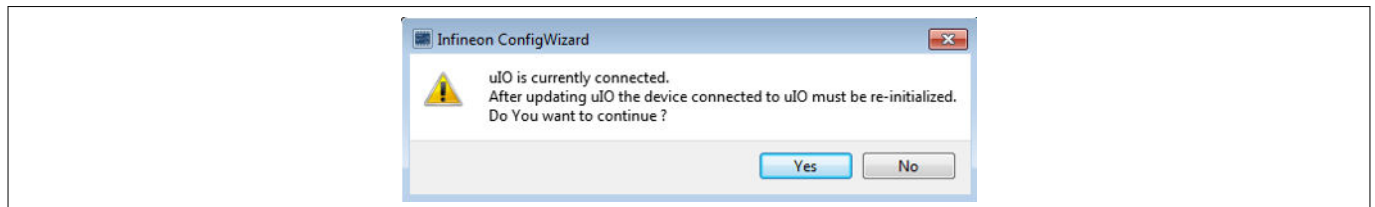


Figure 17 Dialog box: Infineon ConfigWizard

9. Select μ IO.V222.hex and click open (the valid version at the creation time of the document)

4 Config wizard - control tabs

There are three main windows:

 - SBC: Overview – Selected in this view

 - Bridge Driver:



Figure 18 The two main tabs: SBC and bridge driver

4.1 SBC

-  - Green LED: Communication between the uIO stick and the TLE9185QX/TLE9185QX V33 is connected and is working
-  - Target IC accessible:
-  - Firmware version of the connected uIO
-  - RO Pin activated:



Figure 19 Connection status/Signaling pin status

4 Config wizard - control tabs

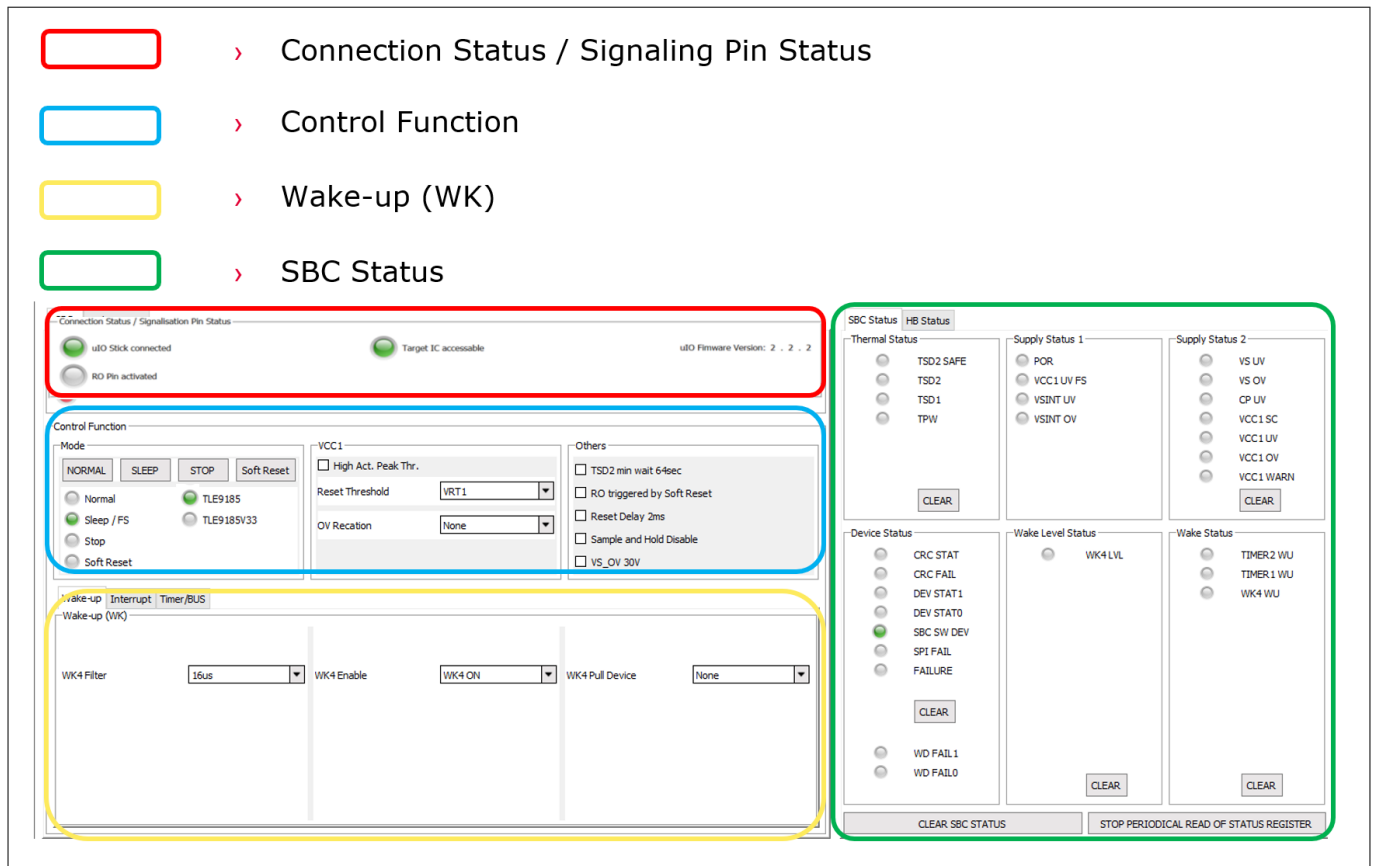


Figure 20 Overview of the SBC tab

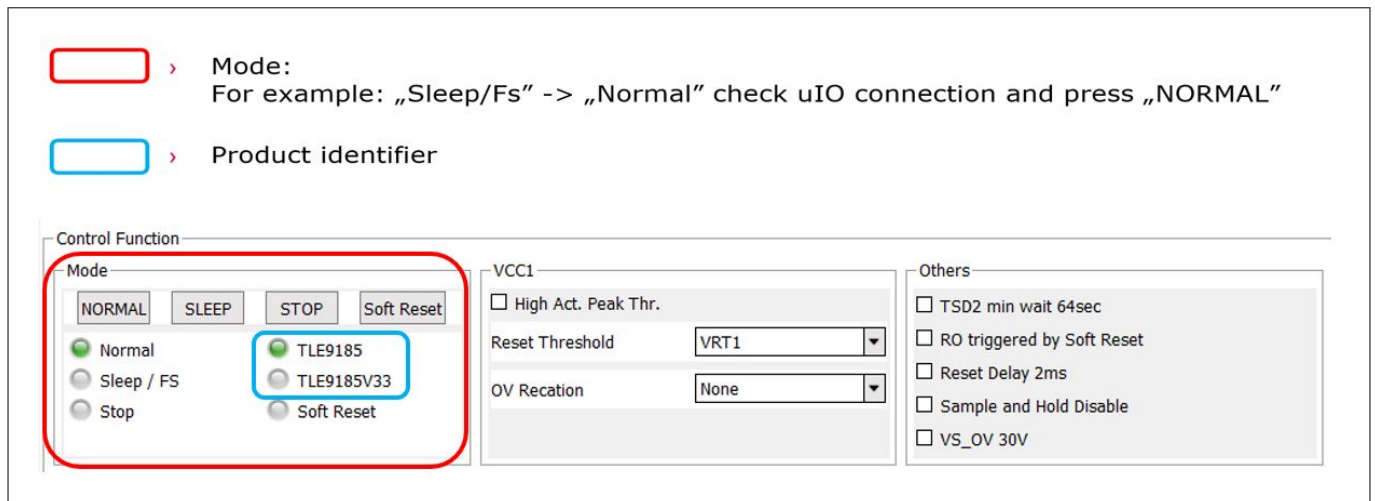


Figure 21 SBC: Control function, Mode

4 Config wizard - control tabs

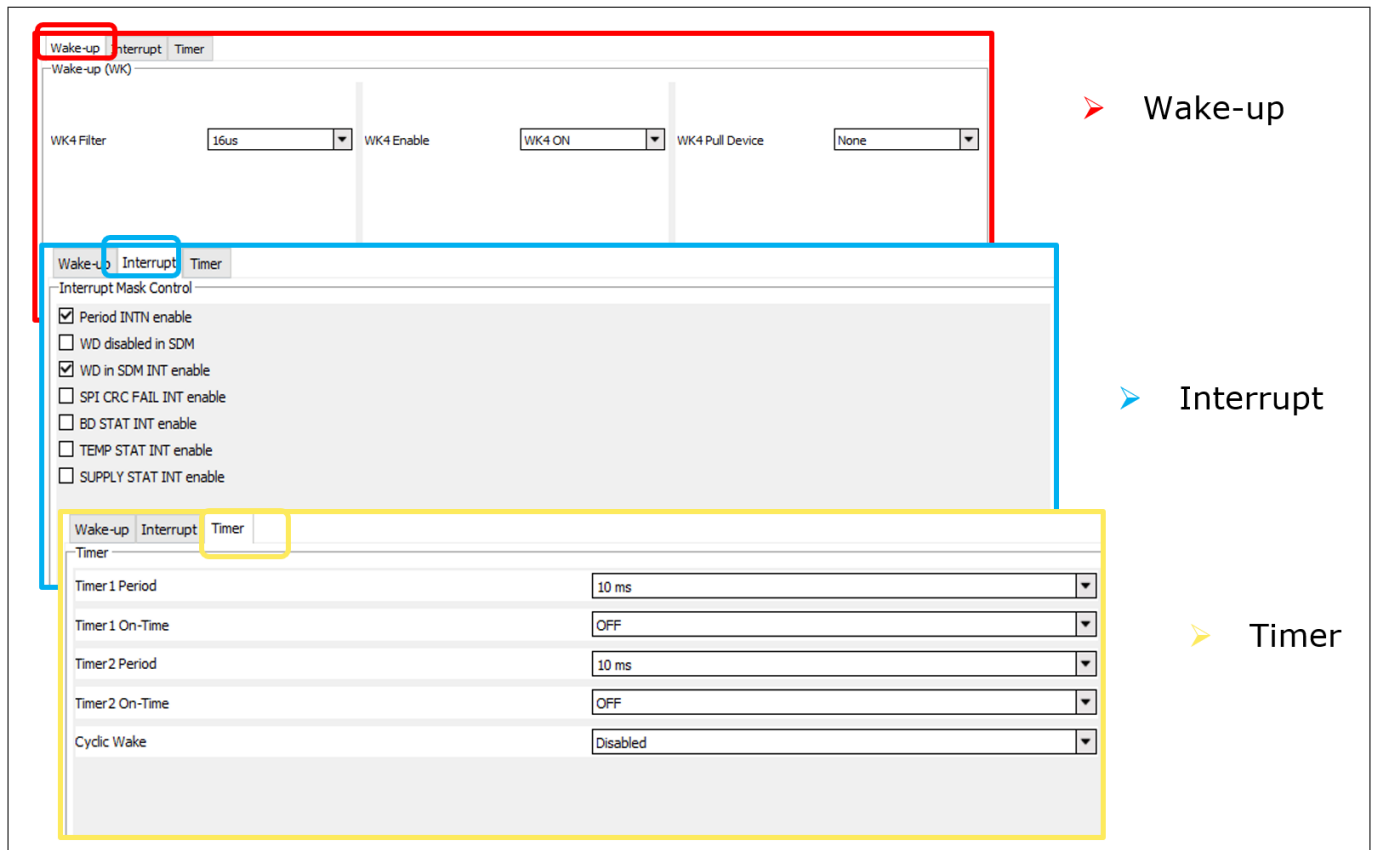


Figure 22 SBC: Wake-up, interrupt, timer

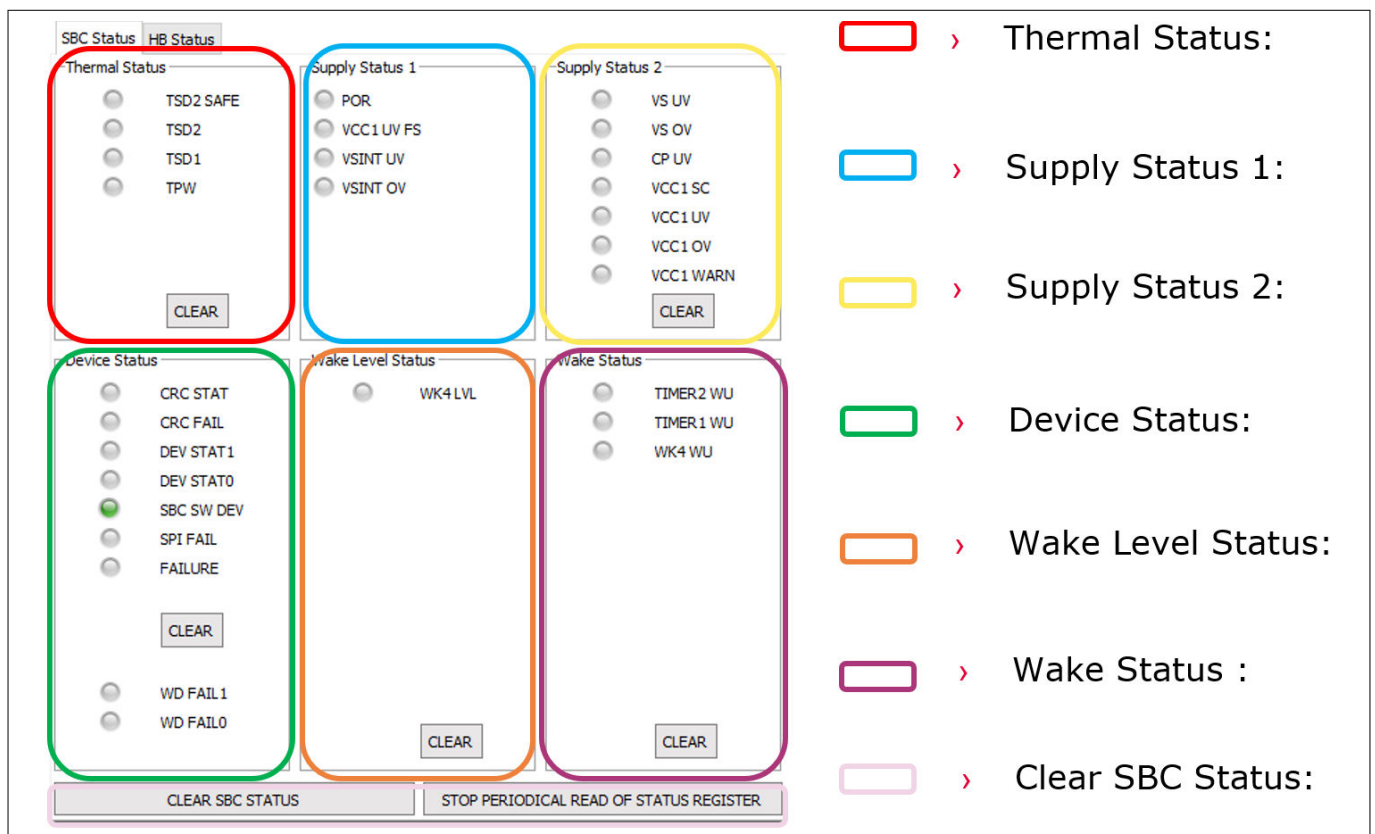


Figure 23 SBC status

4 Config wizard - control tabs

PWM Switching Characteristics

	Config, TDON	Config, TDOFF	Eff, TDON	Eff, TDOFF	Eff, TRISE	Eff, TFALL
PWM Ch.1	639.6ns	639.6ns	0ns	0ns	0ns	0ns
PWM Ch.2	639.6ns	639.6ns	0ns	0ns	0ns	0ns
PWM Ch.3	639.6ns	639.6ns	0ns	0ns	0ns	0ns

Current Sense Amp. (CSA)
 Current Vscox = 0V

GEN Status

- ☐ HB3VOUT
- ☐ HB2VOUT
- ☐ HB1VOUT
- ☐ PWM6STAT
- ☐ PWM5STAT
- ☐ PWM4STAT
- ☐ PWM3STAT
- ☐ PWM2STAT
- ☐ PWM1STAT

TD REG

- ☒ IPDCHG3 ST
- ☒ IPDCHG2 ST
- ☒ IPDCHG1 ST
- ☒ IPCHG3 ST
- ☒ IPCHG2 ST
- ☒ IPCHG1 ST
- ☒ TDREG3
- ☒ TDREG2
- ☒ TDREG1

DSOV

- ☐ CSA OC
- ☐ VSINTOOVBRAKE ST
- ☐ VSOVBRAKE ST
- ☐ LS3DSOV BRK
- ☐ LS2DSOV BRK
- ☐ LS1DSOV BRK
- ☐ LS3DSOV
- ☐ HS3DSOV
- ☐ LS2DSOV
- ☐ HS2DSOV
- ☐ LS1DSOV
- ☐ HS1DSOV

Legend:

- > PWM Switching Characteristics:
- > GEN Status
- > TD REG
- > DSOV
- > Clear Diagnostic Bridge Driver (BD) Status

Figure 24 Half-bridge (HB) status

4.2 Bridge driver

General / CSA / VDS Mon

Ext. PWM Generation via uIO-Std

F = 20 kHz

PWM1 Enable ☐

PWM1 Duty Cycle 0 %

PWM3 Enable ☐

PWM3 Duty Cycle 0 %

PWM5 Enable ☐

PWM5 Duty Cycle 0 %

F = 400 Hz

Info: 0-10 for (0% - 100%)

General Bridge Control

BD Freq ☒ 18.75 MHz ☐ 37.5 MHz

CPUV Threshold 1

ext. MOSFET Logic Level

☐ single/auto CP auto switch over

☐ BRDV recover from OV

☐ 2 steps adaption of precharge/predischarge current

Adaptive Gate Control 0:Disabled

☐ Charge Pump Enable

☐ Postcharge disable

☐ Filter adaptive gate control

☐ Detection of active/FW Mosfet

Hold Current TH1

☐ Frequency Modulation enable

CSA control

PWM Inputs 3 PWM

CSA output cap max. 400pF

CS Direction Bidirectional

CS OV Filter Time 6us

☒ CSA disabled

OC Threshold of CS TH1

Gain of Current Sensor 10V/V

☒ OC shutdown enabled

LS/HS Drain Current

LS Filter Time 0.5us

LS1 OV Threshold 0.20V

LS2 OV Threshold 0.20V

LS3 OV Threshold 0.20V

☐ Deep adaptation enable

HS1 OV Threshold 0.20V

HS2 OV Threshold 0.20V

HS3 OV Threshold 0.20V

Legend:

- > On-Board PWM Generator
- > General Bridge Control
- > CSA Control
- > LS/HS Drain Current

Figure 25 Bridge driver: 1st tab - General, CSA, VDS monitoring (Mon)

4 Config wizard - control tabs

Blank time / CCP time

TBLANK ACTIVE_HB1: 2.45us
TCCP ACTIVE_HB1: 2.45us
TBLANK ACTIVE_HB2: 2.45us
TCCP ACTIVE_HB2: 2.45us
TBLANK ACTIVE_HB3: 2.45us
TCCP ACTIVE_HB3: 2.45us
TBLANK ACTIVE_FW1: 2.45us
TCCP ACTIVE_FW1: 2.45us
TBLANK ACTIVE_FW2: 2.45us
TCCP ACTIVE_FW2: 2.45us
TBLANK ACTIVE_FW3: 2.45us
TCCP ACTIVE_FW3: 2.45us

HBMODE / Precharge Predischarge time

HB1 Mode: Passive Off
☒ Act. Freewheeling HB1
☐ PWM HB1
HB2 Mode: Passive Off
☒ Act. Freewheeling HB2
☐ PWM HB2
HB3 Mode: Passive Off
☒ Act. Freewheeling HB3
☐ PWM HB3
Precharge Time HB1: 107ns
Precharge Time HB2: 107ns
Precharge Time HB3: 107ns
Predischarge Time HB1: 107ns
Predischarge Time HB2: 107ns
Predischarge Time HB3: 107ns

Brake

☐ LS1 Disable in SLAM
☐ LS2 Disable in SLAM
☐ LS3 Disable in SLAM
☐ SLAM Active
VDS OV Brake LS1-3: ☒ 800 mV ☐ 220 mV
Blank Time Brake: ☐ 7 us ☒ 11 us
☐ Parking Brake enable
☐ OV Brake enable
OV Brake Hysteresis: Hyster 1
OV Brake Threshold: 27 V

TDON / TDOFF Timing

tDON HB1: 0.64 us
tDON HB2: 0.64 us
tDON HB3: 0.64 us
tDOFF HB1: 0.64 us
tDOFF HB2: 0.64 us
tDOFF HB3: 0.64 us

Legend:

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

Figure 26 Bridge driver: 2nd tab - blank/CCP time, HBMODE, brake, TDON/TDOFF/timing

Static charge/discharge current

HB1: 15.3 mA / 15.1 mA
HB2: 15.3 mA / 15.1 mA
HB3: 15.3 mA / 15.1 mA

PWM max precharge/predischarge

HB1: 31.6 mA / 30.9 mA
HB2: 31.6 mA / 30.9 mA
HB3: 31.6 mA / 30.9 mA
☐ HB1 off-state pull-down
☐ HB2 off-state pull-down
☐ HB3 off-state pull-down

Precharge / Predischarge INIT

Precharge HB1 Init: 10.8 mA
Predischarge HB1 Init: 13.5 mA
Precharge HB2 Init: 10.8 mA
Predischarge HB2 Init: 13.5 mA
Precharge HB3 Init: 10.8 mA
Predischarge HB3 Init: 13.5 mA

PWM charge/discharge current

Charge HB1 Active: 10.8 mA
Charge HB2 Active: 10.8 mA
Charge HB3 Active: 10.8 mA
Discharge HB1 Active: 13.5 mA
Discharge HB2 Active: 13.5 mA
Discharge HB3 Active: 13.5 mA
Charge/Discharge HB1 FW: 10.8 mA / 10.7 mA
Charge/Discharge HB2 FW: 10.8 mA / 10.7 mA
Charge/Discharge HB3 FW: 10.8 mA / 10.7 mA

Legend:

- 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
- Maximum precharge and pre-discharge currents

Figure 27 Bridge driver: 3rd tab - MOSFET drive currents

Revision history

Document version	Date of release	Description of changes
Rev.1.00	2022-06-27	First release

References

- [1] *www.hitex.com* <http://www.hitex.com/uio>
- [2] *Infineon Developer Center Launcher (formerly Infineon Toolbox)* <https://www.infineon.com/cms/en/design-support/tools/utilities/infineon-developer-center-idc-launcher/>

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