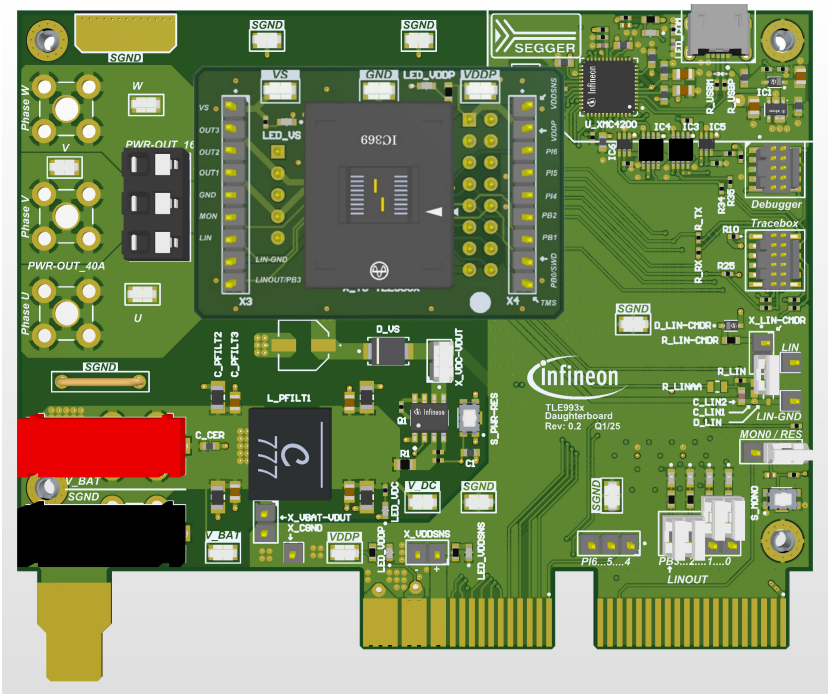
TLE993x boards

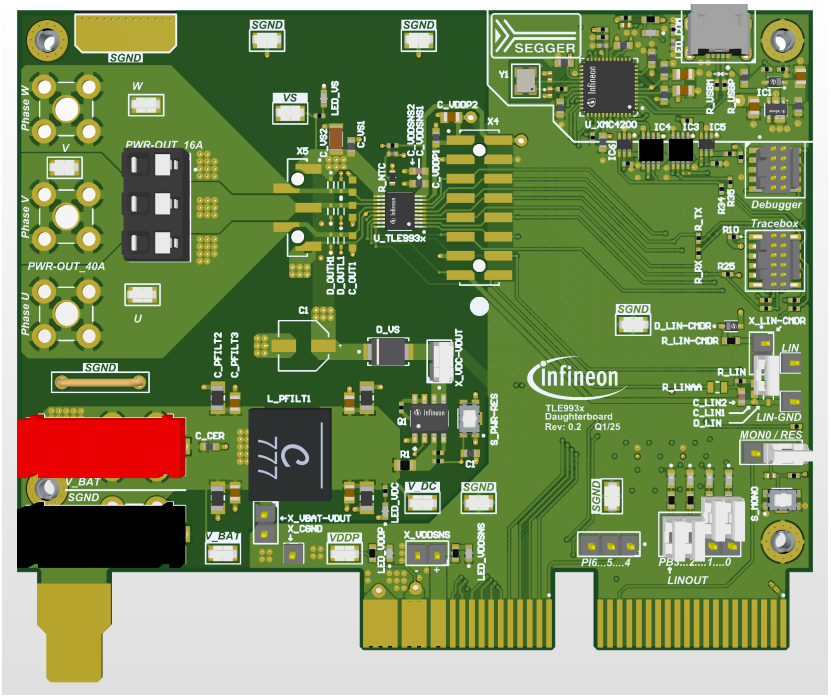
User guide

Hardware: TLE993x_Daughterboard_rev0_2

Evaluation board



Evaluation kit



About this document

Scope and purpose

This user guide is intended to help users operating the TLE993x daughterboards: evaluation board and evaluation kit. They are designed to evaluate the hardware and software features of the MOTIX™ *microcontroller unit (MCU)* TLE993x family.

This document provides information about the boards' functionality, interfaces, jumper settings, assembled components, configurations through optional resistors and debugging options. In addition, it includes the default *bill of materials (BOM)*, schematics, and layout of the board.

Intended audience

This document is intended for anyone using the TLE993x daughterboard.

Evaluation board

The TLE993x evaluation is designed for use with the socket board, described in the corresponding chapter in this document. This board is used during design in, for the evaluation and testing of the MOTIX™ MCU TLE993x family features.

Evaluation kit

The TLE993x evaluation kit (evalkit) includes an on-board TLE993x device, so a socket board is not necessary.

***Note**: The printed circuit board (PCB) and auxiliary circuits are NOT optimized for final customer design.*

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Safety precautions

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 DC supply, or excessive ambient temperatures may result in system malfunction.*
	**Caution:** *The evaluation or reference board is shipped with packing materials that need to be removed prior to installation. Failure to remove all packing materials that are unnecessary for system installation may result in overheating or abnormal operating conditions.*

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1 The board at a glance

This board is designed to provide a simple, easy-to-use set up for getting familiar with Infineon's MOTIX™ *MCU* TLE993x family.

A socket for the device enables the evaluation of multiple device variants without need to re-solder them if a device gets damaged or a different variant needs to be tested.

The board is protected against reverse polarity of the input voltage supply. A *light-emitting diode (LED)* LED_VDC indicates that the board is connected to the supply correctly.

The board is ready to be connected to a car supply or similar and offers an on-board debugger as well as a *serial wire debug (SWD)* interface. The integrated power-stage in the TLE993x family directly allows you to drive a motor.

The board can be operated by standard laboratory equipment.

1.1 Delivery content

The TLE993x daughterboard with evaluation board variant is delivered with the socket on the board.

The TLE993x device is not included in the delivery package.

1.2 Block diagram and realistic view

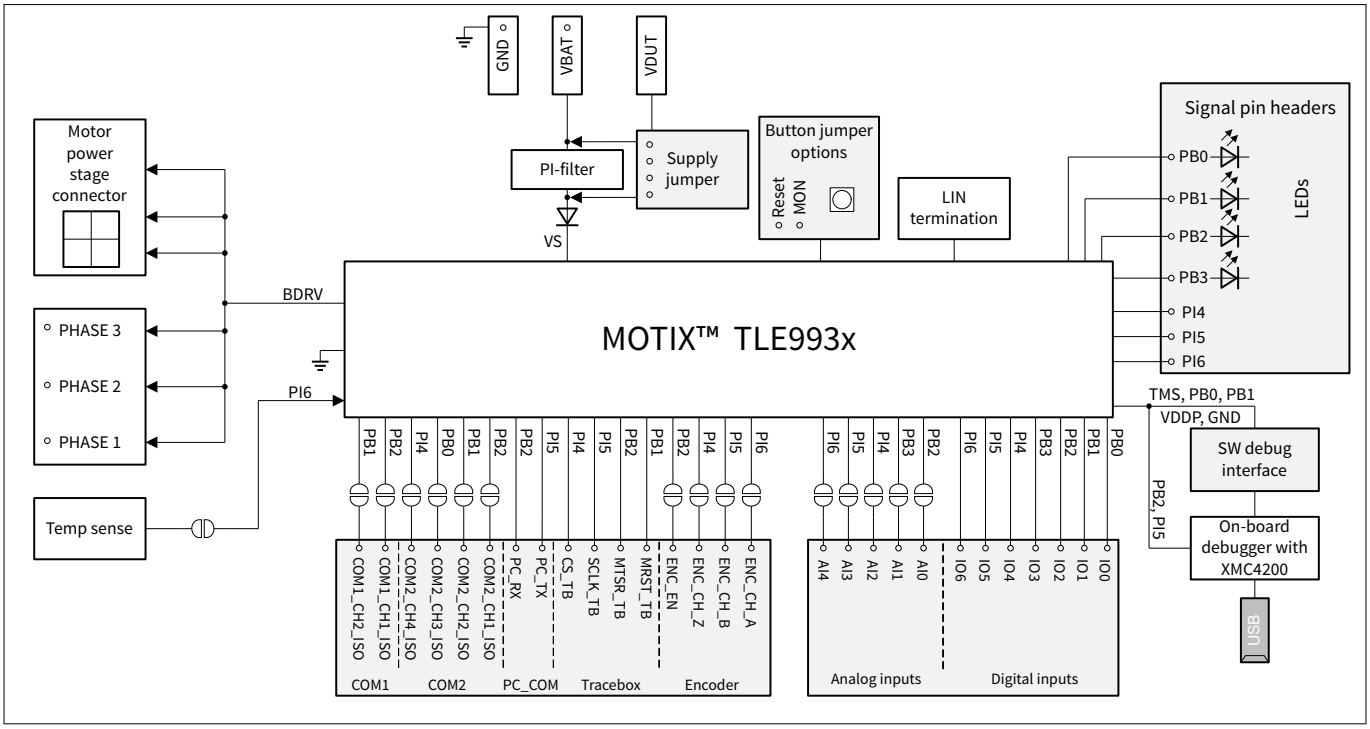

Figure 1 Block diagram

1 The board at a glance

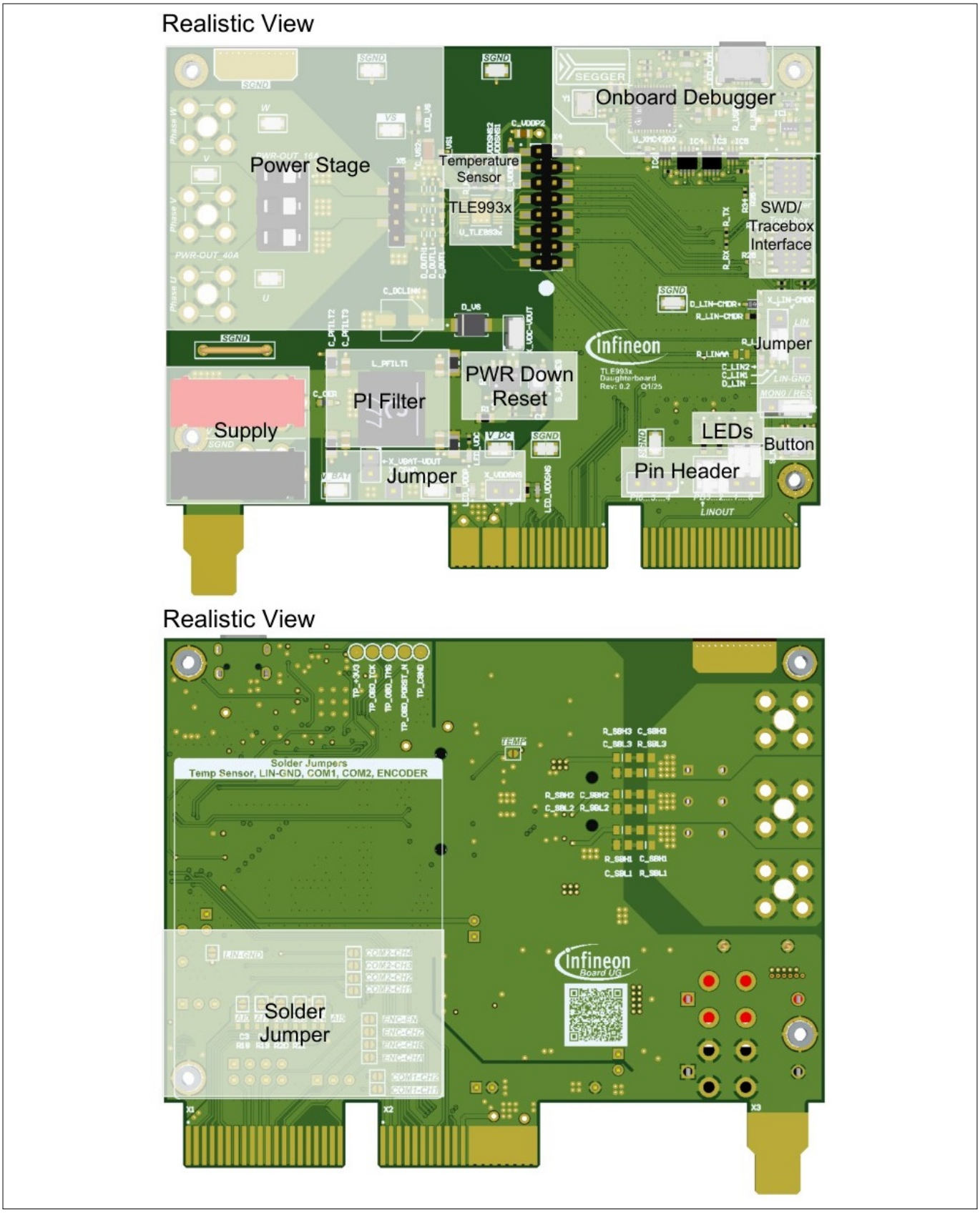

Figure 2 Functional blocks on the TLE993x daughterboard

1.3 Main features

This list provides an outline of the essential features of the TLE993x daughterboard.

- Socket to easily replace the device, as well as direct placement option
- On-board connectors for *brushless direct current (BLDC)* motors
- PI-filter and reverse polarity protection for the supply
- A *local interconnect network (LIN)* connection with option for LIN master termination
- Single configurable push button for the *MON* and *RESET* pins
- LEDs for supply voltage, DC-link voltage, +5 V supply, and for *general purpose input output (GPIO)*s
- On-board debugger to enable plug and play
- Connectors for debugger and Tracebox
- On-board temperature sensor
- Solder jumpers for configuration

1.4 Technical data

The technical data of the TLE993x daughterboard is specified in the table below.

For details on battery and motor connectors, refer to Connectors and Socket board.

A socket board is available for the TLE993x daughterboard with TSDSO-18 spring socket. This variant is the TLE993x evaluation board. Devices of the same package can be exchanged with the plastic spring socket on the socket board.

Measurements can be performed close to the device pins at the pin headers. The following are placed on the socket board: VS and VDDP LEDs, test points, and an external debugger connector. A top and bottom view of the socket is shown in Socket board.

If working with higher currents than the specified maximum ratings, you must apply the safety precautions accordingly.

Table 2 Technical data

Voltage supply	Max. 29 V [1) 2)]
Supply current	Max. 2 A [1) 2)]
Pin ports P0.x, P1.x, P2.x	5 V [2)]
Temperature	25°C

1) Specified by design
2) Limited by the functional range of the TLE993x. Refer to the device datasheet for additional information

2 System and functional description

2.1 Board information

2.1.1 Connectors

The connectors on the daughterboard are used for power supply, power terminals for motor connections, debugging, and other connections.

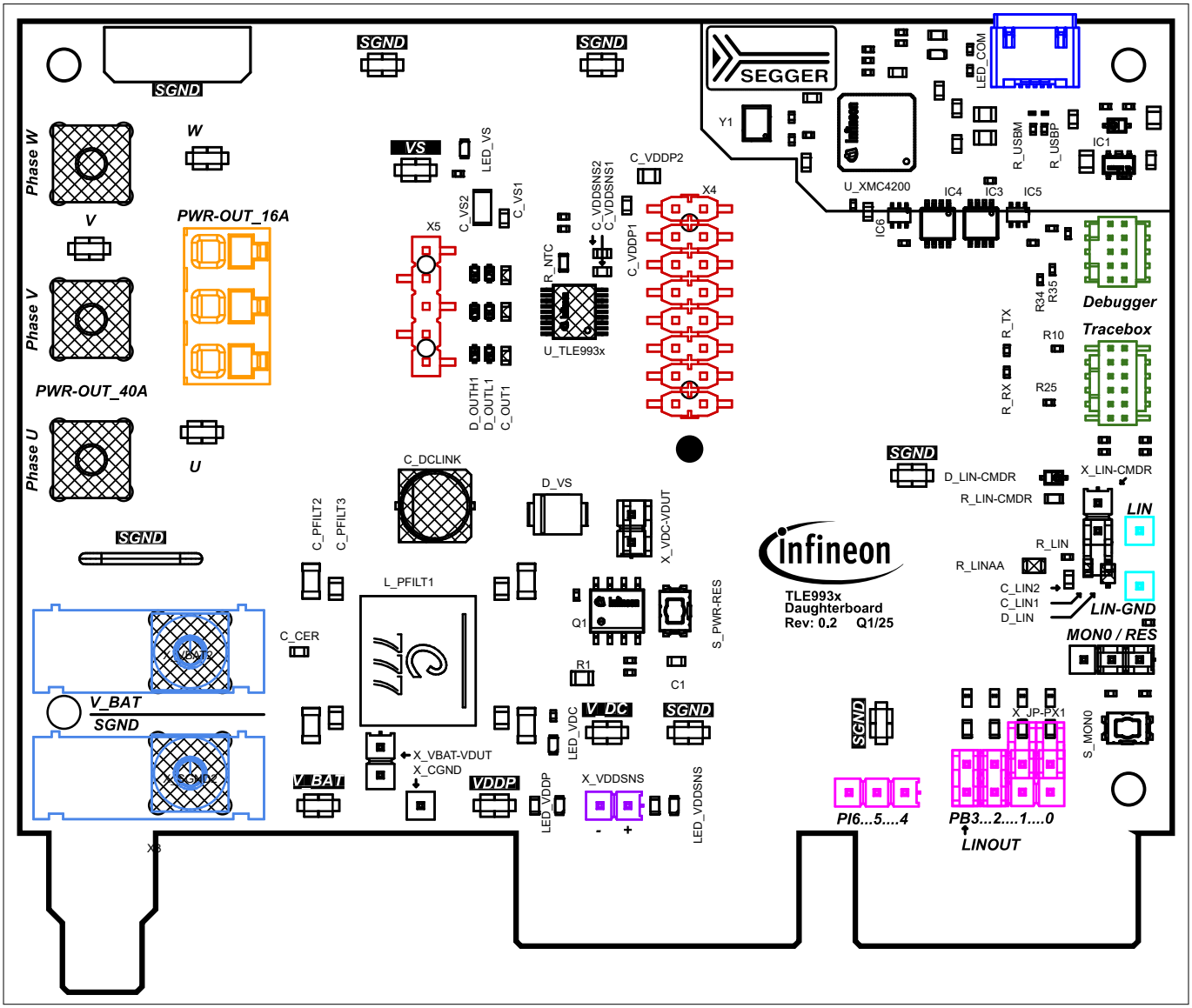

Figure 3 Connectors

Table 3 Connectors

Functionality	Description
V_BAT, SGND	Banana jacks for power supply (red) and ground (black)

(table continues...)

Table 3 (continued) Connectors

Functionality	Description
PWR-OUT_16A	Power terminal for motor connections Phase 1 (bottom), Phase 2 (middle) and Phase 3 (top). The phases of the motor should be connected either to this connector. Refer to Socket board for more information
X4, X5	The connectors for the socket board connection
X_VDDSNS	Connector to measure the VDDSNS and GND
IO 0…7	*input/output (I/O)* connector for PB0 to PB3 along with LEDs and PI4 to PI6
LIN, LIN-GND	LIN connector for using the jumper cable
Debugger	Debugging interface to connect external debugger
Tracebox	12-pin connector for a Tracebox connection (should be enabled by solder jumpers, refer to Solder jumpers)
USB	USB connector for micro-USB cable to connect the on-board debugger to a PC for the debugging and virtual COM port

2.1.2 Test points

The TLE993x daughterboard contains a number of test points to facilitate testing and debugging, as shown below.

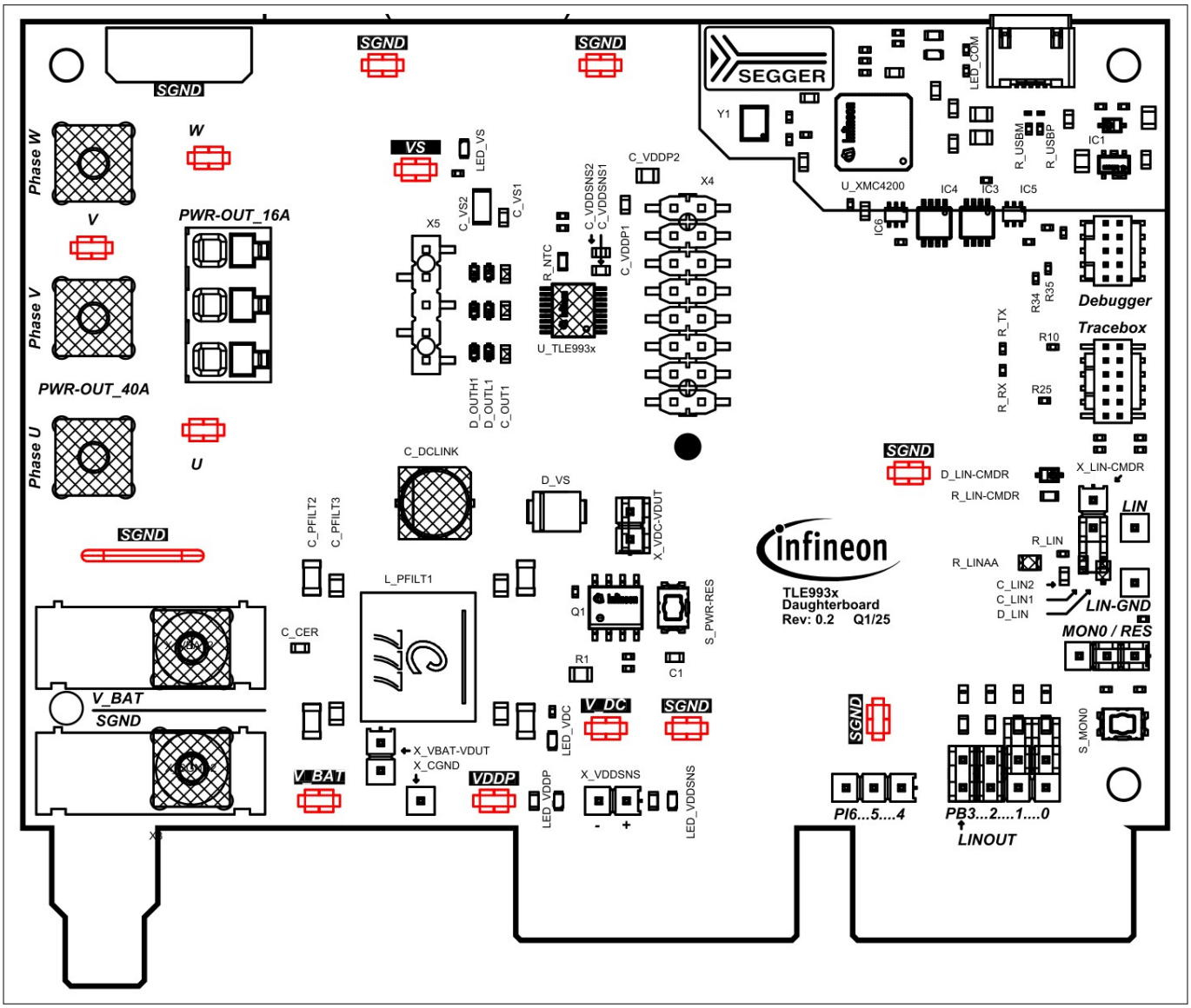

Figure 4 Test points

Table 4 Test points

Signal	Description
V_BAT	Test point to measure the board supply voltage
V_DC	Test point to measure the DC-link voltage
VS	Test point to measure the device Vs pin voltage
VDDP	Test point to measure the device VDDP voltage
SGND	Test points to connect to power ground
U, V, W	Test points to measure the motor phase voltages

2.1.3 LEDs

The LEDs and potential connectors are shown in the figure and table below.

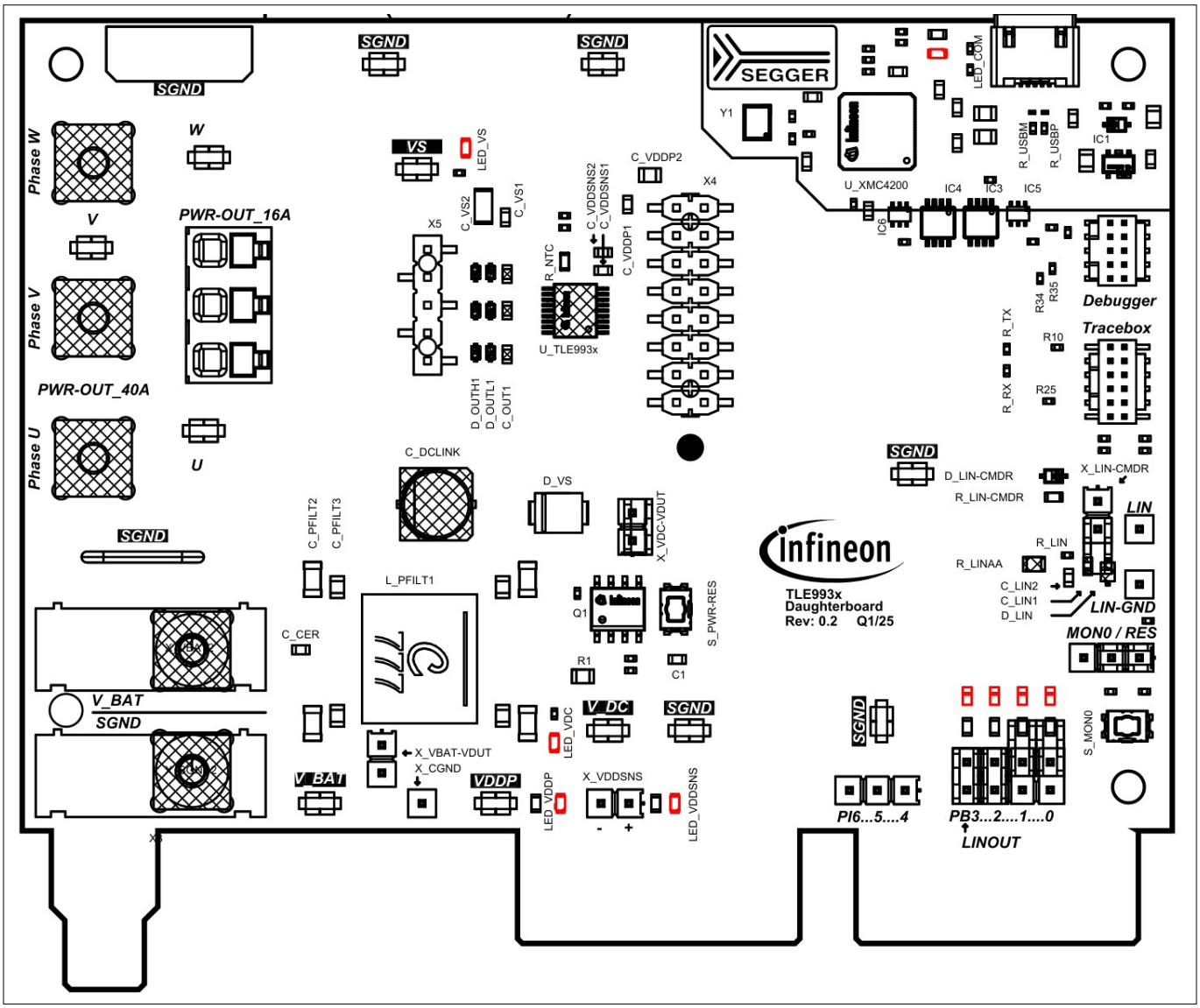

Figure 5 LEDs

Table 5 LEDs

Designator	Description
LED_VDC	Indicates that there is a positive voltage at DC-link (V_DC)
LED_VDDP	Indicates that there is a positive voltage at VDDP
LED_VDDSNS	Indicates that there is a positive voltage at VDDSNS
LED_COM	Indicates that there is a communication with on-board debugger
D2	Can be connected to *GPIO* PB0 with jumper
D3	Can be connected to GPIO PB1 with jumper
D4	Can be connected to GPIO PB2 with jumper
D5	Can be connected to GPIO PB3 with jumper

2.1.4 Jumpers

Jumpers allow for easy configuration changes without the need for soldering. Multiple jumper options are available on this daughterboard. The jumper setting options are described below.

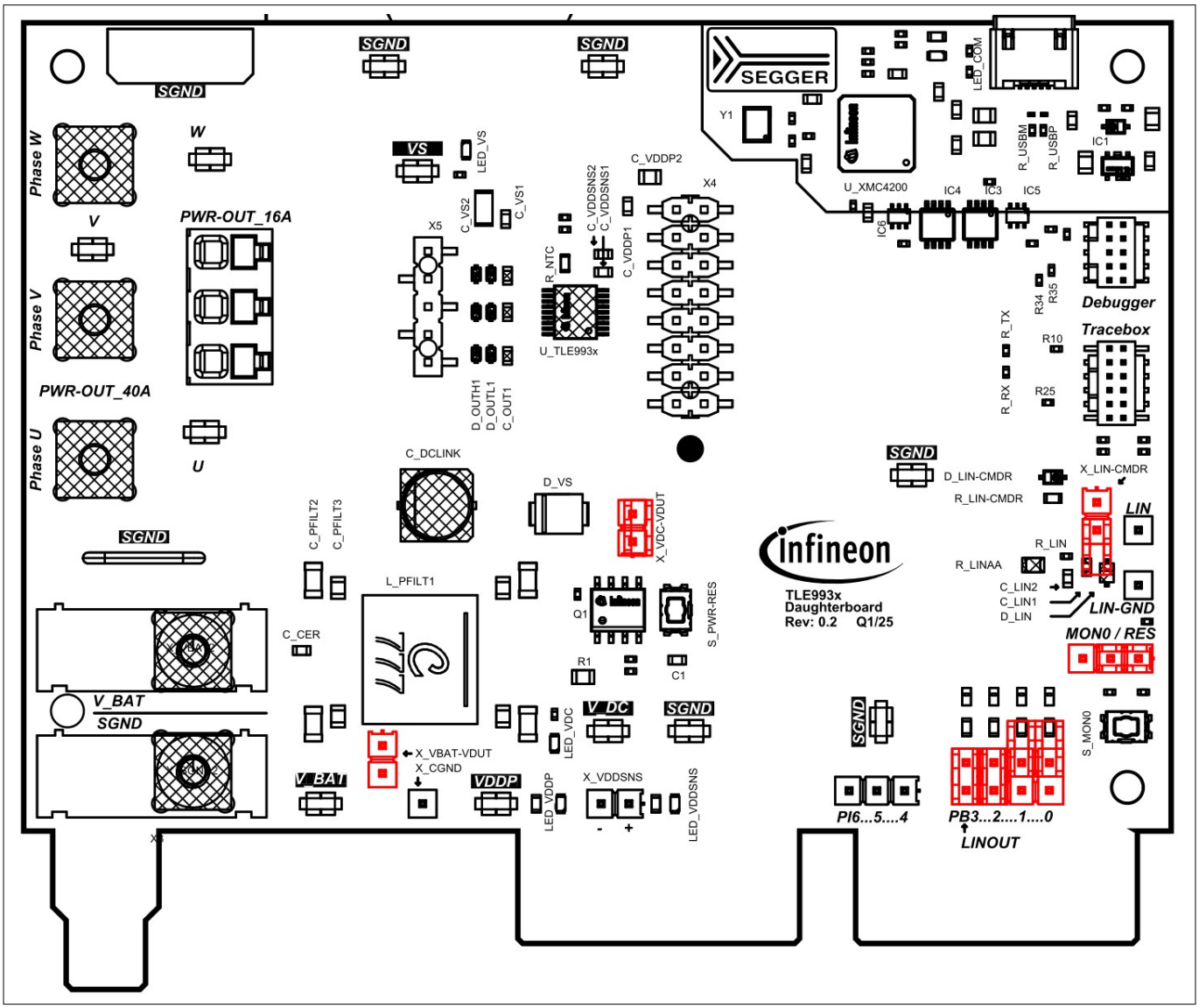

Figure 6 Jumpers

Table 6 Jumpers

Designator	Description
X_VBAT-VDUT	Set jumper to connect V_BAT to V_DUT
X_VDC-VDUT	Set jumper to connect V_DC to V_DUT
PB3…2…1…0	Set jumpers to connect the LEDs to PBx
X_LIN-CMDR	Set jumper to add external 1 kΩ pull-up resistor for *LIN* commander if needed. Remove the jumper to remove external pull-up
MON0 / RES	Set jumper to pin 2 and pin 3 (left two pins) to use the button for *MON* pin input. Set jumper to pin 1 and pin 2 to use the button for Reset (right two pins)

2.1.5 Push buttons

The push button is used for multiple purposes on this daughterboard, depending on the jumper setting.

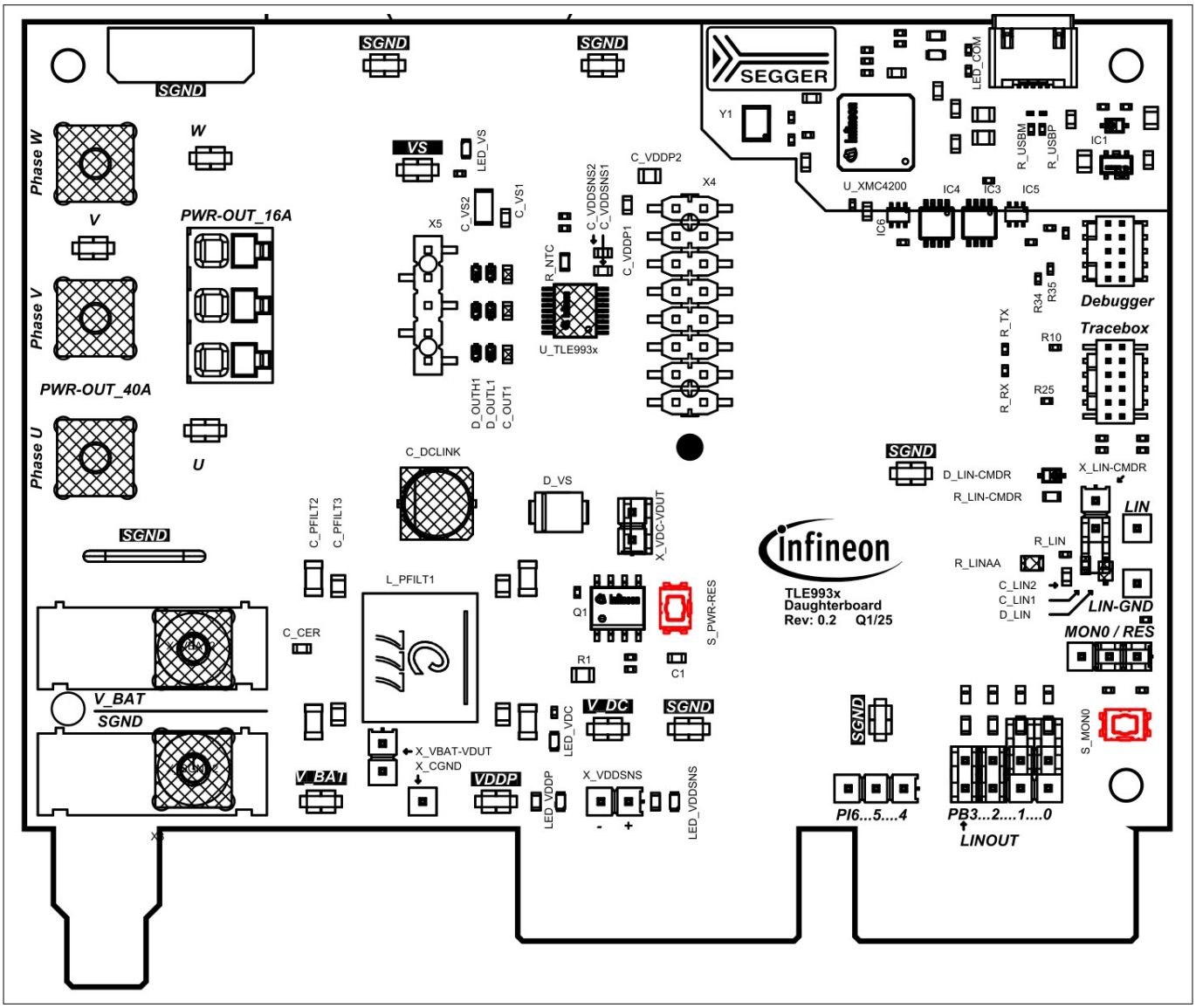

Figure 7 Push button

Table 7 Push buttons

Designator	Description
S_MON0	S_MON0 is a normally opened push button that can be used for both MON input and Reset, depending on the jumper setting. For more information on jumpers, refer to Jumpers
S_PWR-RES	S_PWR-RES is a normally opened push button that can be used to create a power-on reset without turning off the power supply

2.1.6 Solder jumpers

Solder jumpers are connectors used to make connections by soldering two pads. They are provided to offer additional configuration options to the user.

The interconnection for certain functionalities is illustrated in the schematic sheet in Schematics TLE993x daughterboard. Only the solder jumpers TEMP and *LIN*-GND are implemented on the board, while the others come from the MOTIX™ MCU motherboard.

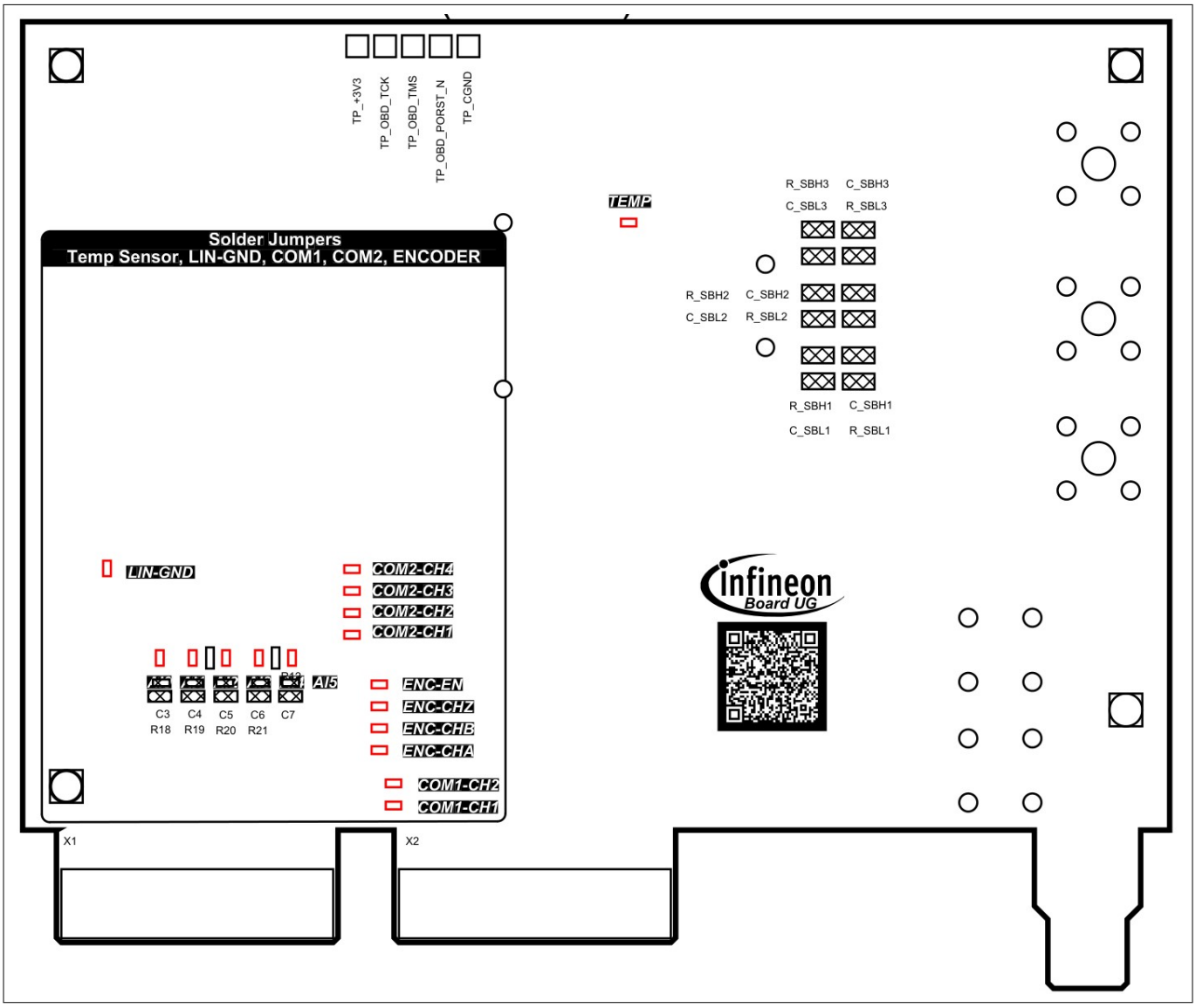

Figure 8 Solder jumpers

Table 8 Solder jumpers

Designator	Description
AI0…AI5	Solder these jumpers to connect analog inputs from motherboard
TEMP	Solder this jumper for the temperature sensor connection
LIN-GND	Solder this to connect LIN GND to common GND (CGND)
ENC-EN… ENC-CHA	Solder these jumpers for Encoder connection from the motherboard

(table continues...)

Table 8 (continued) Solder jumpers

Designator	Description
COM2-CH1… COM2-CH4	Solder these jumpers for COM2 connections from the motherboard
COM1-CH1, COM1-CH2	Solder these jumpers for COM1 connections from the motherboard

2.2 Interfaces

2.2.1 Socket board

A socket board is available for the TLE993x daughterboard with a TSDSO-18 spring socket. This variant is the TLE993x evaluation board. Devices of the same package can be exchanged with the plastic spring socket on the socket board.

Measurements can be performed close to the device pins at the pin headers. On the socket board, VS and VDDP LEDs, test points, as well as an external debugger connector are placed on the socked board. A top and bottom view of the socket is shown below.

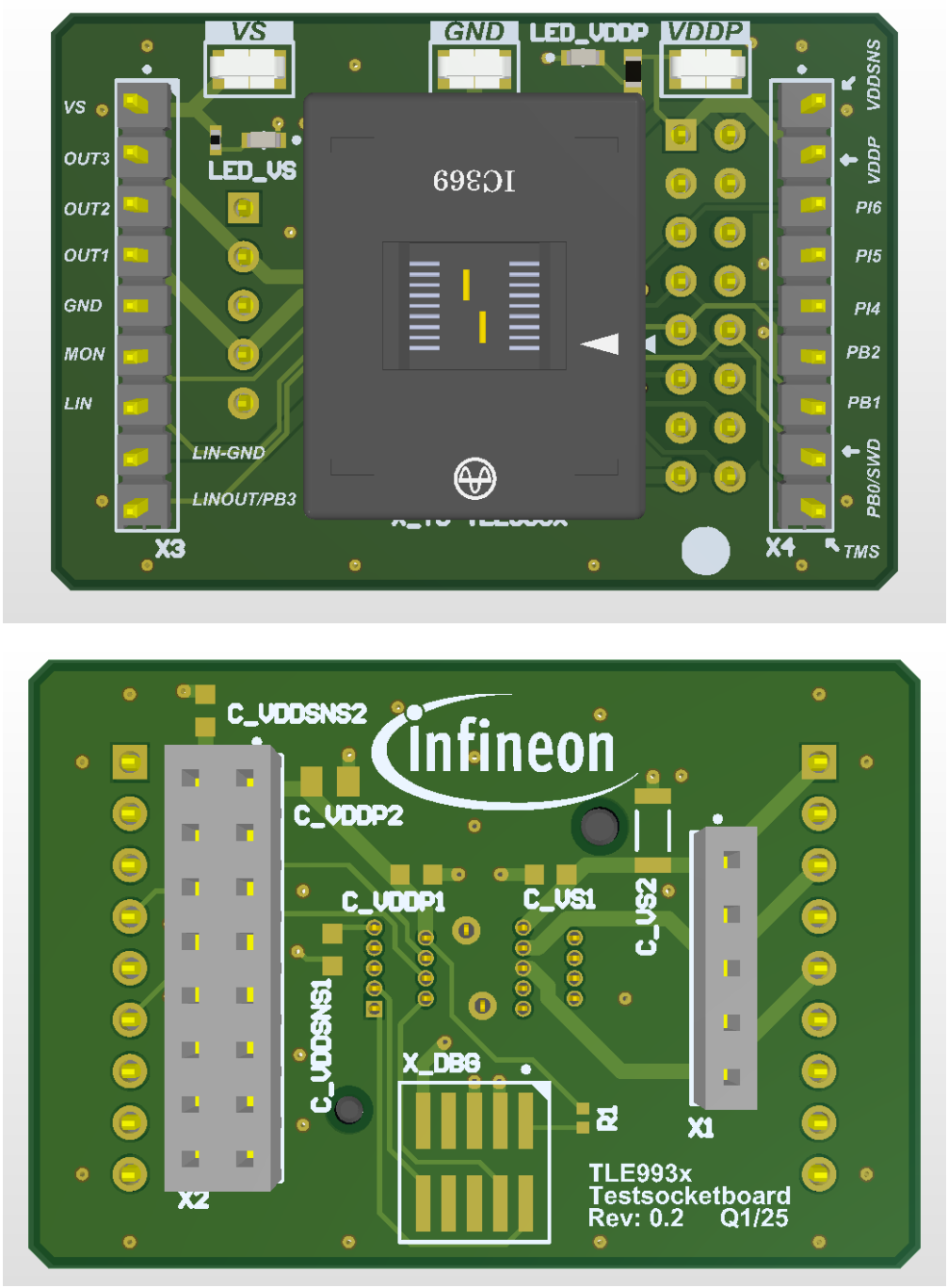

Figure 9 Socket board top and bottom view

2.2.2 Motor power stage

Three *metal-oxide-semiconductor field-effect transistor (MOSFET)* half-bridges are integrated in the device to drive a motor. Additionally, there are placement options for the snubbers (R_SBHx + C_SBHx, R_SBLx + C_SBLx), diodes D_OUTx and the capacitor C_OUT.

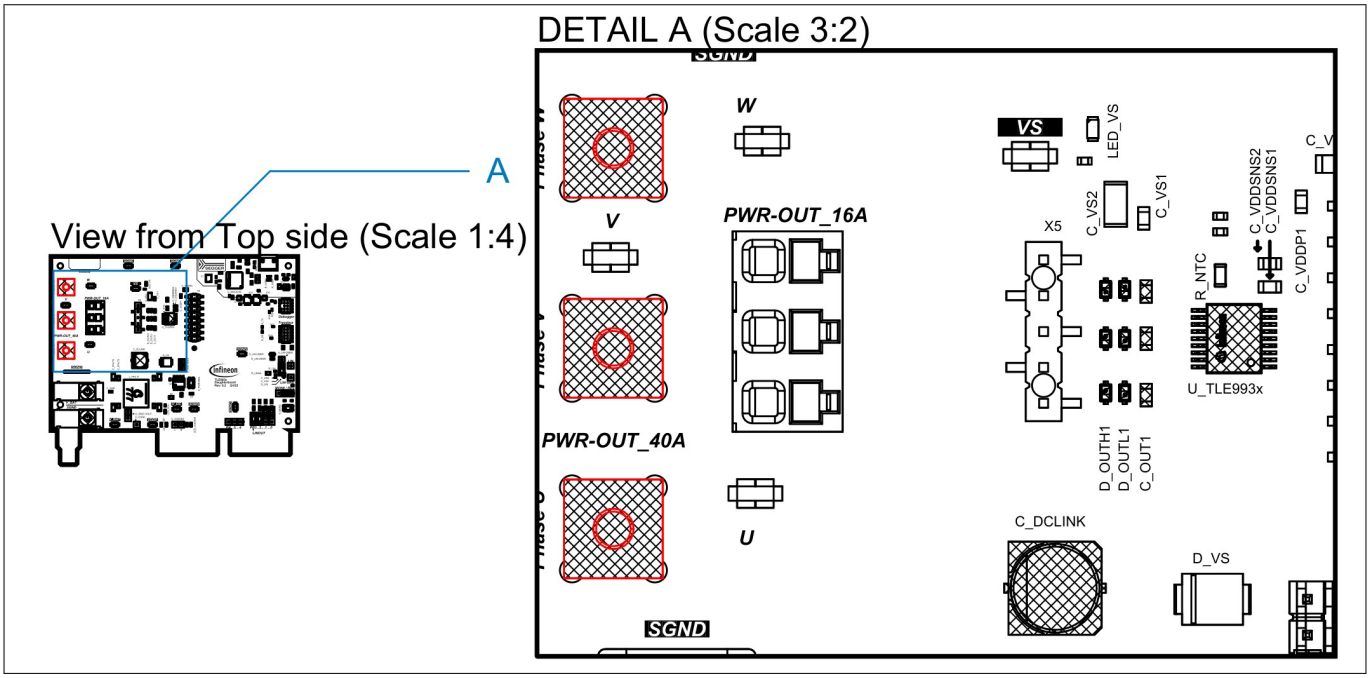

Figure 10 Motor power stage

To connect the motor phases, PWR-OUT_16A terminals can be used. The pinout of the PWR-OUT_16A connector is shown below, which can be used for easy connection and evaluation of the motor. A description and manufacturer number of the terminals used for the board is given in Bill of materials of the TLE993x daughterboard.

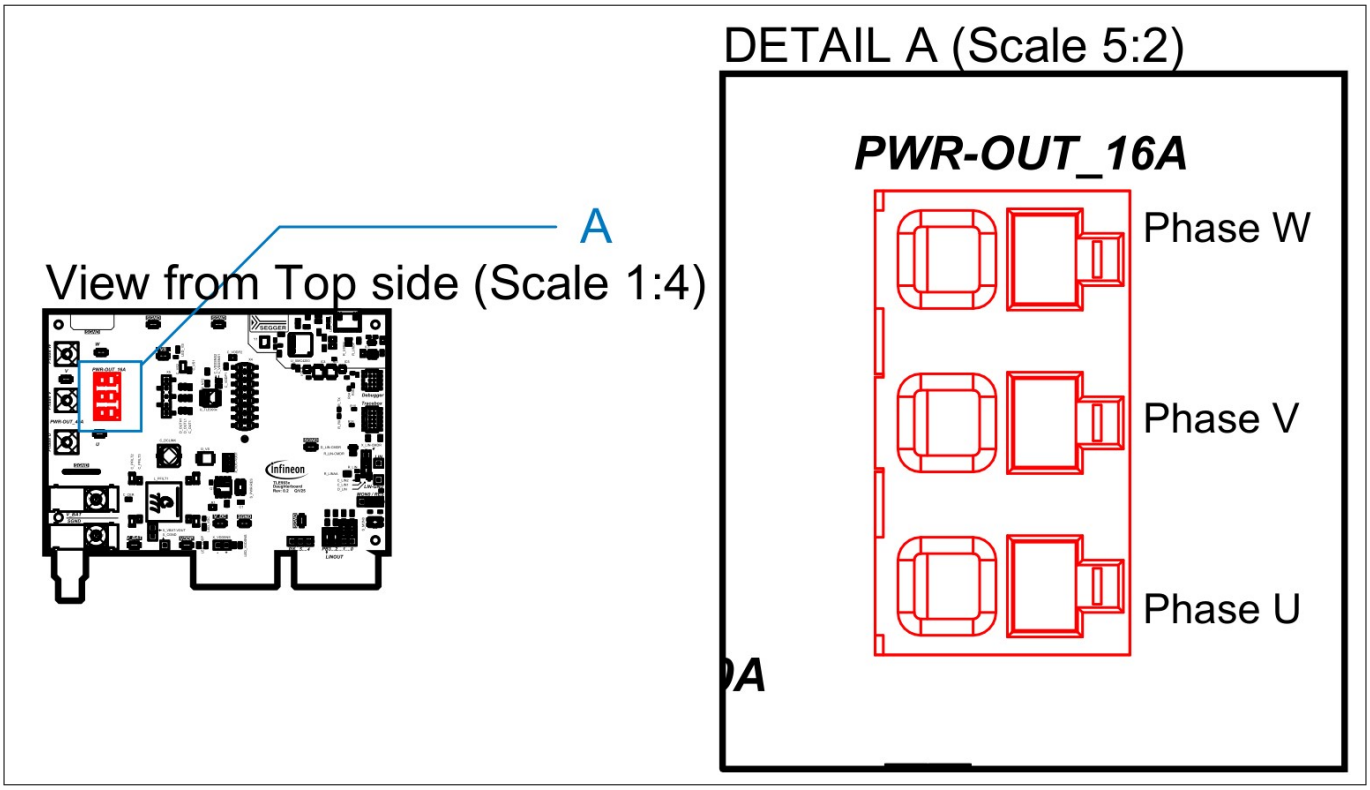

Figure 11 Pinout of PWR-OUT_16A

2.2.3 Pin headers

There are two pin headers on the board which allow access to the *GPIO*s of the device. The two headers are located at the bottom right of the board.

PB0…PB3 can also be connected to the LEDs whereas PI5…7 are for PI4…PI6 of the device and can be used to input an analog signal.

The pin headers have a standard pitch of 2.54 mm and the pinouts of these headers can be observed below.

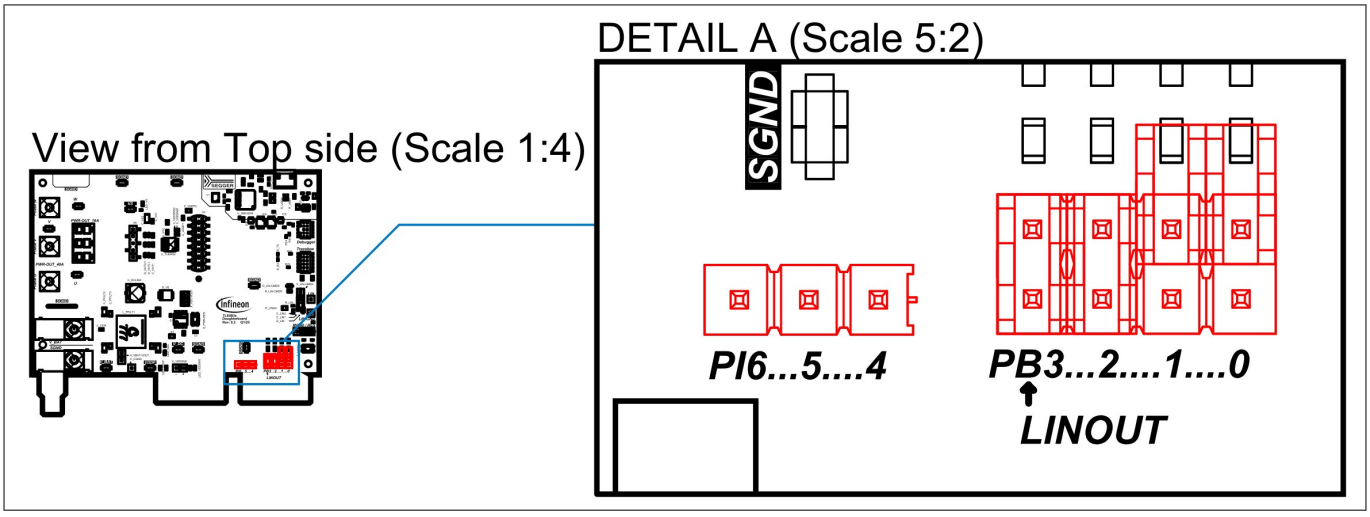

Figure 12 Pinout of pin headers

2.2.4 Debugging

On the board, a SEGGER J-Link debugger is available for debugging, which can be connected with a *USB* cable. Additionally, there are two connectors available for debugging and flashing the device.

The debugger connector is a standard 10-pin connector which can be used for external debuggers, such as the Arm® Keil ULINK2 or an XMC™ Link. The Tracebox 12-pin connector is specifically intended to be used with the Tracebox available from MOTEON. The pinout of the connectors is shown in the image below.

The external debuggers or Tracebox are not delivered with the board.

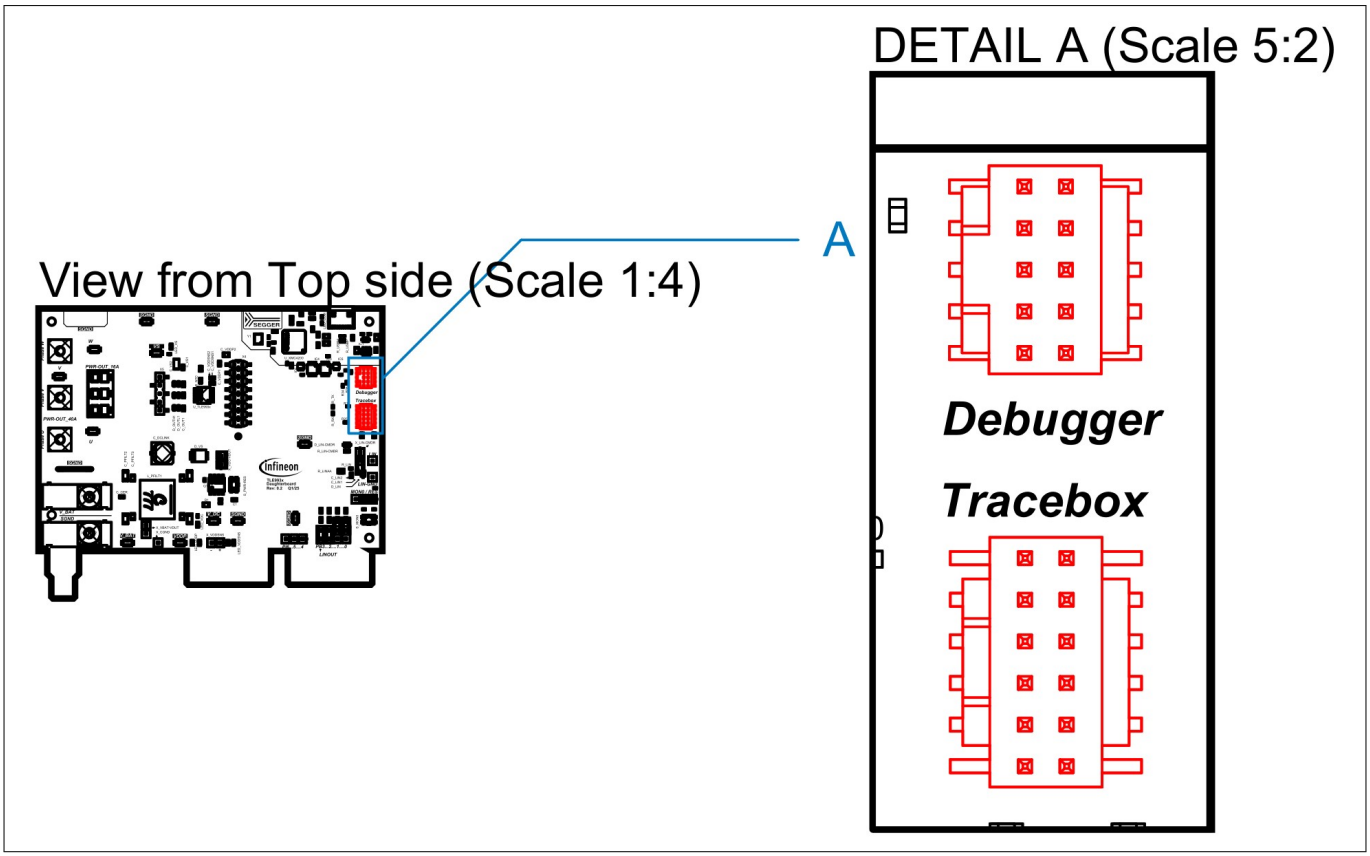

Figure 13 Debugger and Tracebox connector

2.2.5 Card edge connector

On the board, there is also a card edge connector interface which can be used to interface the daughterboard to the motherboard. The motherboard offers several interfaces for additional debug features.

The card edge connector interface is displayed in the figure below.

***Note**: The motherboard is currently not available and will be made available at a later date. The motherboard is not provided with the daughterboard and must be ordered separately if needed.*

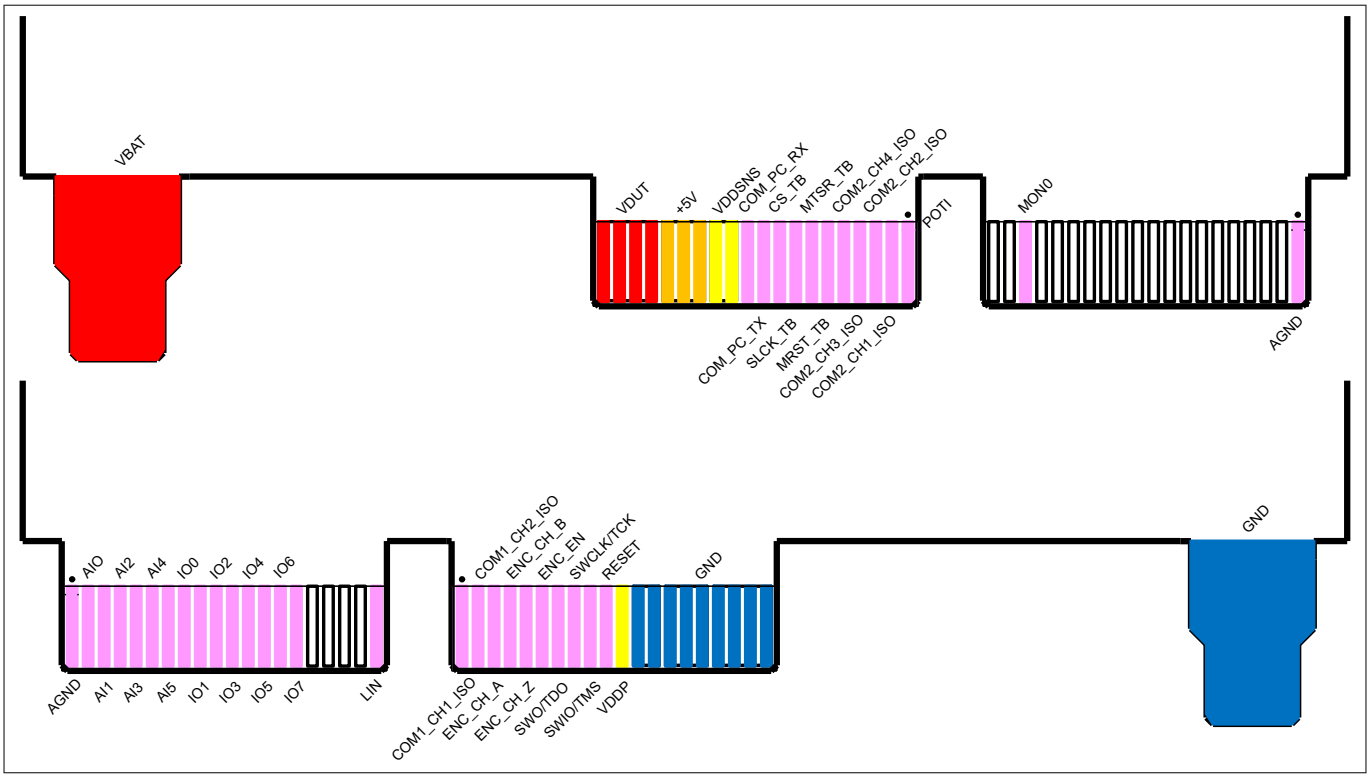

Figure 14 Card edge connector

3 Assembly options

On the board, there are components which are not assembled by default, but which can be soldered by the user if necessary.

These components are highlighted in red in the figures below and are listed in Table 9.

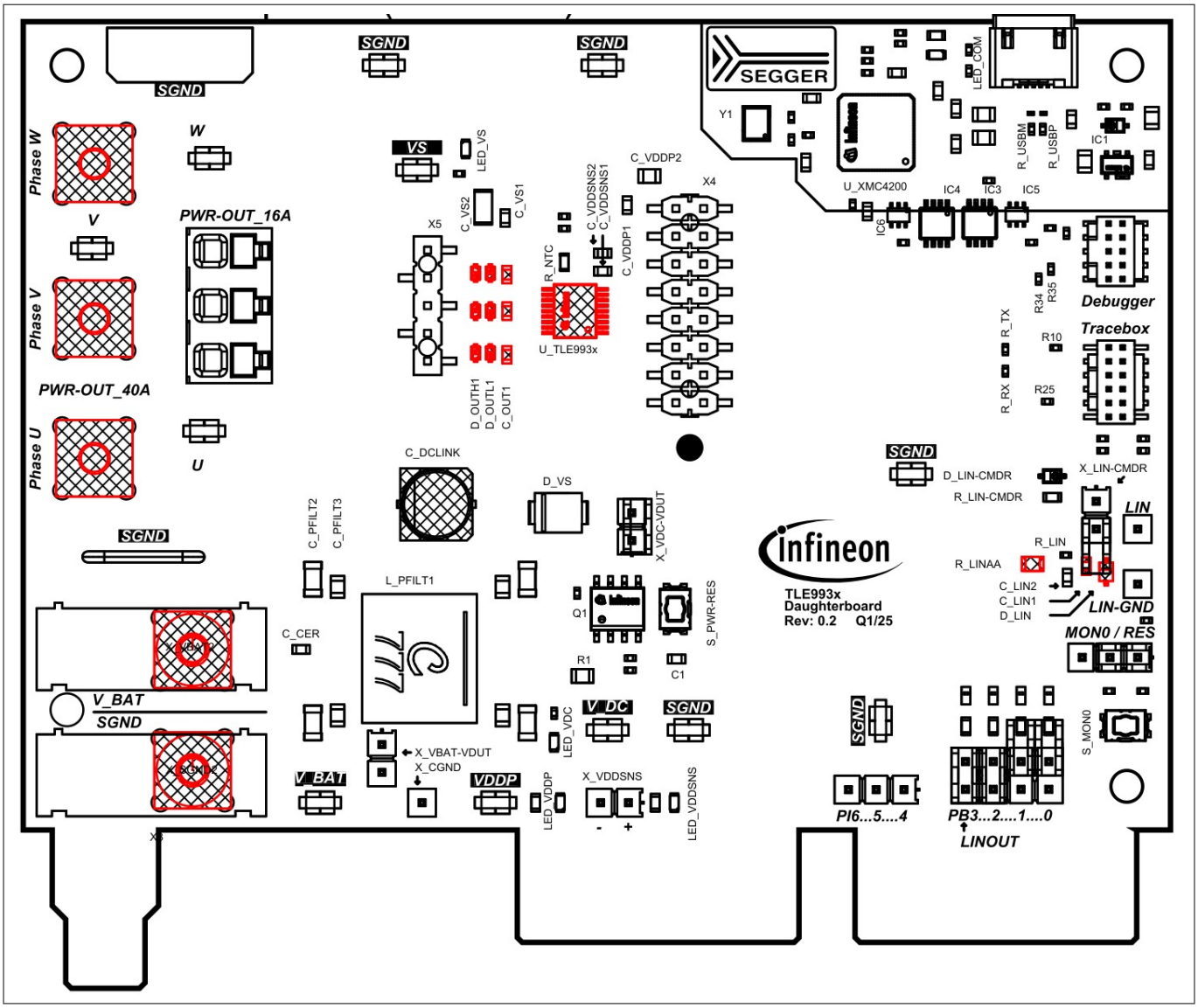

Figure 15 Overview of placement options - top side

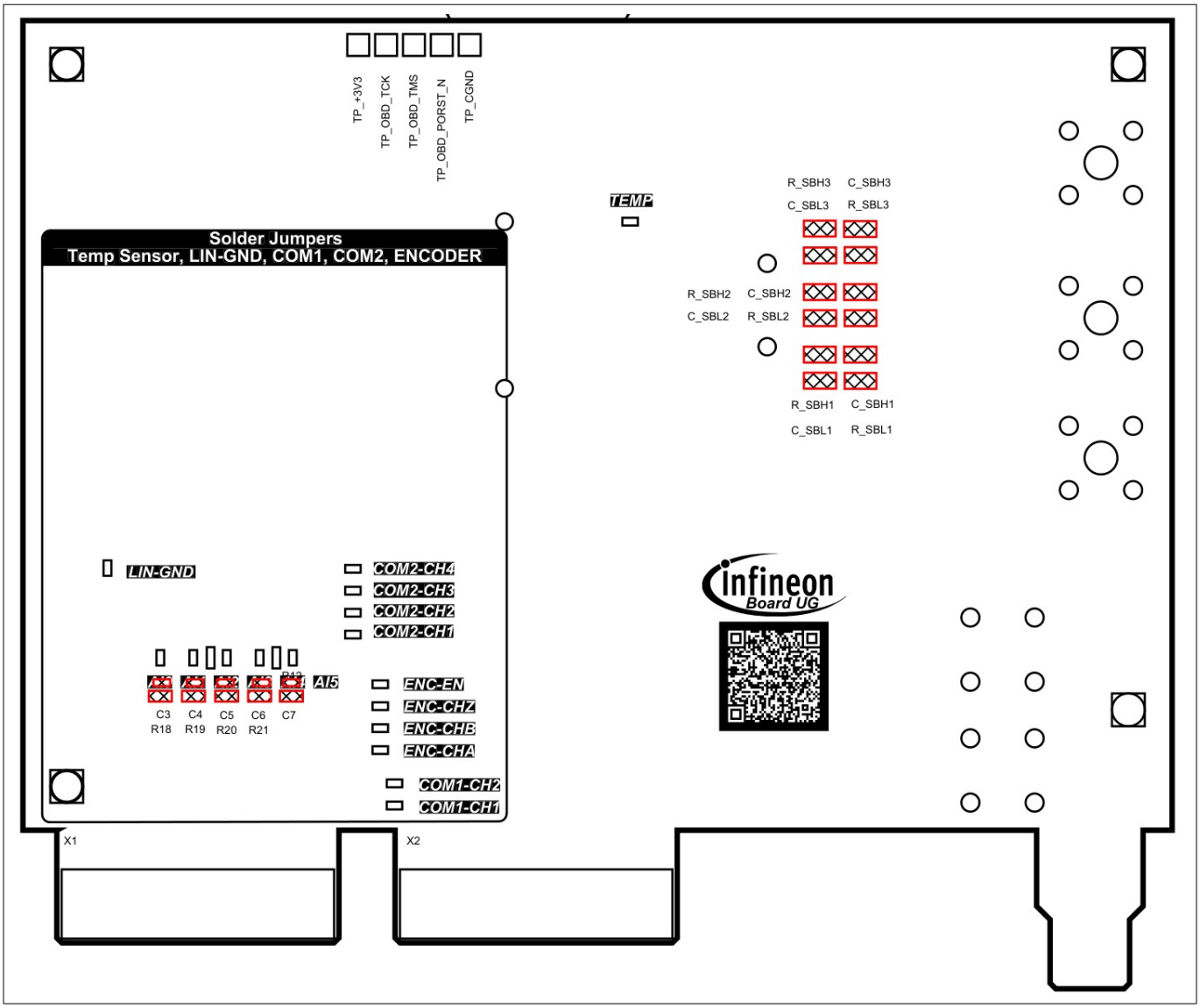

Figure 16 Overview of placement options - bottom side

Values for these optional additional placements have to be determined depending on application. The recommended components and values can be found in Bill of materials of the TLE993x daughterboard.

Table 9 Additional placements

Designator	Description
X_VBAT2, X_SGND2	Power terminals for power supply
PWR-OUT_40A	Power terminal for motor connections Phase 1, Phase 2 and Phase 3.
C_LIN1	Additional capacitor placeholder for *LIN* communication
D_LIN	LIN bus *electrostatic discharge (ESD)* diode
R_LINAA	Shunt resistor for LIN-AA additional feature testing
R_SBHx, C_SBHx, R_SBLx, C_SBLx	Snubber circuit
D_OUTHx, D_OUTLx	Protection diode for HS and LS

(table continues...)

Table 9 (continued) Additional placements

Designator	Description
C_OUTx	An *electromagnetic compatibility (EMC)* filter capacitor at each phase
R12, R18…21, C3…7	A *resistor-capacitor filter (RC filter)* for the *I/O* pins

4 Software toolchain

The software toolchain can be installed by following the instructions in the Getting Started Guide in the relevant documentation website.

5 Design files

5.1 Bill of materials of the TLE993x daughterboard

Automotive qualified components have been preferably used in the TLE993x daughterboard. The complete *BOM* is shown below, including components that are not fitted by default.

***Note**: Based on their availability, some of the components below may differ from the mounted ones.*

Table 10 BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
1	C1	Fitted	1	HHXC350ARA680MF80G	Nippon Chemi-Con	68uF	TC:Aluminium electrolytic;Tol.:-20%/+20%;Vdc:35V
2	C2, C_CER, C_DAGND, C_DVDDC1, C_DVDDC2, C_DVDDP1, C_DVDDP2, C_DVDDP3, C_DVDDP4, C_LDO1, C_VDDP1, C_VDDSNS1, C_VS1	Fitted	13	C0603C104K5RACAUTO	Kemet	100nF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
3	C3, C4, C5, C6, C7	Varied	0	CBR04C101F3GAC	Kemet	100pF	TC:C0G (EIA) / NP0;Tol.:-1%/+1%;Vdc:25V
4	C9	Fitted	1	CGA2B2NP01H102J050BA	TDK Corporation	1nF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
5	C_DVDDC3, C_VDDP2	Fitted	2	GRM21BZ71H475KE15L	MuRata	4.7uF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
6	C_DVDDP5, C_LDO2, C_LDO3	Fitted	3	GCM21BR71A106KE22	MuRata	10uF	TC:X7R (EIA);Tol.:-10%/_P10%;Vdc:10V
7	C_DXTAL1, C_DXTAL2	Fitted	2	GCM1555C1H120JA16	MuRata	12pF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V
8	C_LIN1	Varied	0	CGA3E2C0G1H221J080AA	TDK Corporation	220pF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V
9	C_LIN2	Fitted	1	CGA3E2C0G1H221J080AA	TDK Corporation	220pF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V
10	C_OUT1, C_OUT2, C_OUT3	Varied	0	GCM1885C1H102FA16	MuRata	1nF	TC:C0G (EIA) / NP0;Tol.:-1%/+1%;Vdc:50V
11	C_PFILT1, C_PFILT2, C_PFILT7, C_PFILT8	Fitted	4	CGA5L3X7R1H475K160AB	TDK Corporation	4.7uF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
12	C_PFILT3, C_PFILT4, C_PFILT5, C_PFILT6	Fitted	4	GRM216R71H471KA01	MuRata	470pF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
13	C_PORST1	Fitted	1	C0402C103K4RECAUTO	Kemet	10nF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:16V
14	C_SBH1, C_SBH2, C_SBH3, C_SBL1, C_SBL2, C_SBL3	Varied	0	CGA4C2NP01H103J060AA	TDK Corporation	10nF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
15	C_SHELL, CVDDP	Fitted	2	CGA2B3X7R1H104K050BB	TDK Corporation	100nF	TC:X7R (EIA);Tol.:-10% / _P10%;Vdc:50 V, TC:X7R (EIA);Tol.:-10% /+10%;Vdc:50V
16	C_VDDSNS2	Fitted	1	CC0603KRX7R9BB105	Yageo	1uF	TC:X7R (EIA);Tol.:-10% /+10%;Vdc:50V
17	C_VS2	Fitted	1	C3216X5R1V226M160AC	TDK Corporation	22uF	TC:X5R (EIA);Tol.:-20% /+20%;Vdc:35V
18	D1, D2, D3, D4	Fitted	4	TLMS1100-GS08	Vishay	Red	Vf:3V;If:20mA;Ur:12V;Ir:10uA;Pmax:90mW
19	D_LIN	Varied	0	PESD1IVN27-A	Nexperia	PESD1IVN27-A	Vf:-;If:-;Ur:27V;Ir:50nA;Pmax:-
20	D_LIN-CMDR	Fitted	1	BAS21-03W	Infineon Technologies	BAS21-03W	Vf:1.25V;If:250mA;Ur:200V;Ir:-;Pmax:250mW
21	D_OUTH1, D_OUTH2, D_OUTH3, D_OUTL1, D_OUTL2, D_OUTL3	Varied	0	BAS52-02V	Infineon Technologies	BAS52-02V	Vf:500mV;If:200mA;Ur:45V;Ir:10uA;Pmax:500mW
22	D_USB	Fitted	1	BAT60A	Infineon Technologies	BAT60A	Vf:300mV;If:3A;Ur:10V;Ir:2.6mA;Pmax:1.35W
23	D_USBM, D_USBP	Fitted	2	ESD231-B1-W0201	Infineon Technologies	ESD231-B1-W0201	Vf:-;If:-;Ur:5.5V;Ir:20nA;Pmax:-
24	D_VS	Fitted	1	SS2H10-E3/52T	Vishay	100V	Vf:650mV;If:2A;Ur:100V;Ir:10uA;Pmax:-
25	IC1	Fitted	1	TLS202B1MBV33	Infineon Technologies	TLS202B1MBV33	Linear Not applicable _N;Vo:3.3V to 3.3V

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
26	IC3, IC4	Fitted	2	SN74LVC2T45DCTT	Texas Instruments	SN74LVC2T45DCTT	
27	IC5, IC6	Fitted	2	SN74LVC1T45DCKR	Texas Instruments	SN74LVC1T45DCKR	Industrial Interface/ Transceiver;Vdc min/ max:1.65V/ 5.5V;Iout:32mA ;Fmax:-
28	L_PFILT1	Varied	0	XAL1010-102MED	Coilcraft	1uH	Tol.:-20%/ +20%;Rdc:1.1 mR;Idc:43.5A;Fres:42MHz
29	L_PFILT1	Varied	1	XAL1010-472MED	Coilcraft	4.7uH	Tol.:-20%/ +20%;Rdc:5.2 mR;Idc:25.4A;Fres:19MHz
30	LED_COM, LED_VDC, LED_VDDP, LED_VDDSNS, LED_VS	Fitted	5	LG L29K-G2J1-24	OSRAM Opto Semiconductors	Green	Vf:2.2V;If:20mA ;Ur:12V;Ir:10nA ;Pmax:-
31	LUSB1	Fitted	1	BLM18PG600SN1D	MuRata	60R	Tol.:_N;Rdc:100mR;Idc:1A;Fres:_N
32	MP1, MP2, MP3, MP4	Fitted	4	702916000	Wurth Elektronik	702916000	- Round -x4 Spacers
33	R6, R7	Fitted	2	CRCW04022K20FK	Vishay	2.2k	TCR:100ppm/ K;Tol.:-1%/ +1%;Vdc:50V;Idc:-;P:63mW
34	R8, R9, R_COM	Fitted	3	AC0603FR-07680RL	Yageo	680R	TCR:100ppm/ K;Tol.:-1%/ +1%;Vdc:75V;Idc:-;P:100mW
35	R10, R24, R25, R28, R29, R30, R31, R33, R34, R35, R36, R_LIN, R_RX, R_TX	Fitted	14	ERJ2GE0R00X	Panasonic	0R	TCR:-;Tol.:-;Vdc :50V;Idc:-;P:100mW

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
36	R11, R_PDLS1, R_PDLS2, R_PDLS3, R_PORST, R_USB2	Fitted	6	CRCW040210K0FK	Vishay	10k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
37	R12, R18, R19, R20, R21	Varied	0	TNPW06031K00BEEA	Vishay	1k	125mW;0,1%;25PPM/C;75V
38	R13, R14, R15, R16, R_LIN-CMDR	Fitted	5	RC0603FR-071KL	Yageo	1k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:75V;Idc:-;P:100mW
39	R32	Fitted	1	CRCW04024K02FK	Vishay	4.02k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
40	R_LINAA	Varied	0	RCWE0805R200FKEA	Vishay	200mR	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:200V;Idc:-;P:250mW
41	R_NTC	Fitted	1	NTCG164KF104FTDS	TDK Corporation	100k	TCR:-;Tol.:-1%/+1%;Vdc:-;Idc:-;P:100mW
42	R_PULS1, R_USB1, R_VDDP1, R_VDDP2	Fitted	4	CRCW04024K70FK	Vishay	4.7k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW, TCR:100ppm/K;Tol.:-1%/_P1%;Vdc:50V;Idc:-;P:63mW
43	R_SBH1, R_SBH2, R_SBH3, R_SBL1, R_SBL2, R_SBL3	Varied	0	CRCW08052R00FKEAHP	Vishay	2R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:150V;Idc:-;P:500mW
44	R_SHELL	Fitted	1	CRCW04021M00FK	Vishay	1MEG	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
45	R_USBM, R_USBP	Fitted	2	CRCW040222R0FK	Vishay	22R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
46	R_XTAL1	Fitted	1	CRCW0402150RFK	Vishay	150R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
47	S_MON0	Fitted	1	435451019820	Wurth Elektronik	435451019820	
48	SJ_AI0, SJ_AI1, SJ_AI2, SJ_AI3, SJ_AI4	Fitted	5	Solder Jumper 2 Pins	Infineon Technologies	Solder Jumper 2 Pins	- None (onboard);2x1;Mounting:SMT;Orient:None (onboard);Shielded:No
49	TP_+3V3, TP_CGND, TP_OBD_PORST_N, TP_OBD_TCK, TP_OBD_TMS	Fitted	5	TestPoint2mm	-	TestPoint 2mm	- Socket (female);1x1;Mounting:SMT;Orient:-;Shielded:No
50	TP_OUT-U, TP_OUT-V, TP_OUT-W, TP_SGND1, TP_SGND2, TP_SGND4, TP_SGND5, TP_SGND6, TP_VBAT, TP_VDC, TP_VDDP, TP_VS	Fitted	12	5019	Keystone Electronics Corp.	5019	Board-to-Cable None (onboard);1x1;Mounting:SMT;Orient:None (onboard);Shielded:No
51	TP_SGND3	Fitted	1	D3082-05	Harwin	D3082-05	- None (onboard);-x-;Mounting:THT;Orient:None (onboard);Shielded:No
52	U_TLE993x	Varied	0	TLE993xEQW40C	Infineon Technologies		

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
53	U_XMC4200	Fitted	1	XMC4200Q48K256ABXUMA1	Infineon Technologies	IFX_XMC4200Q48K256ABXUMA1	App.:Industrial;-;Vdc min/max:3.13V/3.63V;Fmax:80MHz;RAM:40KB;ROM:-;Flash:256KB
54	X1, X2	Fitted	2	461130401_Edge Card	Molex	461130401_Edge Card	Edge Header (male);-x-;Mounting:SMT;Orient:0° (vertical);Shielded:No
55	X3	Fitted	1	461120201_Edge card	Molex	461120201_Edge card	Edge Header (male);-x-;Mounting:SMT;Orient:0° (vertical);Shielded:No
56	X4	Varied	1	TSM-108-01-L-DV-A	Samtec	TSM-108-01-L-DV-A	Board-to-Board Header (male);2x8;Mounting:THT;Orient:0° (vertical);Shielded:No
57	X5	Varied	1	TSM-105-01-L-SV-A	Samtec	TSM-105-01-L-SV-A	Board-to-Board Header (male);-x-;Mounting:THT;Orient:0° (vertical);Shielded:No
58	X7	Fitted	1	629105150521	Wurth Elektronik	629105150521	Board_Nto_NCable Socket (female);5x1;Mounting:SMT;Orient:90Â° (right angle);Shielded:Yes

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
59	X_BTN, X_PI7..5	Fitted	2	TSW-103-07-L-S	Samtec	TSW-103-07-L-S	Board-to-Board Header (male);3x1;Mounting:THT;Orient:0° (vertical);Shielded:No
60	X_CGND, X_LIN, X_LIN-GND	Fitted	3	TSW-101-07-L-S	Samtec	TSW-101-07-L-S	Board-to-Board Header (male);1x1;Mounting:THT;Orient:0° (vertical);Shielded:No
61	X_DBG	Fitted	1	FTSH-105-01-L-DV-K	Samtec	FTSH-105-01-L-DV-K	Board-to-Board Header (male);5x2;Mounting:SMT;Orient:0° (vertical);Shielded:-
62	X_JP-BTN, X_JP-LIN, X_JP-PX0, X_JP-PX1, X_JP-PX2, X_JP-PX3, X_JP-VDUT	Fitted	7	SNT_N100_NBK_NG_NH	Samtec	SNT_N100_NBK_NG_NH	_N Socket (female);_Nx_N;Mounting:_N;Orient:_N;Shielded:_N
63	X_LIN-CMDR, X_VBAT-VDUT, X_VDC-VDUT, X_VDDSNS	Fitted	4	TSW-102-07-L-S	Samtec	TSW-102-07-L-S	Board-to-Board Header (male);2x1;Mounting:THT;Orient:0° (vertical);Shielded:No
64	X_PB4..0	Fitted	1	TSW-104-07-L-D	Samtec	TSW-104-07-L-D	Board-to-Board/Cable Header (male);4x2;Mounting:THT;Orient:0° (vertical);Shielded:No

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
65	X_PWR-OUT_16A	Varied	1	2086-3103	WAGO	2086-3103	Board-to-Cable Socket (female);3x2;Mounting:THT;Orient:0° (vertical);Shielded:No
66	X_PWR-OUT-U_40A, X_PWR-OUT-V_40A, X_PWR-OUT-W_40A	Varied	0	74650073R	Wurth Elektronik	74650073R	Board-to-Board Socket (female);2x2;Mounting:THT;Orient:0° (vertical);Shielded:No
67	X_SGND1	Varied	1	973 582-100	Hirschmann Test & Measurement	973 582-100	Board-to-Cable Socket (female);-x-;Mounting:THT;Orient:90Â° (right angle);Shielded:No
68	X_SGND2, X_VBAT2	Varied	0	74650174R	Wurth Elektronik	74650174R	Board-to-Board Socket (female);2x2;Mounting:THT;Orient:0° (vertical);Shielded:No
69	X_TB	Fitted	1	FTSH-106-01-L-DV-K	Samtec	FTSH-106-01-L-DV-K	Board-to-Board Header (male);2x6;Mounting:SMT;Orient:0° (vertical);Shielded:No
70	X_VBAT1	Varied	1	973 582-101	Hirschmann Test & Measurement	973 582-101	Board-to-Cable Socket (female);2x1;Mounting:THT;Orient:90Â° (right angle);Shielded:No

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
1	C1	Varied	0	HHXC350ARA680MF80G	Nippon Chemi-Con	68uF	TC:Aluminium electrolytic;Tol.:-20%/+20%;Vdc:35V
2	C1, C_CER, C_DAGND, C_DVDDC1, C_DVDDC2, C_DVDDP1, C_DVDDP2, C_DVDDP3, C_DVDDP4, C_LDO1, C_VDDP1, C_VDDSNS1, C_VS1	Fitted	13	C0603C104K5RACAUTO	Kemet	100nF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
3	C2, C_PORST1	Fitted	2	GRM155R71H103JA88	MuRata	10nF	TC:X7R (EIA);Tol.:-5%/+5%;Vdc:50V
4	C3, C4, C5, C6, C7	Varied	0	CBR04C101F3GAC	Kemet	100pF	TC:C0G (EIA) / NP0;Tol.:-1%/+1%;Vdc:25V
5	C9	Fitted	1	CGA2B2NP01H102J050BA	TDK Corporation	1nF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V
6	C_DVDDC3, C_VDDP2	Fitted	2	GRM21BZ71H475KE15L	MuRata	4.7uF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
7	C_DVDDP5, C_LDO2, C_LDO3	Fitted	3	GCM21BR71A106KE22	MuRata	10uF	TC:X7R (EIA);Tol.:-10%/_P10%;Vdc:10V
8	C_DXTAL1, C_DXTAL2	Fitted	2	GCM1555C1H120JA16	MuRata	12pF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V
9	C_LIN1	Varied	0	CGA3E2C0G1H221J080AA	TDK Corporation	220pF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
10	C_LIN2	Fitted	1	CGA3E2C0G1H221J080AA	TDK Corporation	220pF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V
11	C_OUT1, C_OUT2, C_OUT3	Varied	0	GCM1885C1H102FA16	MuRata	1nF	TC:C0G (EIA) / NP0;Tol.:-1%/+1%;Vdc:50V
12	C_PFILT1, C_PFILT2, C_PFILT7, C_PFILT8	Fitted	4	CGA5L3X7R1H475K160AB	TDK Corporation	4.7uF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
13	C_PFILT3, C_PFILT4, C_PFILT5, C_PFILT6	Fitted	4	GRM216R71H471KA01	MuRata	470pF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
14	C_SBH1, C_SBH2, C_SBH3, C_SBL1, C_SBL2, C_SBL3	Varied	0	CGA4C2NP01H103J060AA	TDK Corporation	10nF	TC:C0G (EIA) / NP0;Tol.:-5%/+5%;Vdc:50V
15	C_SHELL, CVDDP	Fitted	2	CGA2B3X7R1H104K050BB	TDK Corporation	100nF	TC:X7R (EIA);Tol.:-10%/_P10%;Vdc:50V, TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
16	C_VDDSNS2	Fitted	1	CC0603KRX7R9BB105	Yageo	1uF	TC:X7R (EIA);Tol.:-10%/+10%;Vdc:50V
17	C_VS2	Fitted	1	C3216X5R1V226M160AC	TDK Corporation	22uF	TC:X5R (EIA);Tol.:-20%/+20%;Vdc:35V
18	D1, D2, D3, D4	Fitted	4	TLMS1100-GS08	Vishay	Red	Vf:3V;If:20mA;Ur:12V;Ir:10uA;Pmax:90mW
19	D_LIN	Varied	0	PESD1IVN27-A	Nexperia	PESD1IVN27-A	Vf:-;If:-;Ur:27V;Ir:50nA;Pmax:-
20	D_LIN-CMDR	Fitted	1	BAS21-03W	Infineon Technologies	BAS21-03W	Vf:1.25V;If:250mA;Ur:200V;Ir:-;Pmax:250mW

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
21	D_OUTH1, D_OUTH2, D_OUTH3, D_OUTL1, D_OUTL2, D_OUTL3	Varied	0	BAS52-02V	Infineon Technologies	BAS52-02V	Vf:500mV;If:200mA;Ur:45V;Ir:10uA;Pmax:500mW
22	D_USB	Fitted	1	BAT60A	Infineon Technologies	BAT60A	Vf:300mV;If:3A;Ur:10V;Ir:2.6mA;Pmax:1.35W
23	D_USBM, D_USBP	Fitted	2	ESD231-B1-W0201	Infineon Technologies	ESD231-B1-W0201	Vf:-;If:-;Ur:5.5V;Ir:20nA;Pmax:-
24	D_VS	Fitted	1	SS2H10-E3/52T	Vishay	100V	Vf:650mV;If:2A;Ur:100V;Ir:10uA;Pmax:-
25	IC1	Fitted	1	TLS202B1MBV33	Infineon Technologies	TLS202B1MBV33	Linear Not applicable_N;Vo:3.3V to 3.3V
26	IC3, IC4	Fitted	2	SN74LVC2T45DCTT	Texas Instruments	SN74LVC2T45DCTT	
27	IC5, IC6	Fitted	2	SN74LVC1T45DCKR	Texas Instruments	SN74LVC1T45DCKR	Industrial Interface/ Transceiver;Vdc min/ max:1.65V/ 5.5V;Iout:32mA;Fmax:-
28	L_PFILT1	Varied	0	XAL1010-102MED	Coilcraft	1uH	Tol.:-20%/ +20%;Rdc:1.1mR;Idc:43.5A;Fres:42MHz
29	L_PFILT1	Varied	1	XAL1010-472MED	Coilcraft	4.7uH	Tol.:-20%/ +20%;Rdc:5.2mR;Idc:25.4A;Fres:19MHz
30	LED_COM, LED_VDC, LED_VDDP, LED_VDDSNS, LED_VS	Fitted	5	LG L29K-G2J1-24	OSRAM Opto Semiconductors	Green	Vf:2.2V;If:20mA;Ur:12V;Ir:10nA;Pmax:-

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
31	LUSB1	Fitted	1	BLM18PG600SN1D	MuRata	60R	Tol.:_N;Rdc:100mR;Idc:1A;Fres:_N
32	MP1, MP2, MP3, MP4	Fitted	4	702916000	Wurth Elektronik	702916000	- Round -x4 Spacers
33	Q1	Fitted	1	AUIRF7343Q	Infineon Technologies	AUIRF7343Q	N-Channel Enhancement;Uds:55V;Id:4.7A;Rds:105R;P:2W
34	R1	Fitted	1	CRCW08054R70FKEAHP	Vishay	4.7R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:150V;Idc:-;P:500mW
35	R3, R4, R5, R11, R_PDLS1, R_PDLS2, R_PDLS3, R_PORST, R_USB2	Fitted	9	CRCW040210K0FK	Vishay	10k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
36	R6, R7	Fitted	2	CRCW04022K20FK	Vishay	2.2k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
37	R8, R9, R_COM	Fitted	3	AC0603FR-07680RL	Yageo	680R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:75V;Idc:-;P:100mW
38	R10, R24, R25, R28, R29, R30, R31, R33, R34, R35, R36, R_LIN, R_RX, R_TX	Fitted	14	ERJ2GE0R00X	Panasonic	0R	TCR:-;Tol.:-;Vdc:50V;Idc:-;P:100mW
39	R12, R18, R19, R20, R21	Varied	0	TNPW06031K00BEEA	Vishay	1k	125mW;0,1%;25PPM/C;75V
40	R13, R14, R15, R16, R_LIN-CMDR	Fitted	5	RC0603FR-071KL	Yageo	1k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:75V;Idc:-;P:100mW

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
41	R32	Fitted	1	CRCW04024K02FK	Vishay	4.02k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
42	R_LINAA	Varied	0	RCWE0805R200FKEA	Vishay	200mR	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:200V;Idc:-;P:250mW
43	R_NTC	Fitted	1	NTCG164KF104FTDS	TDK Corporation	100k	TCR:-;Tol.:-1%/+1%;Vdc:-;Idc:-;P:100mW
44	R_PULS1, R_USB1, R_VDDP1, R_VDDP2	Fitted	4	CRCW04024K70FK	Vishay	4.7k	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW, TCR:100ppm/K;Tol.:-1%/_P1%;Vdc:50V;Idc:-;P:63mW
45	R_SBH1, R_SBH2, R_SBH3, R_SBL1, R_SBL2, R_SBL3	Varied	0	CRCW08052R00FKEAHP	Vishay	2R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:150V;Idc:-;P:500mW
46	R_SHELL	Fitted	1	CRCW04021M00FK	Vishay	1MEG	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
47	R_USBM, R_USBP	Fitted	2	CRCW040222R0FK	Vishay	22R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
48	R_XTAL1	Fitted	1	CRCW0402150RFK	Vishay	150R	TCR:100ppm/K;Tol.:-1%/+1%;Vdc:50V;Idc:-;P:63mW
49	S_MON0, S_PWR-RES	Fitted	2	435451019820	Wurth Elektronik	435451019820	

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
50	SJ_AI0, SJ_AI1, SJ_AI2, SJ_AI3, SJ_AI4	Fitted	5	Solder Jumper 2 Pins	Infineon Technologies	Solder Jumper 2 Pins	- None (onboard);2x1; Mounting:SMT; Orient:None (onboard);Shielded:No
51	TP_+3V3, TP_CGND, TP_OBD_PORST_N, TP_OBD_TCK, TP_OBD_TMS	Fitted	5	TestPoint2mm	-	TestPoint 2mm	- Socket (female);1x1;Mounting:SMT;Orient:-;Shielded:No
52	TP_OUT-U, TP_OUT-V, TP_OUT-W, TP_SGND1, TP_SGND2, TP_SGND4, TP_SGND5, TP_SGND6, TP_VBAT, TP_VDC, TP_VDDP, TP_VS	Fitted	12	5019	Keystone Electronics Corp.	5019	Board-to-Cable None (onboard);1x1; Mounting:SMT; Orient:None (onboard);Shielded:No
53	TP_SGND3	Fitted	1	D3082-05	Harwin	D3082-05	- None (onboard);-x-;Mounting:THT;Orient:None (onboard);Shielded:No
54	U_TLE993x	Fitted	0	TLE9934EVW40L	Infineon Technologies		
55	U_XMC4200	Fitted	1	XMC4200Q48K256ABXUMA1	Infineon Technologies	IFX_XMC4200Q48K256ABXUMA1	App.:Industrial;-;Vdc min/max:3.13V/3.63V;Fmax:80MHz;RAM:40KB;ROM:-;Flash:256KB

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
56	X1, X2	Fitted	2	461130401_Edge Card	Molex	461130401_Edge Card	Edge Header (male);-x-;Mounting:SMT;Orient:0° (vertical);Shielded:No
57	X3	Fitted	1	461120201_Edge card	Molex	461120201_Edge card	Edge Header (male);-x-;Mounting:SMT;Orient:0° (vertical);Shielded:No
58	X4	Varied	1	TSM-108-01-L-DV-A	Samtec	TSM-108-01-L-DV-A	Board-to-Board Header (male);2x8;Mounting:THT;Orient:0° (vertical);Shielded:No
59	X5	Varied	1	TSM-105-01-L-SV-A	Samtec	TSM-105-01-L-SV-A	Board-to-Board Header (male);-x-;Mounting:THT;Orient:0° (vertical);Shielded:No
60	X7	Fitted	1	629105150521	Wurth Elektronik	629105150521	Board_Nto_NCable Socket (female);5x1;Mounting:SMT;Orient:90Â° (right angle);Shielded:Yes
61	X_BTN, X_PI7..5	Fitted	2	TSW-103-07-L-S	Samtec	TSW-103-07-L-S	Board-to-Board Header (male);3x1;Mounting:THT;Orient:0° (vertical);Shielded:No

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
62	X_CGND, X_LIN, X_LIN-GND	Fitted	3	TSW-101-07-L-S	Samtec	TSW-101-07-L-S	Board-to-Board Header (male);1x1;Mounting:THT;Orient:0° (vertical);Shielded:No
63	X_DBG	Fitted	1	FTSH-105-01-L-DV-K	Samtec	FTSH-105-01-L-DV-K	Board-to-Board Header (male);5x2;Mounting:SMT;Orient:0° (vertical);Shielded:-
64	X_JP-BTN, X_JP-LIN, X_JP-PX0, X_JP-PX1, X_JP-PX2, X_JP-PX3, X_JP-VDUT	Fitted	7	SNT_N100_NBK_NG_NH	Samtec	SNT_N100_NBK_NG_NH	_N Socket (female);_Nx_N;Mounting:_N;Orient:_N;Shielded:_N
65	X_LIN-CMDR, X_VBAT-VDUT, X_VDC-VDUT, X_VDDSNS	Fitted	4	TSW-102-07-L-S	Samtec	TSW-102-07-L-S	Board-to-Board Header (male);2x1;Mounting:THT;Orient:0° (vertical);Shielded:No
66	X_PB4..0	Fitted	1	TSW-104-07-L-D	Samtec	TSW-104-07-L-D	Board-to-Board/Cable Header (male);4x2;Mounting:THT;Orient:0° (vertical);Shielded:No
67	X_PWR-OUT_16A	Varied	1	2086-3103	WAGO	2086-3103	Board-to-Cable Socket (female);3x2;Mounting:THT;Orient:0° (vertical);Shielded:No

(table continues...)

Table 10 (continued) BOM TLE993x daughterboard

#	Designator	Fitted	Quantity	Manufacturer Order number	Manufacturer	Value	Combined Parameters
68	X_PWR-OUT-U_40A, X_PWR-OUT-V_40A, X_PWR-OUT-W_40A	Varied	0	74650073R	Wurth Elektronik	74650073R	Board-to-Board Socket (female);2x2;Mounting:THT;Orient:0° (vertical);Shielded:No
69	X_SGND1	Varied	1	973 582-100	Hirschmann Test & Measurement	973 582-100	Board-to-Cable Socket (female);-x-;Mounting:THT;Orient:90Â° (right angle);Shielded:No
70	X_SGND2, X_VBAT2	Varied	0	74650174R	Wurth Elektronik	74650174R	Board-to-Board Socket (female);2x2;Mounting:THT;Orient:0° (vertical);Shielded:No
71	X_TB	Fitted	1	FTSH-106-01-L-DV-K	Samtec	FTSH-106-01-L-DV-K	Board-to-Board Header (male);2x6;Mounting:SMT;Orient:0° (vertical);Shielded:No
72	X_VBAT1	Varied	1	973 582-101	Hirschmann Test & Measurement	973 582-101	Board-to-Cable Socket (female);2x1;Mounting:THT;Orient:90Â° (right angle);Shielded:No
73	Y1	Fitted	1	CX3225CA12000D0HSSCC	Kyocera	12MHz	Standard Standard Crystal;Tol.:-50%/+50%

5.2 Schematics TLE993x daughterboard

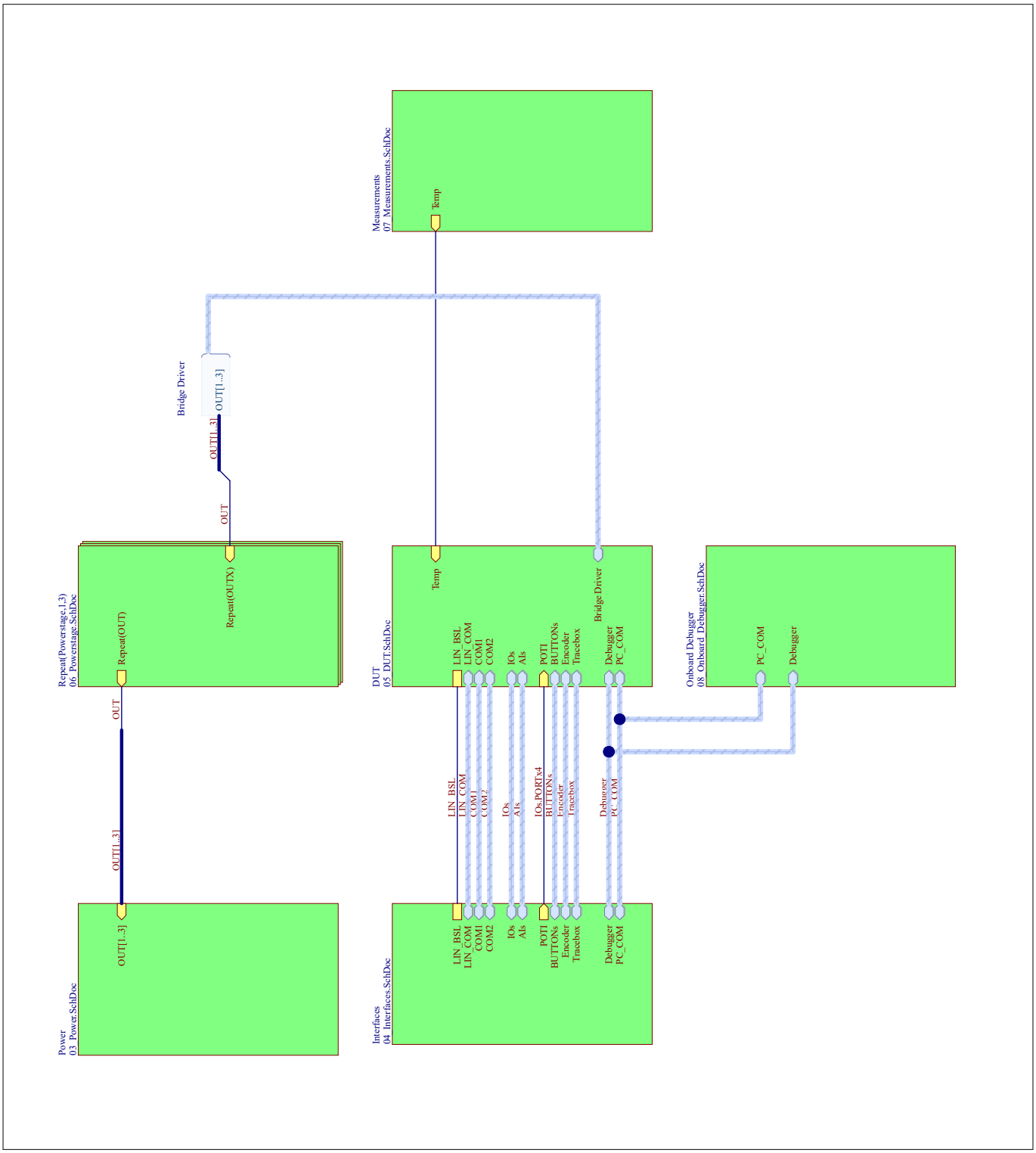

Figure 17 TLE993x daughterboard, Top_Level

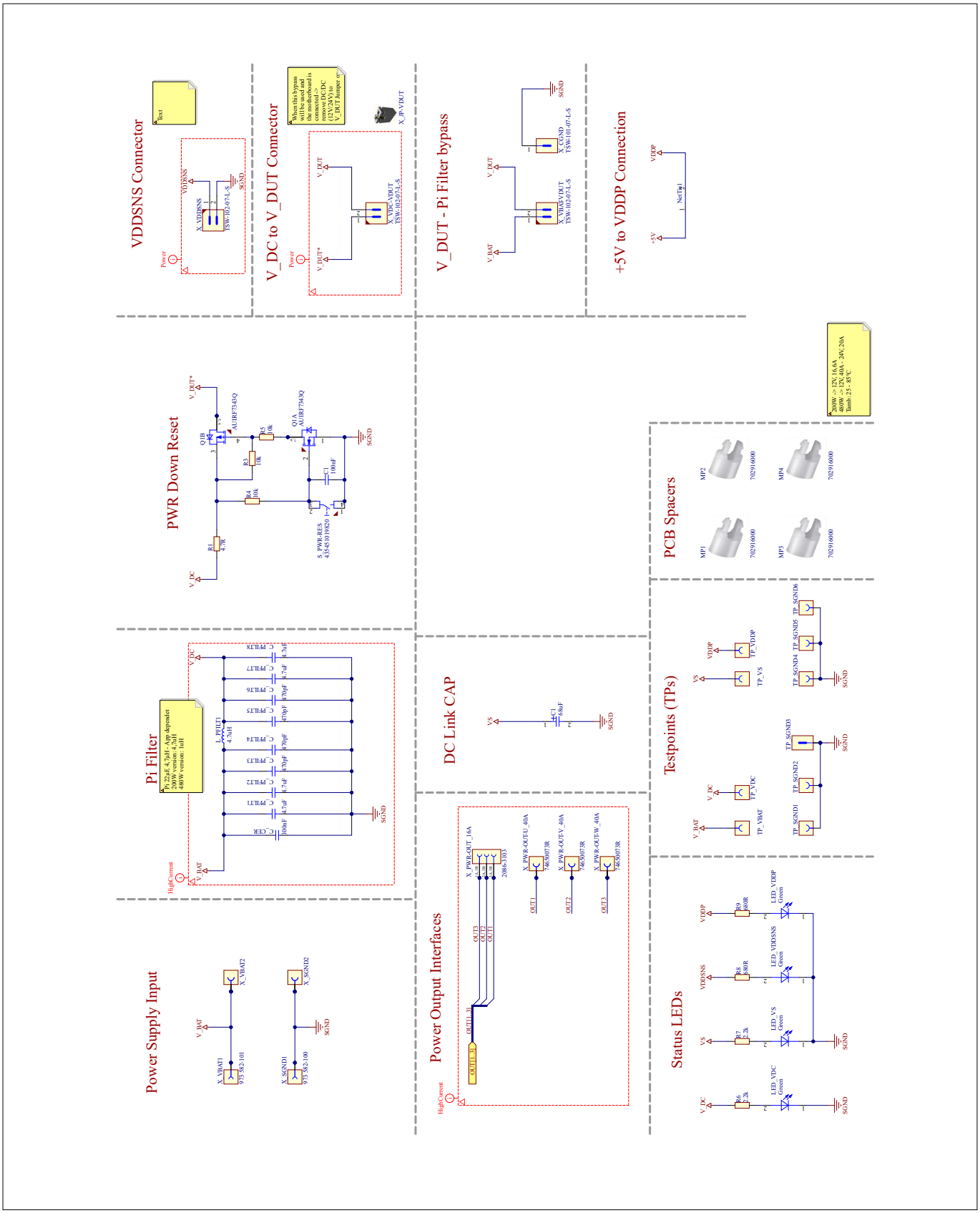

Figure 18 TLE993x daughterboard, Power

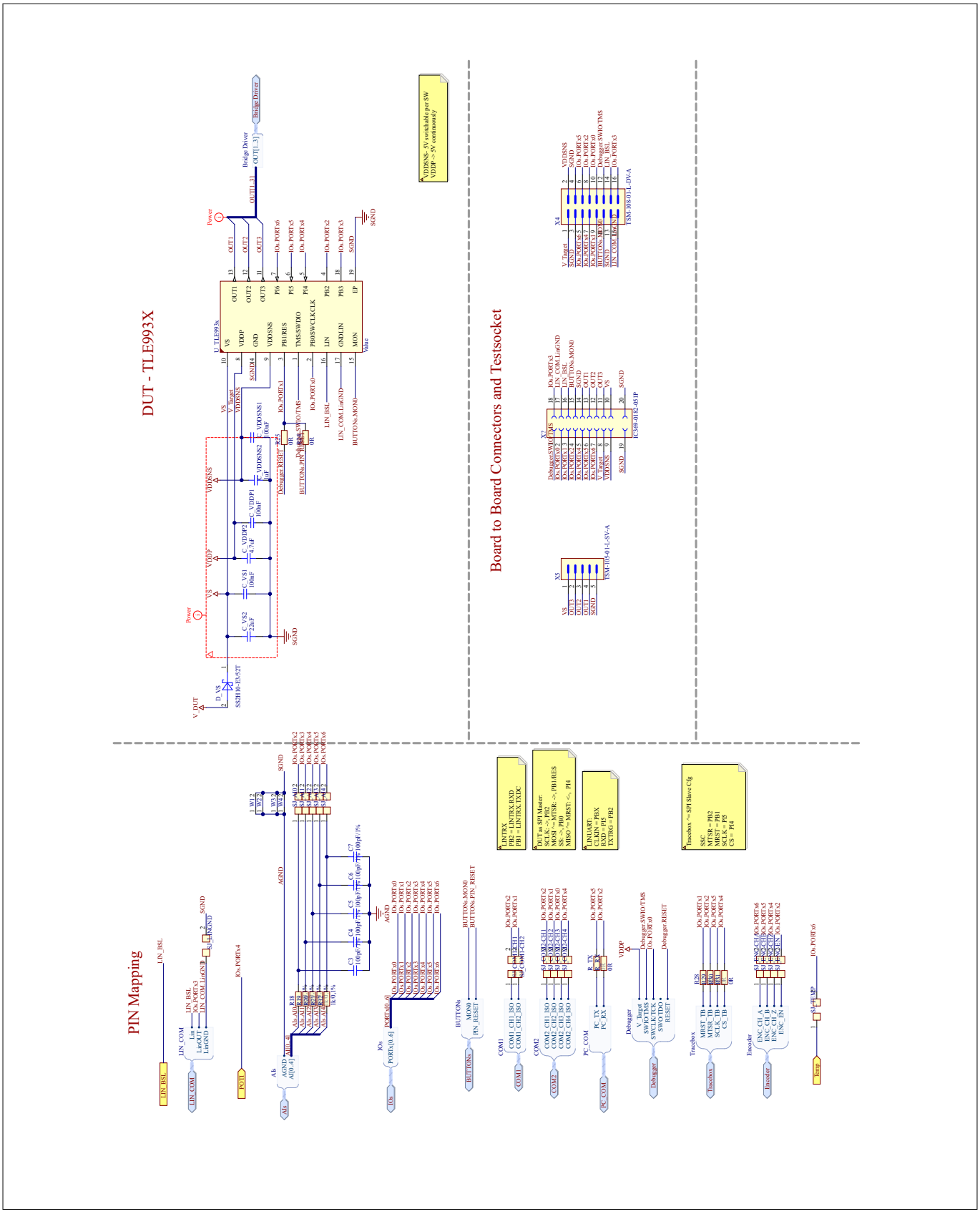

Figure 19 TLE993x daughterboard, DUT

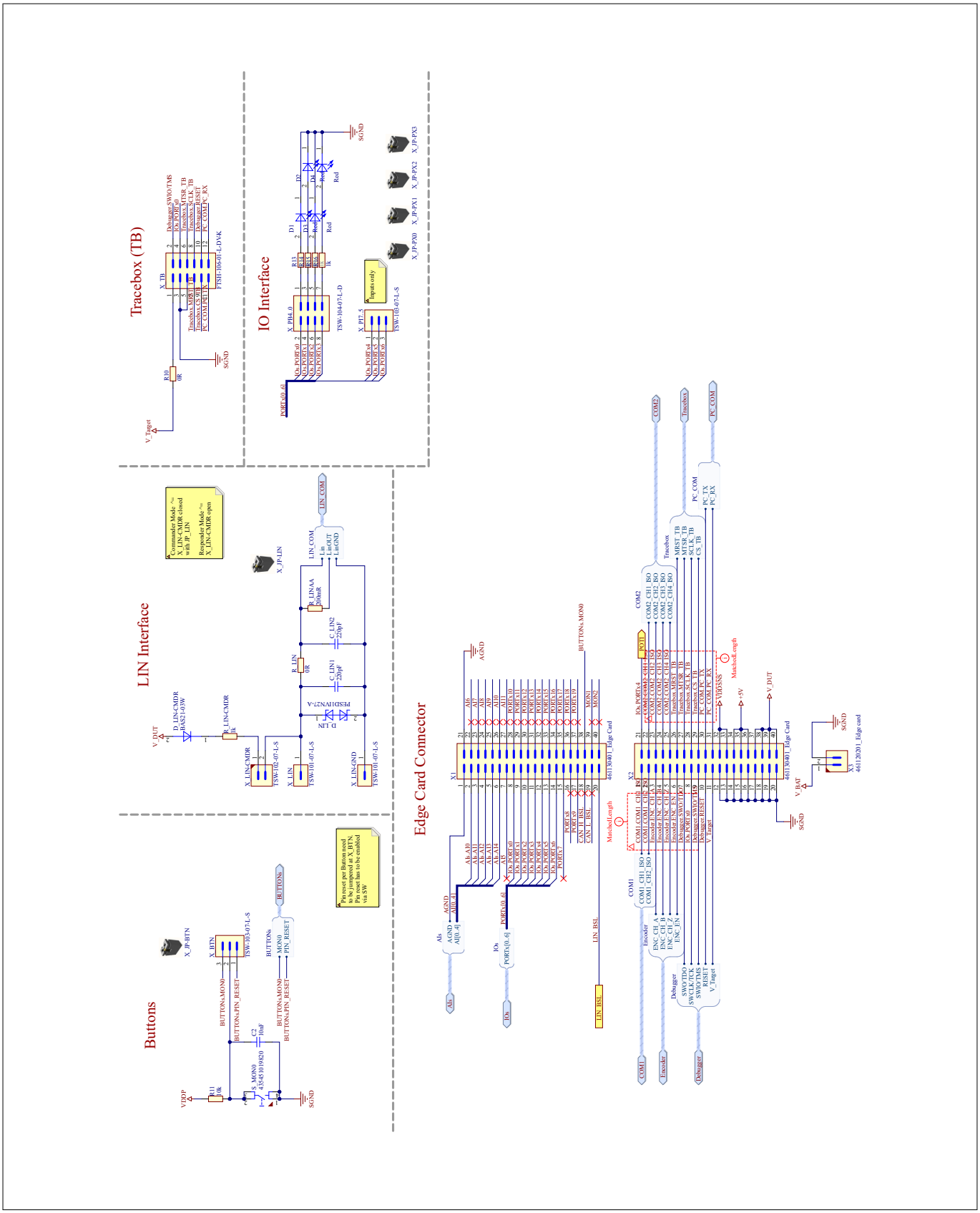

Figure 20 TLE993x daughterboard, Interfaces

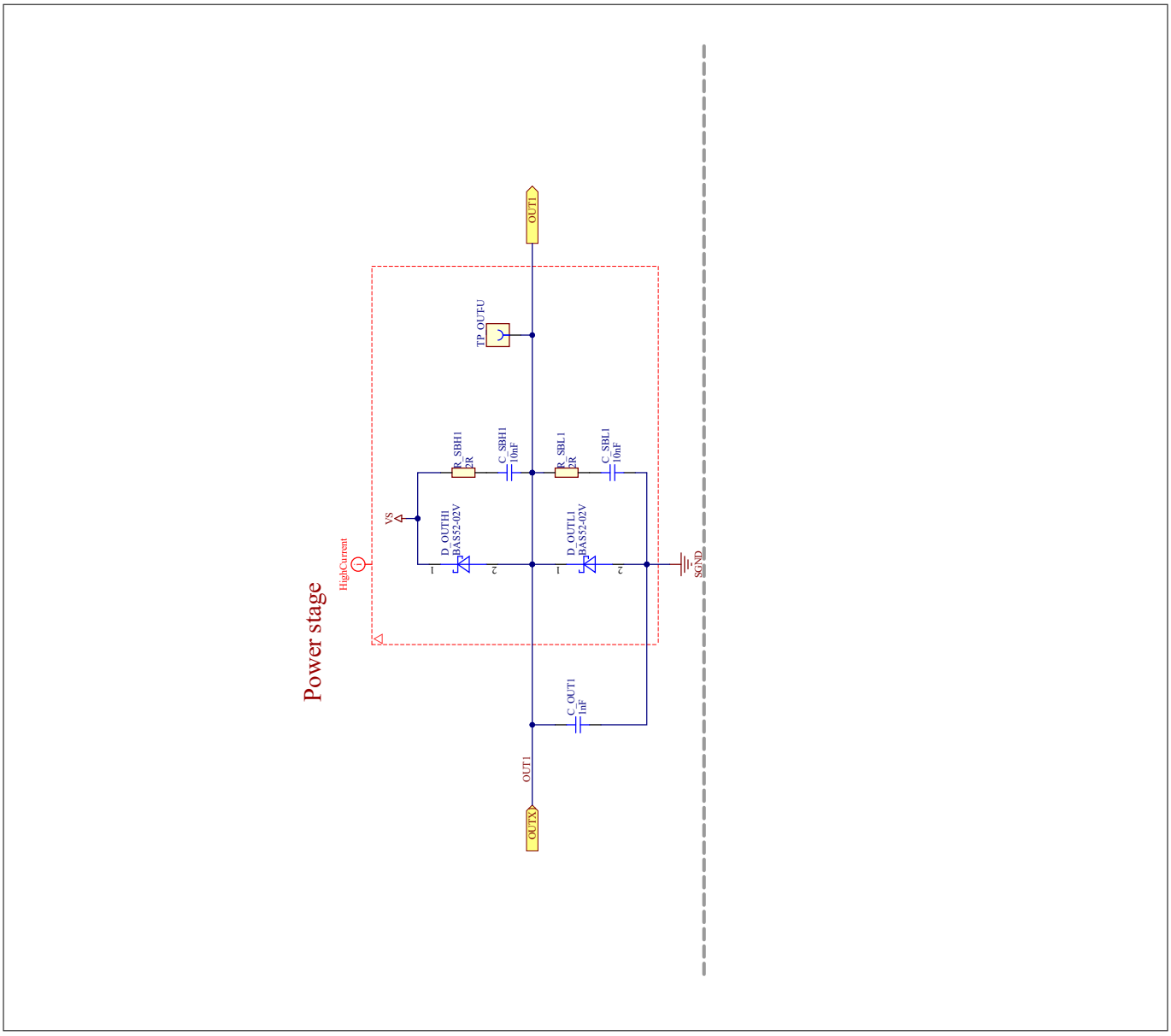

Figure 21 TLE993x daughterboard, 3_Phase external components

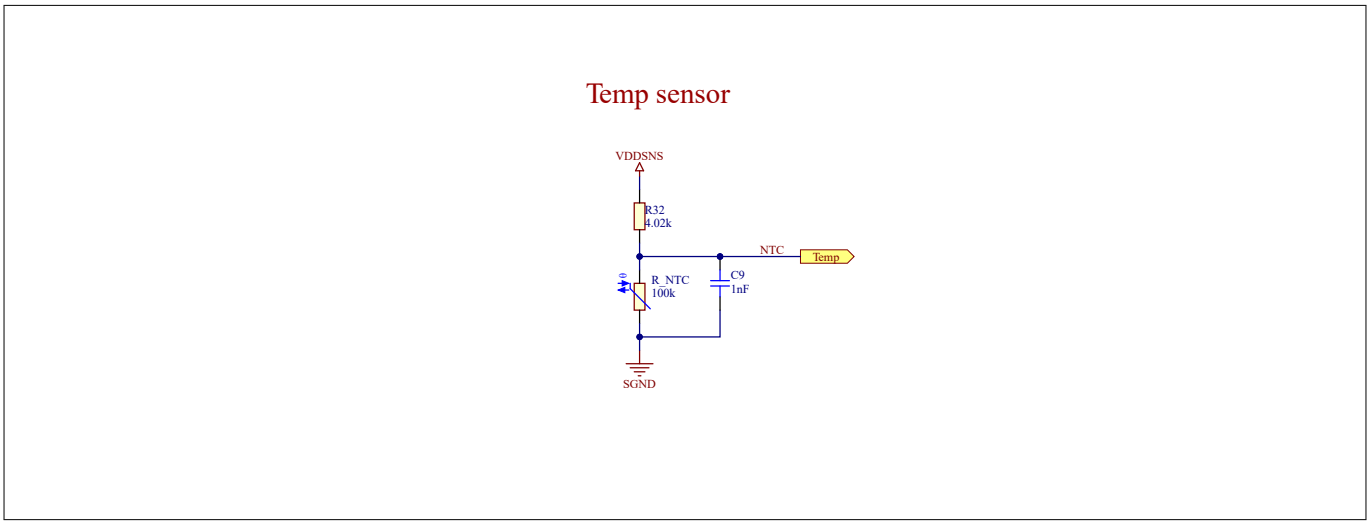

Figure 22 TLE993x daughterboard, Measurements

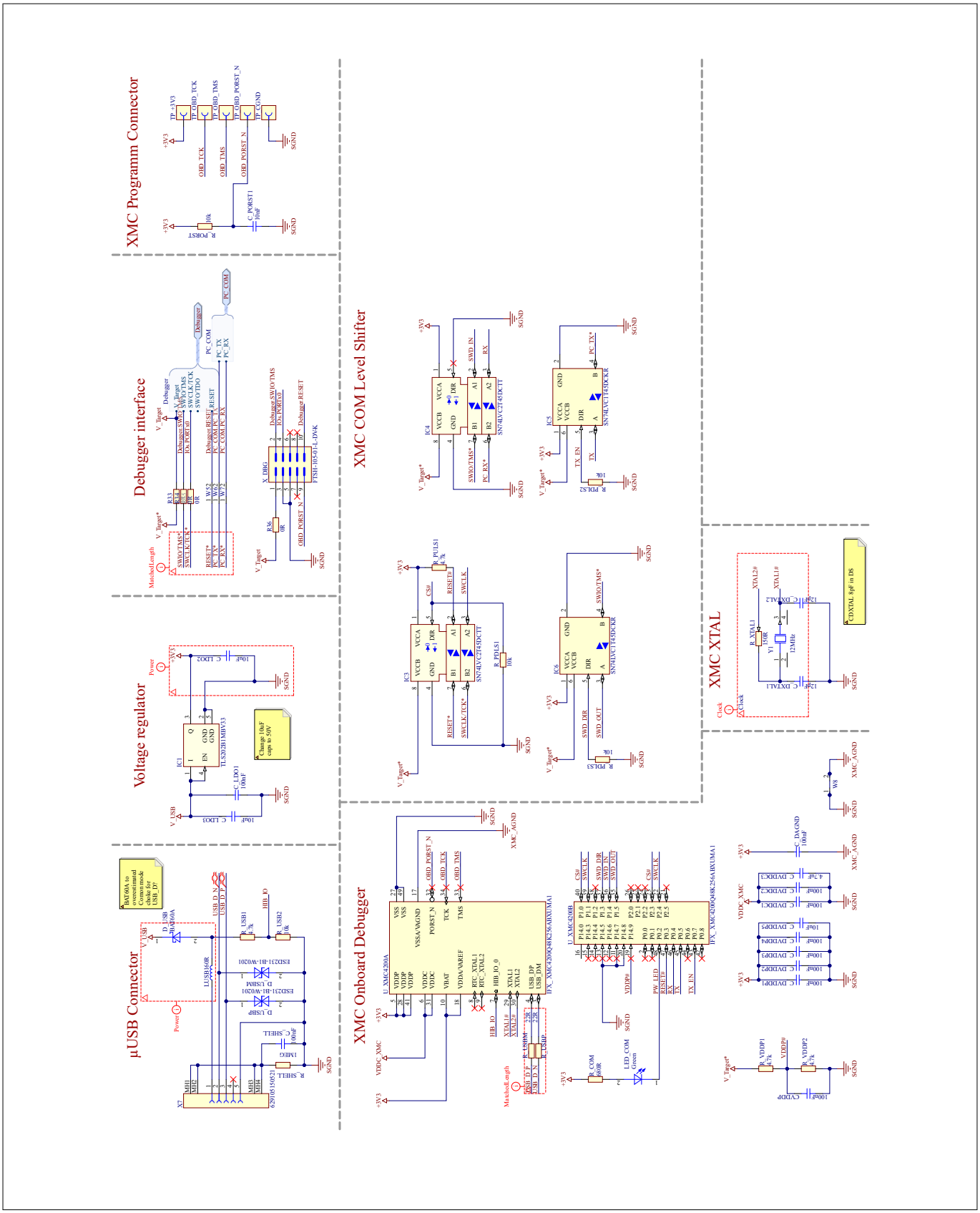

Figure 23 TLE993x daughterboard, Onboard debugger

5.3 Layout TLE993x daughterboard

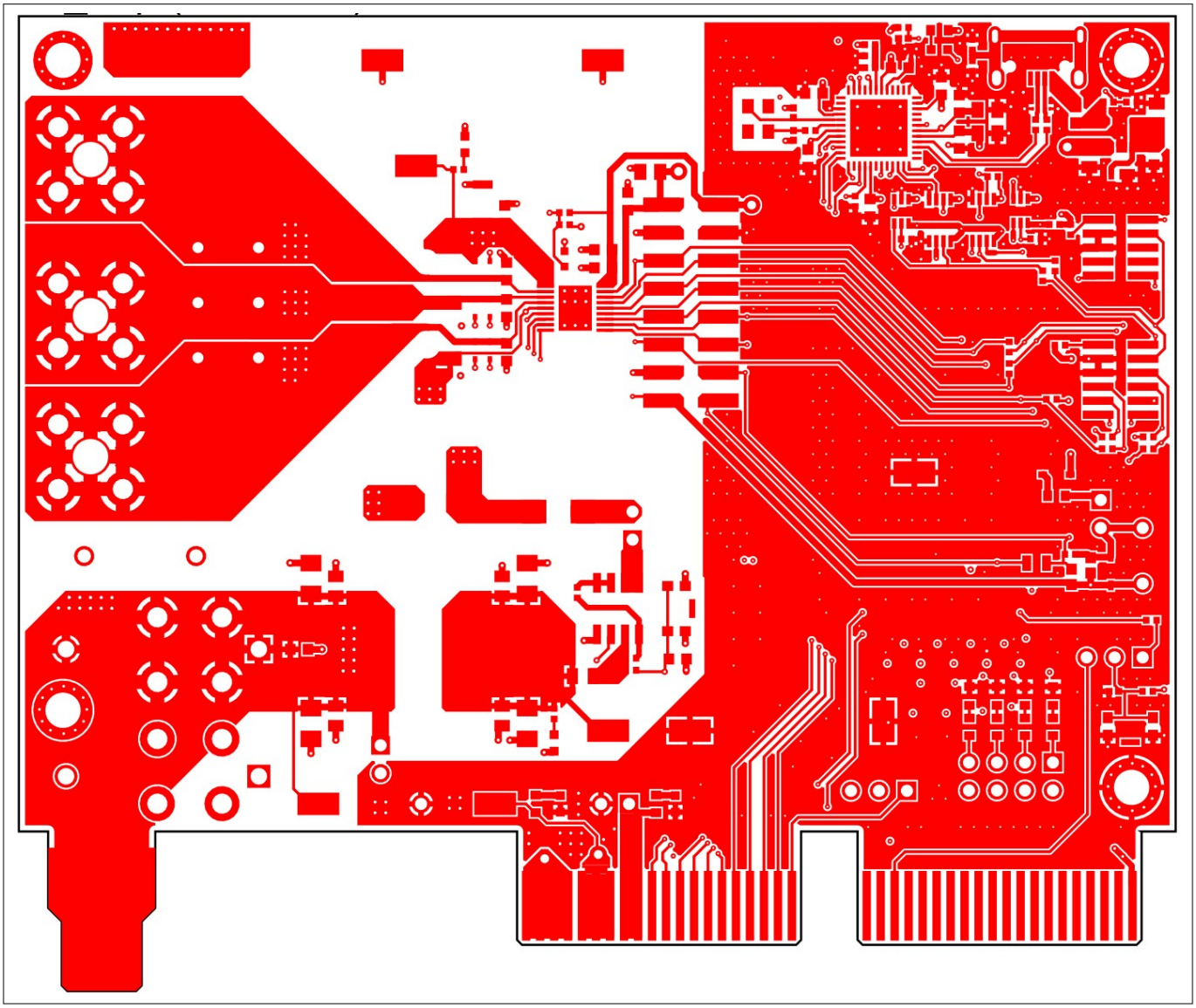

Figure 24 TLE993x daughterboard, layer1 (Top layer, signal)

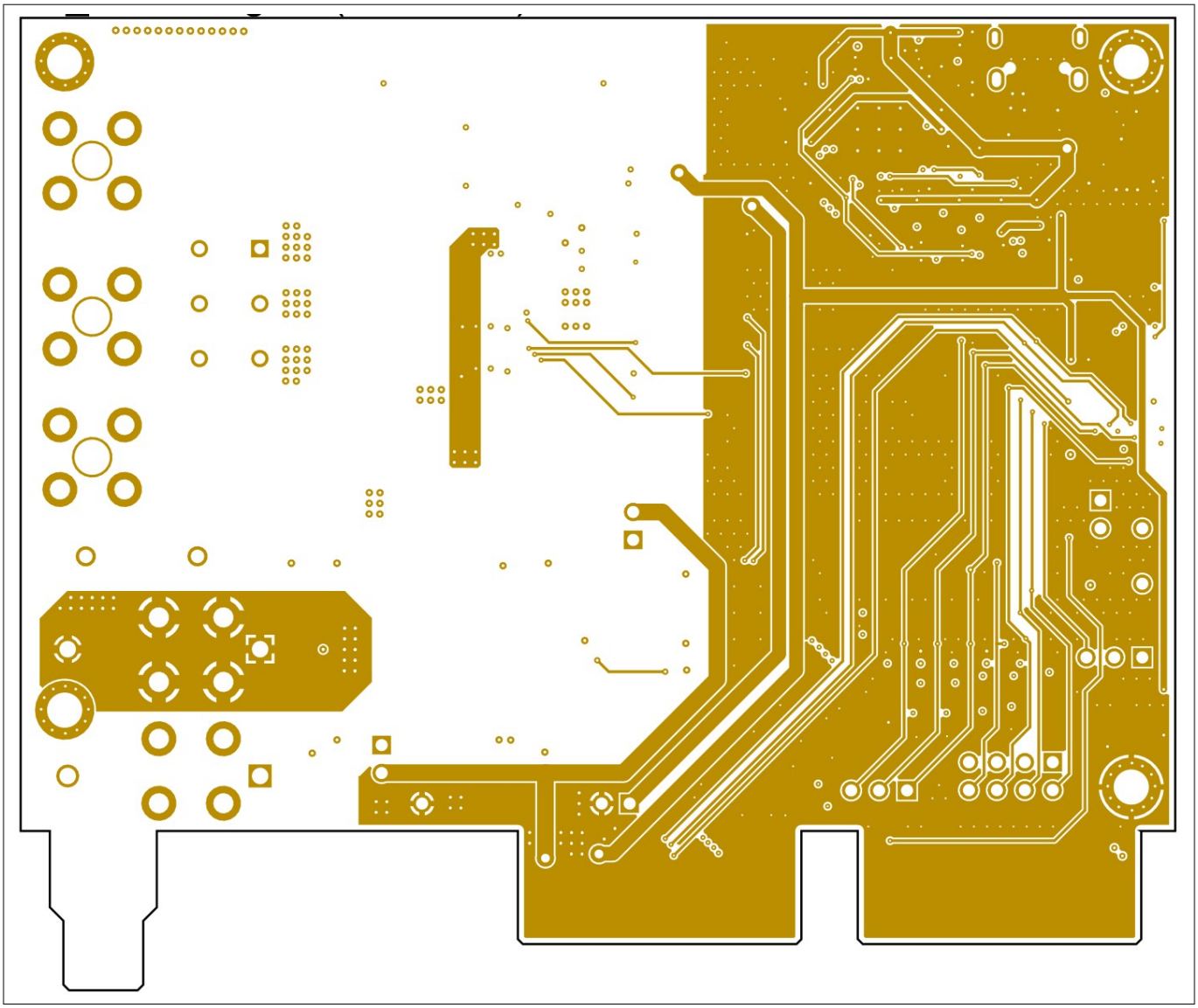

Figure 25 TLE993x daughterboard, layer2 (Middle layer, power)

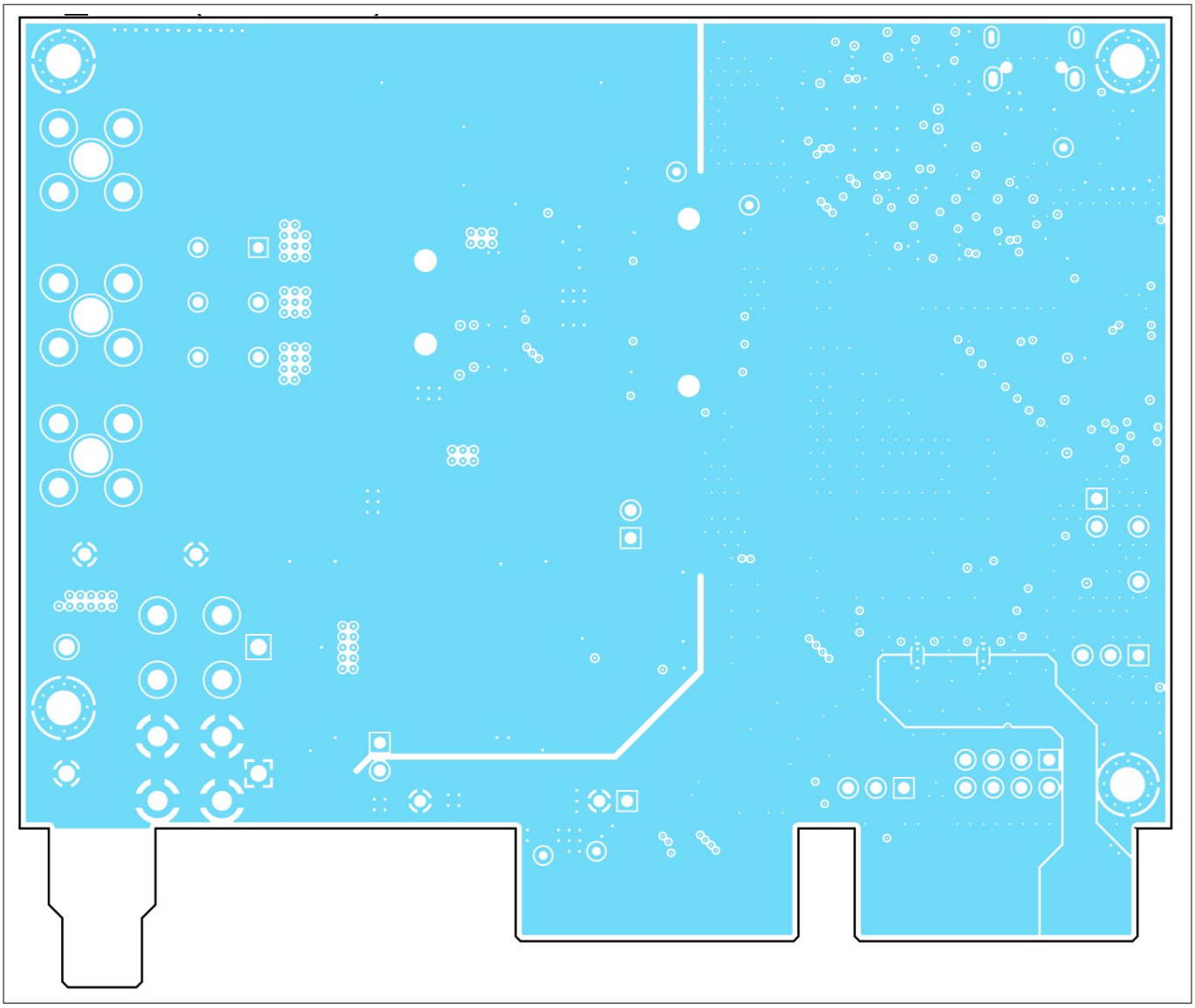

Figure 26 TLE993x daughterboard, layer3 (Middle layer, GND)

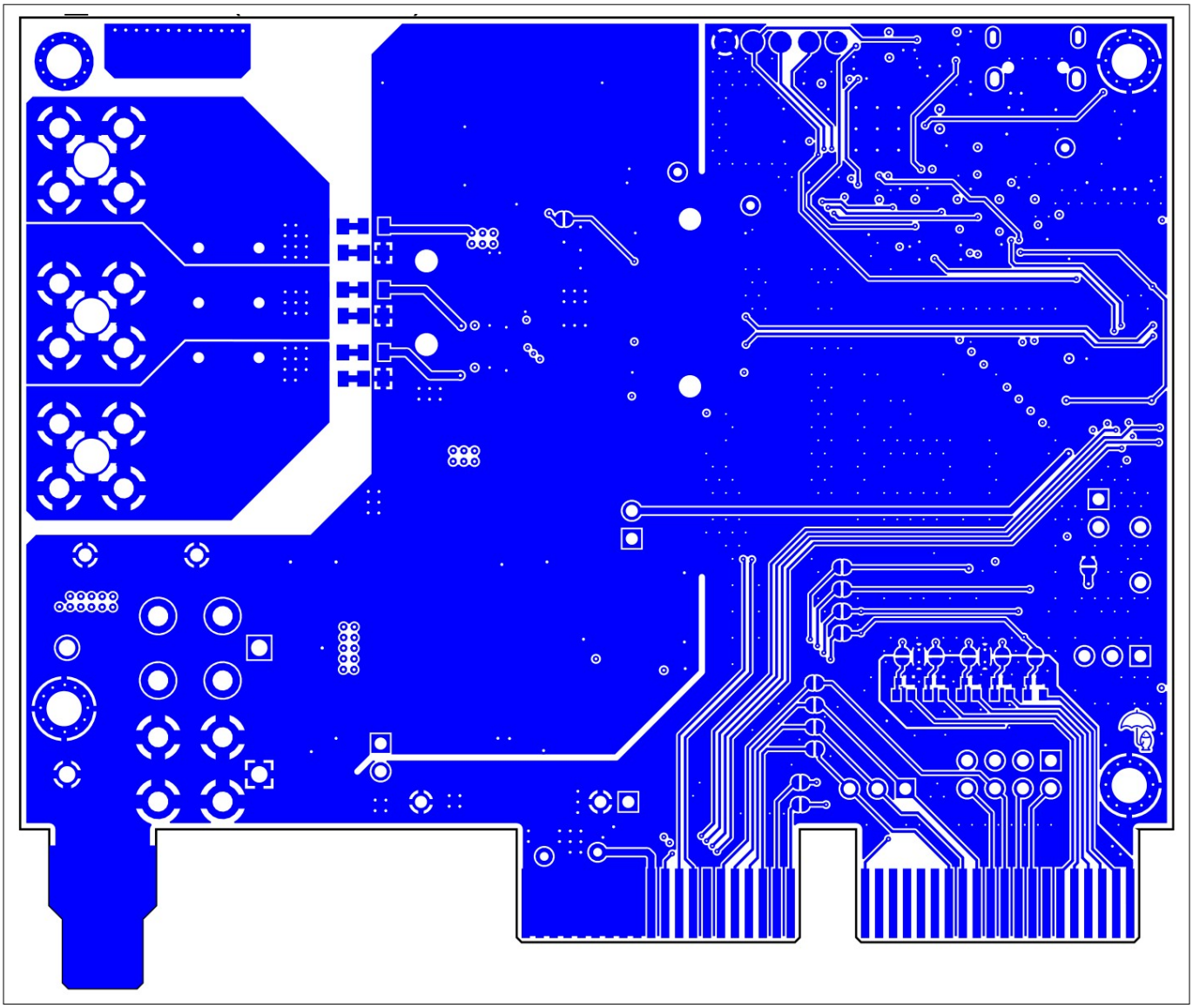

Figure 27 TLE993x daughterboard, layer4 (Bottom layer, signal)

6 Abbreviations and definitions

Table 11 Abbreviations

Abbreviation	Meaning
DUT	Device-under-test
MON	High-voltage monitoring input
N.C.	Not connected
n/u	Not used
SL	Source low-side MOSFET
TMS	Test mode select

For abbreviations regarding the naming and functionalities of the TLE993x family, refer to the device User manual.

Glossary

BLDC

brushless direct current (BLDC)

BOM

bill of materials (BOM)

A list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts, and the quantities of each that are needed to manufacture an end product.

EMC

electromagnetic compatibility (EMC)
The ability of electrical equipment and systems to function acceptably in their electromagnetic environment, by limiting the unintentional generation, propagation and reception of electromagnetic energy which may cause unwanted effects such as electromagnetic interference (EMI) or even physical damage in operational equipment.

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.

GPIO

general purpose input output (GPIO)

I/O

input/output (I/O)
The communication between an information processing system and another information processing system.

LED

light-emitting diode (LED)

A semiconductor circuit that emits light when activated.

LIN

local interconnect network (LIN)

MCU

microcontroller unit (MCU)

A small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals.

MOSFET

metal-oxide-semiconductor field-effect transistor (MOSFET)

PCB

printed circuit board (PCB)

A board that mechanically supports and electrically connects electronic components using conductive tracks, pads, and other features etched from copper sheets laminated onto a non-conductive substrate.

RC filter

resistor-capacitor filter (RC filter)
An electric circuit composed of resistors and capacitors.

SWD

serial wire debug (SWD)

A communication interface and protocol used for debugging and programming embedded systems, particularly microcontrollers and other integrated circuits.

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.

Revision history

Document version	Date of release	Description of changes
Rev. 1.00	2026-03-19	• Initial public release

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