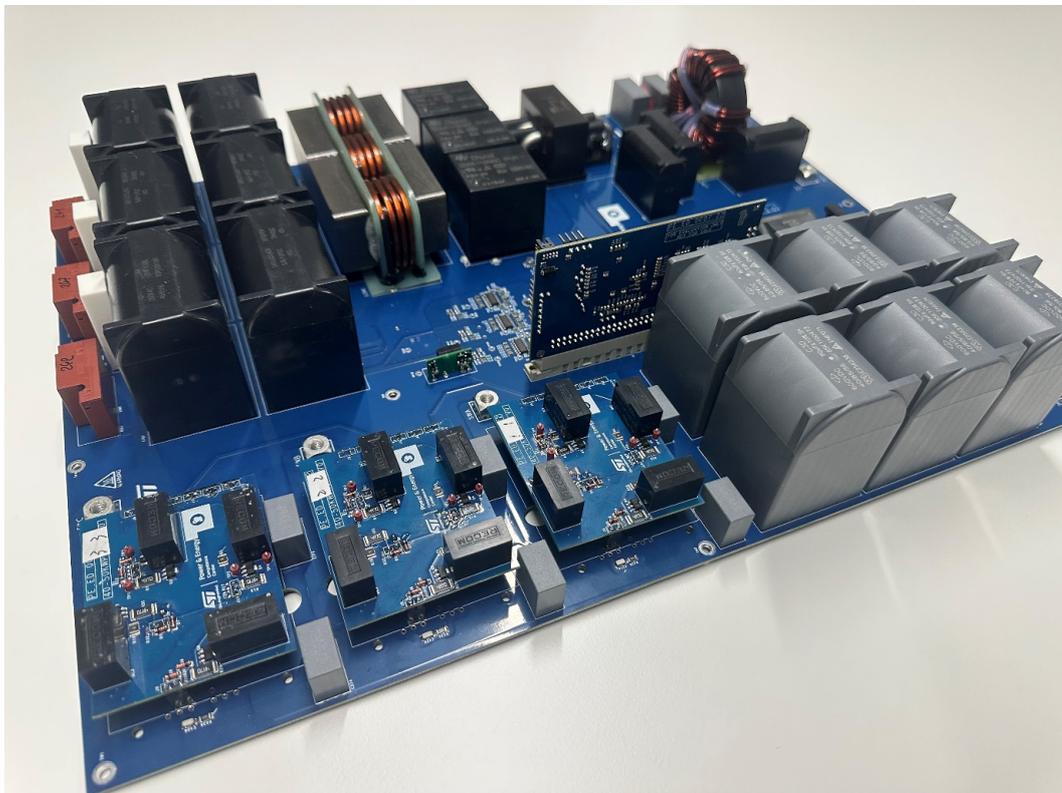


STDES-50KWTPVI bidirectional operation and extension to 60 kW with liquid cooling system

Introduction

This reference design introduces a complete ST's digital power solution for high-power three-phase DC/AC inverter applications, based on the three levels T-type topology. This reference design topology is mostly used for industrial photovoltaic (PV) solar applications, for commercial energy storage applications. We have also tested the bidirectional function in the lab for ESS applications.

Figure 1. STDES-50KWTPVI 50 kW T-type DC/AC inverter evaluation kit



Fully assembled board developed for
performance evaluation only,
[not available for sale](#)

1 Safety instructions

Attention: *This evaluation board is designed for demonstration purposes only and is not intended for domestic or industrial installations.*

Danger: *The high voltage levels used to operate this evaluation board could provoke a serious electrical shock. This evaluation board has to be used in a suitable laboratory by qualified personnel only, familiar with the installation, use, and maintenance of power electrical systems. During operation, do not touch the board as some of its components could reach a very high temperature.*

2 Specifications

Table 1. Electrical characteristics

Symbol	Description	Min.	Typ.	Max.	Units	Comments
V _{in}	Input voltage	650	800	850	V _{rms}	-
f _{AC}	Input AC frequency	47	50	63	Hz	-
f _{AC}	Output AC frequency	45	50	55	Hz	-
V _{out}	Output Line Line AC voltage	310	380	476	V	-
P _{out}	Output power	-	-	50	kW	-
I _{out}	Output current	-	-	76	A	V _{ac(L-L)} = 380 V
η	Peak efficiency	-	-	98.89	%	V _{in} = 800 V V _{ac(L-L)} = 380 V
		-	-	99.1	%	V _{in} = 650 V V _{ac(L-L)} = 380 V
iTHD	Total harmonic distortion	-	<3	-	%	At full load (rated at 800 V dc)
PF	Power factor	-	0.99	-	-	At full load
	Power factor range	-	0.8	-	-	0.8 lead ~ 0.8 lag
I _{out} _OCP	Output current protection	-	-	180	A	-
BUSOVP	Input voltage protection	-	-	600	V	Half of the input voltage

3 Bidirectional function test

This section is a summary of the main experimental results of the bidirectional function based on the 50 kW T-type DC/AC inverter.

Figure 2. 50 kW DC to AC transition state with 800 V_{DC} and V_{AC} = 380 V

- Deep blue trace: DC voltage
- Light green trace: DC current
- Orange trace: phase-A AC current
- Purple trace: phase-B AC current
- Deep green trace: phase-C AC current

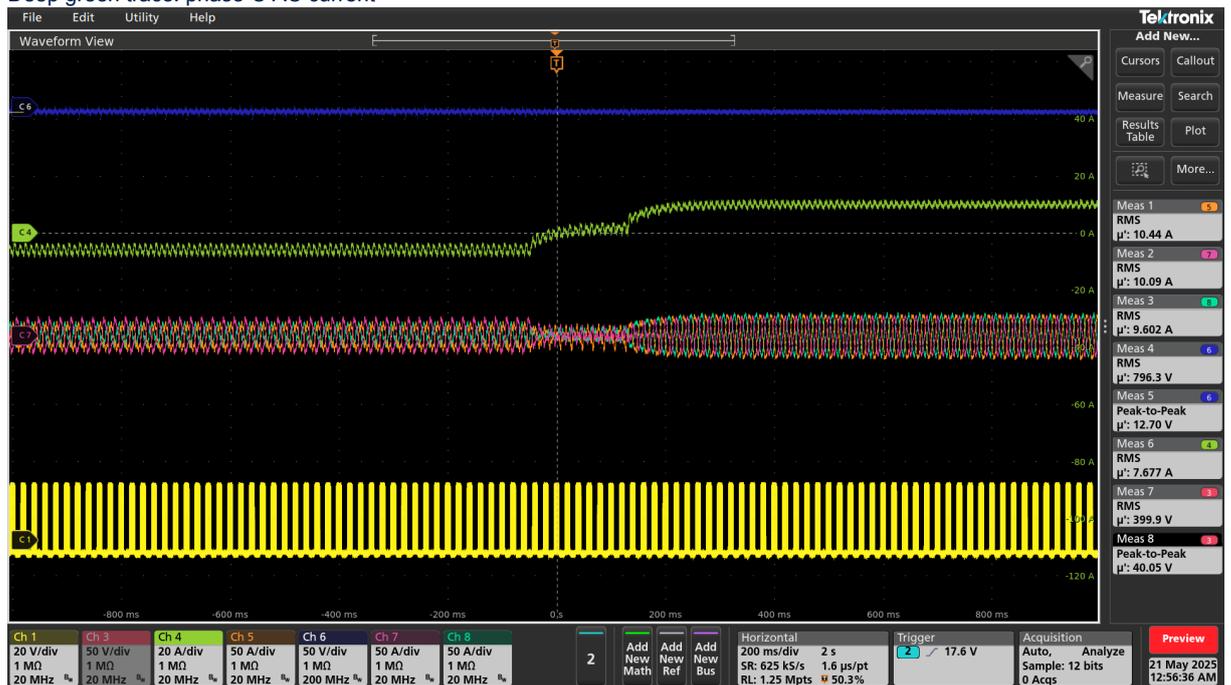


Figure 3. 50 kW AC to DC transition state with 800 V_{DC} and V_{AC} = 380 V

Deep blue trace: DC voltage
 Light green trace: DC current
 Orange trace: phase-A AC current
 Purple trace: phase-B AC current
 Deep green trace: phase-C AC current

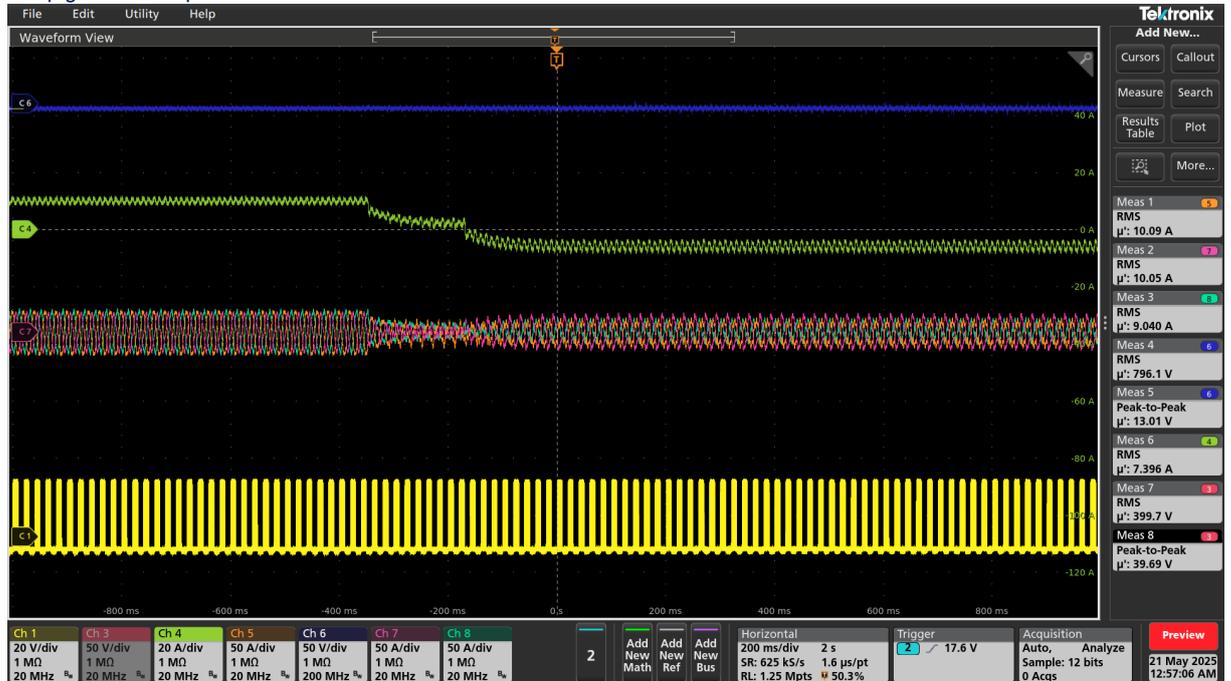
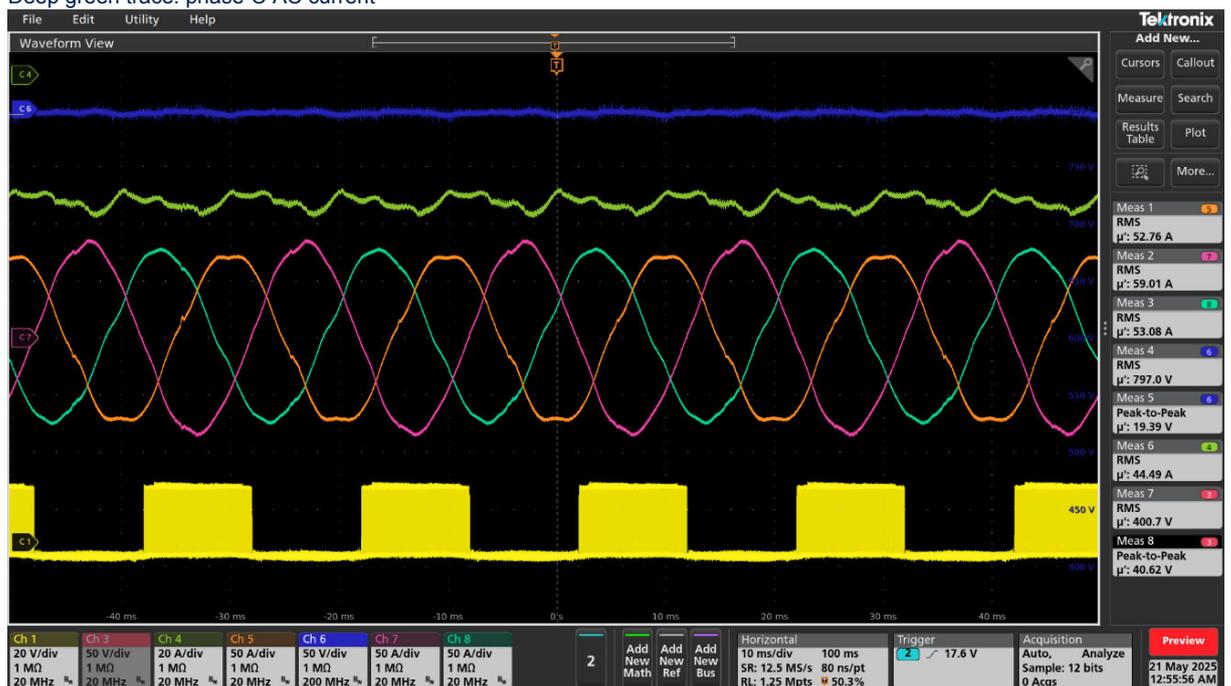


Figure 4. 35 kW AC/DC running state with 800 V_{DC} and V_{AC} = 380 V

Deep blue trace: DC voltage
 Light green trace: DC current
 Orange trace: phase-A AC current
 Purple trace: phase-B AC current
 Deep green trace: phase-C AC current



4 60 kW liquid cooling system test

We have optimized the bidirectional PFC function based on the 50 kW T-type DC/AC inverter. The power was enlarged from 50 kW to 60 kW and the fan cooling system was changed to a liquid cooling system.

Figure 5 shows the total 60 kW liquid cooling system platform, including demo boards, liquid cooling machine, and liquid cooling heatsink.

Figure 5. 60 kW liquid cooling system platform

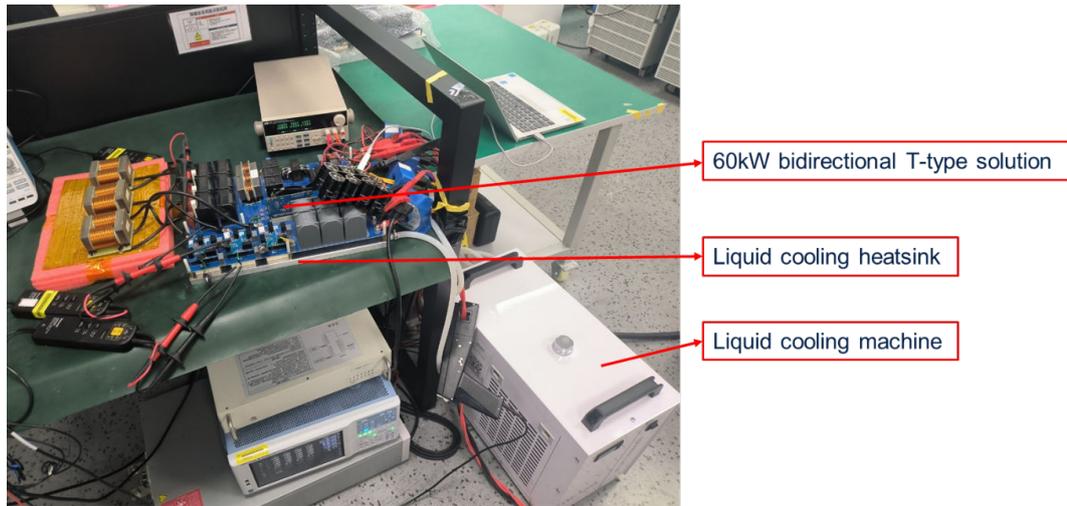


Figure 6. 60 kW AC/DC PFC steady state with 800 V_{DC} and V_{AC} = 380 V

Deep blue trace: DC voltage

Yellow trace: DC current

Light blue trace: phase-A AC voltage

Red trace: phase-B AC voltage

Light green trace: phase-C AC voltage

Orange trace: phase-A AC current

Purple trace: phase-B AC current

Deep green trace: phase-C AC current

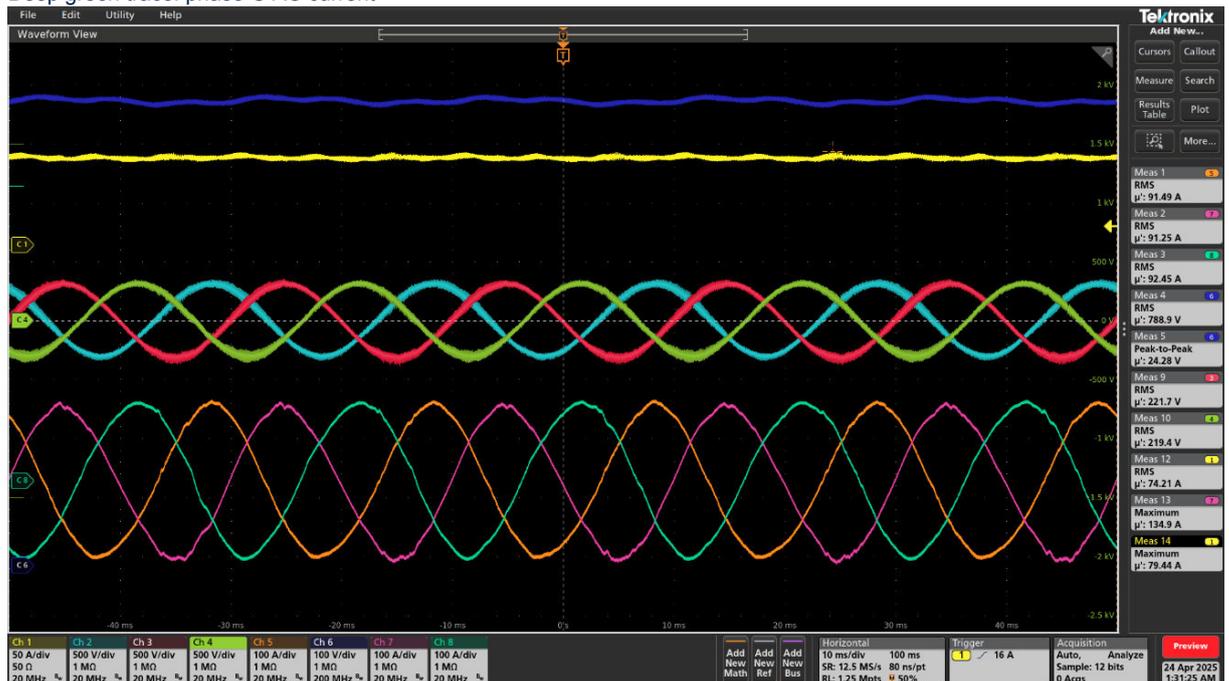
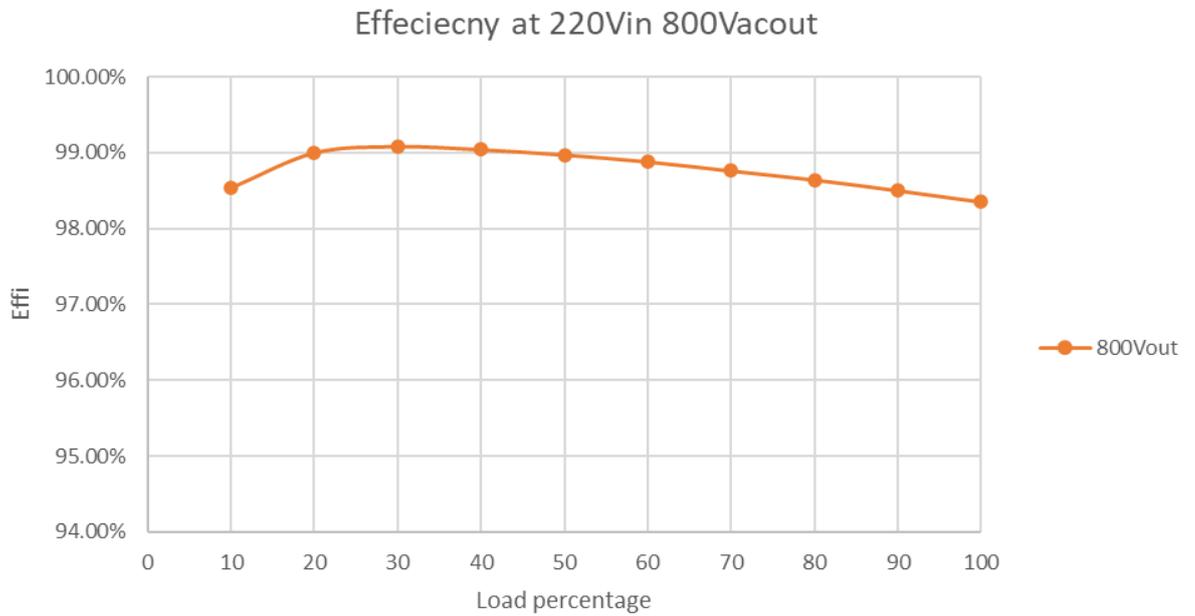


Figure 7 shows the 60 kW liquid cooling system's PFC efficiency's measurement under various operating loads at 800 V_{DC}, 380 V_{AC} (L-L) conditions, with the liquid cooling machine set at 16°C. Its peak efficiency is of 99.05% at 30% load condition (18 kW).

Figure 7. 60 kW liquid cooling PFC efficiency curve at 800 V_{DC} and V_{AC} = 380 V



5 Schematic diagrams

Figure 8. STDES-50KWPVDRV gate driver board - circuit schematic (1 of 2)

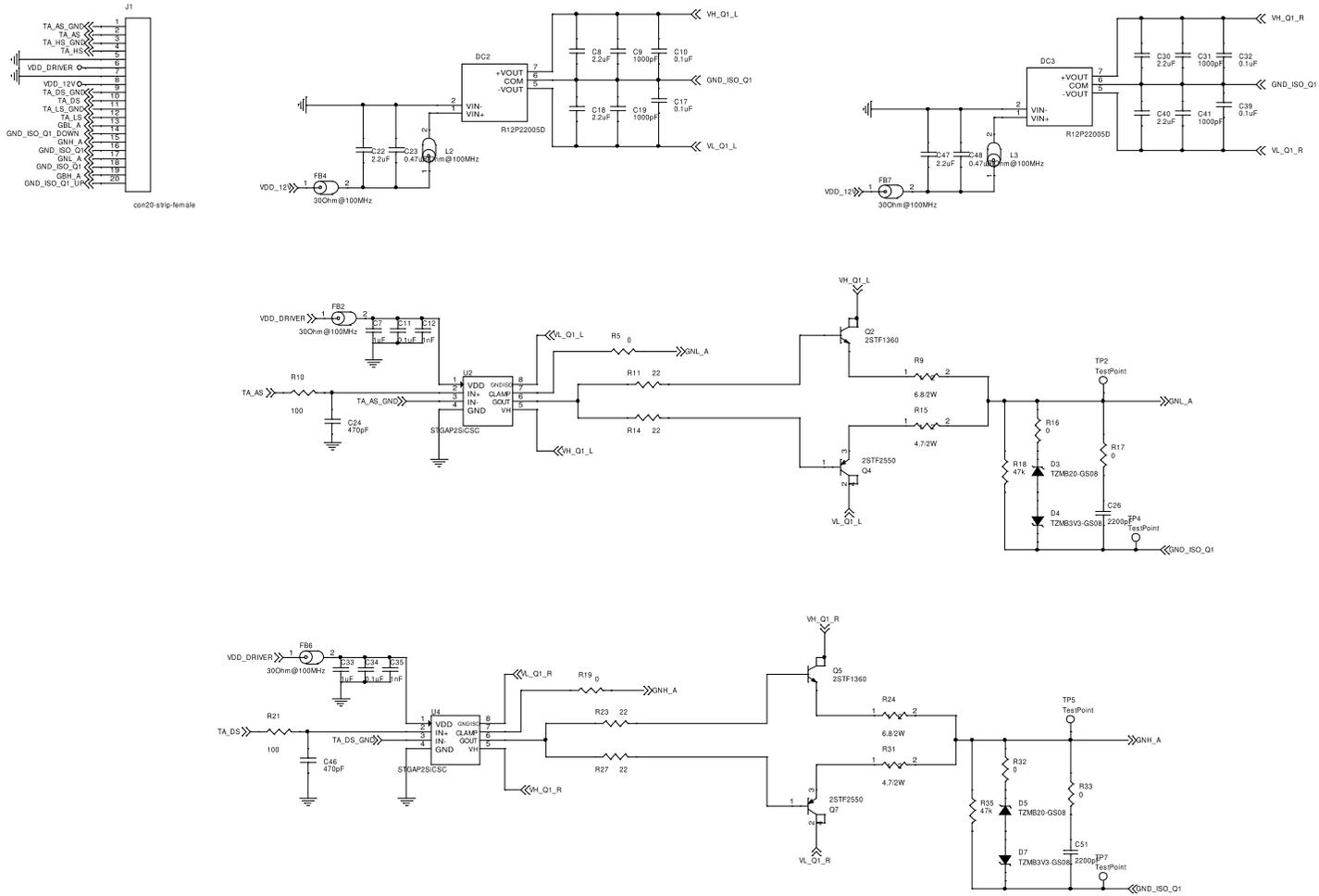


Figure 9. STDES-50KWPVDRV gate driver board - circuit schematic (2 of 2)

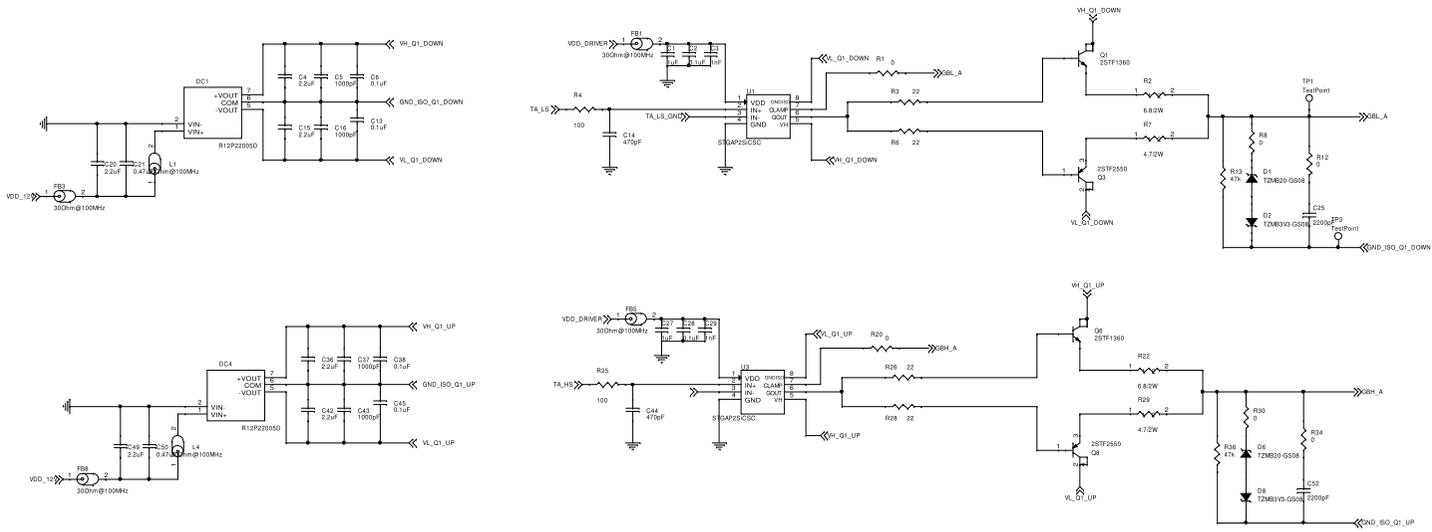


Figure 12. STDES-50KWPVWR main power board - circuit schematic (3 of 13)

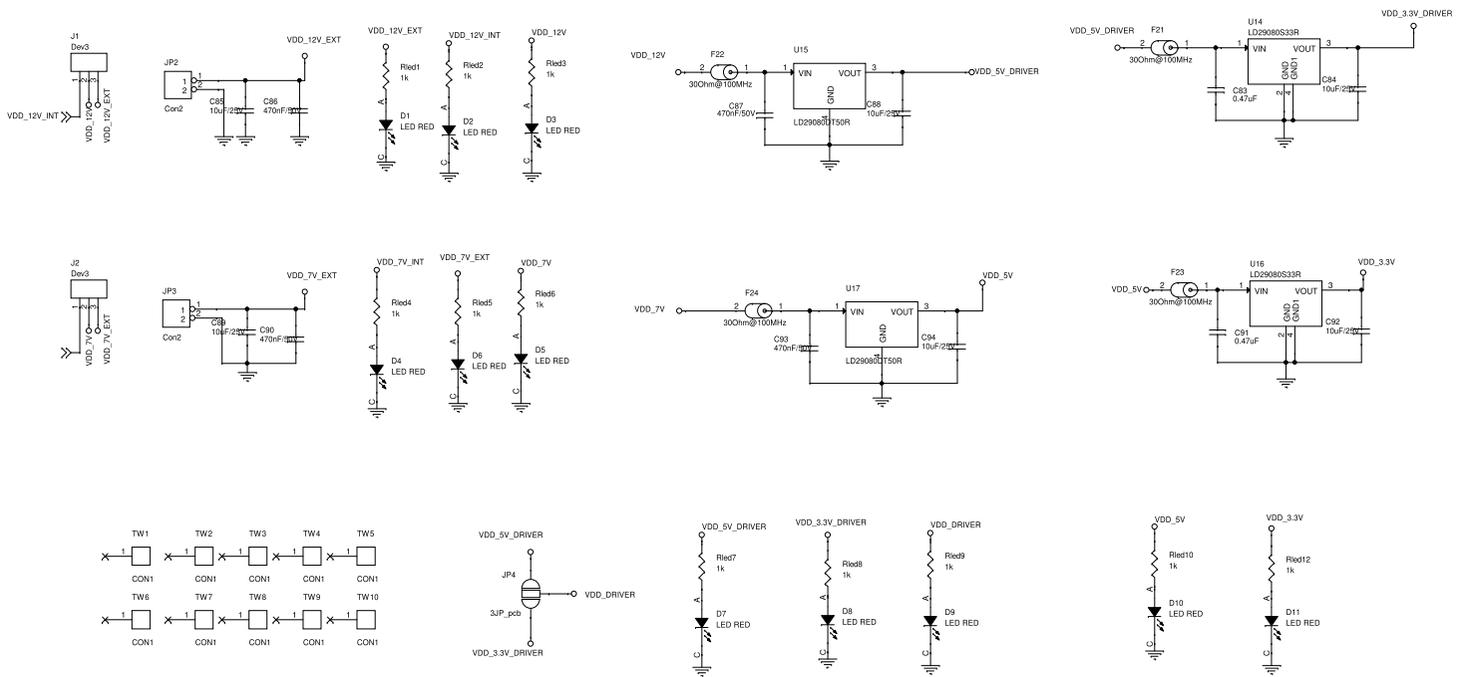


Figure 13. STDES-50KWPVPR main power board - circuit schematic (4 of 13)

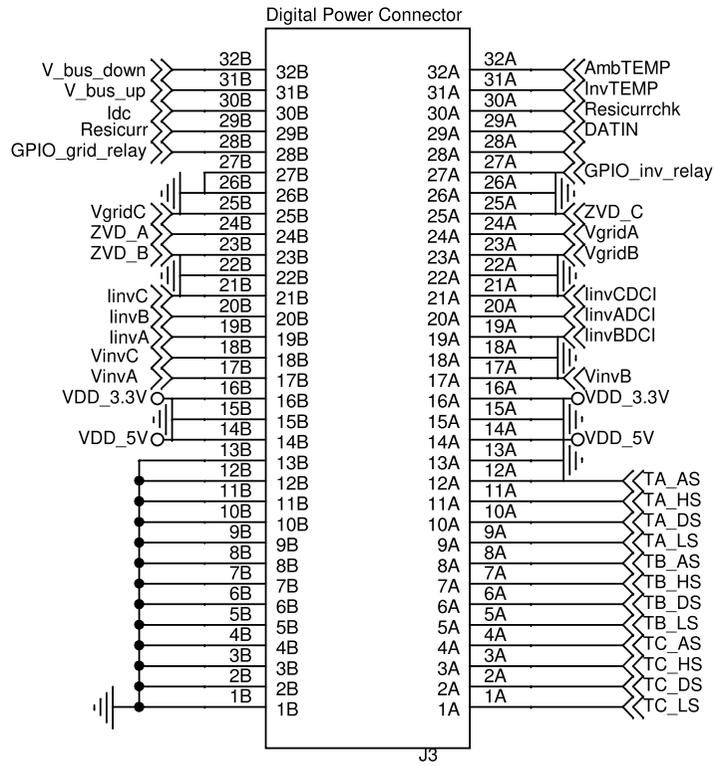
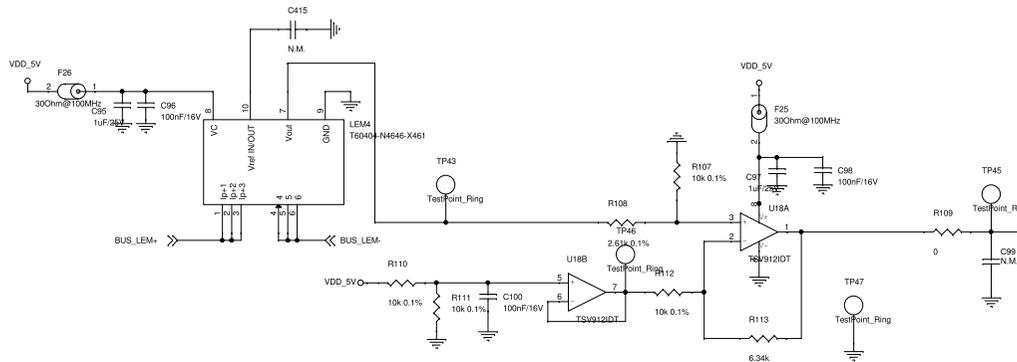


Figure 14. STDES-50KWPVPR main power board - circuit schematic (5 of 13)



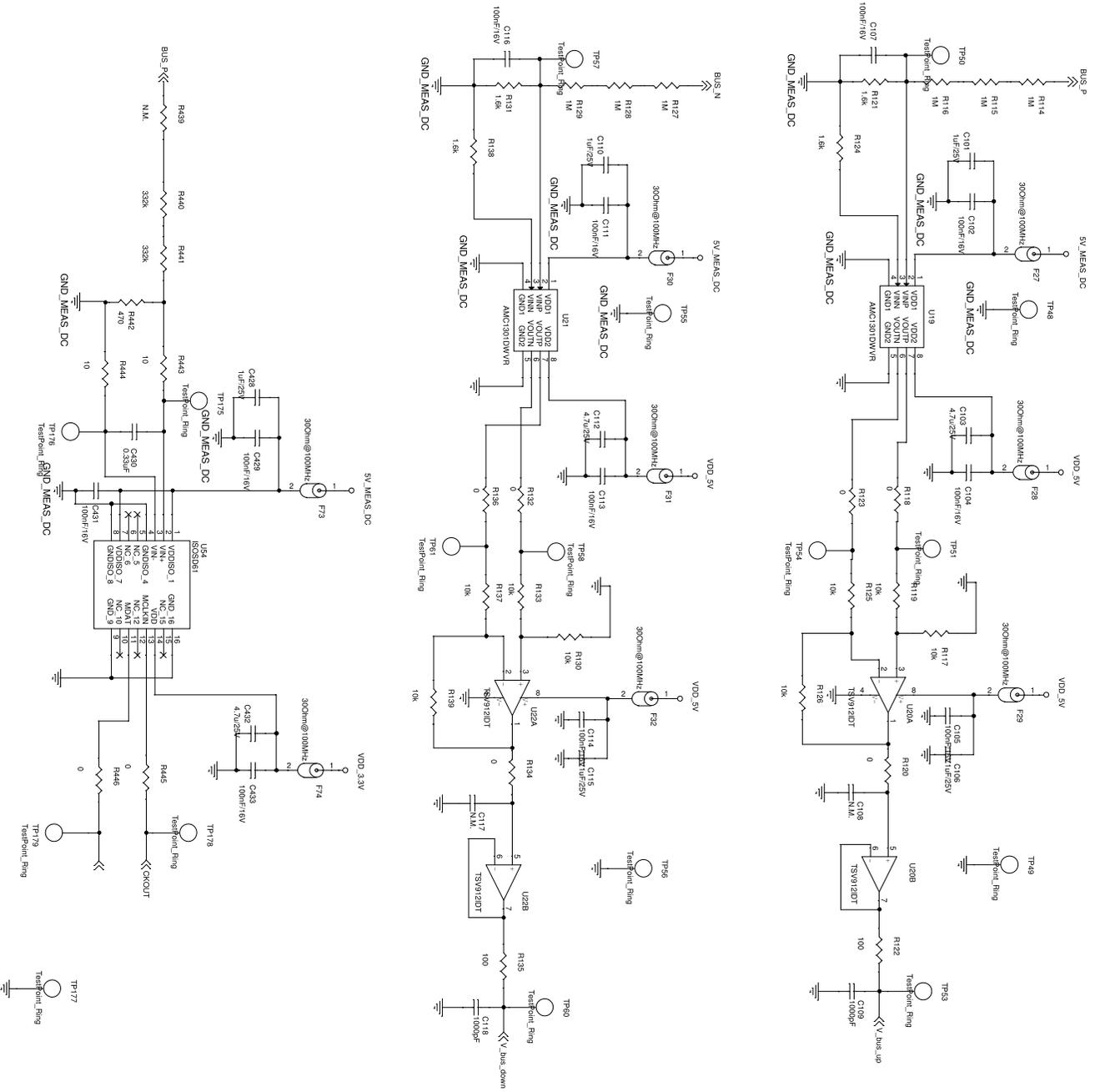


Figure 15. STDES-50KWPVWR main power board - circuit schematic (6 of 13)

Figure 16. STDES-50KWPVPWR main power board - circuit schematic (7 of 13)

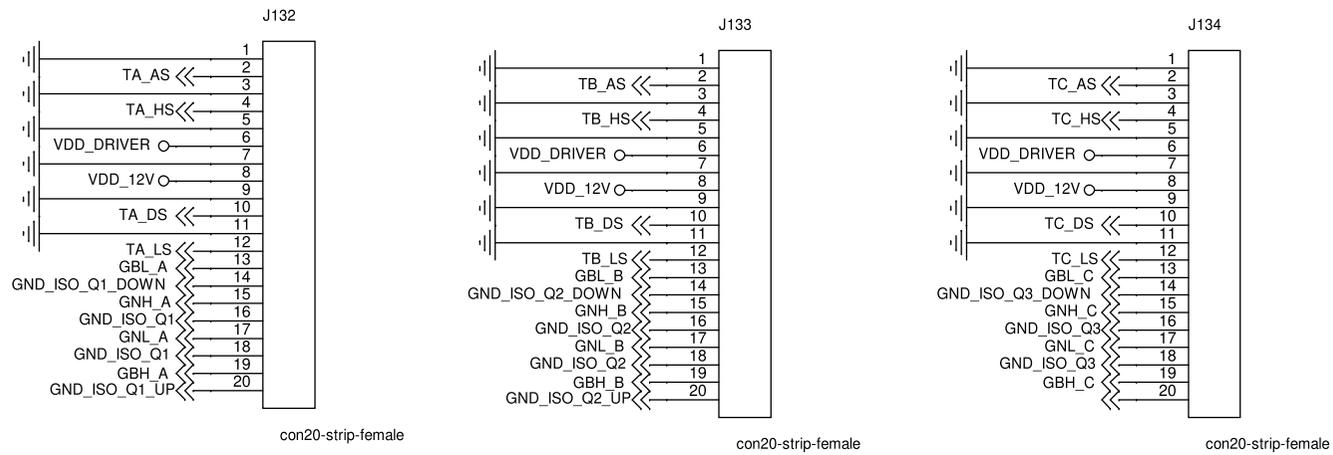


Figure 17. STDES-50KWPVWR main power board - circuit schematic (8 of 13)

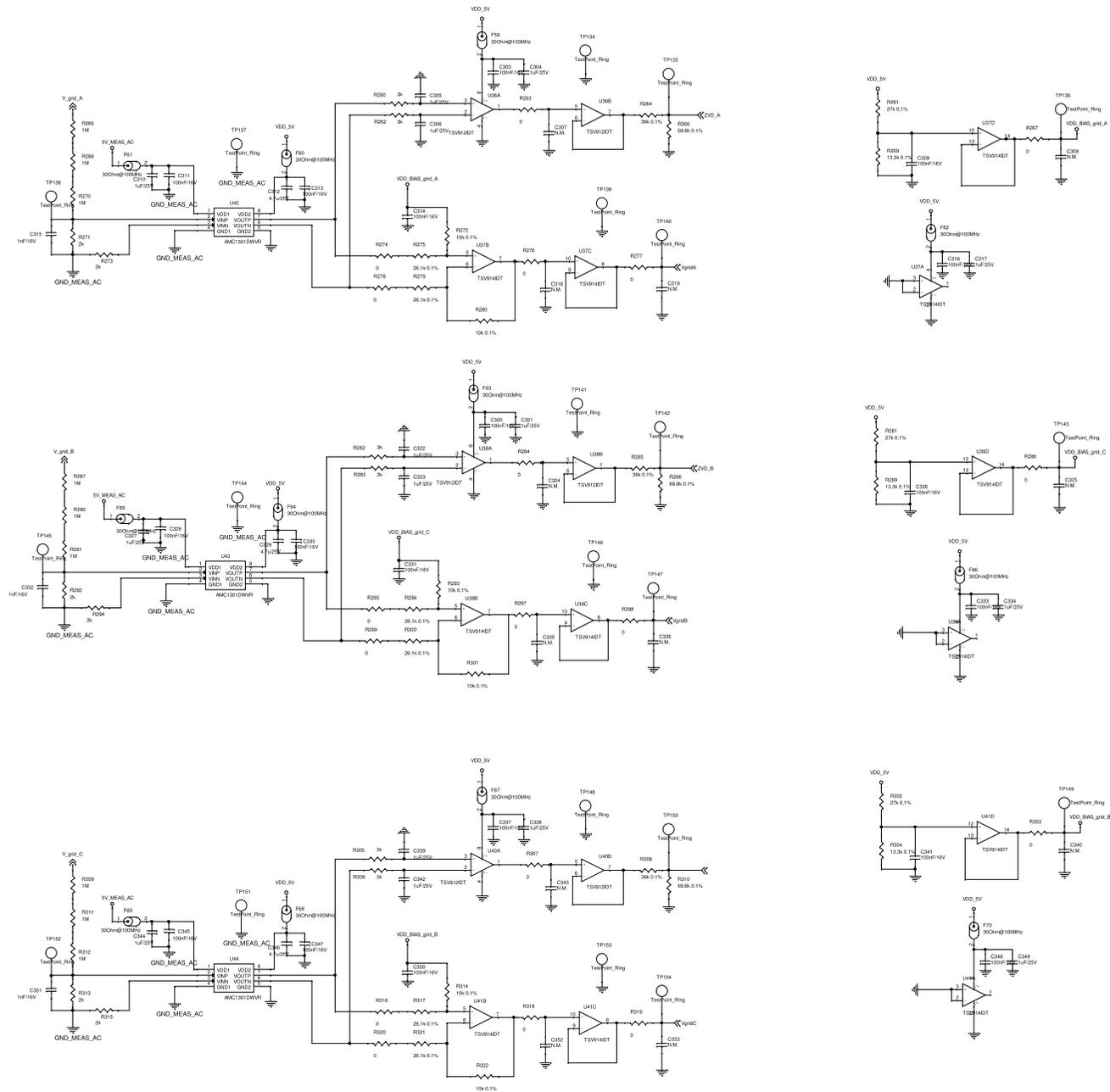


Figure 18. STDES-50KWPVWR main power board - circuit schematic (9 of 13)

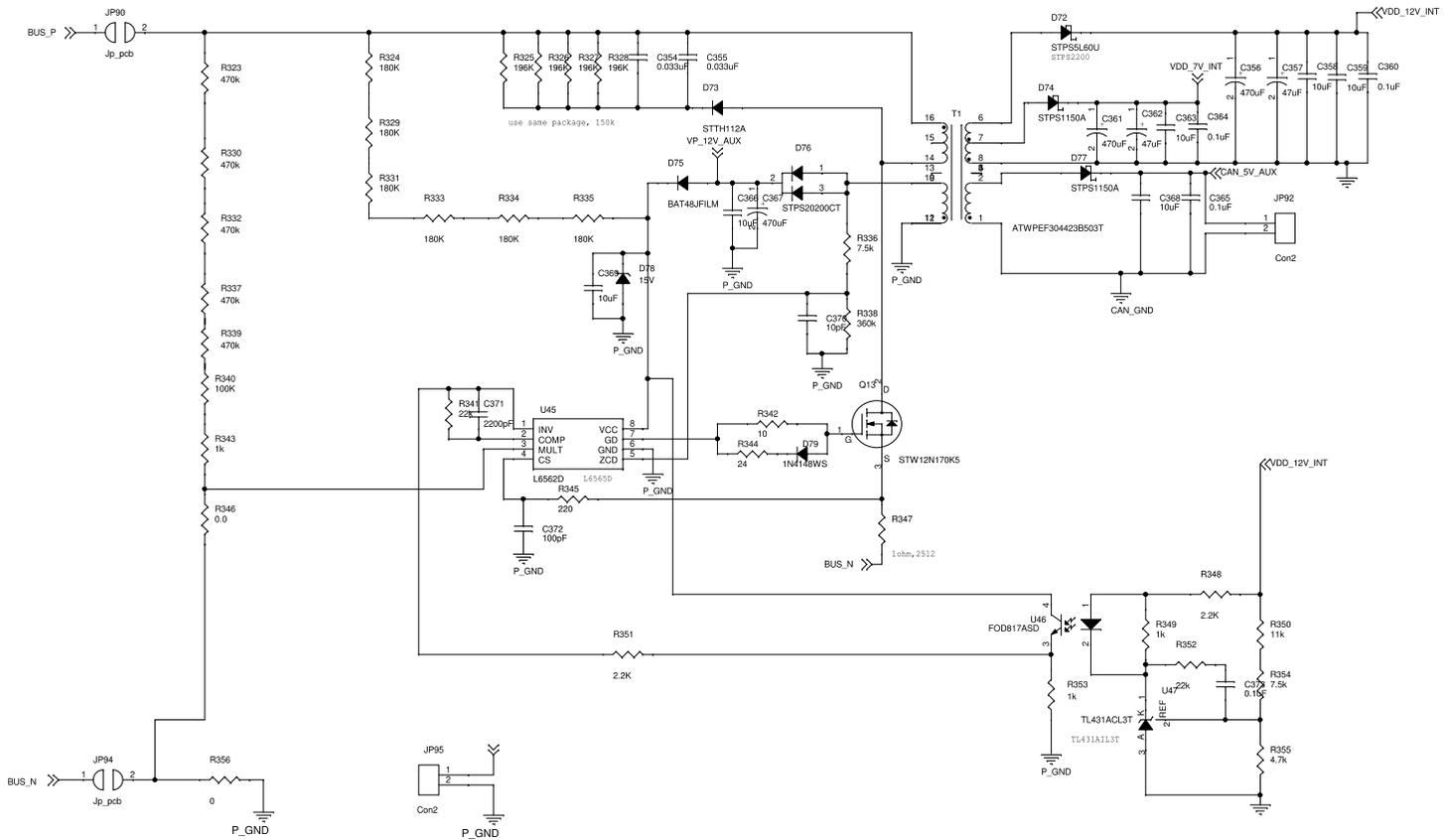


Figure 19. STDES-50KWPVPR main power board - circuit schematic (10 of 13)

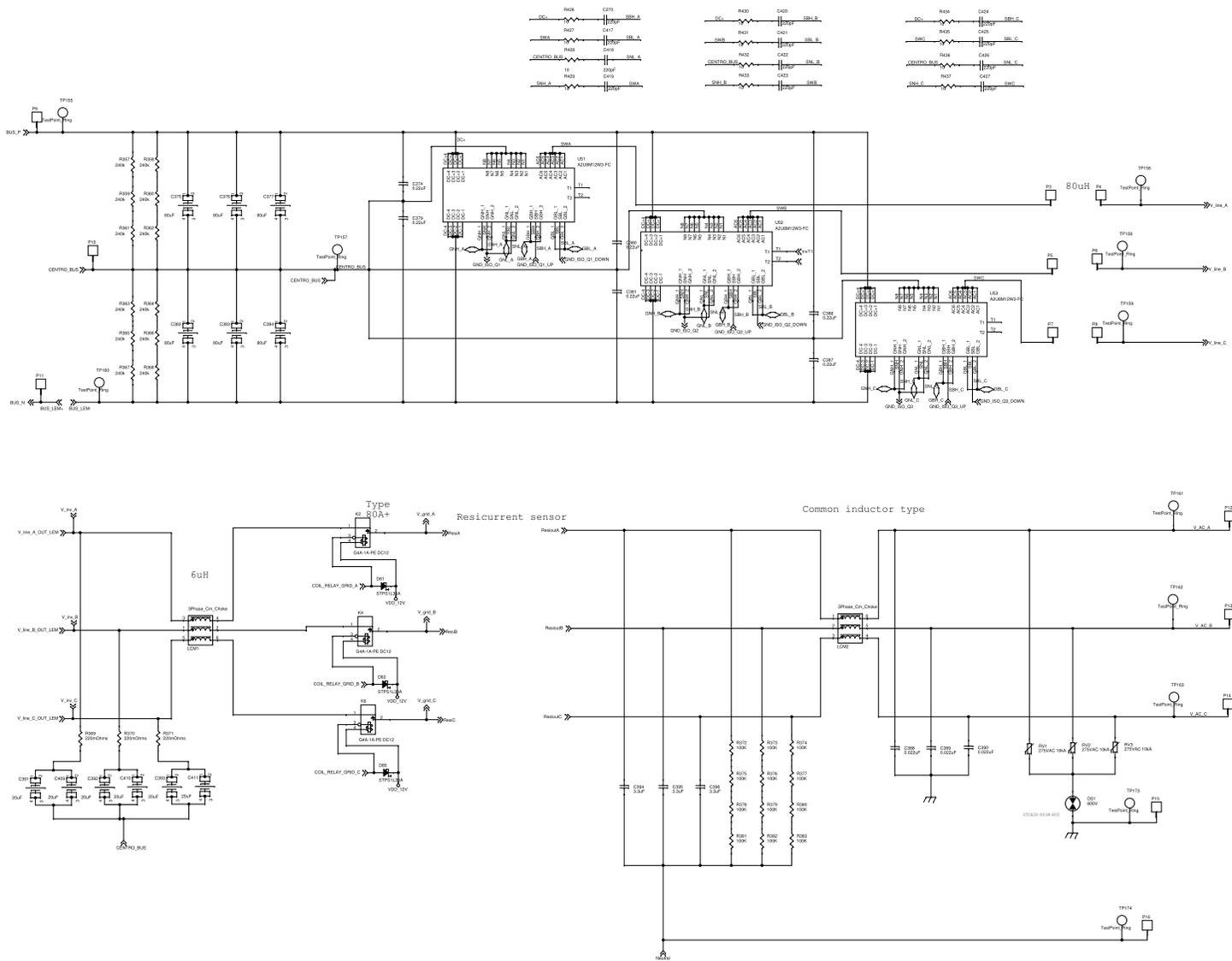


Figure 20. STDES-50KWPVWR main power board - circuit schematic (11 of 13)

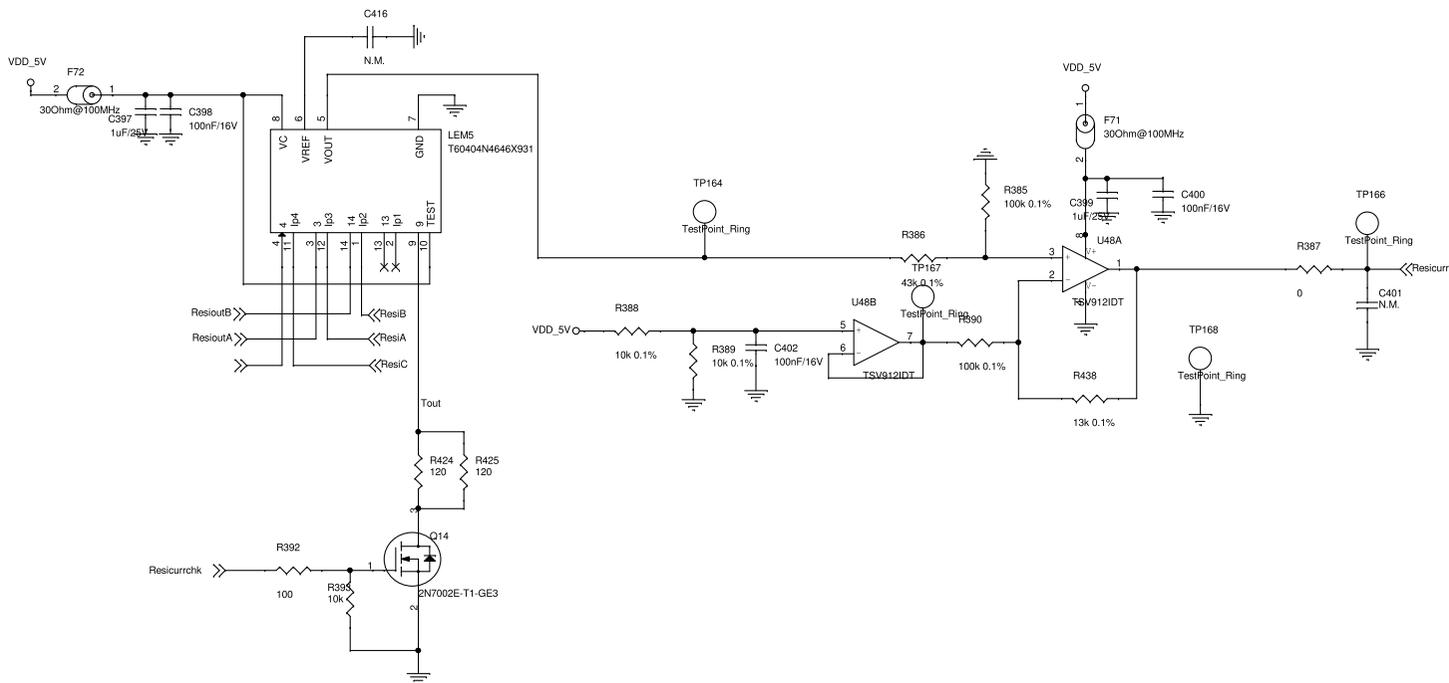


Figure 21. STDES-50KWPVWR main power board - circuit schematic (12 of 13)

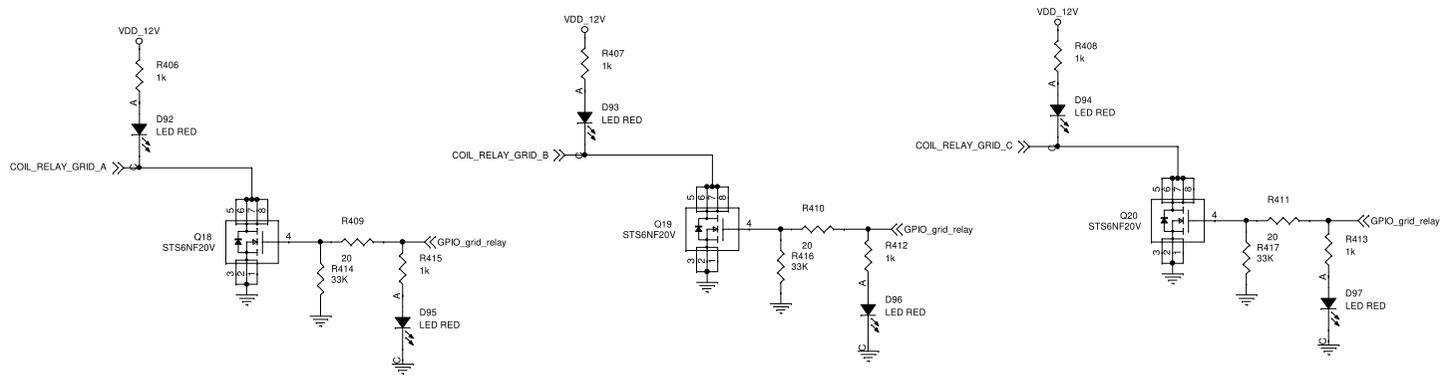


Figure 22. STDES-50KWPVPR main power board - circuit schematic (13 of 13)

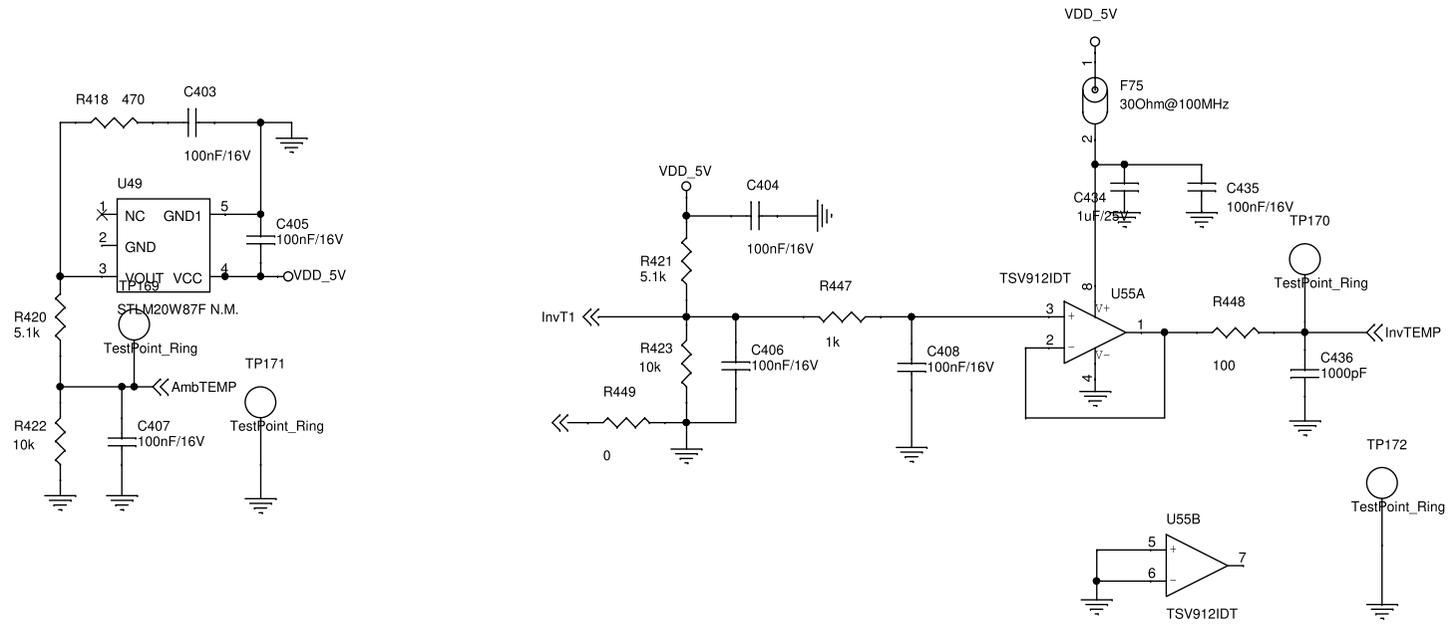


Figure 23. STDES-H743CTRL control board - circuit schematic (1 of 5)

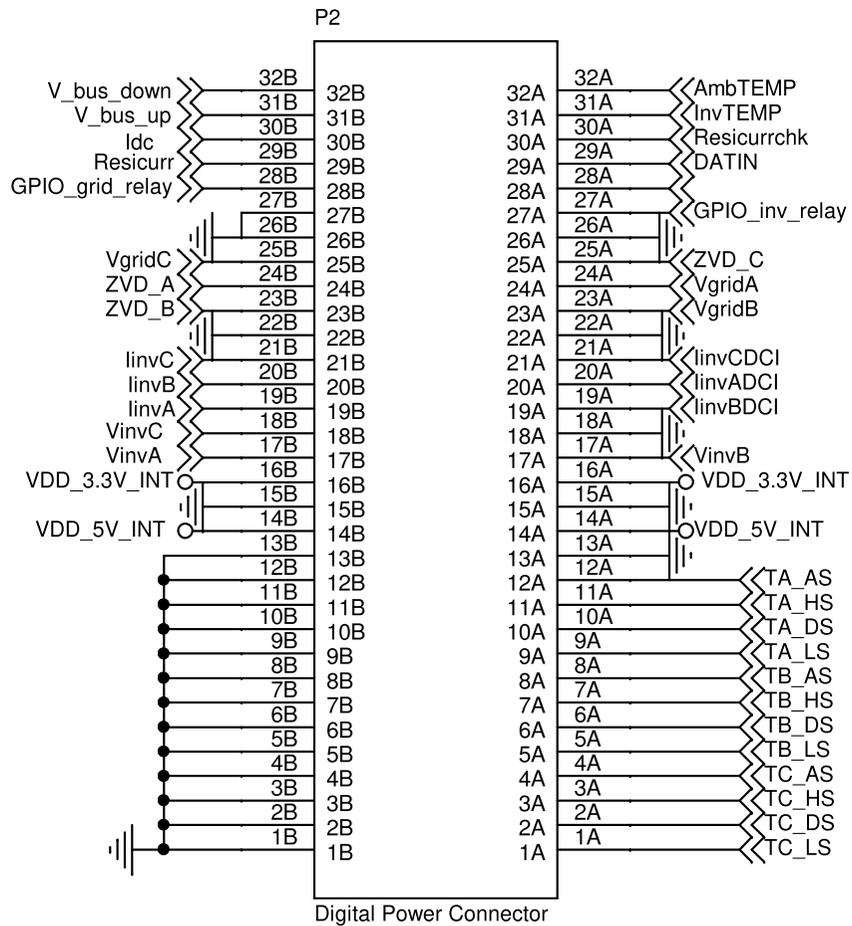


Figure 24. STDES-H743CTRL control board - circuit schematic (2 of 5)

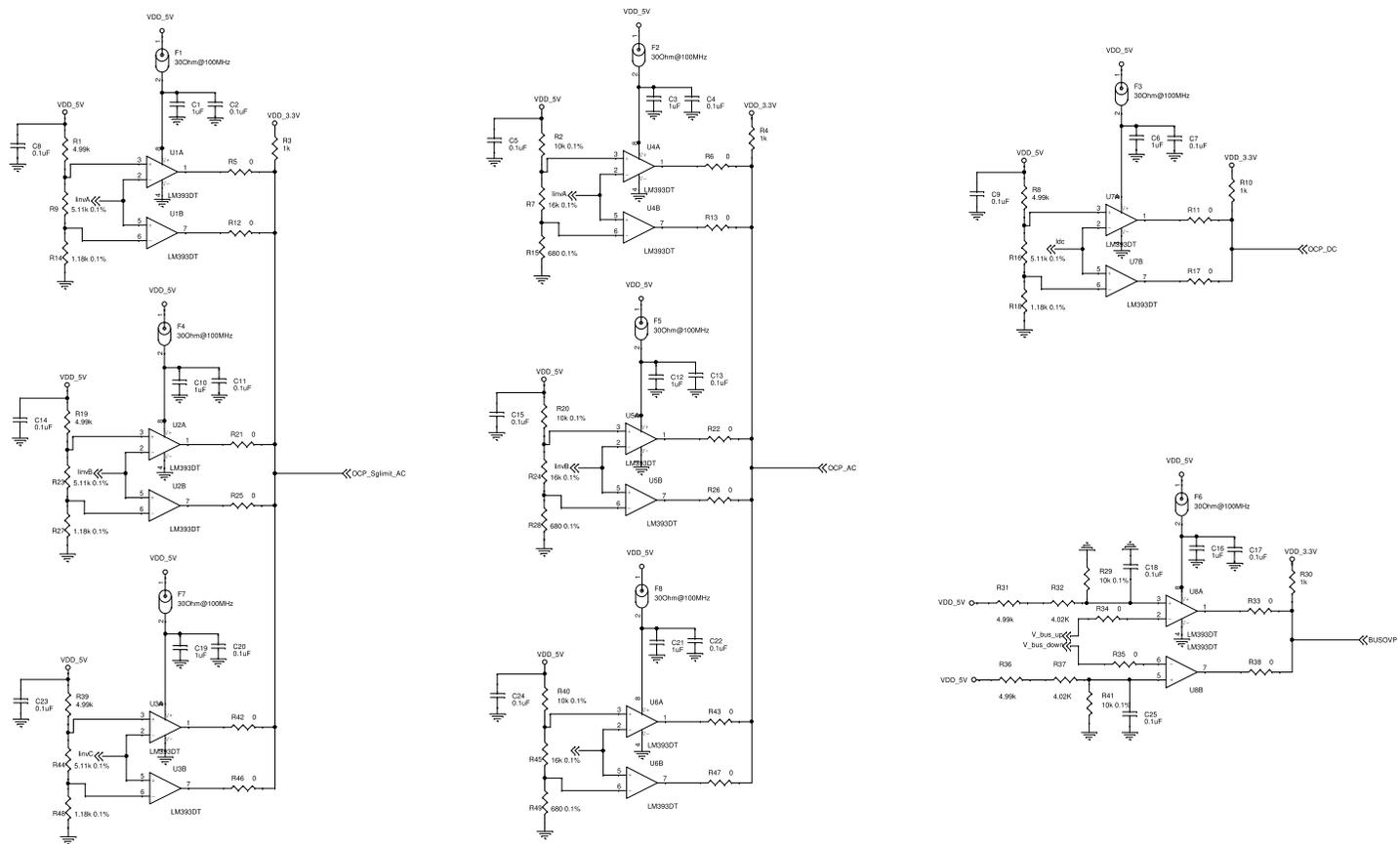


Figure 25. STDES-H743CTRL control board - circuit schematic (3 of 5)

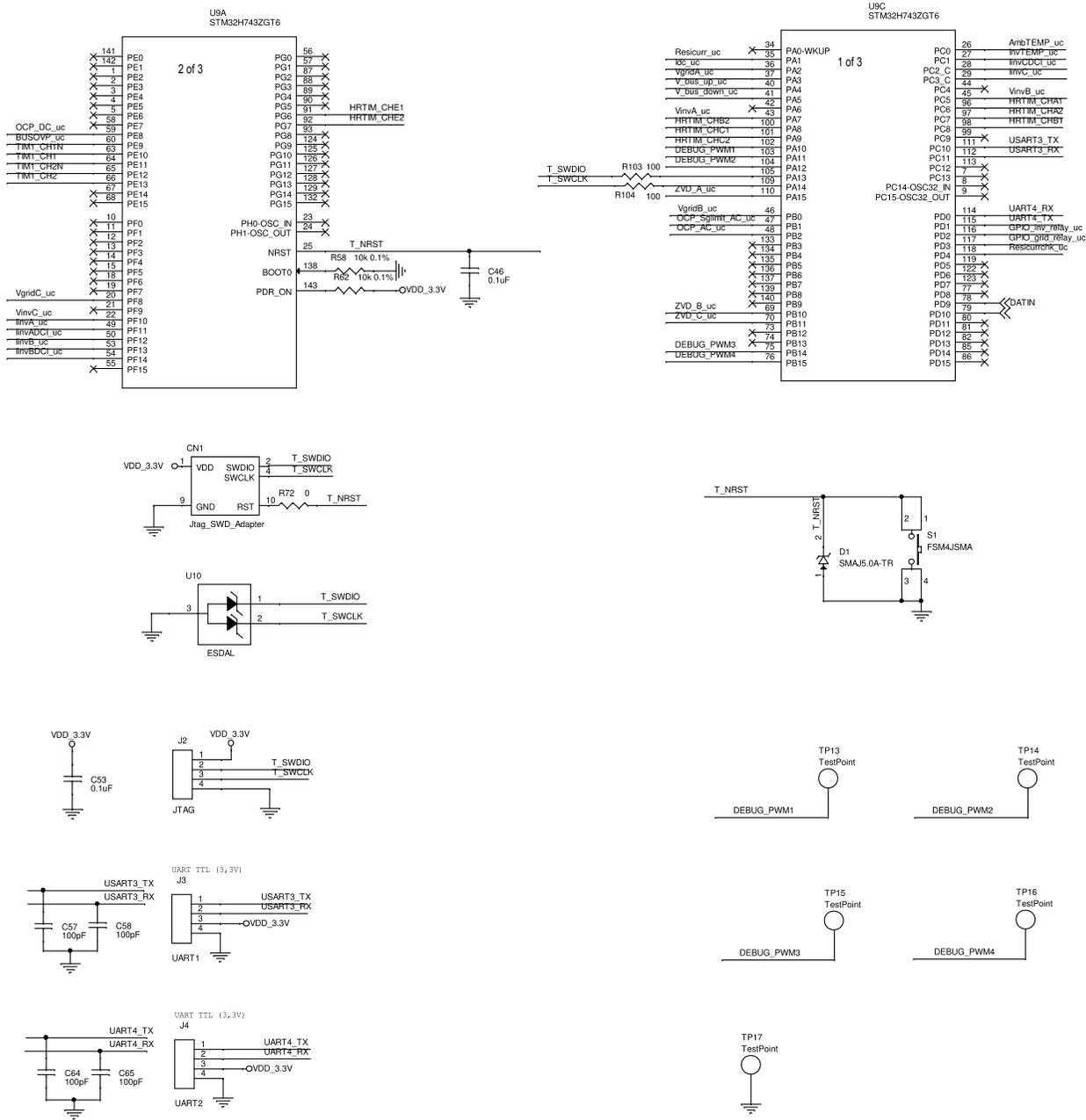


Figure 26. STDES-H743CTRL control board - circuit schematic (4 of 5)

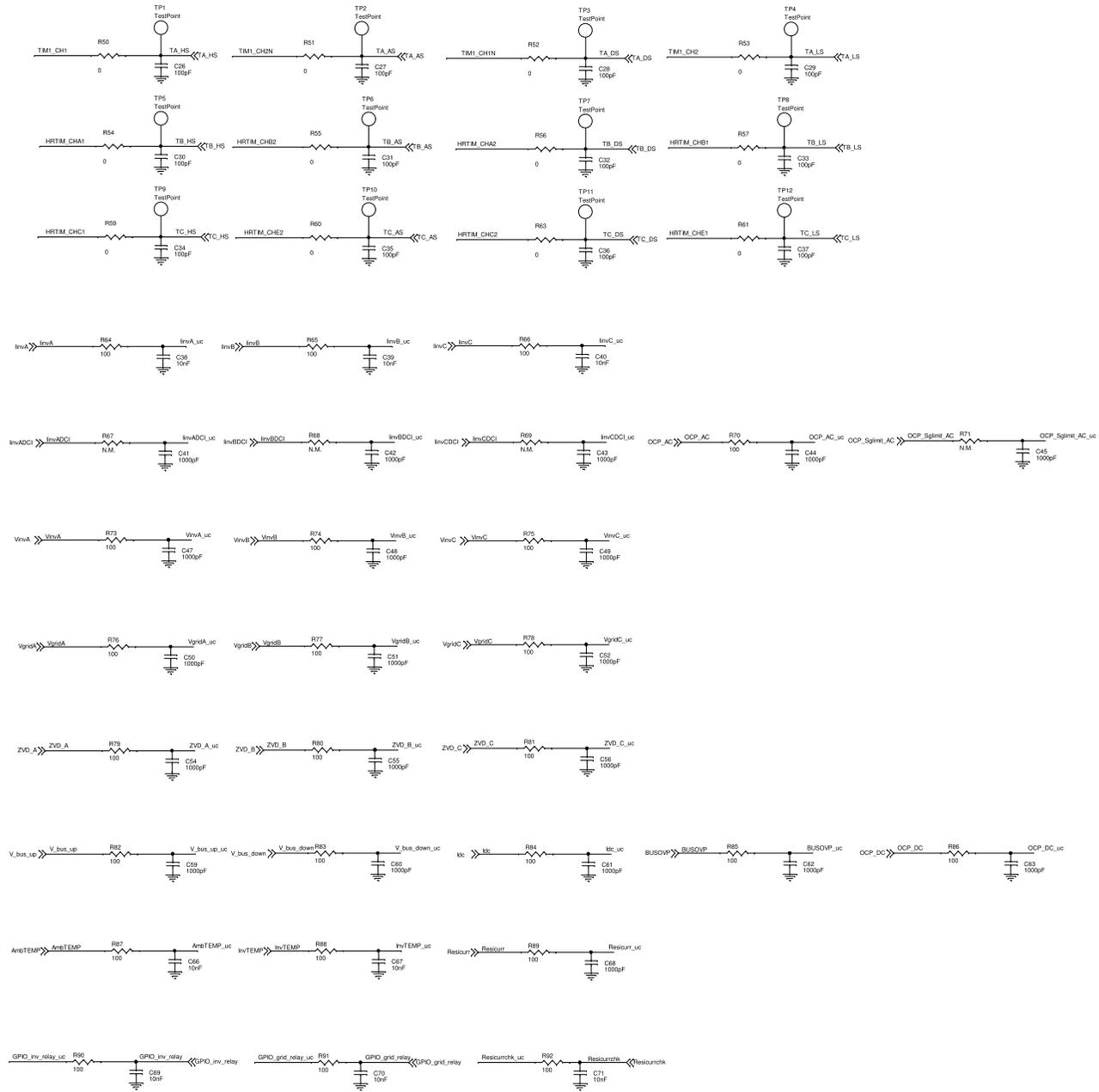
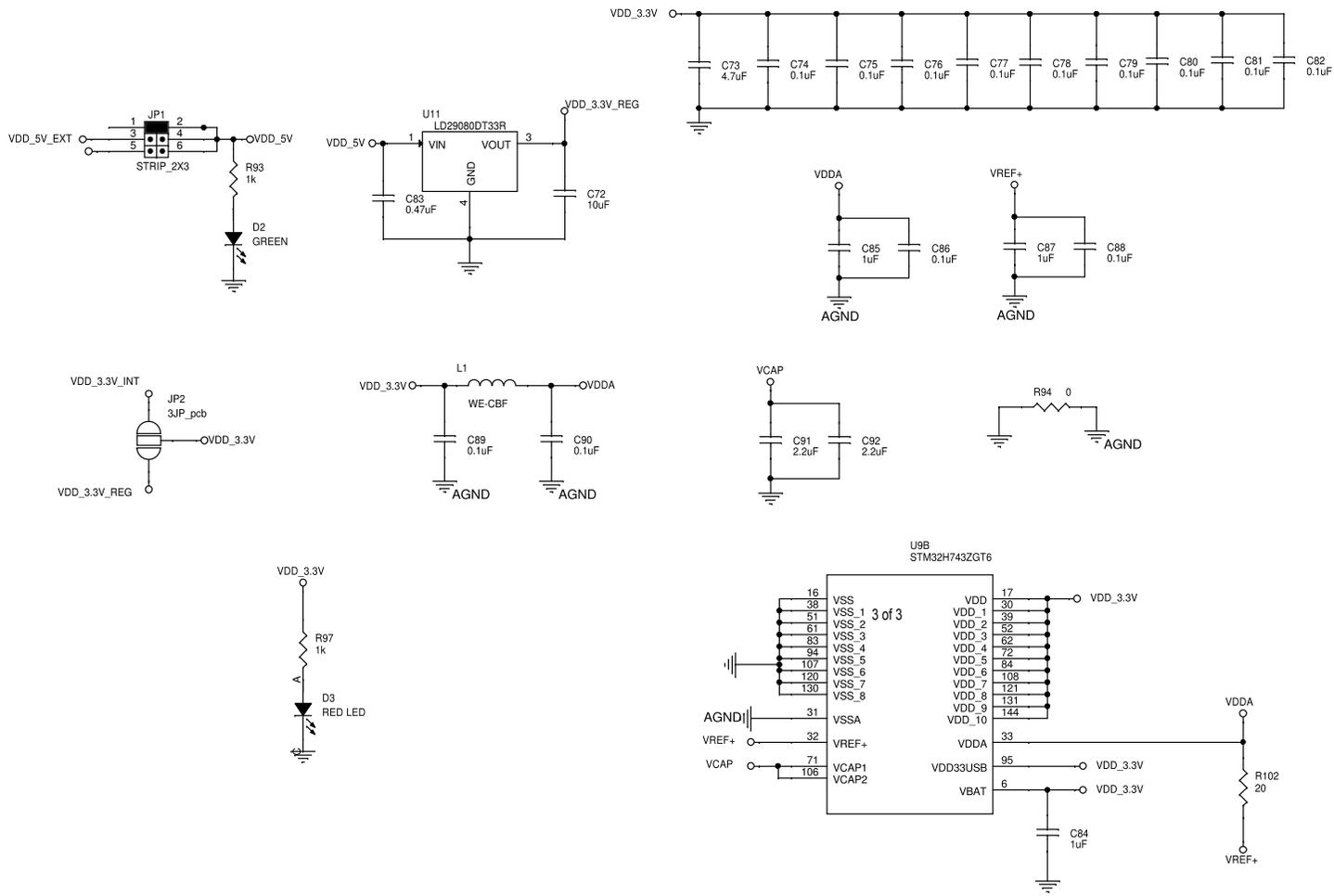


Figure 27. STDES-H743CTRL control board - circuit schematic (5 of 5)



6 Bill of materials

Table 2. STDES-50KWTPVI bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	1	-	Table 3. STDES-50KWPVDRV	Driver board	ST	-
2	1	-	Table 4. STDES-H743CTRL	Control board	ST	-
3	1	-	Table 5. STDES-50KWPVPWR	Power board	ST	-

Table 3. STDES-50KWPVDRV bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	4	C1,C7,C27,C33	1uF,25V,0603	Ceramic capacitor	SAMSUNG	CL10A105KA8NNNC
2	4	C2,C11,C28,C34	100nF,16V,0603	Ceramic capacitor	SAMSUNG	CL10B104KO8NNNC
3	4	C3,C12,C29,C35	1nF,25V,0603	Ceramic capacitor	SAMSUNG	CL10C102JA8NNNC
4	12	C4,C8,C15,C18,C20,C22,C30,C36,C40,C42,C47,C49	2.2uF,50V,0805	Ceramic capacitor	SAMSUNG	CL21A225KBQNNNE
5	8	C5,C9,C16,C19,C31,C37,C41,C43	1000pF,50V,0603	Ceramic capacitor	SAMSUNG	CL10B102KB8NNNC
6	8	C6,C10,C13,C17,C32,C38,C39,C45	0.1uF,50V,0603	Ceramic capacitor	SAMSUNG	CL10B104KB8NNNC
7	4	C14,C24,C44,C46	470pF,50V,0603	Ceramic capacitor	SAMSUNG	CL10B471KB8NNNC
8	4	C21,C23,C48,C50	0.47uF,50V,0805	Ceramic capacitor	AVX Corporation	08055C474KAT2A
9	4	C25,C26,C51,C52	2200pF,50V,0603	Ceramic capacitor	TDK Corporation	CGA3E2X7R1H222K080AD
10	4	DC1,DC2,DC3,DC4	R12P22005D	CONV DC/DC 2W 12VIN +20/-5VOUT T	Recom Power	R12P22005D
11	4	D1,D3,D5,D6	TZMB20-GS08	DIODE ZENER 20V 500MW SOD80	Vishay	TZMB20-GS08
12	4	D2,D4,D7,D8	TZMB3V3-GS08	DIODE ZENER 3.3V 500MW SOD80	Vishay	TZMB3V3-GS08
13	12	L1,FB1,L2,FB2,L3,FB3,L4,FB4,FB5,FB6,FB7,FB8	30Ohm@100MHz,0805	FERRITE BEAD 30 OHM 0805 1LN	TDK Corporation	MPZ2012S300AT000
14	1	J1,J2,J3,J4,J5,J6,J7,J8,J9,J10	con2-strip-male	CONN HEADER MALE STR 2POS 2.54MM	ANY	ANY
15	4	Q1,Q2,Q5,Q6	2STF1360, SOT-89	TRANS NPN 60V 3A SOT-89	ST	2STF1360
16	4	Q3,Q4,Q7,Q8	2STF2550, SOT-89	TRANS PNP 50V 5A SOT 89	ST	2STF2550
17	4	R1,R5,R19,R20	0,5%,1210	Resistor	UNI-ROYAL	1210W2J0000T5E

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
18	8	R8,R12,R16,R17,R30,R32,R33,R34	0,1%,0603	Resistor	UNI-ROYAL	0603WAF0000T5E
19	4	R2,R9,R22,R24	6.8,5%,2512	Resistor	Yageo	RC2512JK-7W6R8L
20	8	R3,R6,R11,R14,R23,R26,R27,R28	22,1%,1210	Resistor	Yageo	AC1210FR-0722RL
21	4	R4,R10,R21,R25	100,1%,0603	Resistor	Yageo	AT0603FRE07100RL
22	4	R7,R15,R29,R31	4.7,1%,2512	Resistor	EVER OHMS	CRH2512F4R70E04S
23	4	R13,R18,R35,R36	47k,1%,0603	Resistor	Yageo	RC0603FR-0747KL
24	6	TP1,TP2,TP3,TP4,TP5,TP7	TestPoint_Ring	Terminal pin, hole diameter 1 mm	TTY	TP-5000
25	2	TP5,TP7	N.A.	N.A.	N.A.	N.A.
26	4	U1,U2,U3,U4	STGAP2SiCSC, SO 8 WIDE 300	Galvanically isolated 4 A single gate driver for SiC MOSFETs	ST	STGAP2SiCSC

Table 4. STDES-H743CTRL bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	1	CN1	Jtag_SWD_Adapter	FTSH series male connector, Samtec, 10 circuits, 2 rows, pitch 1.27 mm, 3.4 A, vertical	Samtec	FTSH-105-01-F-D-K
2	11	C1,C3,C6,C10,C12,C16,C19,C21,C84,C85,C87	1uF,25V	Ceramic capacitor	SAMSUNG	CL10A105KA8NNNC
3	32	C2,C4,C5,C7,C8,C9,C11,C13,C14,C15,C17,C18,C20,C22,C23,C24,C25,C46,C53,C74,C75,C76,C77,C78,C79,C80,C81,C82,C86,C88,C89,C90	100nF,16V	Ceramic capacitor	SAMSUNG	CL10B104KO8NNNC
4	16	C26,C27,C28,C29,C30,C31,C32,C33,C34,C35,C36,C37,C57,C58,C64,C65	100pF,50V	Ceramic capacitor	SAMSUNG	CL10C101JB8NNNC
5	20	C41,C42,C43,C44,C45,C47,C48,C49,C50,C51,C52,C54,C55,C56,C59,C60,C61,C62,C63,C68	1000pF,50V	Ceramic capacitor	Murata Electronics	GRM1885C1H102JA01D
6	8	C38,C39,C40,C66,C67,C69,C70,C71	10nF,50V	Ceramic capacitor	Murata Electronics	GRM188R71H103KA01D
7	1	C72	10uF,35V	Ceramic capacitor	Murata Electronics	GRM21BR6YA106KE43L

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
8	1	C73	4.7uF,16V	Ceramic capacitor	Murata Electronics	GRM188R61C475KAAJD
9	1	C83	0.47uF,50V	Ceramic capacitor	SAMSUNG	CL21B474KBFNNNE
10	2	C91,C92	2.2uF,10V	Ceramic capacitor	Yageo	CC0603KRX5R6BB225
11	1	D1	SMAJ5.0A-TR, SMA	ST unidirectional TVS diode, SMAJ5.0A-TR, surface mount, DO-214AC (SMA), 2 pin	ST	SMAJ5.0A-TR
12	1	D2	GREEN LED	Single Color LED, Brilliant Yellow Green, Water Clear, 1.4mm, ROHS COMPLIANT, SMD, 2 PIN	EVERLIGHT	17-21SYGC/S530-E3/TR8
13	1	D3	RED LED	LED RED CLEAR 0603 SMD	EVERLIGHT	19-21/R6C-FP1Q2L/3T
14	8	F1,F2,F3,F4,F5, F6,F7,F8	30Ohm@100MH z	FERRITE BEAD 30 OHM 0805 1LN	TDK Corporation	MPZ2012S300AT000
15	1	JP1	4 Way, 2 Row, Straight Pin Header,2.54mm	Double row straight pin header	Any	ANY
16	1	JP2	Solder Jumper Selector	Solder Jumper Selector	ANY	ANY
17	1	J2	4 Way, 1 Row, Straight Pin Header,2.54mm	Straight Pin Header	Wurth	61300411121
18	1	J3	4 Way, 1 Row, Straight Pin Header,2.54mm	Straight Pin Header	Wurth	61300411121
19	1	J4	4 Way, 1 Row, Straight Pin Header,2.54mm	Straight Pin Header	Wurth	61300411121
20	1	L1	Bead,0603 (1608 Metric),120Ohm	Ferrite Bead	WE	74279262
21	1	P2	CON32x2, R/A 64POS 2.54 mm,male	Digital Power Connector	ERNI	384241
22	6	R1,R8,R19,R31, R36,R39	4.99k,1%	Resistor	Yageo	RC0603FR-074K99L
23	7	R2,R20,R29,R40 ,R41,R58,R62	10k,0.1%	Resistor	Yageo	RT0603BRD0710KL
24	6	R3,R4,R10,R30, R93,R97	1k,1%	Resistor	Yageo	RC0603FR-071KL
25	32	R5,R6,R11,R12, R13,R17,R21,R2 2,R25,R26, R33,R34,R35,R3 8,R42,R43,R46, R47,R50, R51,R52,R53,R5 4,R55,R56,R57, R59,R60, R61,R63,R72,R9 4	0,1%	Resistor	Yageo	RC0603FR-070RP

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
26	3	R7,R24,R45	16k,0.1%	Resistor	Yageo	RT0603BRD0716KL
27	4	R9,R16,R23,R44	5.11k,0.1%	Resistor	Yageo	RT0603BRD075K11L
28	4	R14,R18,R27,R48	1.18k,0.1%	Resistor	Yageo	RT0603BRD071K18L
29	3	R15,R28,R49	680,0.1%	Resistor	Yageo	RT0603BRD07680RL
30	2	R32,R37	4.02K,0.1%	Resistor	Yageo	RT0603BRE074K02L
31	26	R64,R65,R66,R70,R73,R74,R75,R76,R77,R78,R79,R80,R81,R82,R83,R84,R85,R86,R87,R88,R89,R90,R91,R92,R103,R104	100,1%	Resistor	Yageo	RC0603FR-07100RL
32	4	R67,R68,R69,R71	N.A.	N.A.	N.A.	N.A.
33	1	R102	20,1%	Resistor	Yageo	RC0603FR-0720RL
34	1	S1	FSM4JSMA	SWITCH TACTILE SPST-NO 0.05A 24V	TE	FSM4JSMA
35	15	TP1,TP2,TP3,TP4,TP5,TP6,TP7,TP8,TP9,TP10,TP11,TP12,TP15,TP16,TP17	TestPoint	Terminal pin, hole diameter 1 mm	TYT	TP-5000
36	2	TP13,TP14	N.A.	N.A.	N.A.	N.A.
37	8	U1,U2,U3,U4,U5,U6,U7,U8	LM393DT,8SOIC, SO-8	IC COMPARATOR LP DUAL 8-SOIC	ST	LM393DT
38	1	U9	STM32H743ZGT6, LQFP 144 20x20x1.4 mm	IC MCU 32BIT 1MB FLASH 144LQFP	ST	STM32H743ZGT6
39	1	U10	ESDAL6V1L,SO T23-3L	ST unidirectional TVS diode array, surface mount, SOT-23, 6 pin	ST	ESDA6V1L
40	1	U11	LD29080DT33R, DPAK	IC REG LINEAR 3.3V 800MA DPAK	ST	LD29080DT33R

Table 5. STDES-50KWPVPWR bill of materials

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
1	56	C1,C3,C4,C7,C8,C10,C11,C15,C17,C18,C21,C23,C24,C25,C29,C31,C32,C37,C38,C39,C40,C44,C47,C49,C56,C61,C68,C73,C79,C95,C97,C101,C106,C110,C115,C119,C122,C304,C305,C306,C310,C317,C321,C322,C323,C327,C3	1uF,25V,0603	Ceramic capacitor	Würth Electronics Inc.	885012206076

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
		34,C338, C339,C342,C344 ,C349,C397,C39 9,C428,C434				
2	76	C2,C5,C6,C13,C 14,C16,C19,C20, C27,C28,C30,C3 3,C34, C41,C42,C45,C4 6,C48,C50,C52, C53,C55,C60,C6 2,C64,C65,C67, C72,C74,C76,C7 7,C80,C96,C98, C100,C102,C104 ,C105,C107,C11 1,C113,C114,C11 6,C120,C121,C3 03,C309,C311, C313,C314,C316 ,C320,C326,C32 8,C330,C331,C3 33,C337, C341,C345,C347 ,C348,C350,C39 8,C400,C402,C4 03,C404, C405,C406,C407 ,C408,C429,C43 1,C433,C435	100nF,16V,0603	Ceramic capacitor	Wurth Electronics Inc.	885012206046
3	30	C43,C57,C58,C5 9,C69,C70,C71, C81,C82,C99,C1 08,C117, C307,C308,C318 ,C319,C324,C32 5,C335,C336,C3 40,C343, C352,C353,C401 ,C412,C413,C41 4,C415,C416	N.A.	N.A.	N.A.	N.A.
4	3	C12,C26,C35	10nF,50V,0603	Ceramic capacitor	Murata Electronics	GRM188R71H103KA01D
5	12	C9,C22,C36,C54 ,C66,C78,C109, C118,C315,C332 ,C351, C436	1nF,16V,0603	Ceramic capacitor	SAMSUNG	CL10B104KO8NNNC
6	6	C84,C85,C88,C8 9,C92,C94	10uF,25V,0805	Ceramic capacitor	SAMSUNG	CL21A106KAYNNNE
7	6	C83,C86,C87,C9 0,C91,C93	470nF,50V,0805	Ceramic capacitor	SAMSUNG	CL21B474KBFNNNE
8	9	C51,C63,C75,C1 03,C112,C312,C 329,C346,C432	4.7u,25V,0603	Ceramic capacitor	SAMSUNG	CL10A475KA8NQNC
9	12	C270,C417,C418 ,C419,C420,C42 1,C422,C423,C4 24,C425, C426,C427	220pF,1kV,1206	Ceramic capacitor	Murata Electronics	GRM31A5C3A221JW01D
10	2	C354,C355	0.033uF,250V,12 06	Ceramic capacitor	TDK Corporation	CGA5L3X7R2E333M160A A

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
11	3	C356,C361,C367	470uF,25V,Radial	Alum capacitor	Rubycon	25ZLH470MEFCT810X12.5
12	2	C357,C362	47uF,50V,Radial	Alum capacitor	Panasonic	ECA-1HM470
13	6	C358,C359,C363,C366,C368,C369	10uF,50V,1206	Ceramic capacitor	SAMSUNG	CL31B106KBHNNNE
14	3	C360,C364,C365	0.1uF,50V,0805	Ceramic capacitor	KEMET	C0805C104K5RACTU
15	1	C370	10pF,50V,0603	Ceramic capacitor	TDK Corporation	CGA3E2C0G1H100D080AD
16	1	C371	2200pF,50V,0603	Ceramic capacitor	TDK Corporation	CGA3E2X7R1H222K080AD
17	1	C372	100pF,50V,0603	Ceramic capacitor	Murata Electronics	GRM1885C1H101JA01D
18	1	C373	0.1uF,50V,0603	Ceramic capacitor	KEMET	C0603C104K5RACTU
19	6	C374,C379,C380,C381,C386,C387	0.22uF,630V,Radial	Film capacitor	Faratronic	C322J224J6SC000
20	6	C375,C376,C377,C382,C383,C384	80uF,600V,Radial	Film capacitor	Faratronic	C3D1U806KF0AC00
21	3	C388,C389,C390	0.022uF,440V,Radial	Film capacitor	Faratronic	C47S1223K90C450
22	6	C391,C392,C393,C409,C410,C411	20uF,350V,Radial	Film capacitor	Faratronic	C6AR2206KMWA000
23	3	C394,C395,C396	3.3uF,350V,Radial	Film capacitor	Faratronic	C4BR2335KFWC350
24	1	C430	0.33uF,50V,0603	Ceramic capacitor	TDK Corporation	C1608X5R1H334K080AB
25	1	DS1	800V	Gas Discharge Tube	Littelfuse	GTCA28-801M-R05
26	17	D1,D2,D3,D4,D5,D6,D7,D8,D9,D10,D11,D92,D93,D94,D95,D96,D97	SMD, 1206	LED RED CLEAR 1206 SMD	Lumex Opto/Components Inc.	SML-LX1206SIC-TR
27	1	D72	STPS2200U, SMB	DIODE SCHOTTKY 200V 2A SMB	ST	STPS2200U
28	1	D73	STTH112A, SMA	DIODE GEN PURP 1.2KV 1A SMA	ST	STTH112A
29	2	D74,D77	STPS1150A, SMA	DIODE SCHOTTKY 150V 1A SMA	ST	STPS1150A
30	1	D75	BAT48JFILM, SOD323	DIODE SCHOTTKY 40V 350MA SOD323	ST	BAT48JFILM
31	1	D76	STPS20200CT, TO-220AB	DIODE ARRAY SCHOTTKY 200V TO220	ST	STPS20200CT
32	1	D78	15V, SOT23	DIODE ZENER 15V 250MW SOT23	Nexperia USA Inc.	BZX84-A15,215
33	1	D79	150mA, 75V, SOD323	DIODE GEN PURP 75V 150MA SOD323F	Fairchild/ON Semiconductor	1N4148WS
34	3	D81,D83,D85	STPS1L30A, SMA	DIODE SCHOTTKY 30V 1A SMA	ST	STPS1L30A

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
35	51	F1,F2,F3,F4,F5, F6,F7,F8,F9,F10, F11,F12,F13,F14 ,F15,F16, F17,F18,F19,F20 ,F21,F22,F23,F2 4,F25,F26,F27,F 28,F29, F30,F31,F32,F33 ,F34,F59,F60,F6 1,F62,F63,F64,F 65,F66, F67,F68,F69,F70 ,F71,F72,F73,F7 4,F75	30Ohm@100MH z,0805	FERRITE BEAD 30 OHM 0805 1LN	TDK Corporation	MPZ2012S300AT000
36	4	JP1,JP5,JP90,JP 94	Solder Jumper Selector	Solder Jumper Selector	ANY	ANY
37	4	JP2,JP3,JP92,JP 95	CONN TERM BLOCK 2POS 5.08MM	Connector	Phoenix Contact	1729128
38	1	JP4	Solder Jumper Selector	Solder Jumper Selector	ANY	ANY
39	2	J1,J2	Switch,SPDT,500 mA,12V,10mmx2 .5mm,opposite side connect	Straight mini Slide Switch	Würth Electronics Inc.	450301014042
40	1	J3	CON32x2, R/A 64POS 2.54 mm,	Digital Power Connector	TE	284166-E
41	30	J134(J101,J102, J103,J104,J105, J106,J107,J108, J109,J110), J133(J201,J202, J203,J204,J205, J206,J207,J208, J209,J210), J132(J301,J302, J303,J304,J305, J306,J307,J308, J309,J310)	con2-strip-female	CONN HEADER VERT 2POS 2.54mm	ANY	ANY
42	3	K2,K4,K6	CHAR-112A90C	RELAY SPST 20A 12VDC	Churod	CHAR-112A90C
43	3	LinVA, LinVB, LinV C	DSF700005-125	Inverter Inductor	Sunlord	DSF700005-125
44	1	LCM1	SPT-92F12644-L	Grid Inductor	SPTG	SPT-92F12644-L
45	1	LCM2	DT500002-125	Three-phase CM Choke	Sunlord	DT500002-125
46	4	LEM1,LEM2,LE M3,LEM4	T60404-N4646- X461	Current Sensors	Vacuumsch melze	T60404-N4646-X461
47	1	LEM5	T60404N4646X9 31	Current Sensors	Vacuumsch melze	T60404N4646X931
48	14	P3,P4,P5,P6,P7, P8,P9,P10,P11,P 12,P13,P14,P15, P16	PowerCon,9mmx 9.5mmx 3.5mm, M5	Power Connector	Würth	7460408
49	1	Q13	STW12N170K5, TO-247	N-channel 1700V 2.3ohm 5A Power Mosfet in a TO-247 package	ST	STW12N170K5

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
50	1	Q14	2N7002E-T1-GE3	MOSFET 60V 240mA 0.35W 3.0ohm @ 10V	Vishay	2N7002E-T1-GE3
51	3	Q18,Q19,Q20	STS6NF20V, SO-8	N-channel 20 V 30 mOhm typ 6 A 2.7 V drive STripFET II Power MOSFET	ST	STS6NF20V
52	3	RV1,RV2,RV3	275VAC 10kA	VARISTOR 430V 10KA DISC 20MM	Littelfuse	V20E275P
53	21	Rled1,Rled2,Rled3, Rled4,Rled5,Rled6, Rled7,Rled8, Rled9,Rled10,Rled12, R343,R349,R353, R406,R407,R408, R412,R413,R415,R447	1k,1%,0603	Resistor	Yageo	RC0603FR-071KL
54	42	R2,R3,R12,R13,R14, R15,R17,R18,R21,R22, R31,R32,R33,R34, R36,R37,R40,R41, R50,R51,R52,R53, R55,R56,R65,R73, R81,R89,R97, R105,R280, R301,R322,R107, R110,R111,R112, R272,R293,R314, R388,R389	10k,0.1%,0603	Resistor	Yageo	RT0603BRD0710KL
55	4	R4,R23,R42,R108	2.61k ,0.1%,0603	Resistor	Yageo	RT0603BRD072K61L
56	3	R5,R28,R48	121,0.1%,0603	Resistor	Yageo	RT0603BRD07121RL
57	44	R60,R67,R69,R70, R71,R76,R83,R85, R86,R87,R91,R99, R101,R102,R103, R109,R118,R120, R123,R132,R134, R136,R263,R267, R274,R276,R277, R278,R284,R286, R295,R297,R298, R299,R303,R307, R316,R318,R319, R320,R346,R387, R445,R446	0,1%,0603	Resistor	UNI-ROYAL	0603WAF0000T5E
58	12	R7,R8,R9,R10,R25, R26,R27,R29,R43, R44,R46,R47	20k,0.1%,0603	Resistor	Yageo	RT0603BRD0720KL
59	4	R16,R35,R54,R113	6.34k,1%,0603	Resistor	Yageo	RC0603FR-076K34L
60	3	R19,R38,R57	274k,0.1%,0603	Resistor	Yageo	RT0603BRE07274KL

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
61	6	R58,R74,R90,R261,R281,R302	27k,1%,0603	Resistor	UNI-ROYAL	0603WAF2702T5E
62	24	R59,R62,R63,R75,R78,R79,R92,R94,R95,R114,R115,R116,R127,R128,R129,R265,R268,R270,R287,R290,R291,R309,R311,R312	1M,0.1%,1206	Resistor	Yageo	RT1206BRD071ML
63	6	R61,R77,R93,R269,R289,R304	13.3k,0.1%,0603	Resistor	Yageo	RT0603BRD0713K3L
64	6	R64,R66,R80,R82,R96,R98,R271,R273,R292,R294,R313,R315	2k,0.1%,0603	Resistor	RESI	PTFR0603B2K00N9
65	12	R68,R72,R84,R88,R100,R104,R275,R279,R296,R300,R317,R321	26.1k,0.1%,0603	Resistor	Yageo	RT0603BRD0726K1L
66	11	R117,R119,R125,R126,R130,R133,R137,R139,R393,R422,R423	10k,1%,0603	Resistor	Yageo	RC0603FR-0710KL
67	4	R121,R124,R131,R138	1.6k,0.1%,0603	Resistor	KDA	RN731JTTD1601B25
68	6	R260,R262,R282,R283,R305,R306	3k,0.1%,0603	Resistor	Yageo	RT0603BRD073KL
69	3	R264,R285,R308	36k,0.1%,0603	Resistor	Yageo	RT0603BRE0736KL
70	3	R266,R288,R310	69.8k,0.1%,0603	Resistor	Yageo	RT0603BRD0769K8L
71	5	R323,R330,R332,R337,R339	470k,1%,1206	Resistor	Yageo	RC1206FR-07470KL
72	6	R324,R329,R331,R333,R334,R335	180K,0.1%,1206	Resistor	Yageo	RT1206BRD07180KL
73	4	R325,R326,R327,R328	150k,1%,1210	Resistor	Yageo	RC1210FR-07150KL
74	1	R336	7.5k,1%,0603	Resistor	Yageo	RC0603FR-077K5L
75	1	R338	360k,1%,0603	Resistor	Yageo	RC0603FR-07360KL
76	13	R340,R372,R373,R374,R375,R376,R377,R378,R379,R380,R381,R382,R383	100K,0.1%,1206	Resistor	Yageo	RT1206BRD07100KL
77	2	R341,R352	22k,1%,0603	Resistor	Yageo	RC0603FR-0722KL
78	13	R342,R426,R427,R428,R429,R430,R431,R432,R433,R434,R435,R436,R437	10,0.1%,1206	Resistor	Yageo	RT1206BRD0710RL
79	1	R344	24,1%,1206	Resistor	YAGEO	RC1206FR-0724RL
80	1	R345	220,1%,0603	Resistor	Yageo	RC0603FR-07220RL
81	1	R347	1,1%,2512	Resistor	Vishay	CRCW25121R00FKEG

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
82	2	R348,R351	2.2K,1%,0603	Resistor	Yageo	RC0603FR-072K2L
83	1	R350	11k,0.1%,0603	Resistor	Panasonic	ERA-3AEB113V
84	1	R354	7.5k,0.1%,0603	Resistor	Yageo	RT0603BRD077K5L
85	1	R355	4.7k,1%,0603	Resistor	Yageo	RC0603FR-074K7L
86	1	R356	0,1206	Resistor	Yageo	RC1206JR-070RL
87	12	R357,R358,R359 ,R360,R361,R362, R363,R364,R365, R366, R367,R368	240k,1%,1206	Resistor	Yageo	AC1206FR-07240KL
88	3	R369,R370,R371	220m,5%,Radial	Resistor	TE	SQMW7R22J
89	2	R385,R390	100k,0.1%,0603	Resistor	Yageo	RT0603BRE07100KL
90	1	R386	43k,0.1%,0603	Resistor	Yageo	RT0603BRE0743KL
91	10	R6,R11,R24,R30 ,R45,R49,R122, R135,R392,R448	100,0.1%,0603	Resistor	Yageo	RT0603BRD07100RL
92	3	R409,R410,R411	20,1%,0603	Resistor	Yageo	RC0603FR-0720RL
93	3	R414,R416,R417	33K,1%,0603	Resistor	Yageo	RC0603FR-0733KL
94	1	R418,R442	470,1%,0603	Resistor	Yageo	RC0603FR-07470RL
95	2	R420,R421	5.1k,1%,0603	Resistor	Panasonic	ERJPA3J512V
96	2	R424,R425	120,1%,0603	Resistor	Vishay	MCT06030C1200FP500
97	1	R438	13k,0.1%,0603	Resistor	Yageo	RT0603BRE0713KL
98	2	R440,R441	332k,0.1%,1206	Resistor	Yageo	RT0603BRD07332KL
99	1	R439	N.A.	N.A.	N.A.	N.A.
100	2	R443,R444	10,0.1%,0603	Resistor	Bourns Inc.	CRT0603-BY-10R0ELF
101	1	R449	0,0805	Resistor	Yageo	RC0805JR-070RL
102	84	TP1,TP5,TP6,TP8, TP9,TP10,TP11, TP14,TP15,TP18, TP19, TP20,TP21,TP25, TP26,TP28,TP29, TP30,TP31,TP32, TP33, TP34,TP35,TP36, TP37,TP38,TP39, TP40,TP41,TP42, TP43, TP45,TP46,TP47, TP48,TP49,TP50, TP53,TP55,TP56, TP57, TP60,TP134,TP135, TP136,TP137, TP138,TP139,TP140, TP141,TP142,TP143, TP144,TP145,TP146, TP147, TP148, TP149,TP150,TP151, TP152,TP153,TP154, TP155, TP156, TP157,TP158,TP	TestPoint_Ring	Terminal pin, hole diameter 1 mm	TTY	TP-5000

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
		159,TP160,TP161,TP162,TP163,TP164,TP166,TP168,TP171,TP172,TP173,TP174,TP175,TP176,TP177,TP178,TP179				
103	10	TP7,TP17,TP27,TP51,TP54,TP58,TP61,TP167,TP169,TP170	N.A.	N.A.	N.M.	N.M.
104	10	TW1,TW2,TW3,TW4,TW5,TW6,TW7,TW8,TW9,TW10	Support M3X40	PCB support M3 High 40mm	Essentra	TCBN-T1-M3-8-40
105	1	T1	ATWPEF304423B503T	Aux power transformer	Sunlord	ATWPEF304423B503T
106	11	U1,U3,U5,U18,U20,U22,U36,U38,U40,U48,U55	TSV912IDT, SO-8	Wide-bandwidth (8MHz) rail to rail input/output 5V CMOS Op-Amps, dual	ST	TSV912IDT
107	9	U2,U4,U6,U7,U8,U9,U37,U39,U41	TSV914IDT, SO-14	Wide-bandwidth (8MHz) rail to rail input/output 5V CMOS Op-Amps, qual	ST	TSV914IDT
108	2	U10,U23	DCH010505SN7	DC-DC power supply module DCH010505SN7, SIP module, 4-Pin	Texas Instruments	DCH010505SN7
109	8	U11,U12,U13,U19,U21,U42,U43,U44	AMC1301DWVR, 8SOIC	IC AMP ISOLATION 250MV 8SOIC	Texas Instruments	AMC1301DWVR
110	2	U14,U16	LD29080S33R, SOT223	800 mA fixed and adjustable output very low drop voltage regulator	ST	LD29080S33R
111	2	U15,U17	LD29080DT50R, DPAK	800 mA fixed and adjustable output very low drop voltage regulator	ST	LD29080DT50R
112	1	U45	L6565D, SO-8	IC PFC CTRLR TRANSITION 1MHZ 8SO	ST	L6565D
113	1	U46	FOD817ASD, SMD	OPTOISOLATOR 5KV TRANSISTOR 4SMD	ON Semiconductor	FOD817ASD
114	1	U47	TL431ACL3T, SOT23	IC VREF SHUNT ADJ SOT23-3	ST	TL431ACL3T
115	1	U49	STLM20W87F, SOT323-5L	SENS TEMP ANLG VOLT SOT-323-5	ST	STLM20W87F
116	3	U51,U52,U53	A2U8M12W3-FC, ACEPACK 2	ACEPACK 2 power module, 3-level topology, 1200 V, 100 A based on SiC Power MOSFET	ST	A2U8M12W3-FC

Item	Q.ty	Ref.	Part / Value	Description	Manufacturer	Order code
117	1	U54	ISOSD61, SO-16W	16-BIT ISOLATED SIGMA-DELTA MODULATOR,single- ended and LVDS interfaces	ST	ISOSD61TR

7 Conclusions

This technical note has shown the bidirectional function and 60 kW liquid cooling PFC system performance based on the 50 kW T-type DC/AC inverter platform.

For further information, please contact us directly.

Appendix A Reference design warnings, restrictions and disclaimer

Important: *The reference design is not a complete product. It is intended exclusively for evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical/mechanical components, systems and subsystems.*

Danger: *Exceeding the specified reference design ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings, contact an STMicroelectronics field representative prior to connecting interface electronics, including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the reference design and/or interface electronics. During normal operation, some circuit components may reach very high temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified in the reference design schematic diagrams.*

STMicroelectronics reference designs are solely intended to assist designers ("buyers") who are developing systems that incorporate STMicroelectronics semiconductor products (herein, also referred to as "components"). The buyer understands and agrees that he/she is the only responsible for independent analysis, evaluation and judgment in designing his/her own systems and products. STMicroelectronics has conducted only the measurements and tests specifically described in the published documentation for the specified reference design. STMicroelectronics may correct, enhance, improve its reference designs for future development.

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You further acknowledge and agree that the reference designs may not be used in or in connection with any legal or administrative proceeding in any court, arbitration, agency, commission or other tribunal or in connection with any action, cause of action, litigation, claim, allegation, demand or dispute of any kind.

Revision history

Table 6. Document revision history

Date	Revision	Changes
06-Mar-2026	1	Initial release.
10-Mar-2026	2	Updated Section 6: Bill of materials .

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