STDES-200GANADP test report

Introduction

This document reports the functional, thermal, and efficiency measurements results for the STDES-200GANADP 200 W TMPFC and HBLLC AC-DC converter reference design for gaming adapters.

This reference design meets CoC Tier 2 and DoE Level 6 efficiency requirements with a peak efficiency of 95.0% at full load. The STDES-200GANADP adopts the planar transformer technology, with an integrated GaN-based solution and TMPFC and HBLLC combo control.

The main devices used in this reference design are:

- STCMB1: transition mode PFC with X-cap discharge and LLC resonant combo controller
- STL36N60M6: N-channel 600 V, 91 mOhm typ., 25A MDmesh^{TM} M6 power MOSFET in a PowerFLAT 8x8 package
- MASTERGAN1: high voltage enhancement mode GaN with a half bridge configuration and integrated gate driver
- SRK2001: adaptive synchronous rectification controller for LLC resonant converters
- STL140N6F7: N-channel 60 V, 2.4mOhm typ., 140 A STripFET F7 Power MOSFET in a PowerFLAT 5x6 package
- TSM1014: low consumption voltage and current controller for battery chargers and adapters

The STDES-200GANADP is a fully assembled kit developed for performance evaluation only, not available for sale.

1 Overview

The main features of the STDES-200GANADP are:

- Input voltage: universal AC from 90 V_{AC} to 264 V_{AC} with 47 Hz to 63 Hz frequency
- Output voltage: 19 V_{DC}
- Output power: 200 W maximum
- Form factor: 160 mm (L) * 55 mm (W) * 18 mm (H)
- Efficiency: meets the CoC Tier 2 and DoE Level 6 efficiency requirements, with a full load efficiency of 94% at 115 V_{AC} and of 95% at 230 V_{AC}
- STCMB1 transition mode PFC with X-cap discharge and LLC resonant combo controller at the primary side
- MASTERGAN1 integrated GaN IC for a compact, simplified PCB layout and bill of material reduction
- Planar transformer technology to achieve a high power density

Figure 1. STDES-200GANADP architecture block diagram

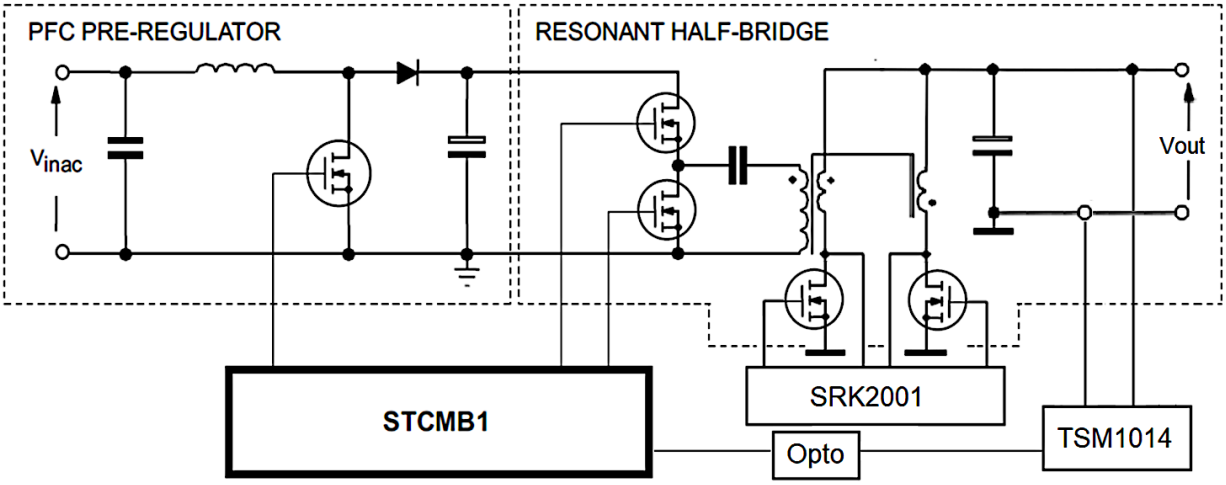


Figure 2. STDES-200GANADP top view

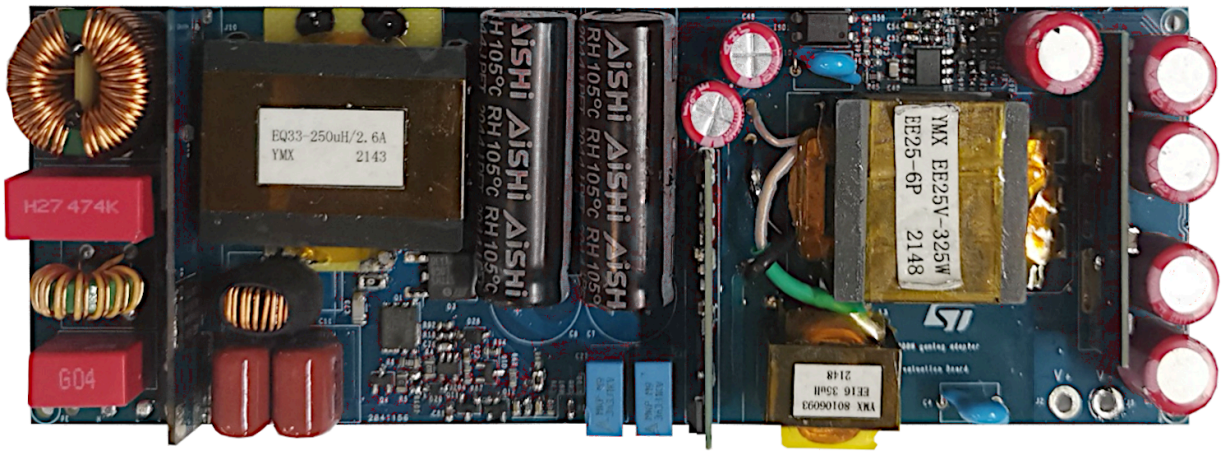
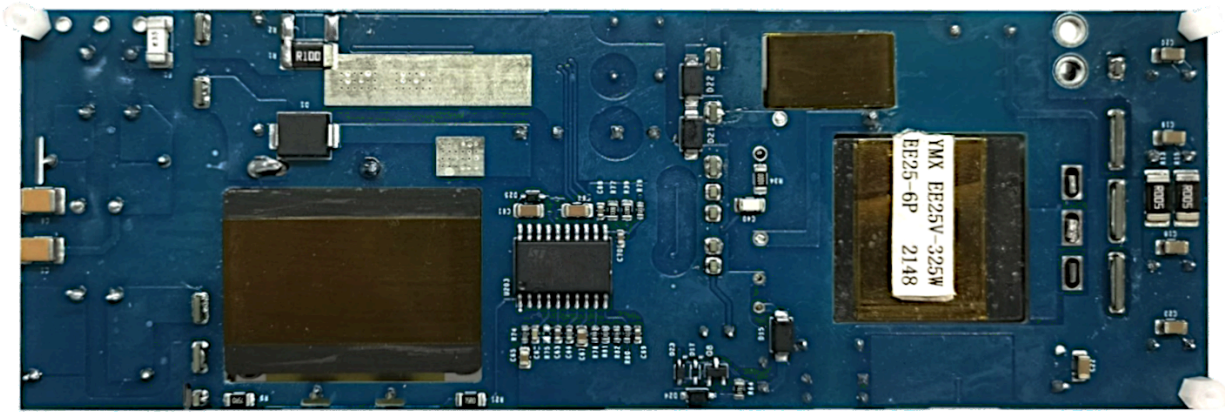


Figure 3. **STDES-200GANADP bottom view**



2 Specifications

Table 1. STDES-200GANADP electrical specifications

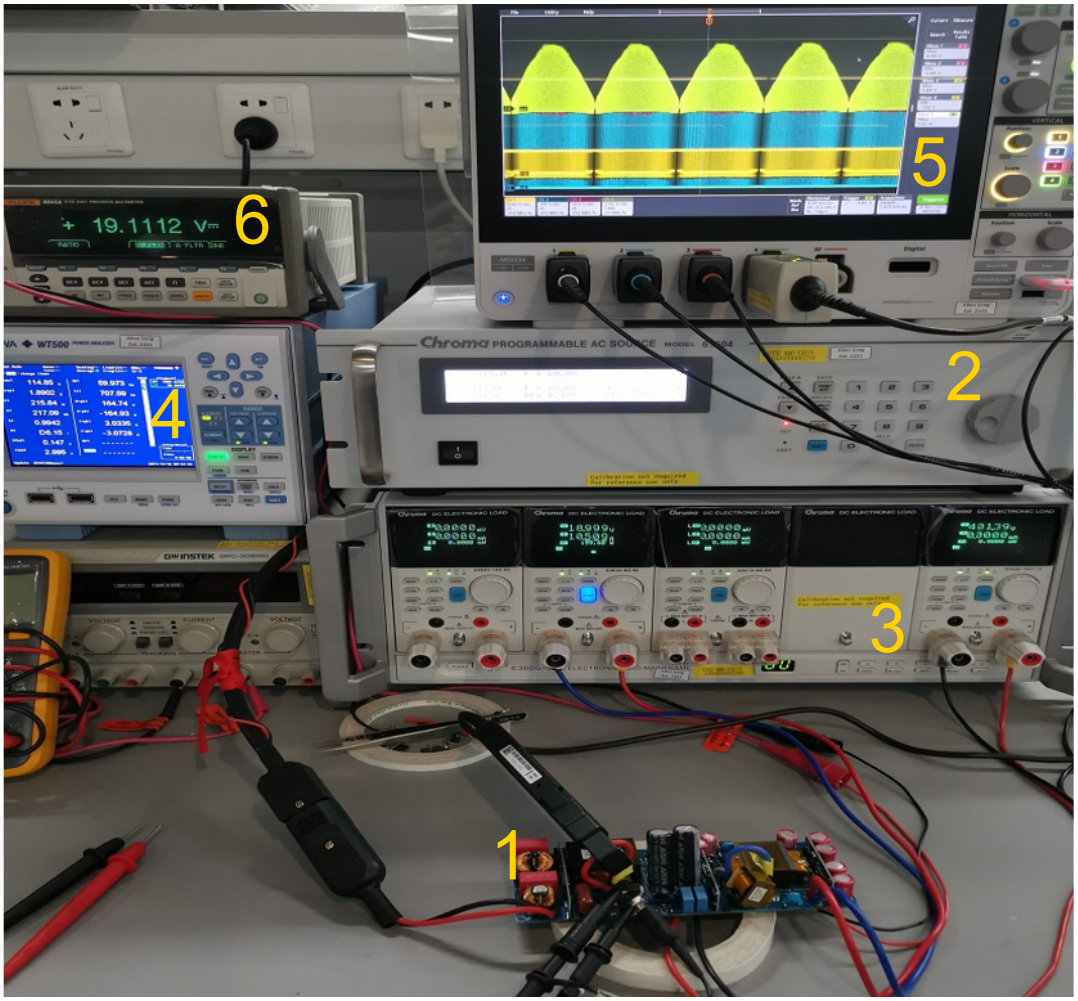
Symbol	Parameter	Test conditions	Min.	Nominal	Max.	Unit
Input parameters						
V_{IN}	Input line voltage		90	115/230	264	Vrms
f_{LINE}	Input Line Frequency		47	50/60	63	Hz
P_{STBY}	No load input power	V_{IN} = 115 V_{RMS} and 230 V_{RMS}			150	mW
Output parameters						
V_{OUT}	Output voltage	VIN = 90 V_{RMS}~264 V_{RMS} I_{OUT} = 0A~3A		19		V
V_{ripple}	Output voltage ripple	Peak to peak value with 20 MHz bandwidth			250	mV
I_{out}	Output current		0		10.5	A
P_{out}	Continuous output power		0		200	W
η_{ave}	Four-point average efficiency: 25%, 50%,75%, and 100% load	At 115 V_{AC} and measured at the end on the kit		92		%
η_{ave}	Four-point average efficiency: 25%, 50%,75%, and 100% load	At 230 V_{AC} and measured at the end on the kit		93		%
Ambient and EMI parameters						
T_{AMB}	Ambient temperature	Free convection sea level	0	25	40	°C

3 Test setup

3.1 Test conditions and equipment

1. 1 x STDES-200GANADP reference design
2. 1 x 61604A programmable AC source by Chroma
3. 1 x 63600-5 DC E-load by Chroma
4. 1 x WT500 power analyzer by YOKOGAWA
5. 1 x MDO34 mixed signal oscilloscope by Tektronix
6. 1 x 8845A 6-1/2 digit precision multimeter by FLUKE
7. Ambient temperature = 25°C

Figure 4. STDES-200GANADP test setup



3.2 Procedure

To test the STDES-200GANADP performance, follow the procedure below.

Step 1. Connect the e-load to the reference design DC output V+/V- terminal.

Step 2. Connect the AC source to the reference design AC input L/N cables.

Step 3. Power up the reference design with 115 V_{AC} or 230 V_{AC} input to start the test.

Step 4. Adjust the output current through the e-load.

4 Measurements/waveforms/test data

4.1 Efficiency test results

Efficiency at 115 V_{AC} and 230 V_{AC} has been tested. The results show that theSTDES-200GANADP reference design meets the EU CoC Rev.05 tier2 and DoE level 6 requirement with an adequate margin.

The efficiency test V_{OUT} sense points at the board end.

4.1.1 Efficiency at 115 V_{AC} input

Figure 5. **STDES-200GANADP efficiency at 115 V_{AC} input**

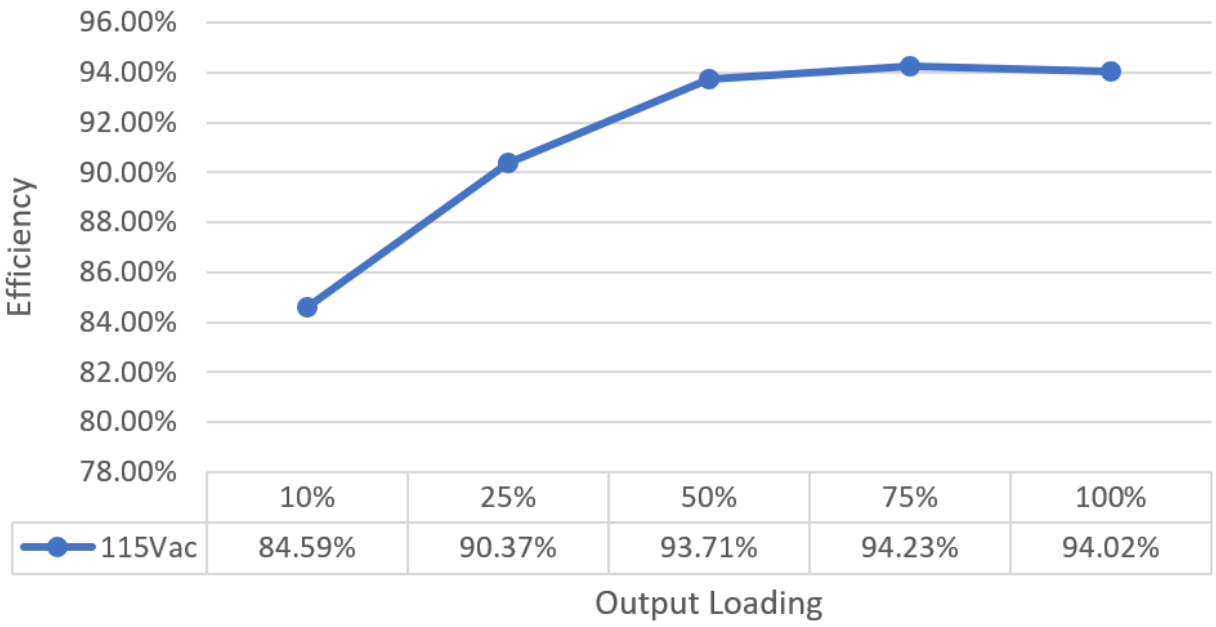


Table 2. **STDES-200GANADP efficiency at 115 V_{AC} input**

Condition	% of full loading	Efficiency
EU CoC Rev.05-Tier2 limit for 10% loading		79%
115 V_{AC} 60 Hz input	10%	84.59%
	25%	90.37%
	50%	93.71%
	75%	94.23%
	100%	94.02%
Four-point average result	-	93.09%
EU CoC Rev.05-Tier2 limit	-	89%

4.1.2 Efficiency at 230 V_{AC} input

Figure 6. **STDES-200GANADP efficiency at 230 V_{AC} input**

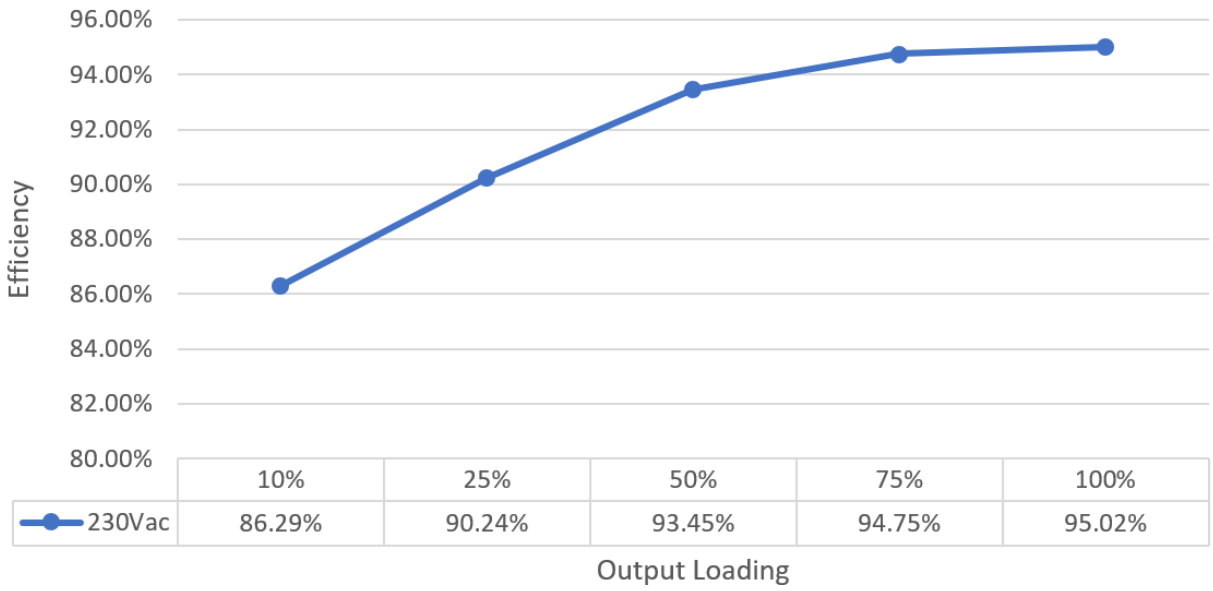


Table 3. **STDES-200GANADP efficiency at 230 V_{AC} input**

Condition	% of full loading	Efficiency
EU CoC Rev.05-Tier2 limit for 10% loading		79%
230 V_{AC} 50 Hz input	10%	86.29%
	25%	90.24%
	50%	93.45%
	75%	94.75%
	100%	95.02%
Four-point average result	-	93.37%
EU CoC Rev.05-Tier2 limit	-	89%

4.2 Load and line regulation test results

Table 4. **Load and line regulation**

Loading (%)	115 V_{AC} (V)	230 V_{AC} (V)	SPEC limit (V)	
0	19.12	19.12	18.62	19.38
10	19.04	19.11		
25	19.08	19.10		
50	19.10	19.09		
75	19.12	19.10		
100	19.15	19.13		

4.3 Ripple and noise

4.3.1 V_{OUT} ripple and noise test setup: test at the end of the PCB

Figure 7. **Ripple and noise test setup probe: 10 µ electrolytic capacitor and 100 nF ceramic capacitor added**

4.3.2 Ripple and noise results

Figure 8. Ripple and noise at 230 V_{AC} input with full load: Vpeak-peak = 240 mV (1 of 2)

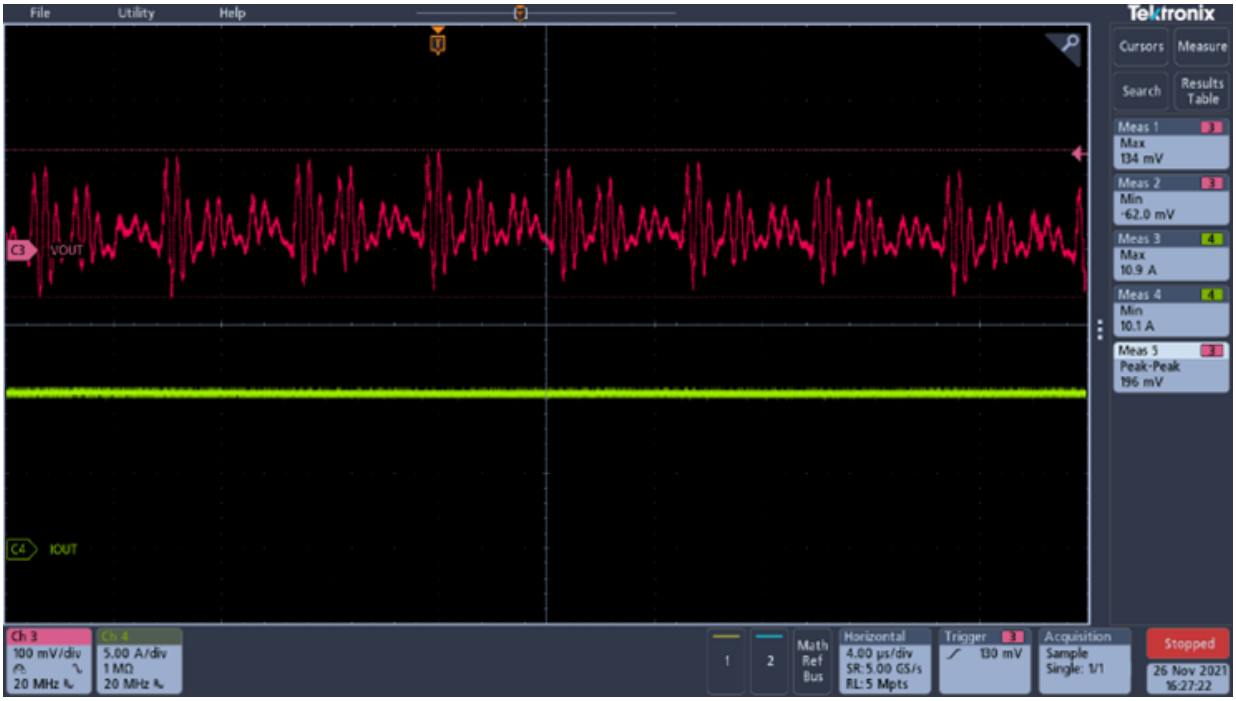
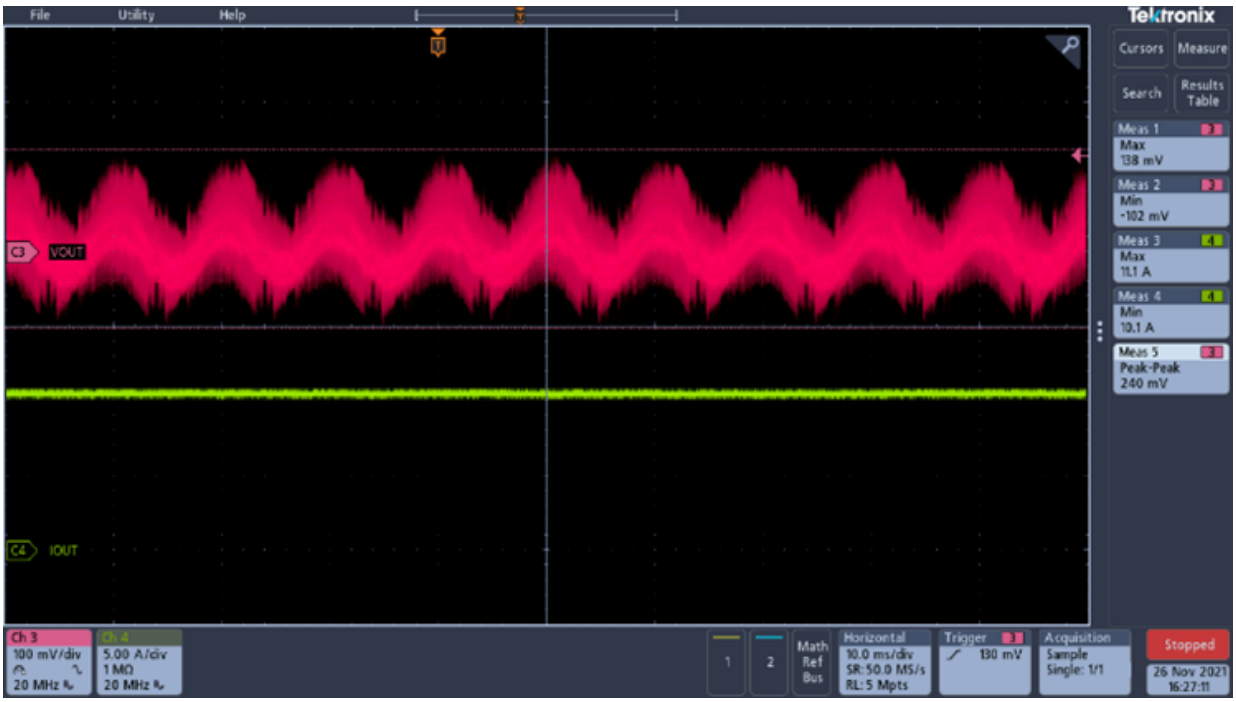


Figure 9. Ripple and noise at 230 V_{AC} input with full load: Vpeak-peak = 240 mV (2 of 2)



4.4 Typical waveforms

4.4.1 Startup waveforms

Figure 10. PFC section startup waveform

- Yellow line: CH1 - Vgs
- Light blue line: CH2 - Vds
- Red line: CH3 - driver signal
- Light green line: CH4 - inductor current

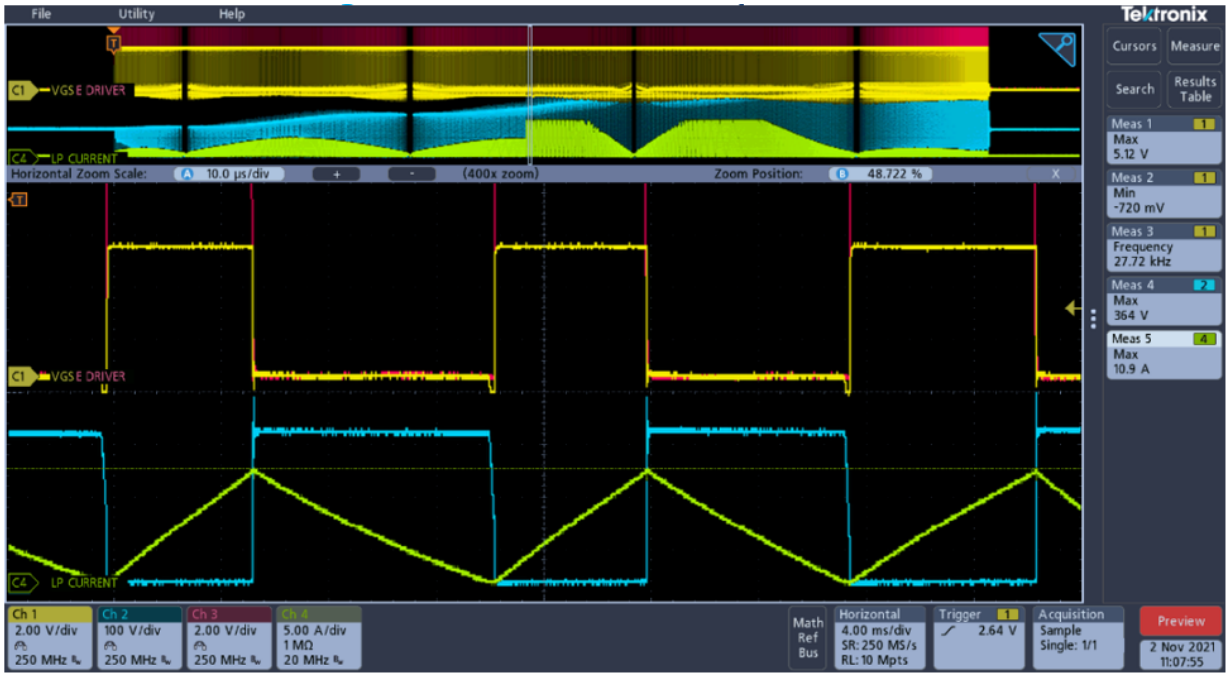
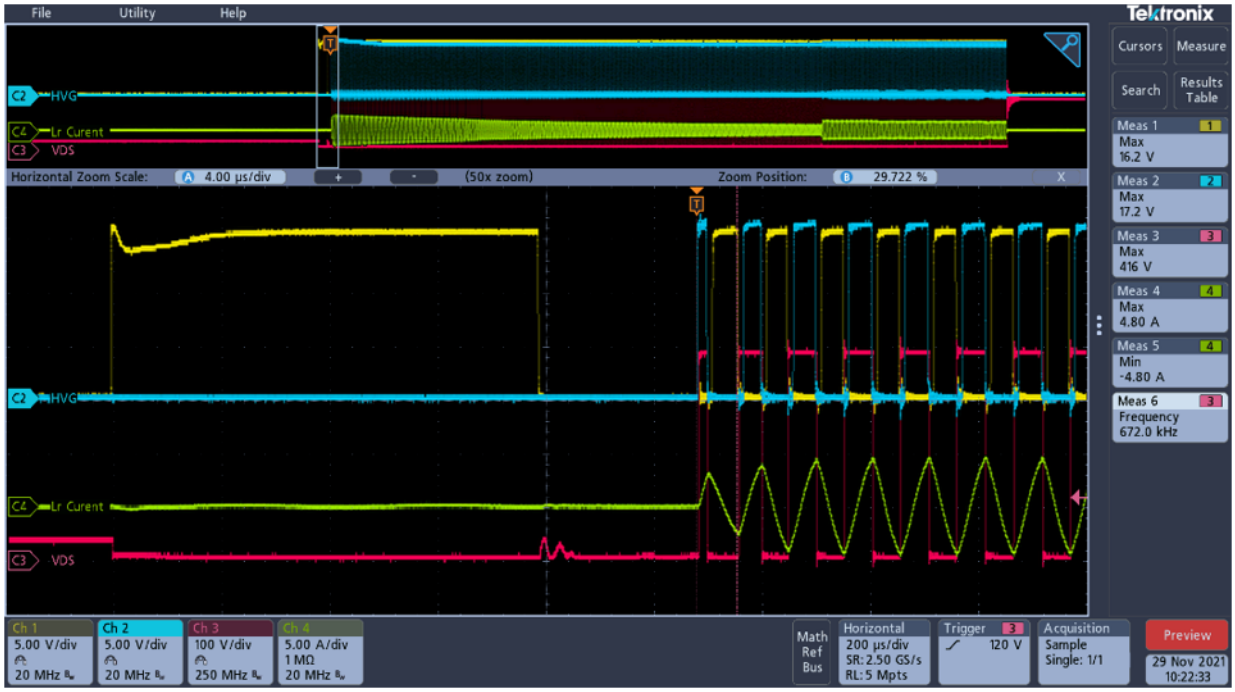


Figure 11. LLC section startup waveform

- Yellow line: CH1 - Low side Vgs
- Light blue line: CH2 - High side Vgs
- Red line: CH3 - HB voltage
- Light green line: CH4 - LLC tank current



4.4.2 Normal operation waveforms

Figure 12. PFC section: normal operation @ 115 V_{IN} with full load

- Yellow line: CH1 - Vgs
- Light blue line: CH2 - Vds
- Light green line: CH4 - inductor current

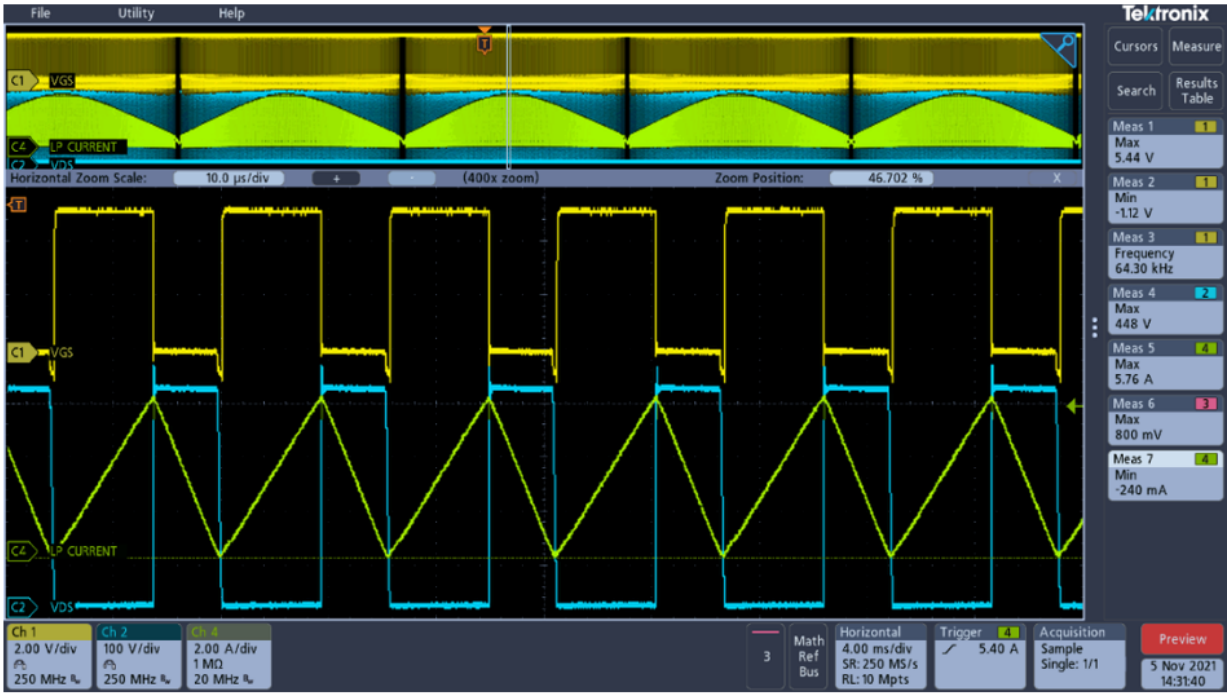


Figure 13. LLC section normal operation @ 115 V_{IN} with full load

- Yellow line: CH1 - Low side Vgs
- Light blue line: CH2 - High side Vgs
- Red line: CH3 - HB voltage
- Light green line: CH4 - LLC tank current

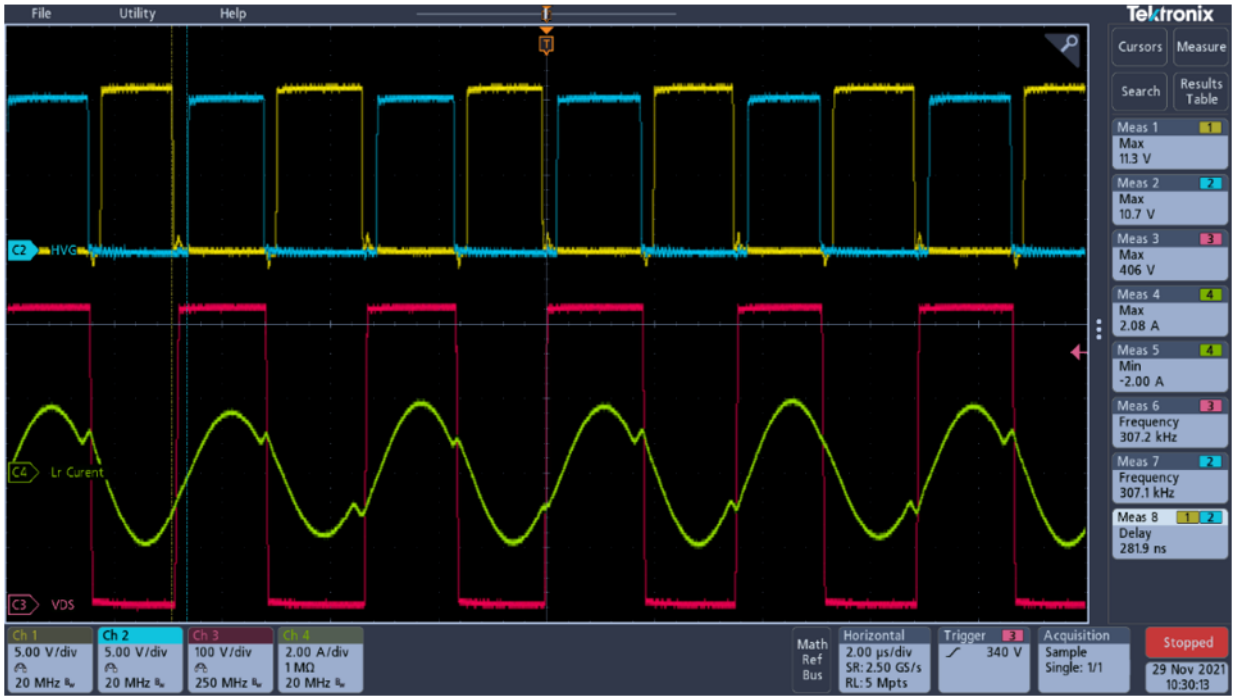
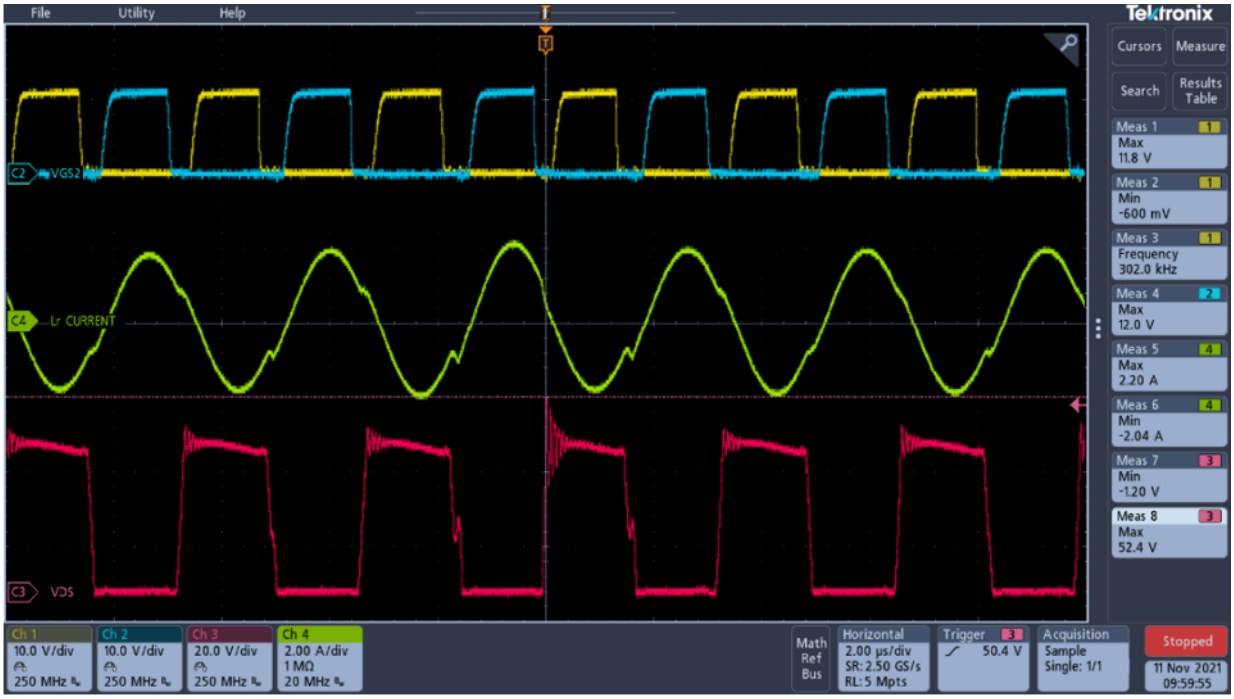


Figure 14. **SR MOSFET normal operation @ 115 V_{IN} with full load**

- Yellow line: CH1 - SR FET Vgs1
- Light blue line: CH2 - SR FET Vgs2
- Red line: CH3 - SR FET Vds
- Light green line: CH4 - Primary tank current



4.4.3 Burst mode waveforms

To improve the efficiency at light load, the controller works in the synchronous burst mode operation with the PFC.

Figure 15. **Burst mode waveform**

- Yellow line: CH1 - PFC FET Vds
- Light blue line: CH2 - VCC voltage
- Red line: CH3 - LLC FET Vds

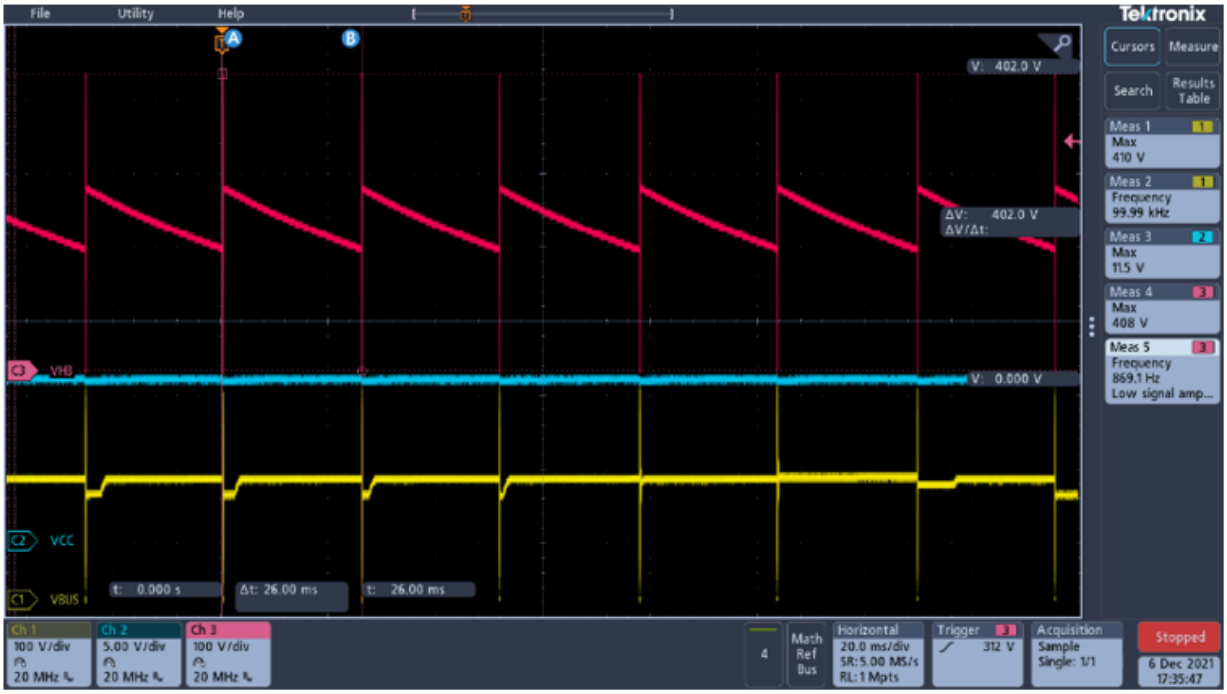
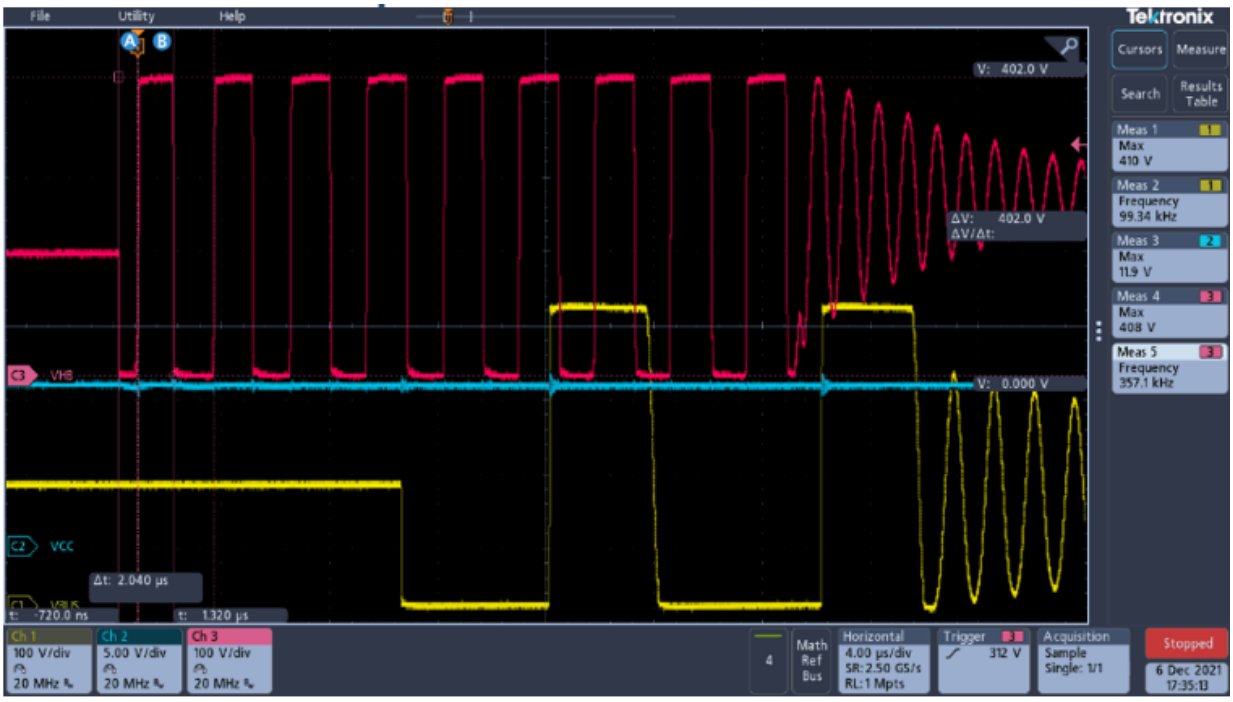


Figure 16. **Burst mode waveform (zoom)**



4.5 Thermal performance

Table 5. **PFC section key component temperature at full load, T_A = 25ºC**

Devices	115 V_{AC}	230 V_{AC}
	Max. temp	Max. temp
PFC FET	88.7	66.5
PFC diode	83.4	71.1
Bridge diode 01	105.1	62.7
Active bridge FET 01	79.8	46.2
Active bridge FET 02	86.9	56.1

Figure 17. **PFC section key component thermal at full load (115 V_{AC}) - 1 of 2**

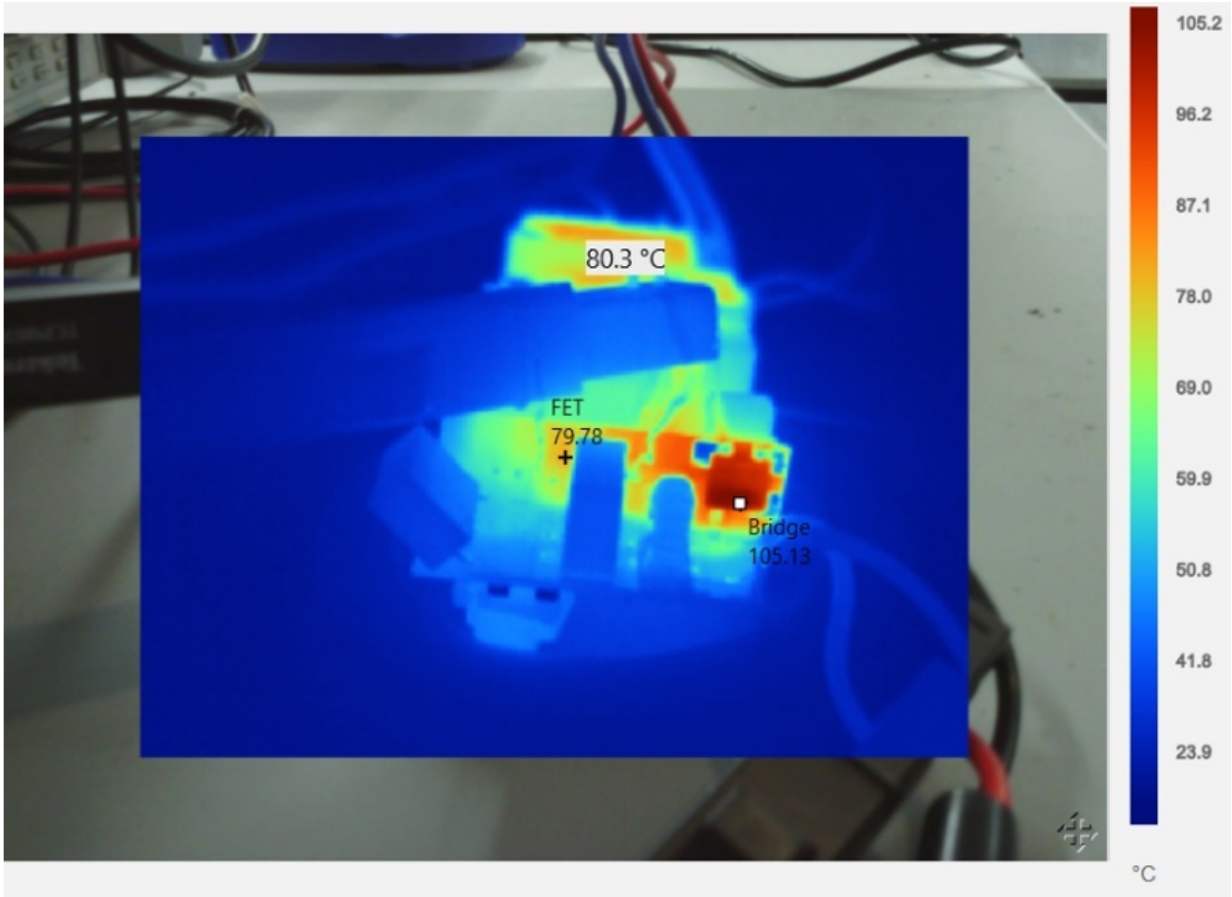


Figure 18. **PFC section key component thermal at full load (115 V_{AC}) - 2 of 2**

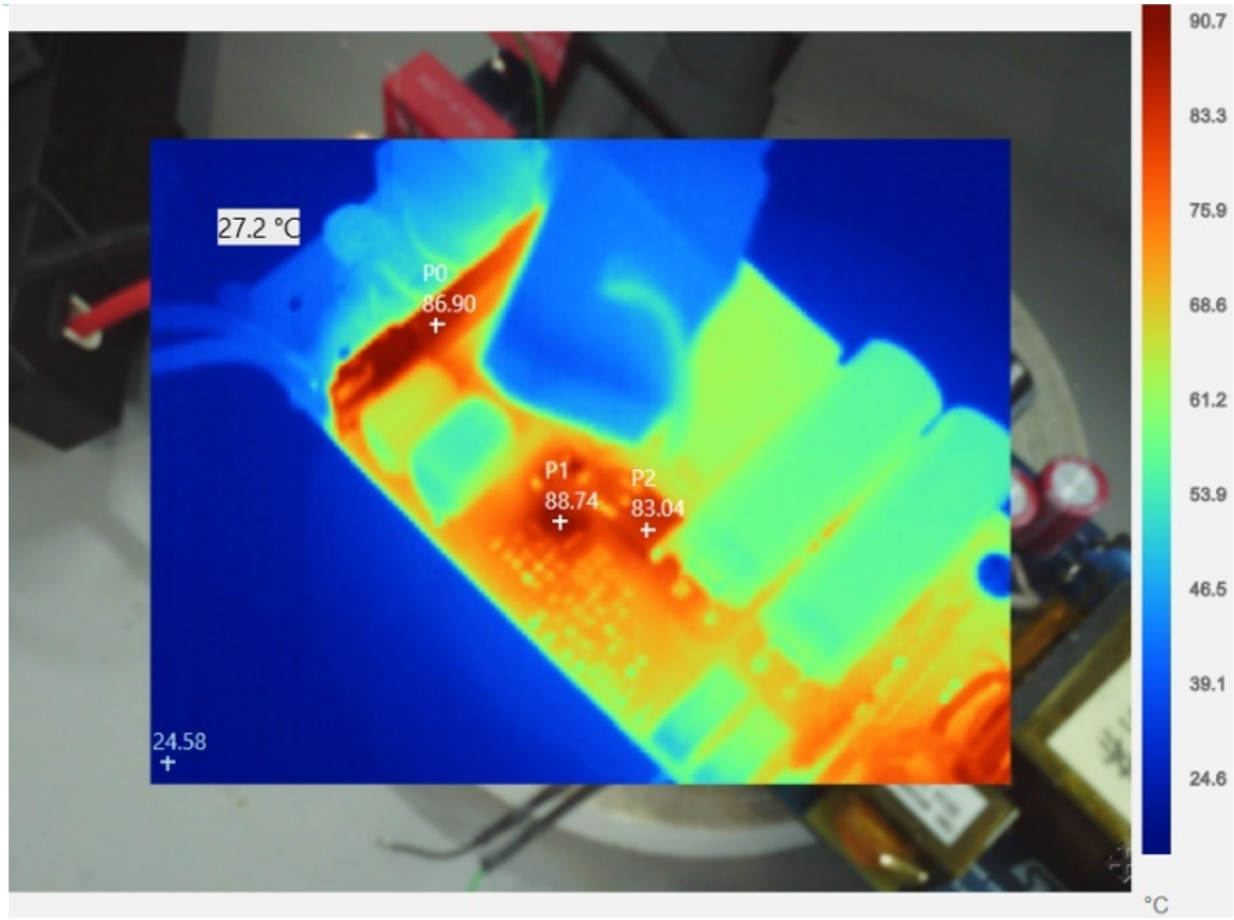


Figure 19. **PFC section key component thermal at full load (230 V_{AC}) - 1 of 2**

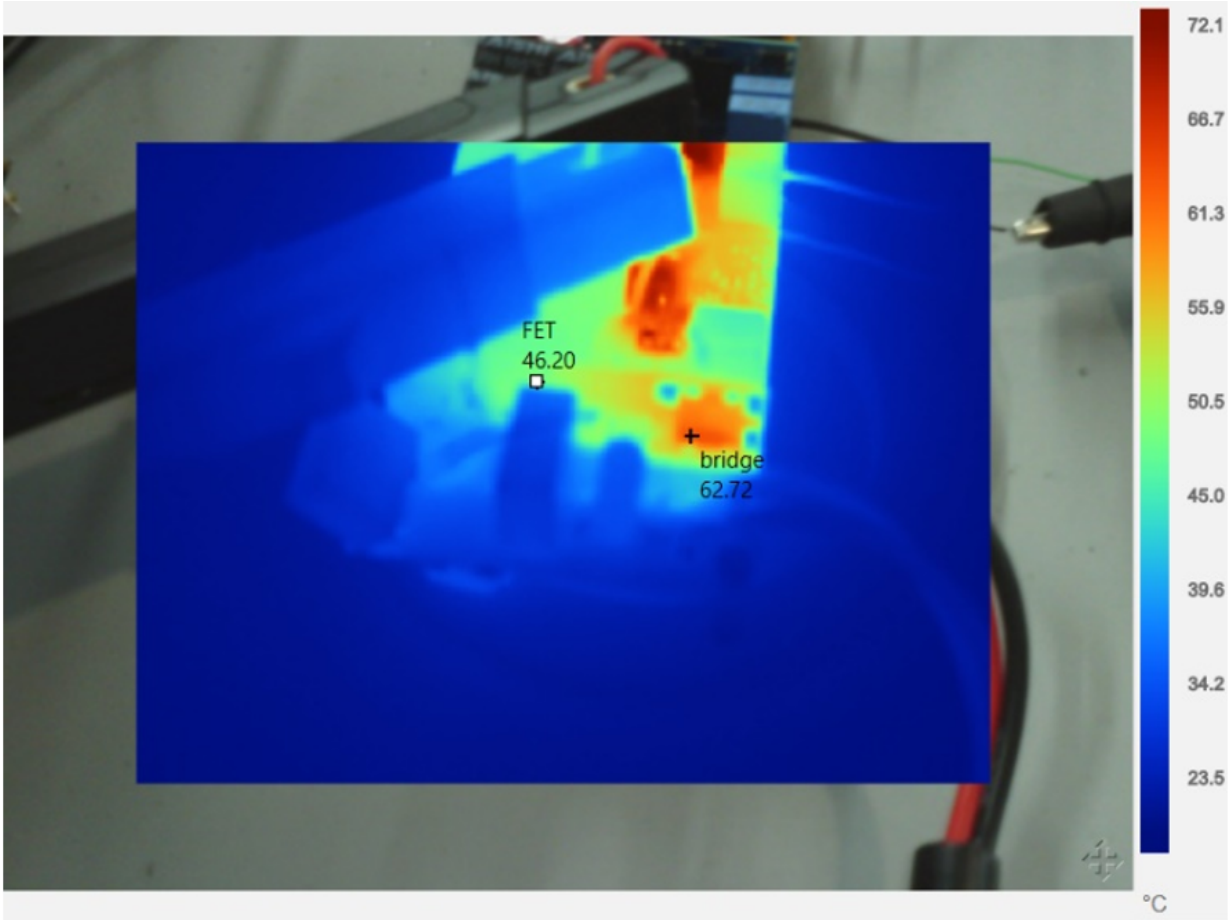


Figure 20. **PFC section key component thermal at full load (230 V_{AC}) - 2 of 2**

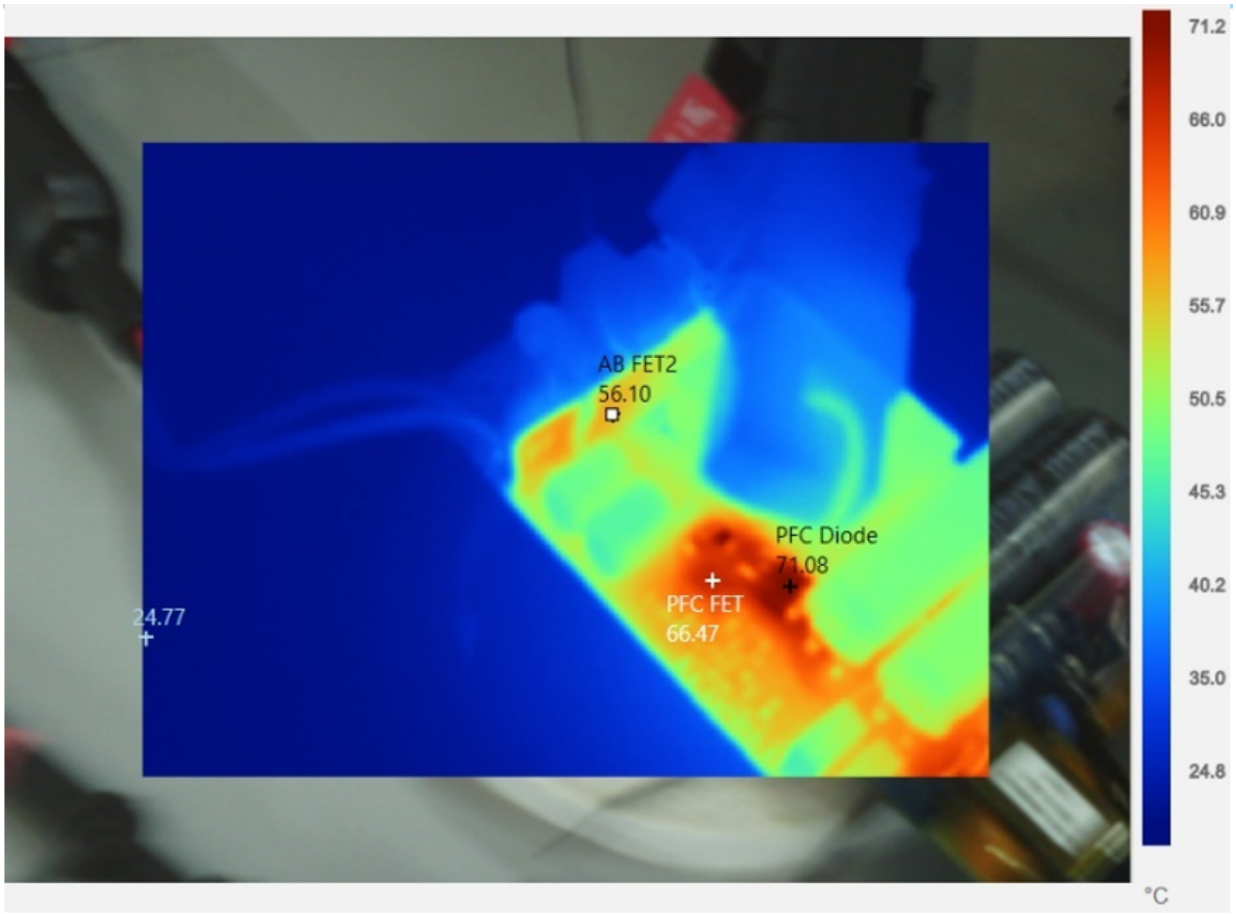


Table 6. **LLC section Key components temperature at Full Load, Ta=25ºC**

Devices	115 V_{AC}	230 V_{AC}
	Max. temp	Max. temp
MasterGaN1	75.0	74.1
Resonance inductor	79.5	80.0
Transformer	79.6	77.4
SR MOSFET 01	90.0	89.3
SR MOSFET 02	87.6	87.3
SR controller	96.6	97.1

Figure 21. **LLC section key component thermal at full load (115 V_{AC})**

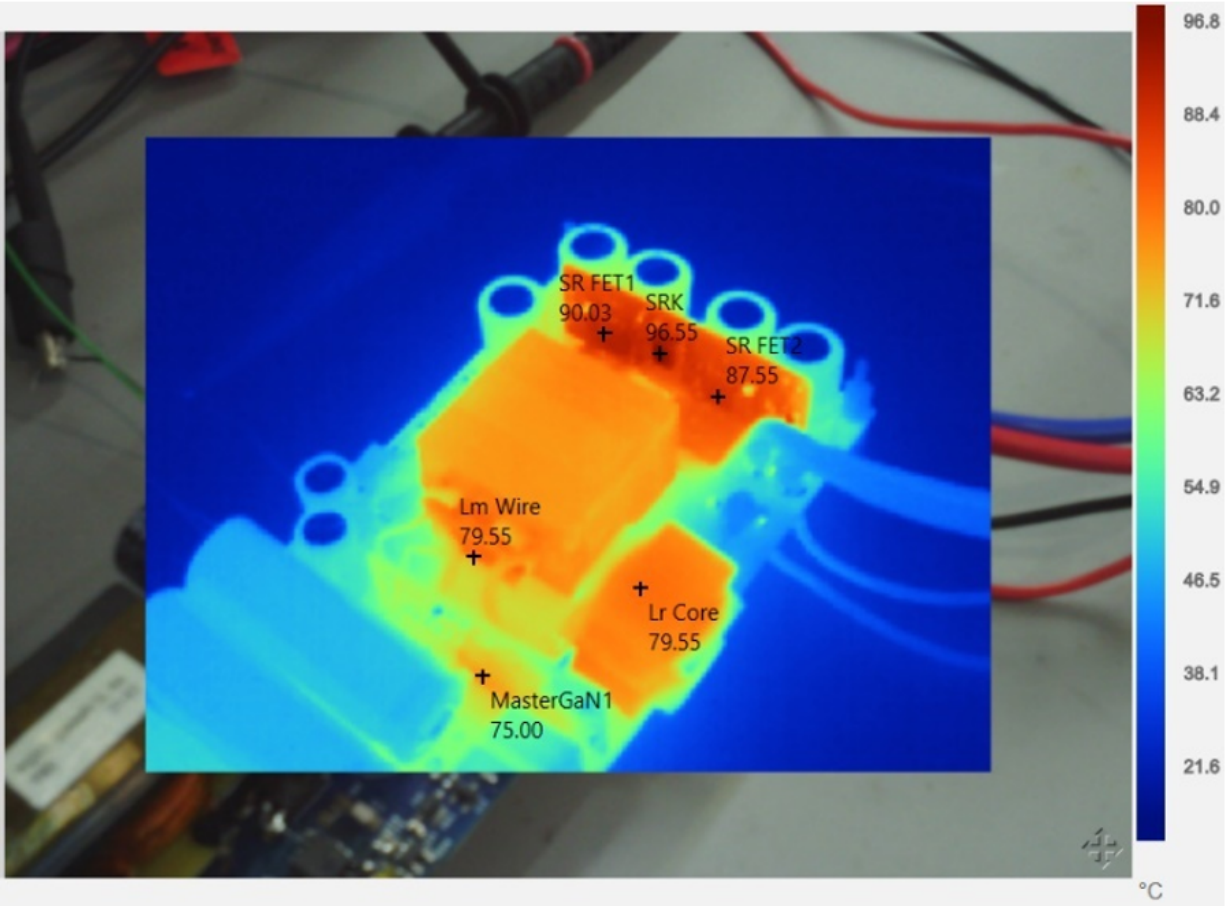
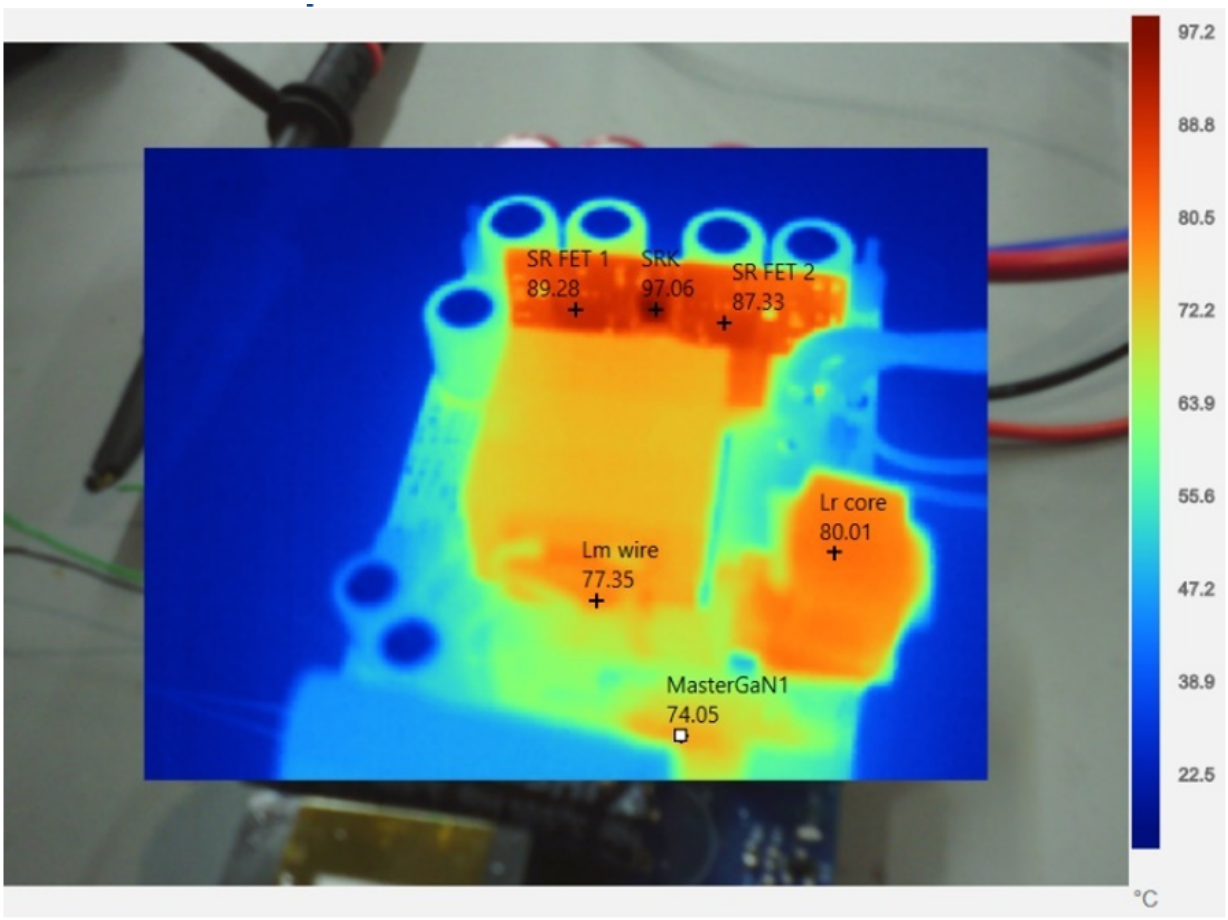


Figure 22. LLC section key component thermal at full load (230 V_{AC})



5 Schematic diagrams

Figure 23. **STDES-200GANADP circuit schematic (1 of 4)**

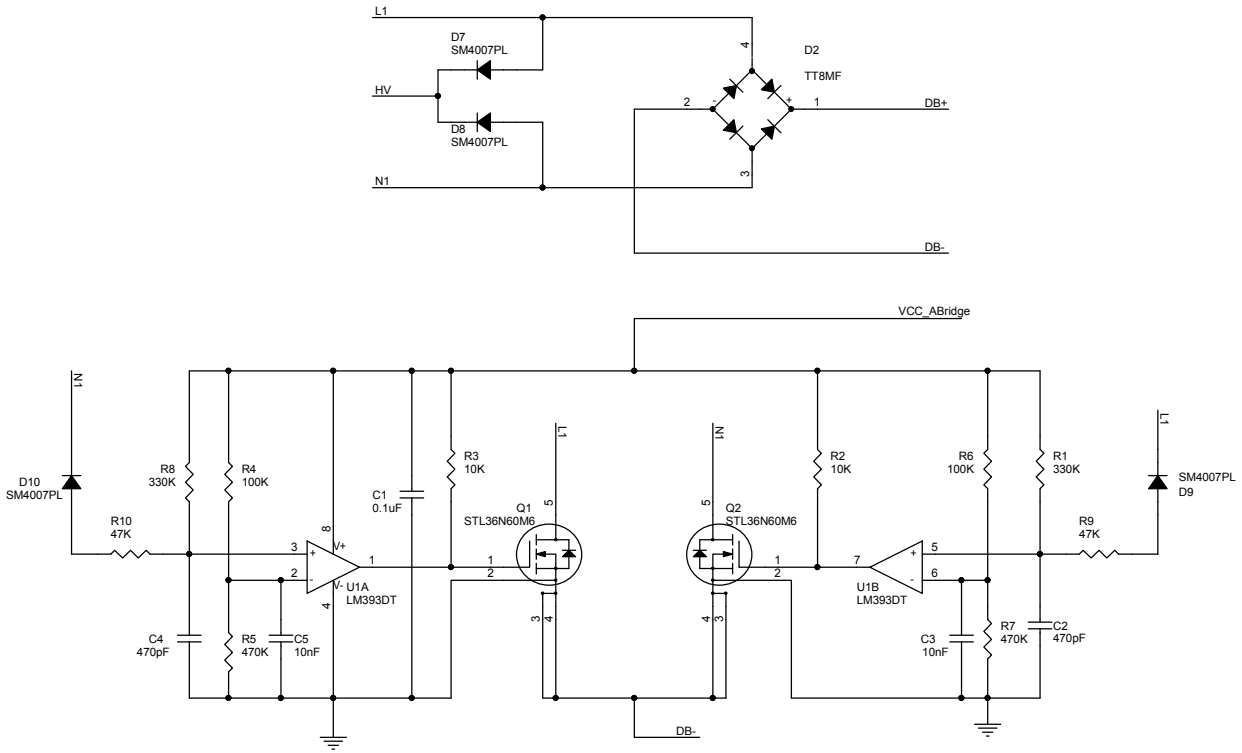


Figure 24. STDES-200GANADP circuit schematic (2 of 4)

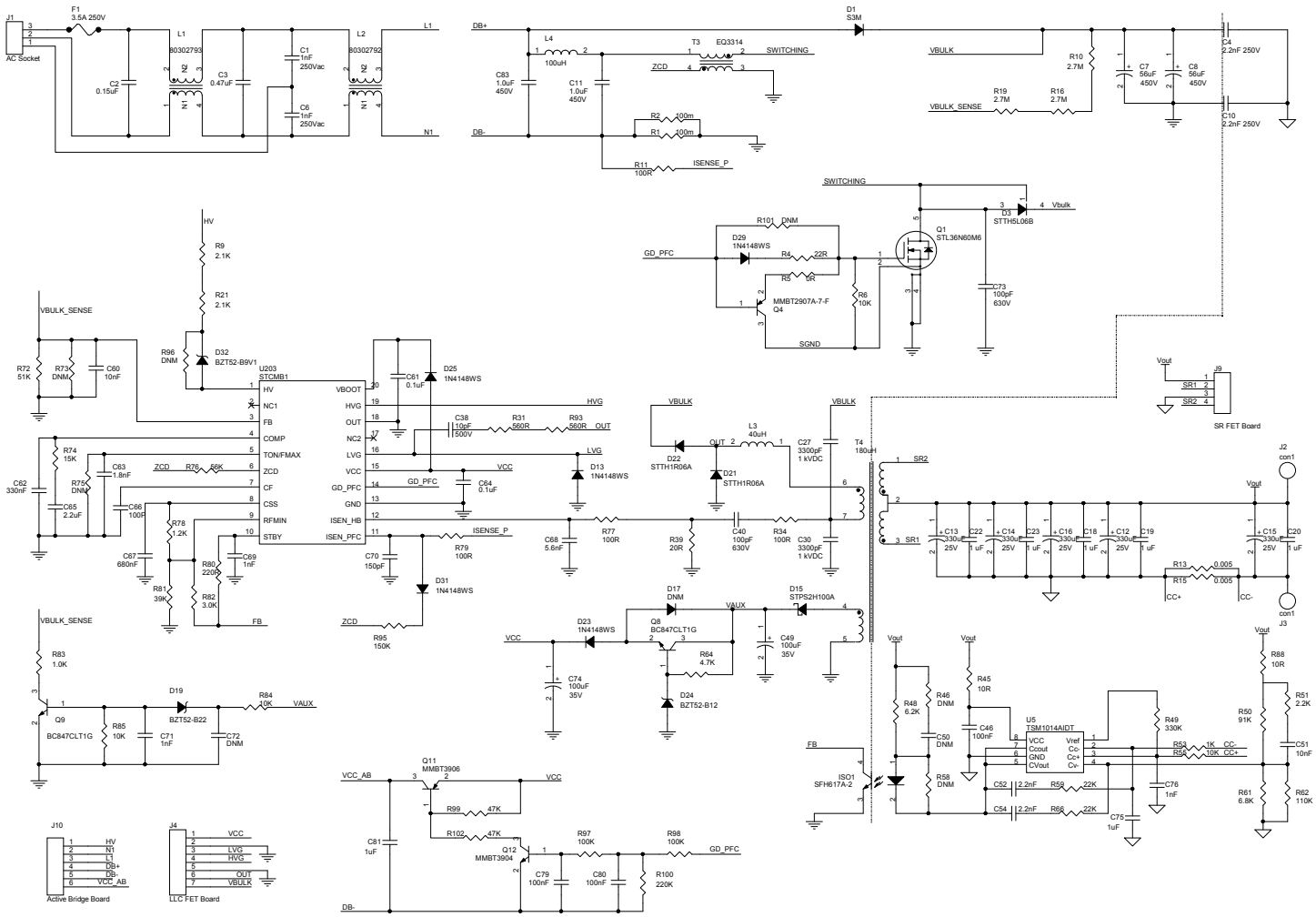


Figure 25. **STDES-200GANADP circuit schematic (3 of 4)**

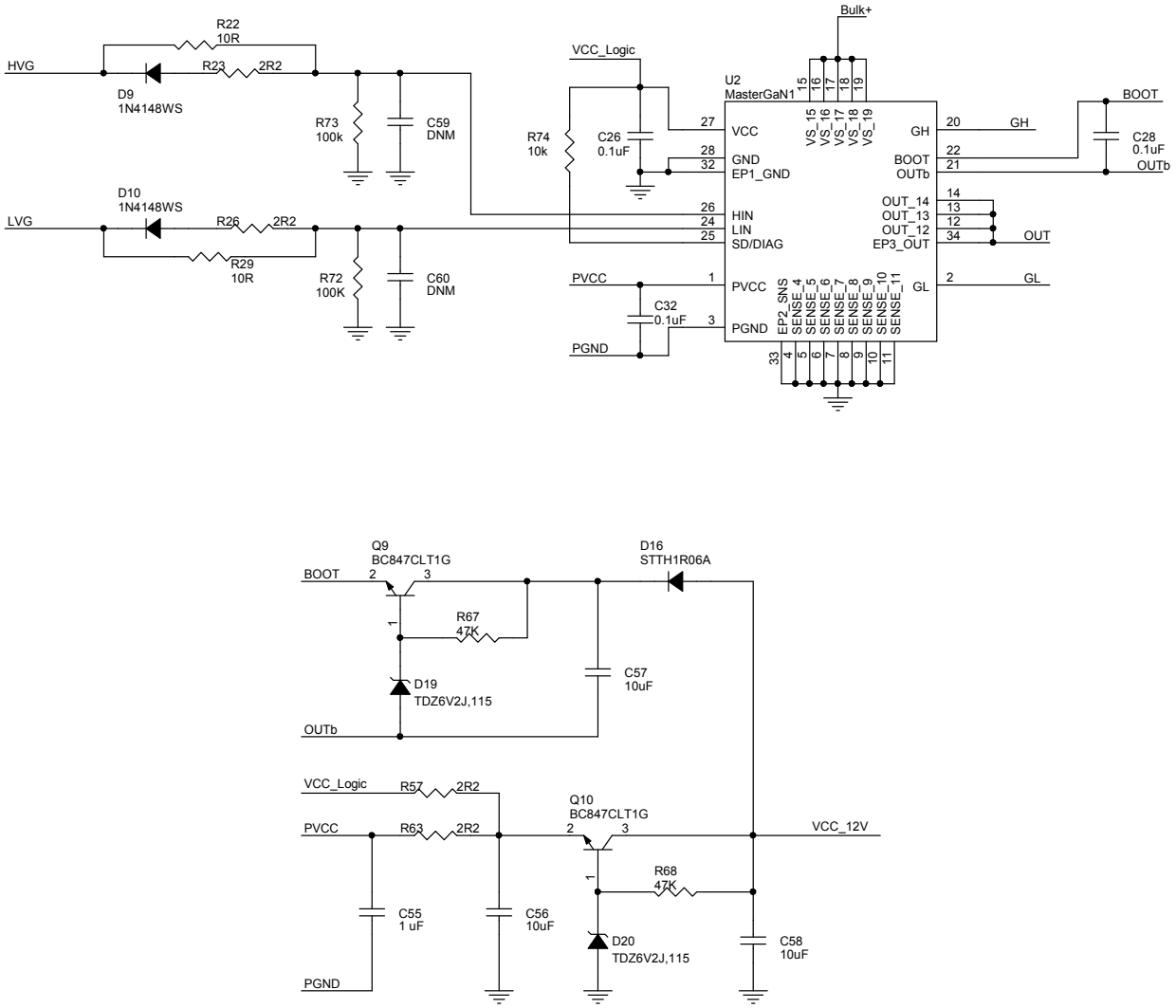
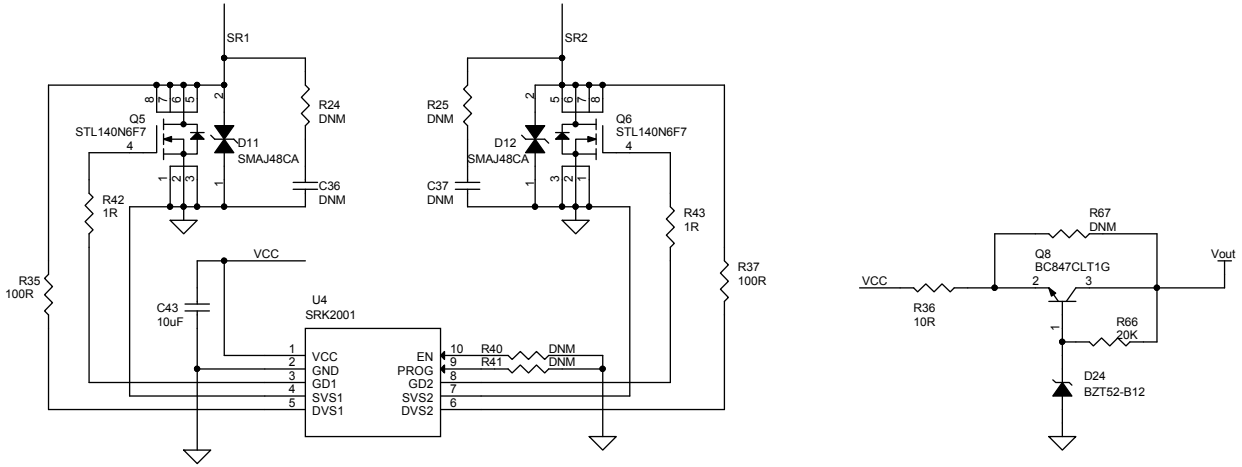


Figure 26. **STDES-200GANADP circuit schematic (4 of 4)**



6 Bill of materials

Table 7. STDES-30KWVRECT bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	Table 8. STDES-200GANADP: mother board bill of materials	-	Mother board	ST	Not available for separate sale
2	1	Table 9. STDES-200GANADP: active bridge rectifier board bill of materials	-	Active bridge rectifier board	ST	Not available for separate sale
3	1	Table 10. STDES-200GANADP: LLC FET board bill of materials	-	LLC FET board	ST	Not available for separate sale
4	1	Table 11. STDES-200GANADP: SR FET board bill of materials	-	SR FET board	ST	Not available for separate sale

Table 8. STDES-200GANADP: mother board bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	2	C1, C6	Y2 1812 1nF ±10% 250Vac	Safety capacitors	Wurth	8853522110031
2	1	C2	X2 0.15uF ±10% 275Vac	Safety capacitors	Wurth	890324023025
3	1	C3	X2 0.47uF ±10% 275Vac	Safety capacitors	Wurth	890324025039
4	2	C4, C10	Y2 2.2nF ±20% 250Vac	Safety capacitors	Murata	DE2E3KY222MN3AM02F
5	2	C7, C8	56uF ±20% 450V	E-CAP	Aishi Cap	ERH2WM560W35OT
6	1	C11, C83	1.0uF ±10% 450V	Film capacitors	Panasonic	ECWFD2W105Q1
7	5	C12, C13, C14, C15, C16	330uF ±20% 25V	Aluminum Polymer capacitors	Wurth	870025575009
8	5	C18, C19, C20, C22, C23	1206 1uF 10% 50V	Ceramic capacitors	SAMSUNG	CL21A475KB
9	1	C46	0805 100nF 10% 25V	Ceramic capacitors	SUP	C0805X7R104K500NTDD
10	2	C27, C30	3.3nF 5% 1KV	Film capacitors	TDK	B32620A0332J000
11	1	C38	1206 10pF 5% 500V	Ceramic capacitors	SUP	C1206C0G100J501NTHC
12	2	C40, C73	1206 100pF 5% 630V	Ceramic capacitors	YAGEO	CC1206JKNPOZBN101
13	2	C49, C74	100uF 5% 35V	E-CAP	Wurth	860080574007
14	2	C50, C72	Not Mounted	Ceramic capacitors	-	-
15	1	C51	0603 10nF ±10% 50V	Ceramic capacitors	SUP	C0603X7R103K500NTDD

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
16	1	C52, C54	0603 2.2nF ±10% 50V	Ceramic capacitors	SUP	C0603X7R222K500NTDD
17	1	C60	0805 10nF ±10% 50V	Ceramic capacitors	SUP	C0805X7R103K500NTFD
18	2	C61, C64	1206 100nF ±10% 50V	Ceramic capacitors	SUP	C1206X7R104K500NTFD
19	1	C62	0603 330nF ±10% 50V	Ceramic capacitors	SUP	C0603X7R334K500NTDD
20	1	C63	0603 1.8nF ±10% 50V	Ceramic capacitors	SUP	C0603X7R182K500NTDD
21	1	C65	0805 2.2uF ±10% 50V	Ceramic capacitors	SUP	C0805X5R225K500NTHB
22	1	C66	0603 100pF ±5% 50V	Ceramic capacitors	CCTC	TCC0603COG101J500CT
23	1	C67	0805 680nF ±10% 50V	Ceramic capacitors	SUP	C0805X5R684K500NTHB
24	1	C68	0603 5.6nF ±10% 50V	Ceramic capacitors	SUP	C0603X7R562K500NTDD
25	3	C69, C71, C76	0603 1nF ±10% 50V	Ceramic capacitors	SUP	C0603X7R102K500NTDD
26	1	C70	0603 22pF ±10% 50V	Ceramic capacitors	SUP	C0603X7R220K500NTDD
27	2	C75, C81	0603 1uF ±10% 50V	Ceramic capacitors	SAMSUNG	CL10A105KB
28	2	C79, C80	0603 100nF ±10% 50V	Ceramic capacitors	SUP	C0603X7R104K500NTDD
29	1	D1	S3M 1KV 3A	Diode	MDD	S3MC
30	1	D3	STTH5L06B-TR, 600V 5A, DPAK	600 V, 5 A low drop ultrafast diode	ST	STTH5L06B-TR
31	5	D13,D23,D25,D30,D31	1N4148WS 75V 150mA	Diode	ON	1N4148WS
32	1	D15	STPS2H100AY 100V 2A SMA	Automotive 100 V, 2 A power Schottky rectifier	ST	STPS2H100AY
33	1	D17	Not mounted	Diode	-	-
34	1	D19	BZT52-B22 22V 500mW	Zener diode	Nexperia	BZT52-B22J
35	2	D21, D22	STTH1R06A, SMA	600 V, 1 A Turbo 2 ultrafast diode	ST	STTH1R06A
36	1	D24	BZT52-B12	Zener Diode	Nexperia	BZT52-B12J
37	1	D28	BZT52-B6V2	Zener Diode	Nexperia	BZT52-B6V2J
38	1	D32	BZT52-B9V1	Zener Diode	Nexperia	BZT52-B9V1J
39	2	F1	047603.5MR	SMD Fuse	Littelfuse	047603.5MR
40	1	ISO1	SFH617A-2	Opto-coupler	ISOCOM	SFH617A-2X
41	1	J1	Not Mounted	AC Socket	-	-
42	2	J2, J3	Not Mounted	Connecter	-	-

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
43	1	J4	LLC power FET Board	Daughter board	-	-
44	1	J9	SR FET Board	Daughter board	-	-
45	1	J10	Bridge Diode Board	Daughter board	-	-
46	1	L1	1mH 3.5A 1mH T12x6x4	Common Choke	Any	Any
47	1	L2	10mH 3.5A	Common Choke	YAMAXI	80302792
48	1	L3	40uH 3.5A	Inductor	YAMAXI	80106093
49	1	L4	100uH 3.5A	Differential Choke	YAMAXI	80302793
50	1	Q1	STL36N60M6, PowerFLAT 8x8 HV	N-channel 600 V, 91 mOhm typ., 25 A MDmesh M6 power MOSFET in a PowerFLAT 8x8 HV package	ST	STL36N60M6
51	1	Q4	PNP 60V 0.6A SOT23-3	Transistors	Diodes	MMBT2907A-7-F
52	3	Q8, Q9	NPN 45V 0 .1A SOT23	Transistors	ON	BC847CLT1G
53	1	Q11	PNP 40V 0.2A SOT23-3	Transistors	Diodes	MMBT3906-7-F
54	1	Q12	NPN 40V 0.2A SOT23-3	Transistors	ON	MMBT3904
55	2	R1, R2	2512 100mΩ ±1% 1W	Resistors	SUP	RR6432(2512)L0R10FT
56	1	R4	0805 22Ω ±5%	Resistors	SUP	RR2012(0805)L220JT
57	1	R5	0805 0Ω ±5%	Resistors	SUP	RR2012(0805)L0R0JT
58	1	R6	0805 10KΩ ±5%	Resistors	SUP	RR2012(0805)L103JT
59	2	R9, R21	1206 2.1KΩ ±5%	Resistors	SUP	RR3216(1206)L2102FT
60	3	R10, R16, R19	1206 2.7MΩ ±1%	Resistors	SUP	RR3216(1206)L2704FT
61	2	R11, R79	0603 150Ω ±1%	Resistors	SUP	RR1608(0603)L1500FT
62	2	R13, R15	2512 5mΩ ±1%	Resistors	SUP	MRN036432(2512)LR005FTS
63	2	R31, R93	1206 1KΩ ±1%	Resistors	SUP	RR3216(1206)L1001FT
64	1	R34	1206 100Ω ±1%	Resistors	SUP	RR3216(1206)L1000FT
66	1	R39	0805 20Ω ±1%	Resistors	SUP	RR2012(0805)L20R0FT
67	2	R45, R88	0805 10Ω ±5%	Resistors	SUP	RR2012(0805)L100JT
68	4	R46, R58, R73, R96	Not Mounted	Resistors	-	-
69	1	R48	0603 6.2KΩ ±1%	Resistors	SUP	RR1608(0603)L6201FT
70	1	R49	0603 330KΩ ±1%	Resistors	SUP	RR1608(0603)L3303FT

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
71	1	R50	0603 91KΩ ±0.1%	Resistors	YAGEO	RT0603BRE0791KL
72	1	R51	0603 2.2KΩ ±1%	Resistors	SUP	RR1608(0603)L2201FT
73	1	R53	0603 1KΩ ±1%	Resistors	SUP	RR1608(0603)L1001FT
74	3	R55, R84, R85	0603 10KΩ ±1%	Resistors	SUP	RR1608(0603)L1002FT
75	2	R59, R66	0603 22KΩ ±1%	Resistors	SUP	RR1608(0603)L2202FT
76	1	R61	0603 6.8KΩ ±0.1%	Resistors	YAGEO	RT0603BRE076K8L
77	1	R62	0603 110KΩ ±0.1%	Resistors	YAGEO	RT0603BRD07110KL
78	1	R64	0805 4.7KΩ ±1%	Resistors	SUP	RR2012(0805)L4701FT
79	1	R72	0805 51KΩ ±1%	Resistors	SUP	RR2012(0805)L5102FT
80	1	R73	Not Mounted	Resistors	-	-
81	1	R74	0603 15KΩ ±1%	Resistors	SUP	RR1608(0603)L1502FT
82	1	R76	1206 56KΩ ±1%	Resistors	SUP	RR3216(1206)L5602FT
83	1	R77	0805 100Ω ±1%	Resistors	SUP	RR2012(0805)L1000FT
84	1	R78	0603 1.2KΩ ±1%	Resistors	SUP	RR1608(0603)L1201FT
85	1	R80	0603 220Ω ±1%	Resistors	SUP	RR1608(0603)L2200FT
86	1	R81	0603 39KΩ ±1%	Resistors	SUP	RR1608(0603)L3902FT
87	1	R82	0603 3.0KΩ ±1%	Resistors	SUP	RR1608(0603)L3001FT
88	1	R83	0603 1KΩ ±1%	Resistors	SUP	RR1608(0603)L1001FT
89	1	R95	0603 150KΩ ±1%	Resistors	SUP	RR1608(0603)L1503FT
90	1	R97	0603 100KΩ ±1%	Resistors	SUP	RR1608(0603)L1003FT
91	1	R98	0805 150KΩ ±1%	Resistors	SUP	RR2012(0805)L1503FT
92	2	R99, R102	0603 47KΩ ±1%	Resistors	SUP	RR1608(0603)L4702FT
93	1	R100	0603 220KΩ ±1%	Resistors	SUP	RR1608(0603)L2203FT
94	1	R101	Not Mounted	Resistors	-	-
95	1	T3	EQ3314, 250uH	Transformer	YAMAXI	80302735
96	1	T4	EE25AG, 160uH	Transformer	YAMAXI	80106380

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
97	1	U5	TSM1014IDT, SO-8	Low consumption voltage and current controller for battery chargers and adapters	ST	TSM1014IDT
98	1	U203	STCMB1, SO-20	Transition mode PFC with X-cap discharge and LLC resonant combo controller	ST	STCMB1

Table 9. STDES-200GANADP: active bridge rectifier board bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	C1	0603 100nF ±10% 50V	Ceramic capacitors	YAGEO	CC0603KRX7R9BB104
2	2	C2 C4	0603 470pF ±10% 50V	Ceramic capacitors	YAGEO	CC0603KRX7R9BB471
3	2	C3 C5	0603 10nF ±10% 50V	Ceramic capacitors	YAGEO	CC0603KRX7R9BB103
4	1	D2	1000V 8A Surface mount bridge rectifier	Diodes	MDD	TT8MF
5	4	D7 D8 D9 D10	1000V 1A SOD123F	Diodes	MDD	SM4007PL
6	1	Q1, Q2	STL36N60M6, PowerFLAT 8x8 HV	N-channel 600 V, 91 mOhm typ., 25 A MDmesh M6 power MOSFET in a PowerFLAT 8x8 HV package	ST	STL36N60M6
7	2	R1 R8	0603 330KΩ ±1%	Resistors	YAGEO	RC0603FR-07330KL
8	2	R2 R3	0603 10KΩ ±1%	Resistors	YAGEO	RC0603FR-0710KL
9	2	R4 R6	0603 100KΩ ±1%	Resistors	YAGEO	RC0603FR-07100KL
10	2	R5 R7	0603 470KΩ ±1%	Resistors	YAGEO	RC0603FR-07470KL
11	2	R9 R10	0603 47KΩ ±1%	Resistors	YAGEO	RC0603FR-0747KL
12	1	U1	LM393DT, SO-8	Low power dual voltage comparator	ST	LM393DT

Table 10. STDES-200GANADP: LLC FET board bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	3	C26, C28, C32	0603 0.1uF ±10% 50V	Ceramic capacitors	CCTC	TCC0603X7R104K500CT

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
2	1	C55	0603 1uF ±10% 16V	Ceramic capacitors	SUP	C0603X7R105K160NTDD
3	3	C56, C57, C58	0805 10uF ±10% 25V	Ceramic capacitors	SUP	C0805X5R106K250NTHC
4	2	C59, C60	Not mounted	Ceramic capacitors	-	-
5	2	D9, D10	75V 150mA SOD323F	Diode	ON	1N4148WS
6	1	D16	600V 1A SMA	Diode	STMicroelectronics	STTH1R06A
7	2	D19, D20	6.2V 500mW SOD323F	Zener Diode	Nexperia	TDZ6V2J,115
8	2	Q9, Q10	NPN 45V 0.1A SOT23	NPN transistor	ON	BC847CLT1G
9	2	R22, R29	0805 10Ω ±1%	Resistors	SUP	RR2012(0805)L100JT
10	4	R23, R26, R57, R63	0805 2.2Ω ±1%	Resistors	SUP	RR2012(0805)L2R2JT
11	2	R67, R68	0603 47KΩ ±5%	Resistors	SUP	RR1608(0603)L473JT
12	2	R72, R73	0603 100KΩ ±5%	Resistors	SUP	RR1608(0603)L104JT
13	1	R74	0603 10KΩ ±5%	Resistors	SUP	RR1608(0603)L103JT
14	1	U2	MASTERGAN1, VFQFPN 9X9X1.0 31L PITCH 0.6MM	High power density 600V half-bridge driver with two enhancement mode GaN HEMTs	ST	MASTERGAN1

Table 11. STDES-200GANADP: SR FET board bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	2	C36, C37	Not Mounted	Ceramic capacitors	-	-
2	1	C43	1206 10uF ±10% 50V	Ceramic capacitors	SAMSUNG	CL31A106KB
3	2	D11, D12	48V TVS SMA	TVS Diode	MDD	SMAJ48CA/SMA
4	1	D24	12V 500mW SOD123	Zener Diode	Nexperia	BZT52-B12J
5	2	Q5, Q6	STL140N6F7, PowerFLAT 5x6	N-channel 60 V, 0.0024 Ohm typ., 140 A STripFET F7 power MOSFET in a PowerFLAT 5x6 package	ST	STL140N6F7
6	1	Q8	NPN 45V 0.1A SOT23	Transistors	ON	BC847CLT1G
7	2	R24, R25	Not Mounted	Resistors	-	-
8	2	R35, R37	1206 100Ω ±1%	Resistors	SUP	RR3216(1206)L1000FT

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
9	1	R36	0603 10RΩ ±5%	Resistors	SUP	RR1608(0603)L10R0FT
10	2	R40, R41, R67	Not Mounted	Resistors	-	-
11	2	R42, R43	0603 1RΩ ±5%	Resistors	SUP	RR1608(0603)L1R00FT
12	1	R66	0603 20KΩ ±5%	Resistors	SUP	RR1608(0603)L203JT
13	2	U4	SRK2001, SSOP 10	Adaptive synchronous rectification controller for LLC resonant converter	ST	SRK2001

7 Conclusions

The test results shown demonstrate the good performances achieved by the STDES-200GANADP.

The reference design shows a peak efficiency of ~ 95%, a clear and well appreciated advantage. It also meets CoC Tier 2 and DoE Level 6 efficiency requirements for average efficiency. The soft switching topology helps for the low switching losses. The low quiescent current consumption makes it the best in-class no-load consumption device.

The soft-switching architecture, based on the zero voltage switching (ZVS), is achieved and the switching losses are minimized.

The controller has the proprietary ZVS active clamp flyback with low RMS current, which makes this achieve a high performance. Thanks to the reduction of switching and conduction losses, it reaches a high performance. The MasterGaN application eliminates the reverse recovery loss and ensures an optimized power consumption. The secondary losses are minimized by using the high efficiency and optimized synchronous rectification digital control.

Thanks to the highly integrated MasterGaN IC, you can enjoy the benefits of the GaN technology, without worrying about the GaN driving complexity. The MasterGaN also enhances the application robustness. The digital controller is optimized for a high frequency driver optimized for GaN, for fast, effective, and layout simplifications.

These STDES-200GANADP features ensure a little power loss and a good thermal performance.

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.

STMicroelectronics reference designs are provided "as is". STMicroelectronics does not promise that reference designs are accurate or error free. STMicroelectronics makes no warranties or representations with regard to the reference designs or use of the reference designs, express, implied or statutory, and specifically disclaims all warranties, express or implied, as to the accuracy or completeness of the information contained therein.

STMicroelectronics disclaims any warranty of title and any implied warranties of merchantability, fitness for a particular purpose and non-infringement of any third-party intellectual property rights concerning STMicroelectronics reference designs or their use. STMicroelectronics shall not be liable for and shall not defend or indemnify buyers against third-party infringement claim that relates to or is based on a combination of components provided in an STMicroelectronics reference design.

In no event shall STMicroelectronics be liable for any actual, special, incidental, consequential or indirect damages, however caused, on any theory of liability and whether or not STMicroelectronics has been advised of the possibility of such damages, arising in any way out of STMicroelectronics reference designs or buyer's use of STMicroelectronics reference designs.

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 12. **Document revision history**

Date	Revision	Changes
20-Sep-2022	1	Initial release.

Contents

List of tables

List of figures