170 W AC-DC converter reference design with wide input for eBike chargers

Using XDP™ XDPS2201E hybrid-flyback controller

About this document

Scope and purpose

This document is an engineering report for a 170 W AC-DC converter reference design which uses Infineon's XDP™ XDPS2201E digital power hybrid-flyback (HFB) controller.

The updated reference design uses the advanced HFB-controller XDP™ XPDS2201E, which brings an updated and expanded feature set. Notably, this new generation of controllers focuses on ease of use, making it more convenient to design and integrate the product into your systems.

The converter has an extraordinarily high peak efficiency of 95.0% and two control inputs that define the setpoints for the constant current (CC) and constant voltage (CV) regulation loops. Therefore, it is ideal for use in battery charging applications in combination with a safety switch and charging controller. Therefore, it can be used in standard power supply applications as well. A voltage doubler ensures configurable wide input range to cover different residential voltages across the world.

The hybrid-flyback topology enables an extraordinarily small transformer size, comparable to resonant half-bridge and much smaller than standard flyback. Unlike resonant topologies the transformer construction is as simple as that of a standard flyback, without the need to minimize leakage inductance. This results in a competitive system cost for the presented solution.

If you want to add an independent auxiliary supply, a CoolSET™ daughterboard with Infineon's CoolSET™ ICE5AR4770AG quasi-resonant (QR) flyback controller is implemented as an option.

This document contains information regarding the design features and test setup, board specifications, board design data, performance data, and bill of materials (BOM) including transformer specifications.

Intended audience

The intended audiences for this document are design engineers, technicians, and developers of electronic systems.

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“Evaluation Boards and Reference Boards” shall mean products embedded on a printed circuit board (PCB) for demonstration and/or evaluation purposes, which include, without limitation, demonstration, reference and evaluation boards, kits and design (collectively referred to as “Reference Board”).

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Safety precautions

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

Table 1 Safety precautions

	Warning: *The DC link potential of this board is up to 1000 VDC. When measuring voltage waveforms by oscilloscope, high voltage differential probes must be used. Failure to do so may result in personal injury or death.*
	Warning: *The evaluation or reference board contains DC bus capacitors which take time to discharge after removal of the main supply. Before working on the drive system, wait five minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.*
	Warning: *The evaluation or reference board is connected to the grid input during testing. Hence, high-voltage differential probes must be used when measuring voltage waveforms by oscilloscope. Failure to do so may result in personal injury or death. Darkened display LEDs are not an indication that capacitors have discharged to safe voltage levels.*
	Warning: *Remove or disconnect power from the drive before you disconnect or reconnect wires, or perform maintenance work. Wait five minutes after removing power to discharge the bus capacitors. Do not attempt to service the drive until the bus capacitors have discharged to zero. Failure to do so may result in personal injury or death.*
	Caution: *The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.*
	Caution: *Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.*
	Caution: *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*
	Caution: *A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.*
	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.*

Table of contents

1 Test setup and safety instructions

This AC-DC reference design consists of a main board and an optional CoolSET™ daughterboard. The main board includes the hybrid-flyback (HFB) stage with Infineon's XDP™ XDPS2201E digital power hybrid-flyback controller and the output regulation circuit (CC-control and CV-control feature). A programming interface gives access to the XDPS2201E for parameter configuration and failure mode reporting.

The optional CoolSET™ daughterboard includes a QR flyback stage with Infineon's ICE5AR4770AG flyback controller and provides an independent constant 5 V auxiliary supply for the secondary side.

To implement a battery charger with this reference design, a battery safety switch must be connected in order to guarantee safe operation.

Attention: ***For safety reasons, it is prohibited to connect this reference design board to any battery without adding the battery safety switch externally.***

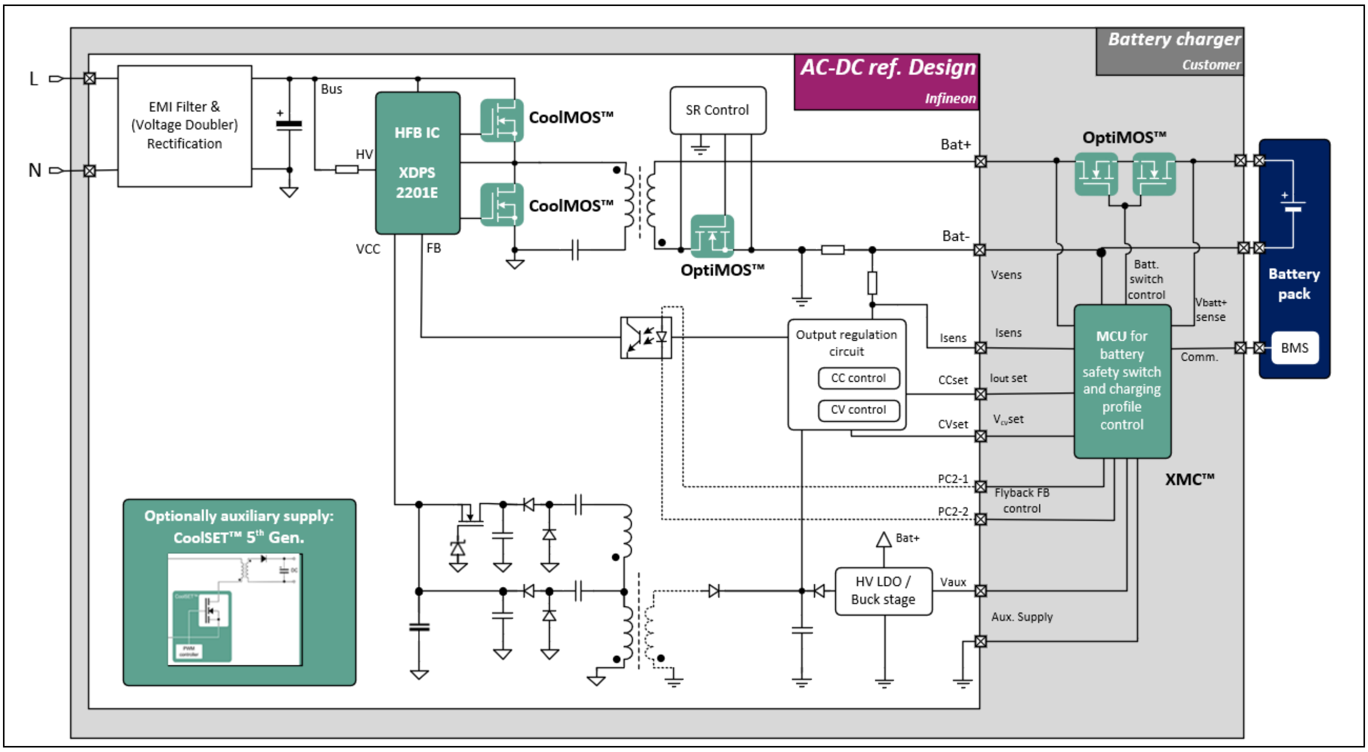


Figure 1 Test setup of AC-DC reference design with external battery

1.1 CC/CV test setup

All mentioned measurements in the engineering report have been performed with the following test setup. An AC source is used to power the reference board.

Attention: ***Lethal voltages are present on this reference design. Do not operate the board unless you are trained to handle high-voltage circuits. Do not leave this board unattended when it is powered up.***

Attention: ***For changing between low mains (100–130 V AC) and high mains (198–230 V AC) a jumper X1 has to be soldered on bottom side for low line operation or removed for high line operation mode***

To set the desired charging current and the voltage the CC_{set} and CV_{set} value is controlled via an external DC source, according to Figure 2. An electronic load in CV mode is used to simulate a charging battery.

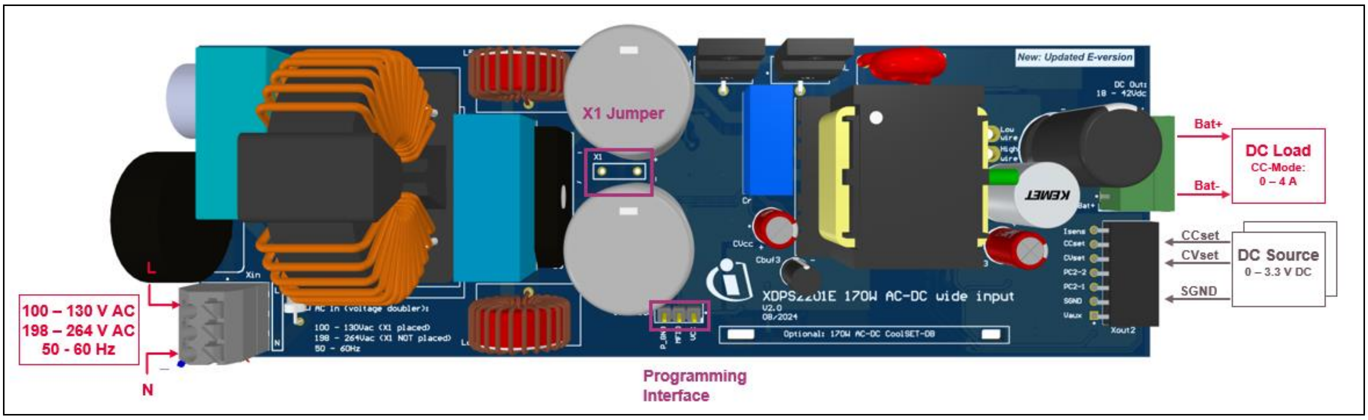


Figure 2 **CC/CV test setup with electronic load and settings via DC source**

2 Board specifications

Table 2 Input and output specifications

Description	Symbol	Value	Unit
Input voltage range (configurable via jumper X1)	V_{in}	100 to 130 198 to 264	V AC
Input frequency range	f_{in}	50 to 60	Hz
CC_{set} range (see Figure 3)	CC_{set}	0 to 3.3	V DC
CV_{set} range (see Figure 4)	CV_{set}	0 to 3.3	V DC
Output voltage range	V_{out}	18 to 42	V DC
Nominal output current	I_{outnom}	4.0	A
High line peak efficiency at full output power (V_{in} = 230 V AC; V_{out} = 42 V; I_{outmax} = 4.0 A)	$\eta_{HL,peak}$	95.0	%
Four-point average efficiency at high line (V_{in} = 230 V AC)	$\eta_{HL,avg}$	94.0	%
Low line peak efficiency at full output power (V_{in} = 115 V AC; V_{out} = 42 V; I_{outmax} = 4.0 A)	$\eta_{LL,peak}$	93.8	%
Four-point average efficiency at low line (V_{in} = 115 V AC)	$\eta_{LL,avg}$	93.4	%

The following table highlights the key components and board dimensions of the main board.

Table 3 Main board components and dimensions

Item	Specification
HFB controller IC	XDPS2201E
Other Infineon components	2x IPA60R280P7S, BSC160N15NS5, BSS169
PCB dimensions (L x W x H)	170 mm x 55.5 mm x 27 mm

The following table highlights the key components and board dimensions of the CoolSET™ daughterboard.

Table 4 CoolSET™ daughterboard (optional) components and dimensions

Item	Specification
Controller IC + integrated CoolMOS™	ICE5AR4770AG
PCB dimensions (L x W x H)	50 mm x 25 mm x 14 mm

Set the CC_{set} value via control interface connector Xout2, Pin 6 according to the desired charging current, as described in Figure 3. By default, the CC_{set} is not set internally and needs to be set from external DC supply.

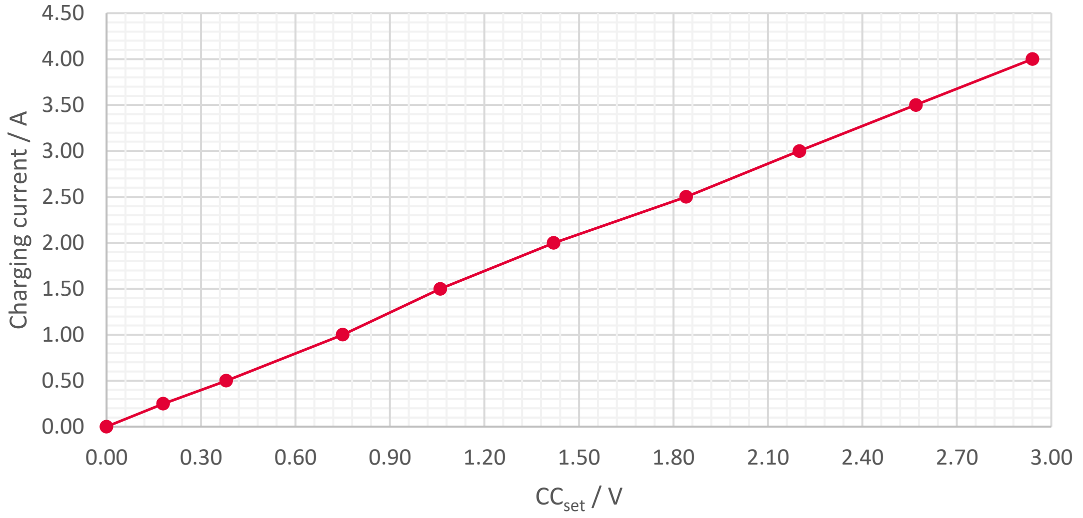


Figure 3 CC_{set} values for desired charging current

Set the CV_{set} value via control interface connector Xout2, Pin5 according to the desired CV voltage, as described in Figure 4. By default, the CV_{set} value is set to 3.00 V via a resistor network, so the output voltage is set to the nominal value V_{CV} = 42 V.

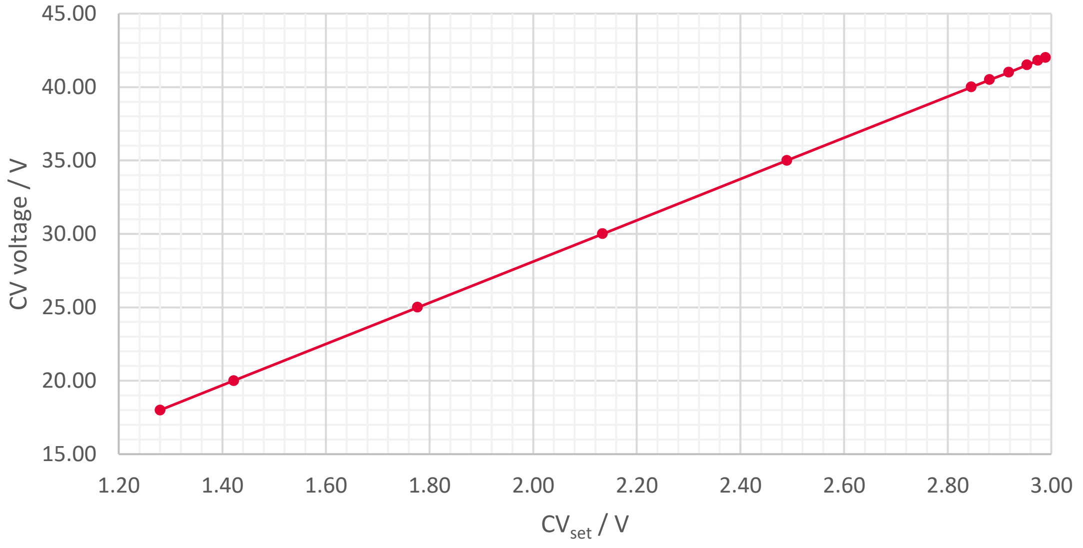


Figure 4 CV_{set} values for desired CV voltage

3 Schematic and layout

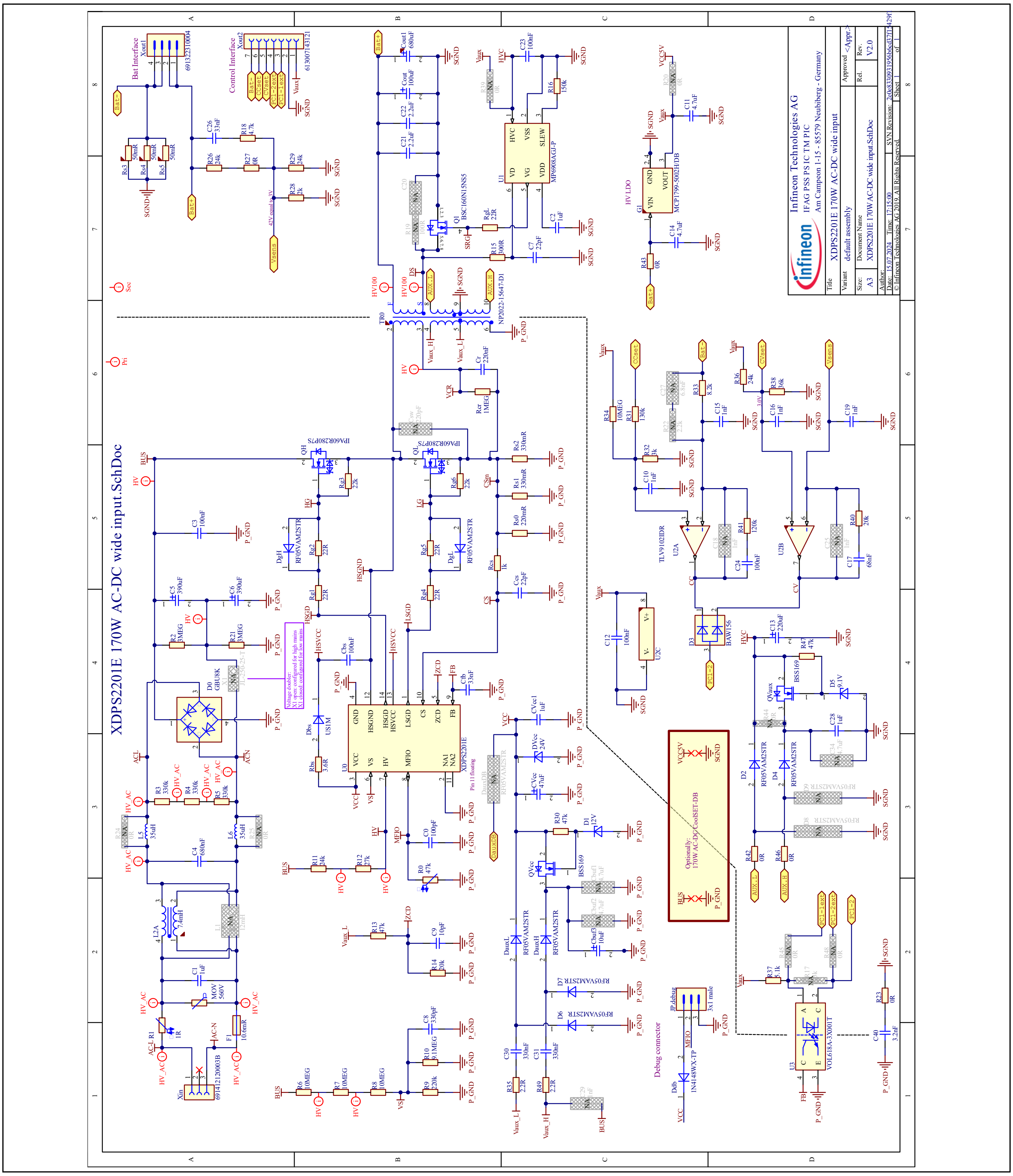


Figure 5 **Main board schematic**

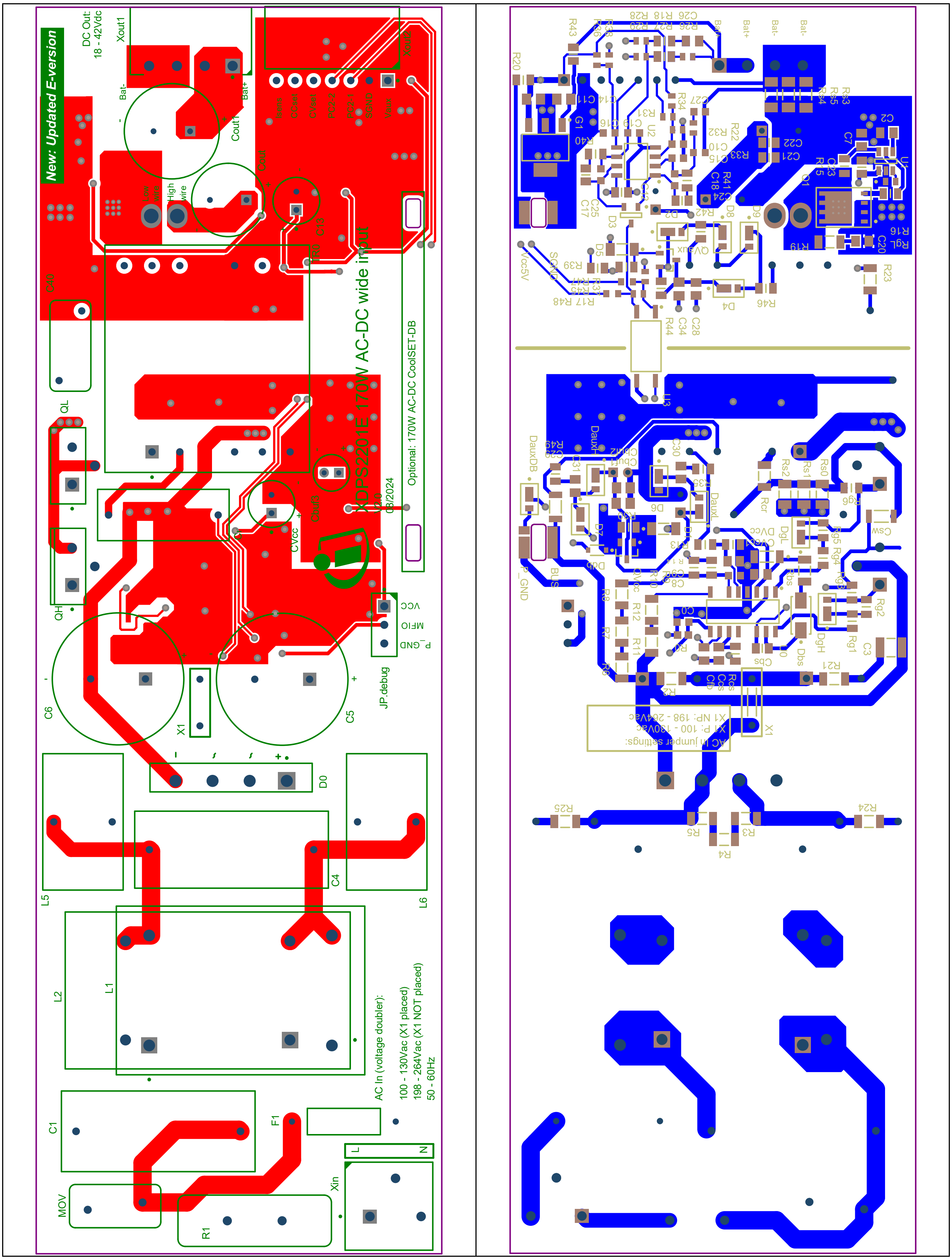


Figure 6 Main board PCB top (left) and bottom (right)

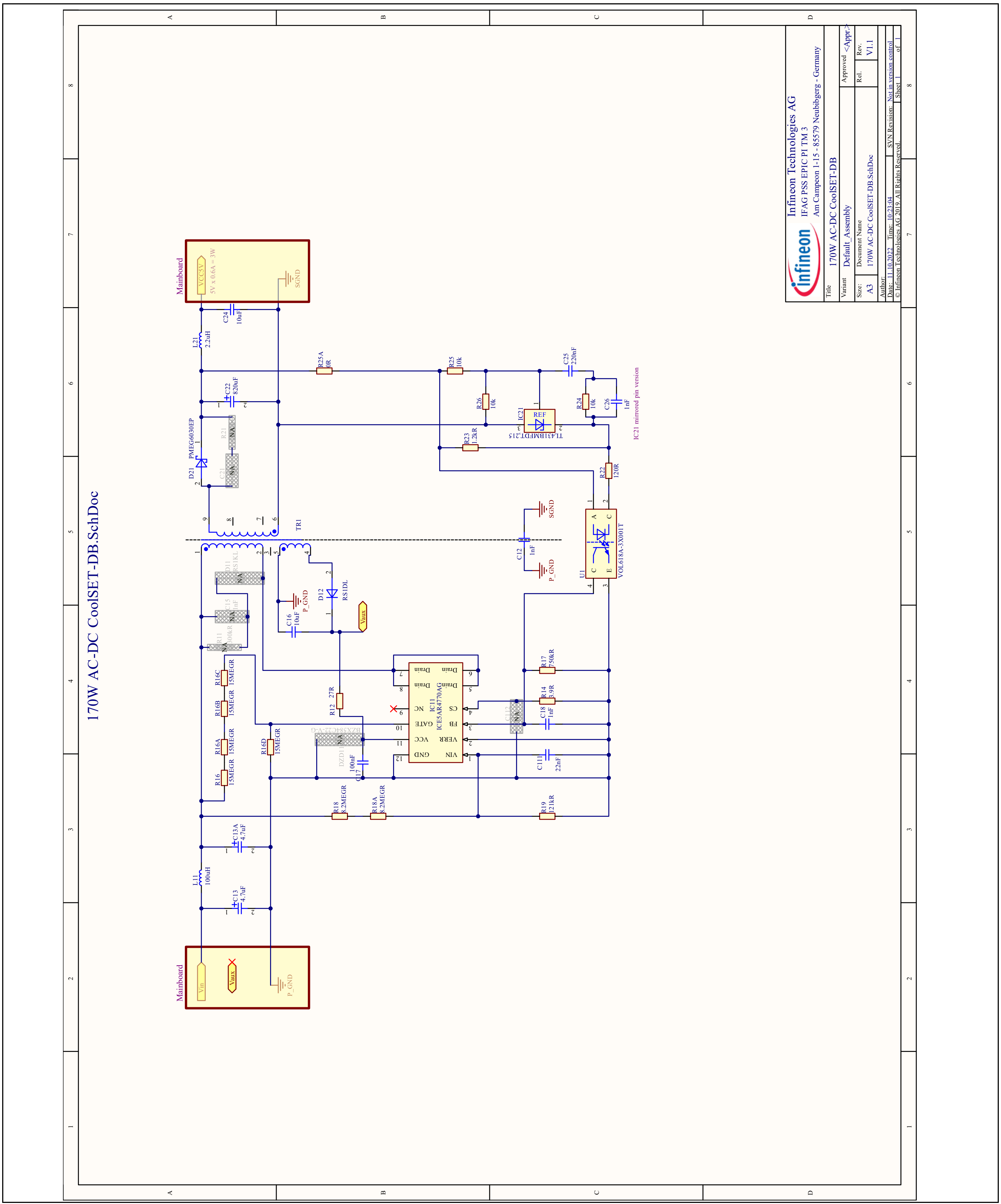


Figure 7 Optional: CoolSET™ daughterboard schematic

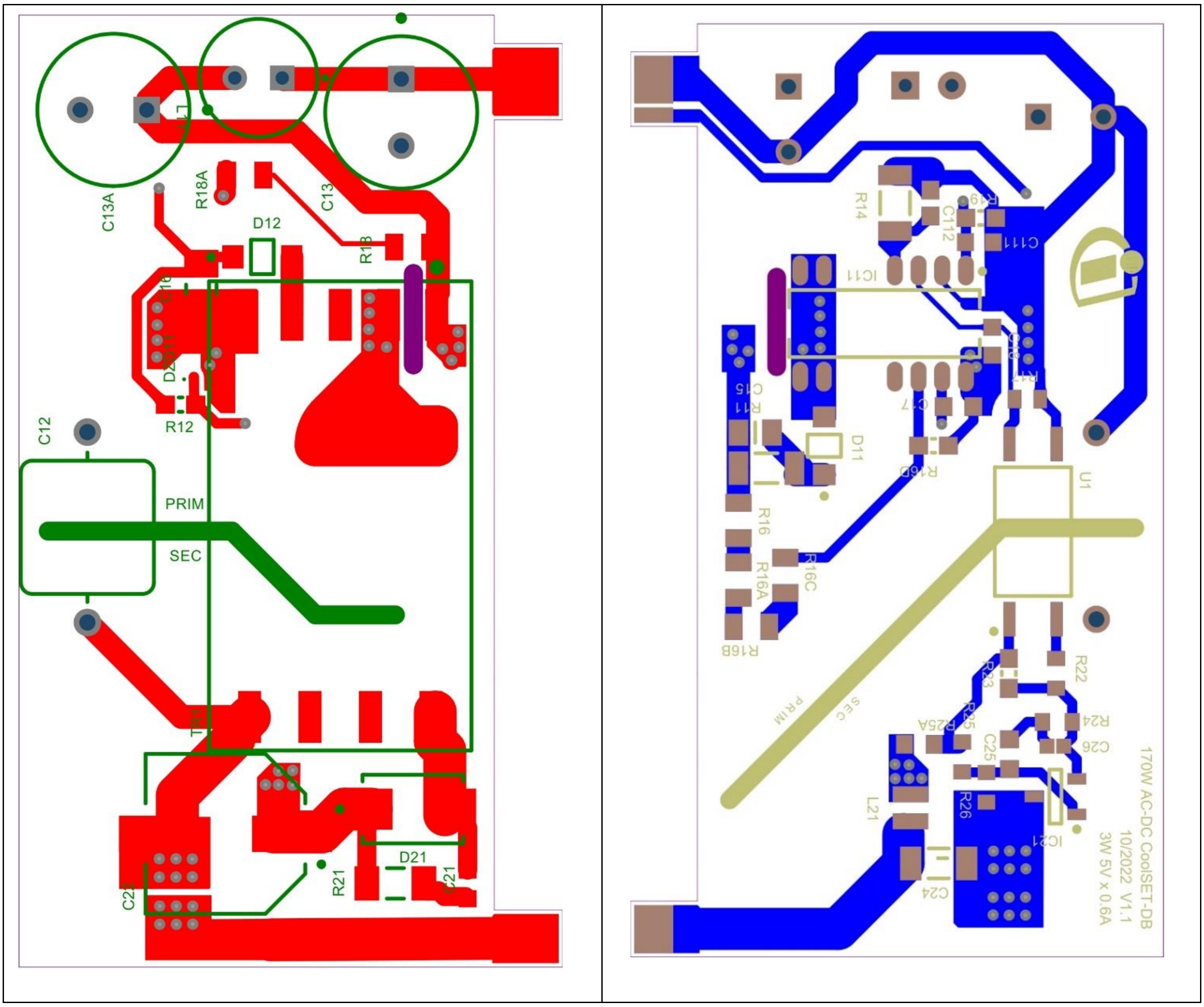


Figure 8 Optional: CoolSET™ daughterboard PCB top (left) and bottom (right)

4 Performance data

The performance data have been measured with the CC/CV test setup described in Figure 2.

4.1 Efficiency at high mains

The efficiency was measured with different input voltage V_{in}. The battery load was simulated via an electronic load in CV mode. The board was placed on a laboratory bench under free air convection.

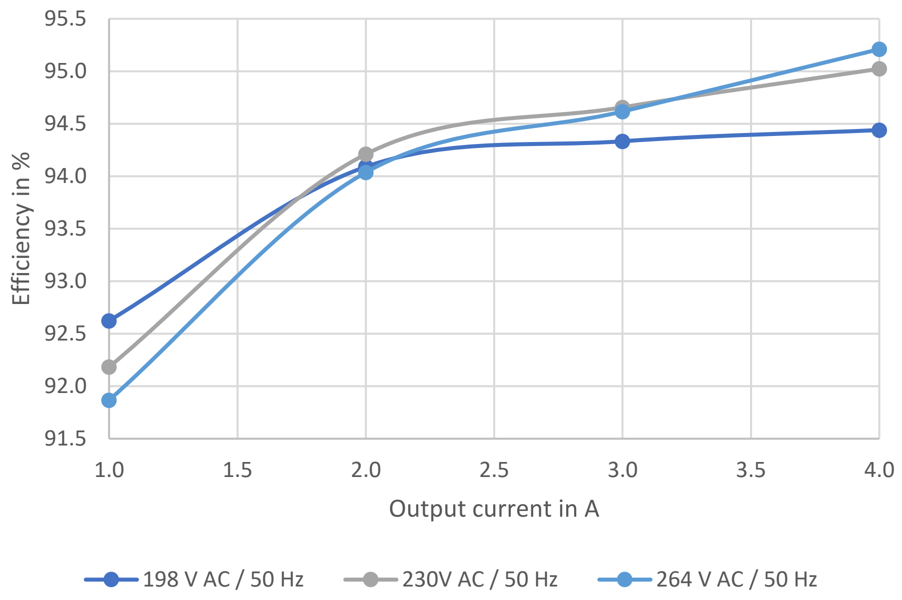


Figure 9 Efficiency versus load at different input voltages (high mains)

The four-point (25%, 50%, 75%, and 100% of I_{outnom}) average efficiency was measured at different input voltages – see Table 5.

Table 5 Average efficiency at high mains

V AC (V_{RMS})	Output load (V)	I_{out} (A)	I_{outnom} (%)	Efficiency	Average efficiency
198	42	1.00	25	92.6	93.9
		2.00	50	94.1	
		3.00	75	94.3	
		4.00	100	94.4	
230	42	1.00	25	92.2	94.0
		2.00	50	94.2	
		3.00	75	94.7	
		4.00	100	95.0	
264	42	1.00	25	91.9	93.9
		2.00	50	94.0	
		3.00	75	94.6	
		4.00	100	95.2	

4.2 Efficiency at low mains

The efficiency was measured with different input voltage V_{in}. The battery load was simulated via an electronic load in CV mode. The board was lying on a laboratory desk under free air convection.

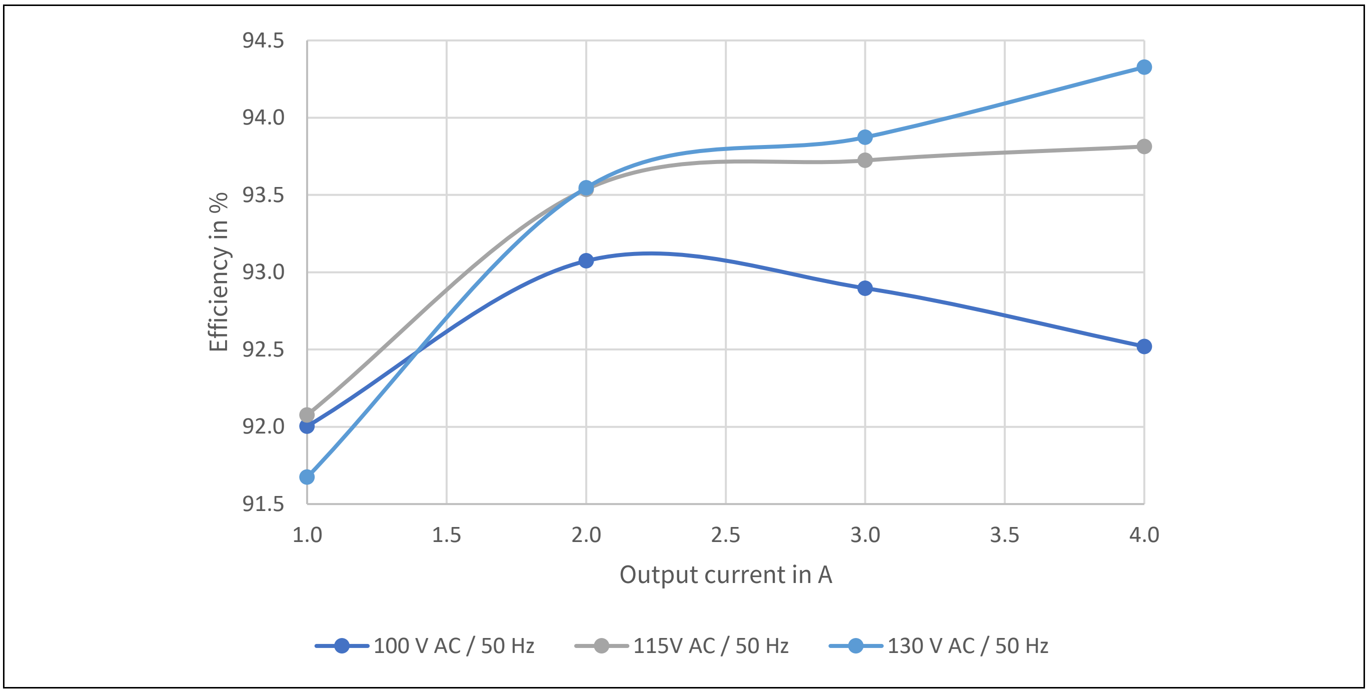


Figure 10 Efficiency versus load at different input voltages (low mains)

The four-point (25%, 50%, 75%, and 100% of I_{outnom}) average efficiency was measured at different input voltages – refer to Table 6.

Table 6 Average efficiency at low mains

V AC (V_{RMS})	Output load (V)	I_{out} (A)	I_{outnom} (%)	Efficiency	Average efficiency
100	42	1.00	25	92.0	92.6
		2.00	50	93.1	
		3.00	75	92.9	
		4.00	100	92.5	
115	42	1.00	25	92.1	93.4
		2.00	50	93.5	
		3.00	75	93.7	
		4.00	100	93.8	
130	42	1.00	25	91.7	93.4
		2.00	50	93.5	
		3.00	75	93.9	
		4.00	100	94.3	

4.1 Charging behavior

Figure 11 shows the measured efficiency while charging a completely depleted 40 V battery pack with default CV setting (CV_{set} = 3.0 V) and external CC setting to 4.0 A (CC_{set} = 3.0 V) for nominal charging current. At 42 V battery voltage, CV control takes over and limits the battery voltage accordingly. The accuracy depends on the tolerance of the resistor network of voltage sensing and the accuracy of the reference voltage.

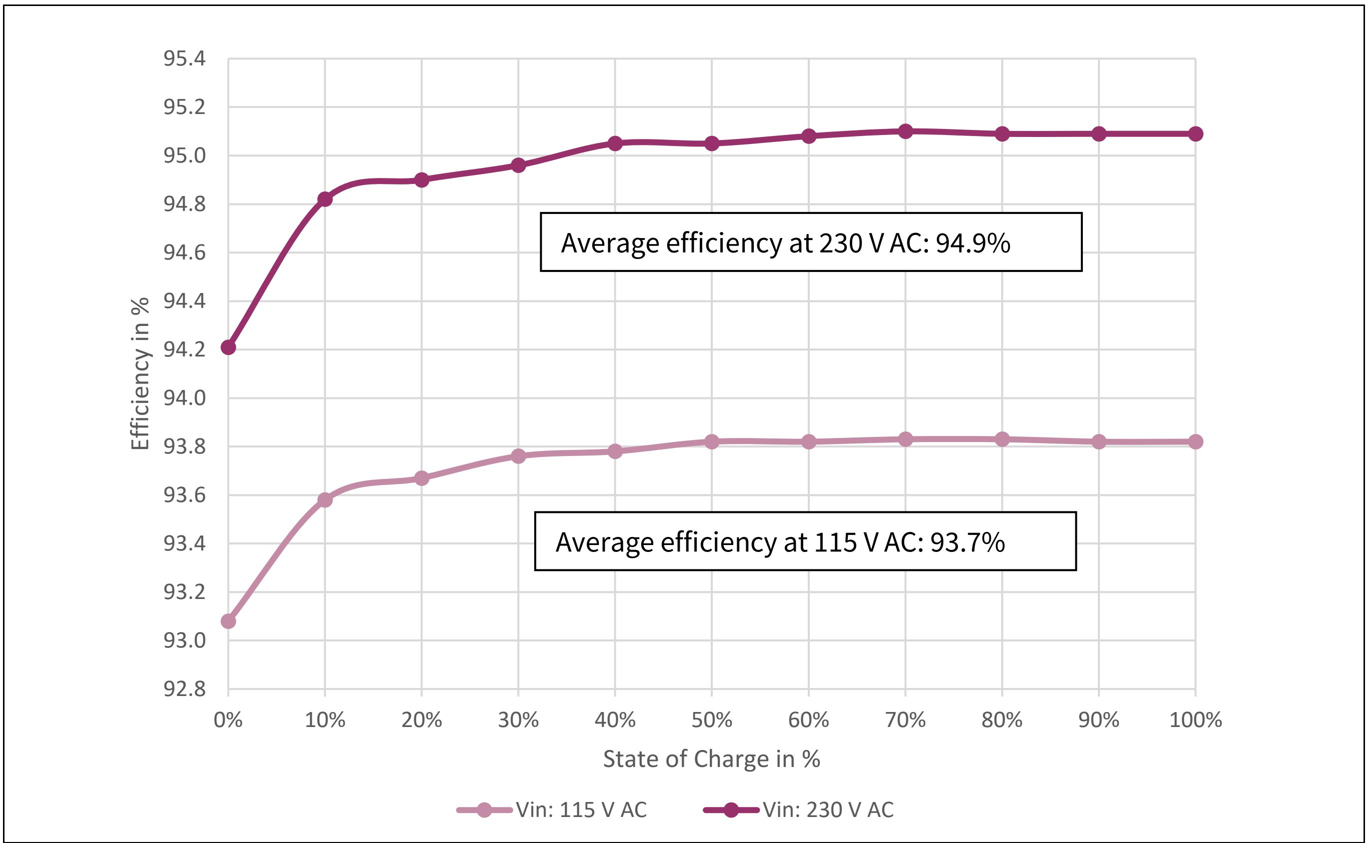


Figure 11 CC-CV charging behavior, Iload = 4 A, CCset = 3.0 V, and CVset = 3.0 V

4.2 Standby power

The reference board is operating in CV mode at an output voltage of Vout = 42 V without any load attached. Figure 12 shows the input power consumption under no-load condition in different configuration.

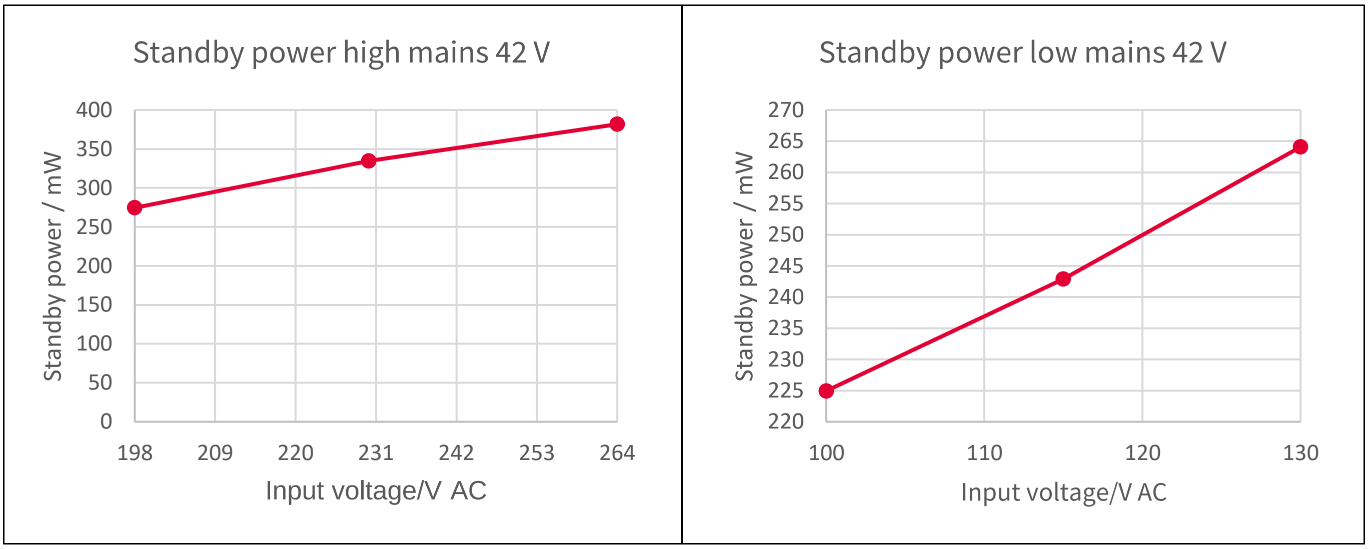


Figure 12 Standby power consumption at different input voltage values , Vout = 42 V

The reference board is operating in CV mode at an output voltage of Vout = 18 V without any load attached. Figure 13 shows the input power consumption under no-load condition in different configuration.

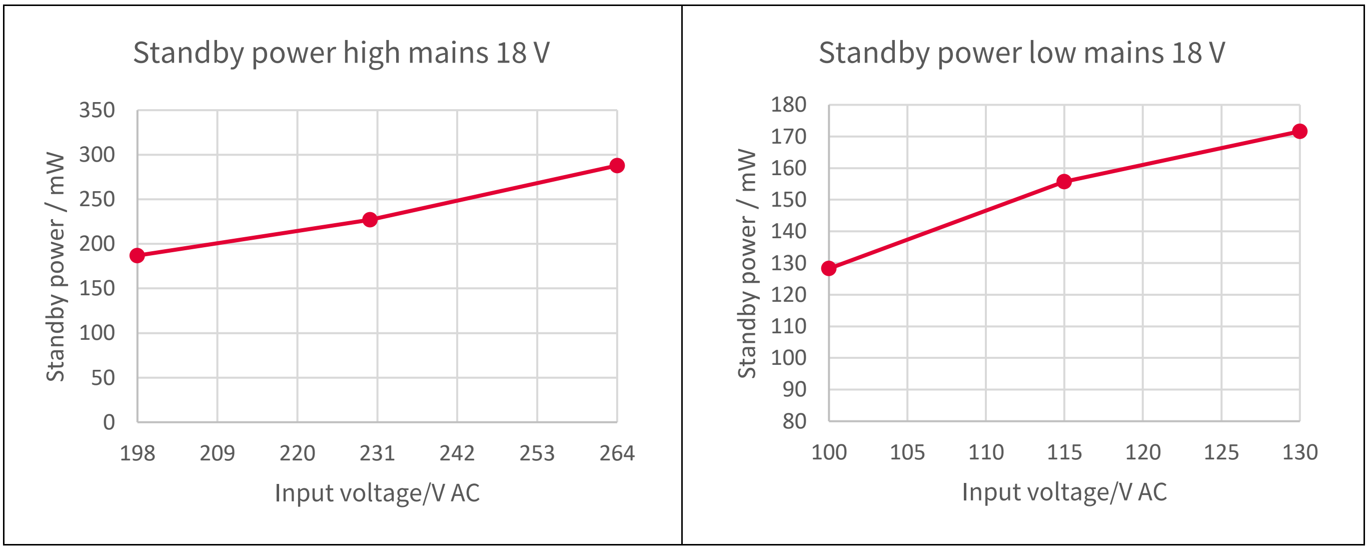
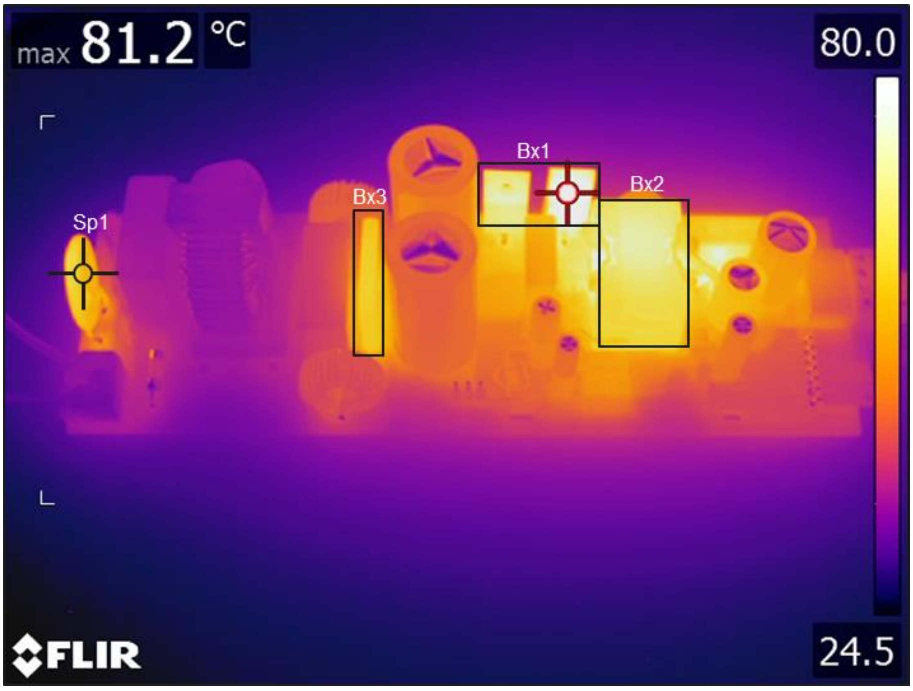


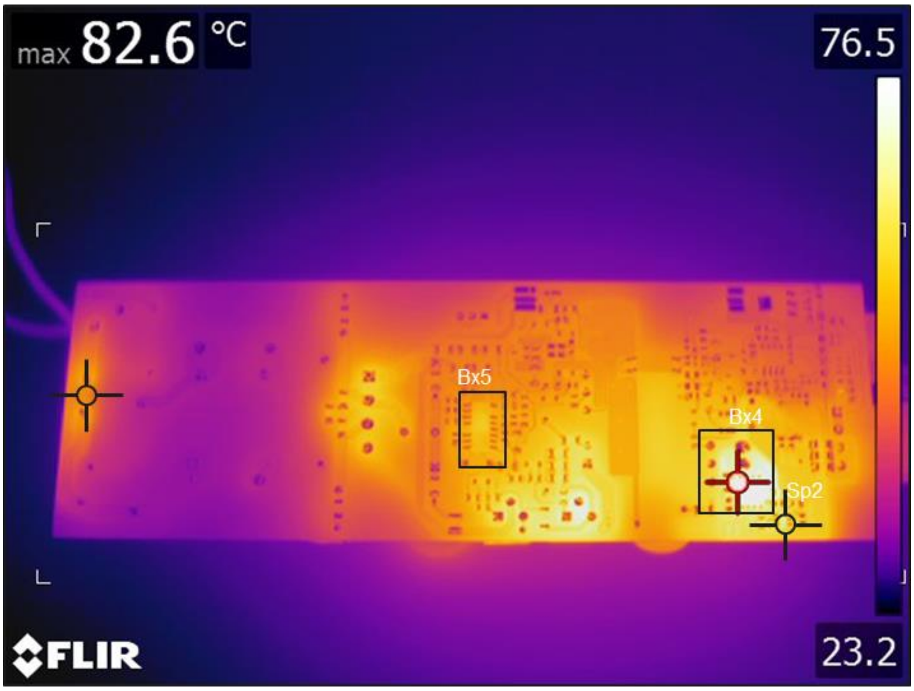
Figure 13 Standby power consumption at different input voltage values , Vout = 18 V

4.3 Thermal measurement

The open-frame thermal measurement was done after one hour of operation at nominal output load, using an infrared thermography camera. The ambient temperature was approximately 24°C.

V_{in} = 230 V AC, P_{out} = 170 W





Parameters	
Emissivity	0.97
Reflected temp.	24.0°C
Atmospheric temp.	24.0°C
Relative humidity	50.0%

Camera information	
Camera model	FLIR T600
Lens	FOL13
Camera serial	55905689
Field of view	45.01

Figure 14 Infrared thermal image of PCB top and bottom side 230 V AC

Table 7 Temperature spots of PCB top and bottom side 230 V AC

No.	Designator	Function	Component	Temperature (Max.)
Bx1	QH, QL	Half-bridge CoolMOS™	IPA60R280P7S	81.2°C
Bx2	TR0	Transformer	NP2022-15647-D1	80.6°C
Bx3	D0	Bridge rectifier	GBU8K	69.2°C
Bx4	Q1	SR MOSFET OptiMOS™	BSC160N15NS5	82.6°C
Bx5	U0	HFB controller	XDPS2201E	62.2°C
Sp1	R1	NTC resistor	B57364S0109M000	71.2°C
Sp2	U1	SR controller	MPS6908	72.6°C

V_{in} = 115 V AC, P_{out} = 170 W

Parameters	
Emissivity	0.97
Reflected temp.	20.0°C
Atmospheric temp.	24.0°C
Relative humidity	50.0%

Camera information	
Camera model	FLIR T600
Lens	FOL13
Camera serial	55905689
Field of view	45.01

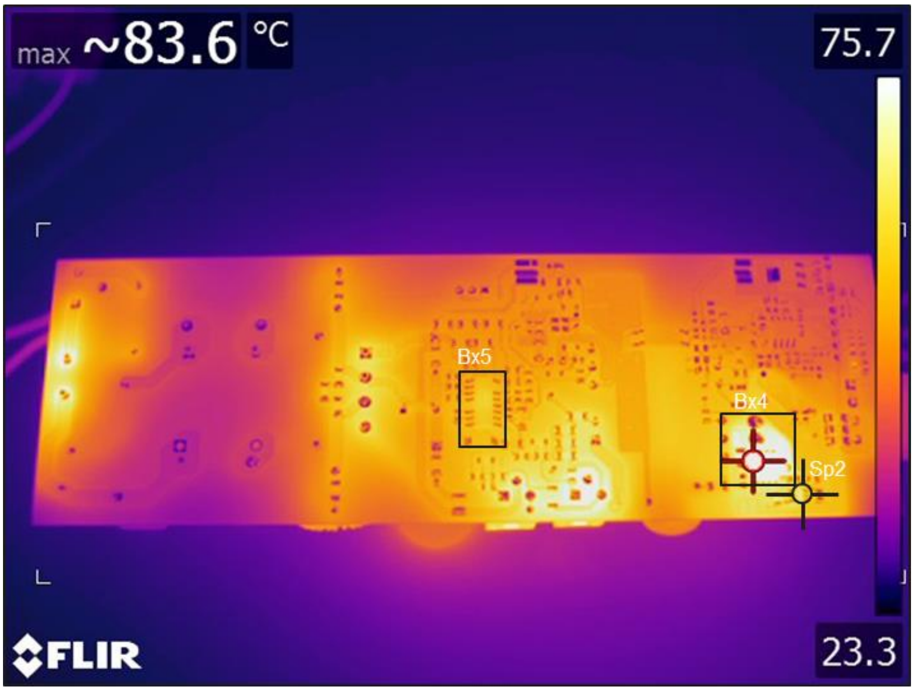


Figure 15 Infrared thermal image of PCB top and bottom side 115 V AC

Table 8 Temperature spots of PCB top and bottom side 115 V AC

No.	Designator	Function	Component	Temperature (Max.)
Bx1	QH, QL	Half-bridge CoolMOS™	IPA60R280P7S	80.8°C
Bx2	TR0	Transformer	NP2022-15647-D1	77.8°C
Bx3	D0	Bridge rectifier	GBU8K	76.0°C
Bx4	Q1	SR MOSFET OptiMOS™	BSC160N15NS5	83.6°C
Bx5	U0	HFB controller	XDPS2201E	65.9°C
Sp1	R1	NTC resistor	B57364S0109M000	97.3°C
Sp2	U1	SR controller	MPS6908	98.0°C

4.4 Conducted emissions

The conducted emissions test was performed at full output power according to EN 55014 for battery chargers. The measurement was performed in phase and neutral configuration with a rated input voltage of 115 V AC / 50 Hz and 230 V AC / 50 Hz. The results reveal that there is sufficient margin, higher than the limit of 6 dB as shown in the plots from Figure 17 to Figure 20.

The measurement equipment used for this emissions test was Rohde & Schwarz HM6050-2 and Tektronix RSA503A. The setup was based on EN 55022 standard class B limits. A variable wire resistor adjusted to 10.5 Ω was used as a load.

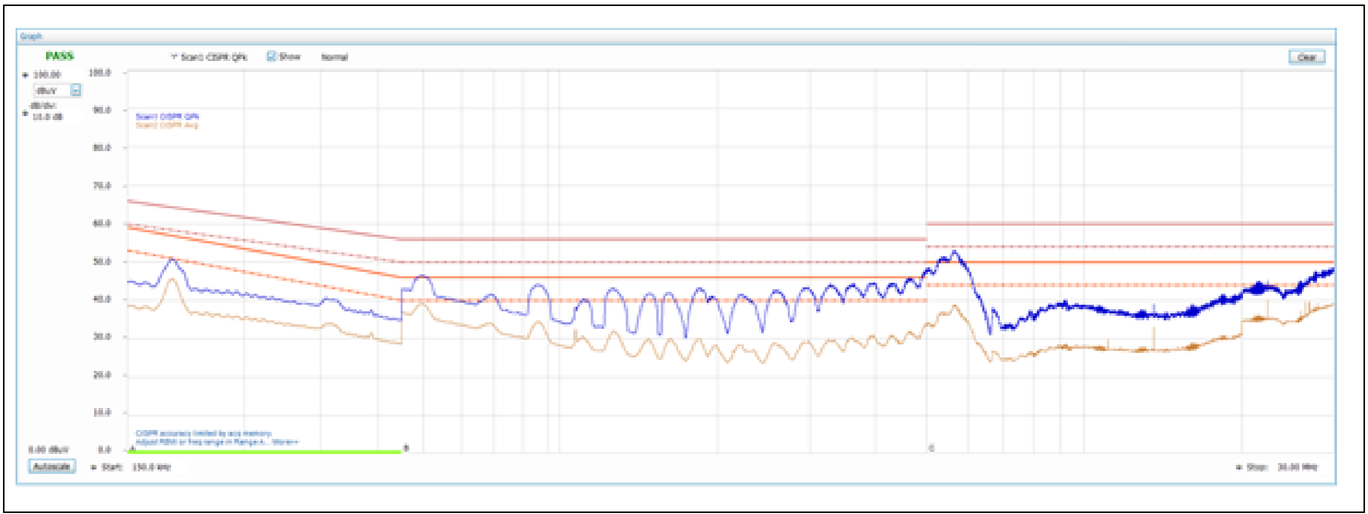


Figure 16 Conducted emissions – phase line 230 V AC

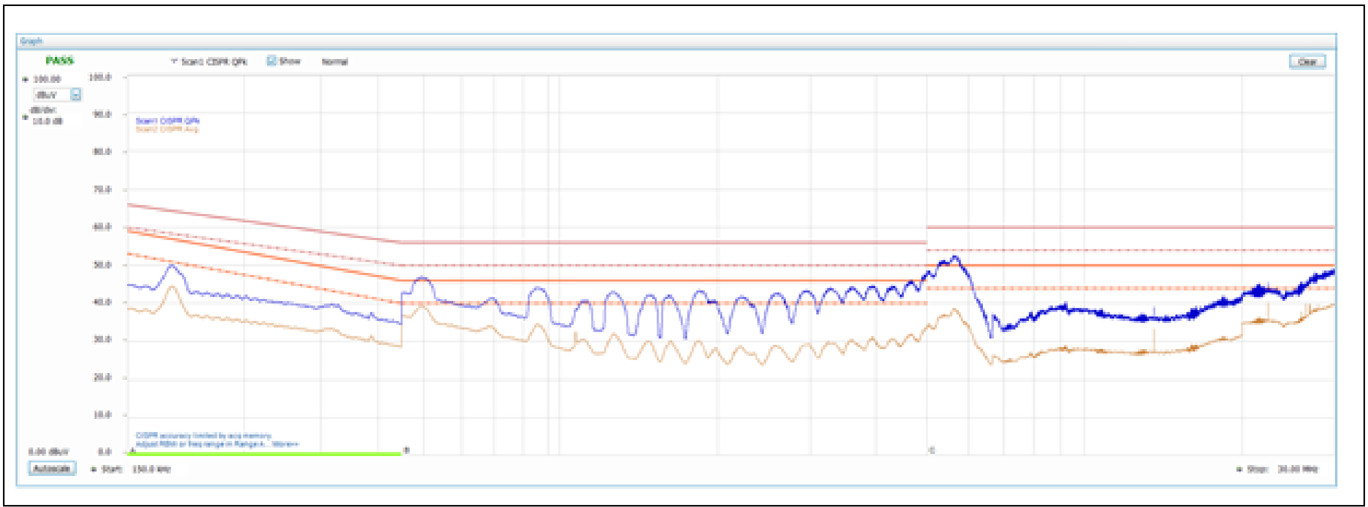


Figure 17 Conducted emissions – neutral line 230 V AC

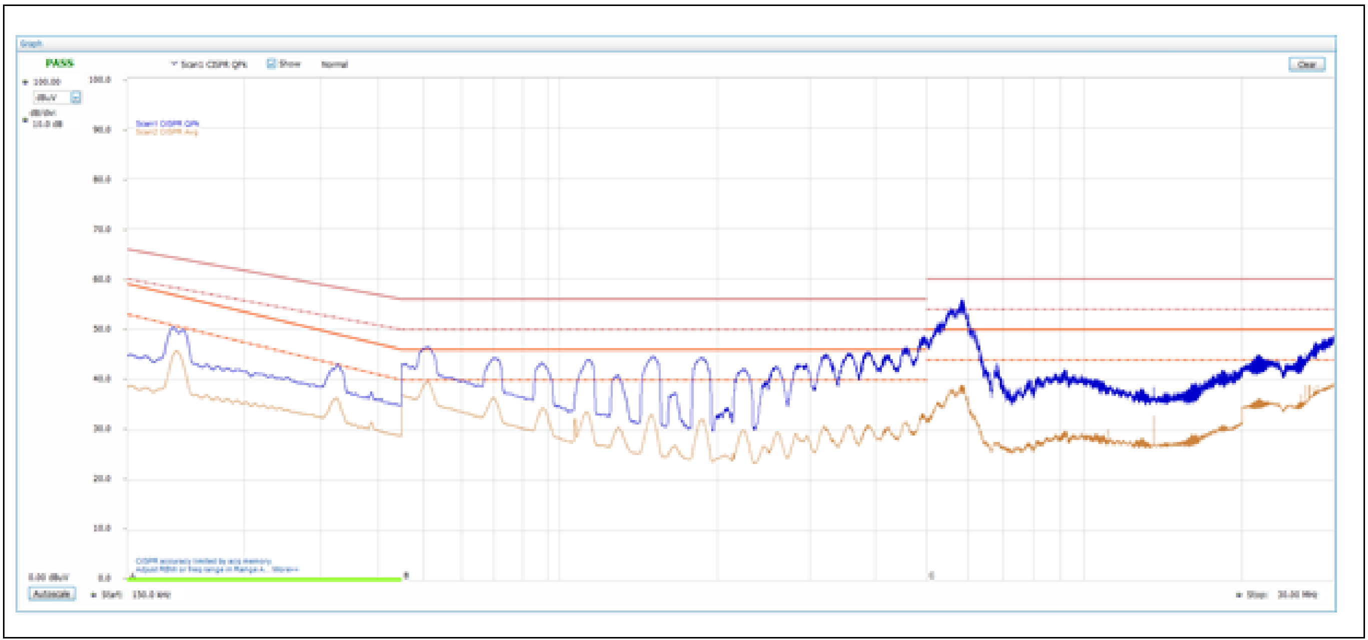


Figure 18 Conducted emissions – phase line 115 V AC

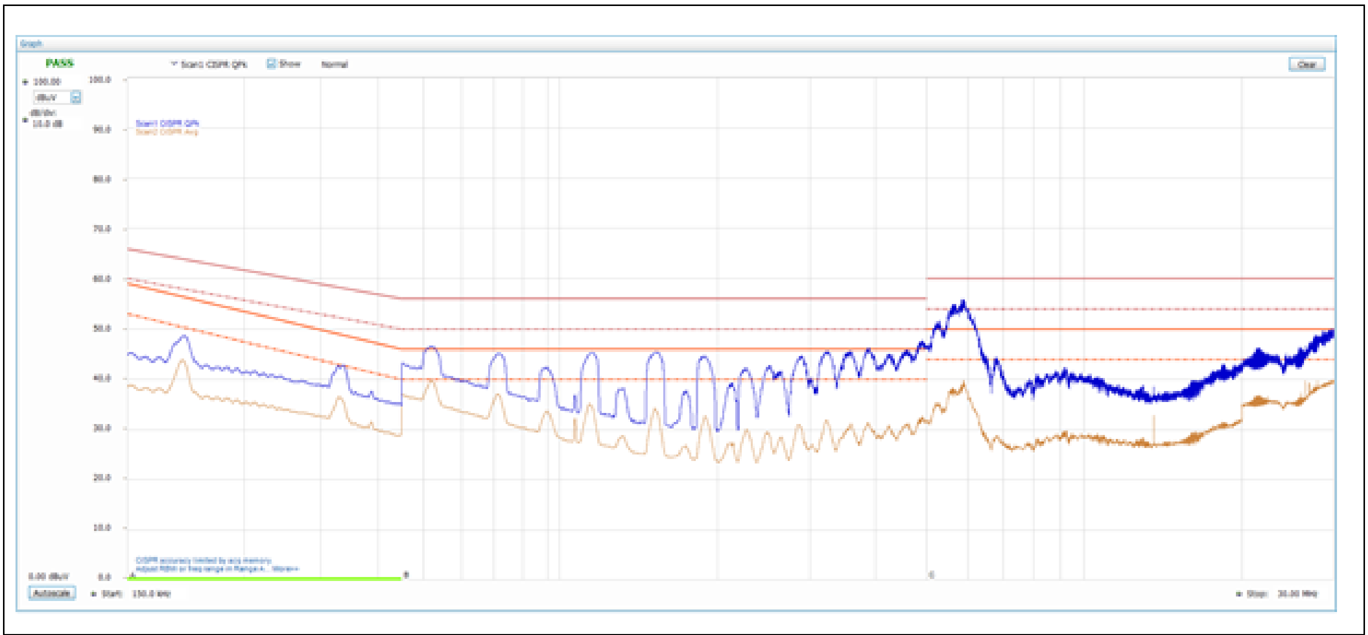


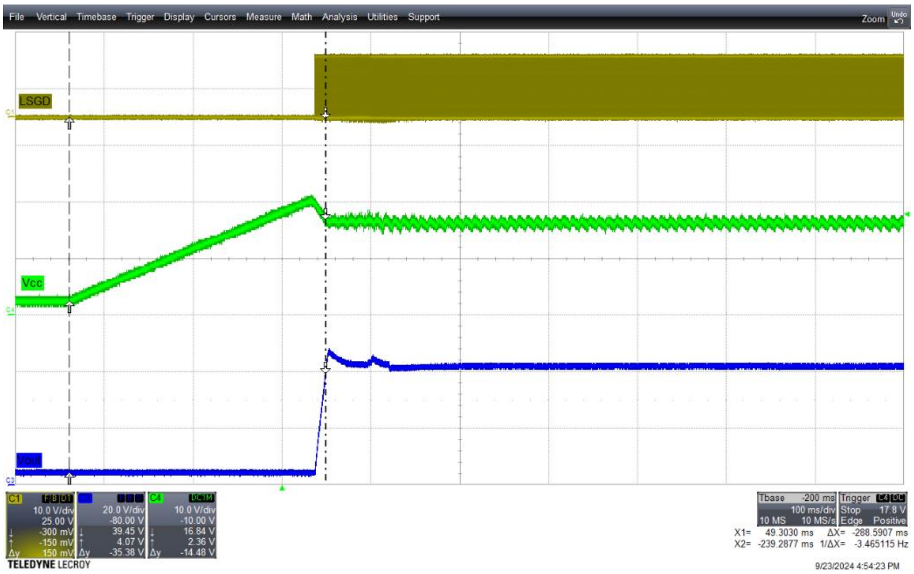
Figure 19 Conducted emissions – neutral line 115 V AC

5 Switching waveforms

This chapter contains switching waveforms for start-up phase, operation mode, and protection features.

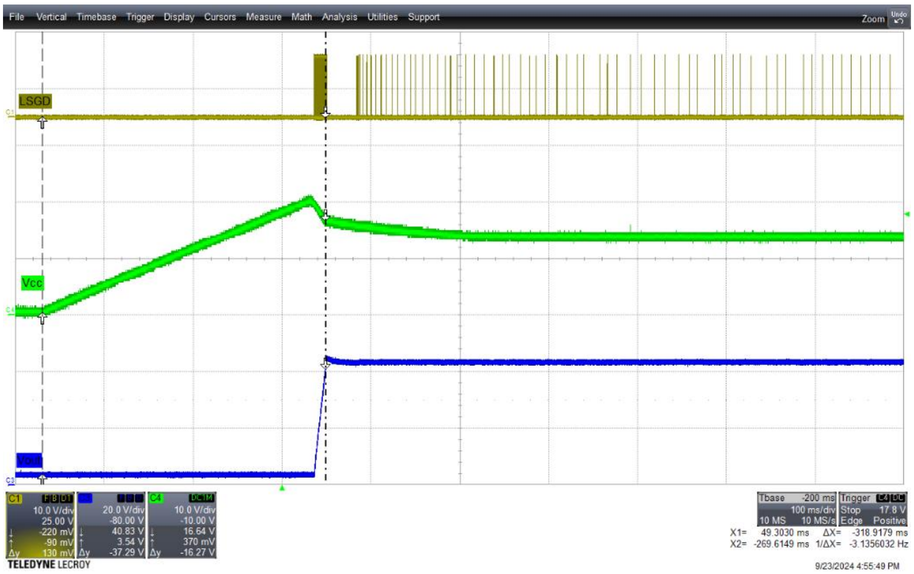
5.1 Start-up

Start-up behavior was measured at full-load condition and high line input. The HFB operates in continuous resonant mode (CRM) – see Figure 21. After start-up at no-load condition, the HFB remains in burst mode (BM) mode, as shown in Figure 22.



C1: V_{CC} C3: V_{Bat+} C4: I_{SW}

Figure 20 Start-up at full load, 230 V AC input

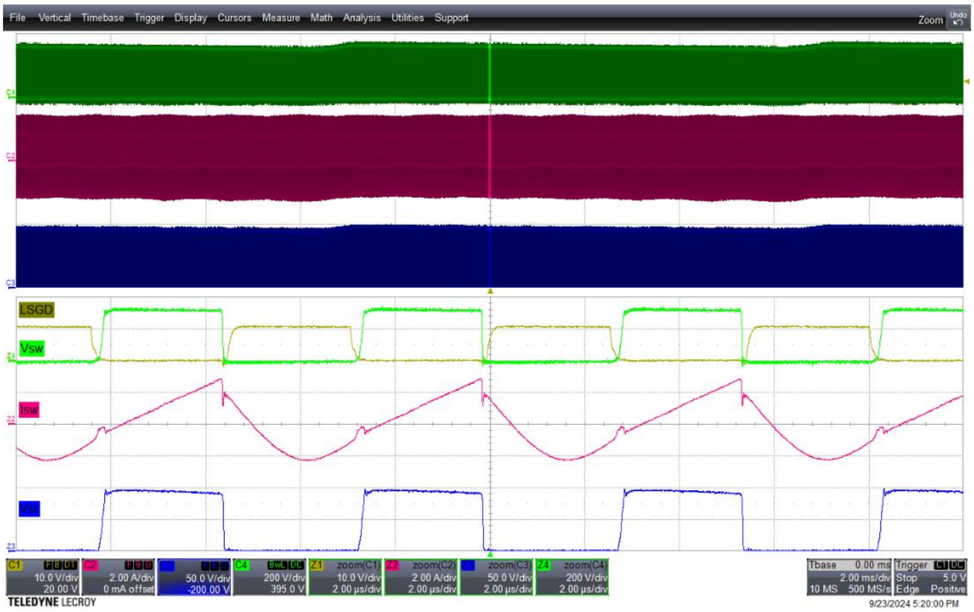


C1: LSGD C3: V_{out} C4: V_{cc}

Figure 21 Start-up at no-load, 230 V AC input

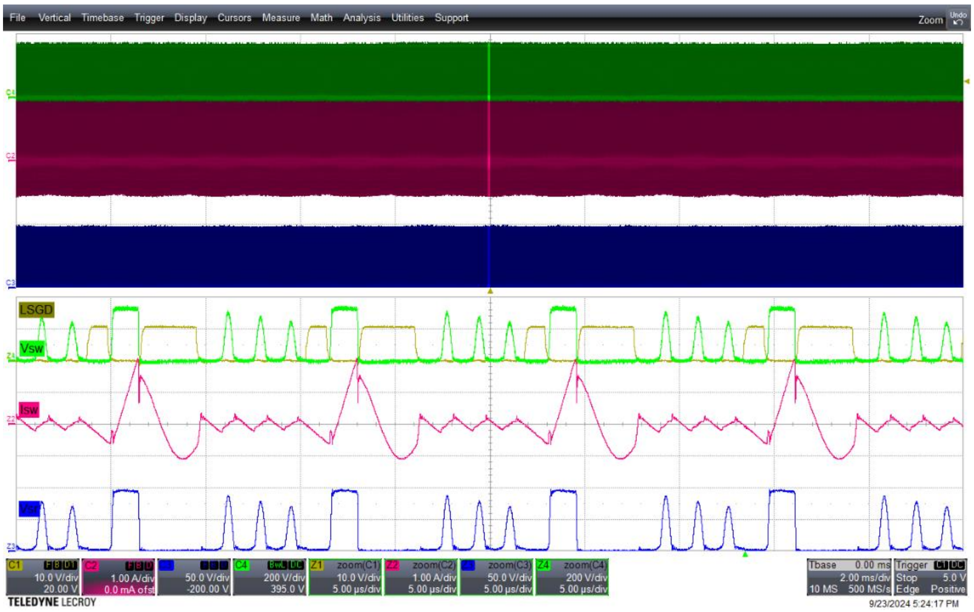
5.2 Operation mode

The HFB has multiple operation modes to optimize efficiency over the line, load current, and output voltage ranges. Figure 22 shows CRM operation at full-load condition in steady-state. For medium-load condition, the HFB operates in the zero-voltage resonant valley switching (ZV-RVS) mode (see Figure 23) while BM mode covers the no-load to light-load range, as shown in Figure 24.



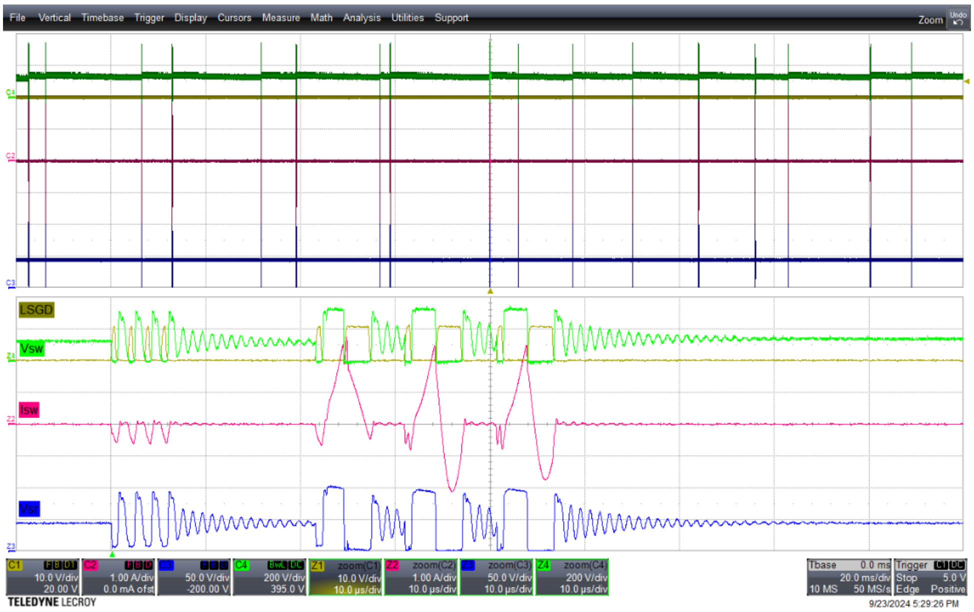
C1: LSGD C2: I_{SW} C3: V_{SR} C4: V_{SW}

Figure 22 CRM mode at VBat+ = 42 V, load = 4 A, CCset: 3.0 V



C1: LSGD C2: I_{SW} C3: V_{SR} C4: V_{SW}

Figure 23 ZV-RVS mode at VBat+ = 20 V, load = 1.4 A, CCset: 1.0 V



C1: LSGD C2: I_{SW} C3: V_{SR} C4: V_{SW}

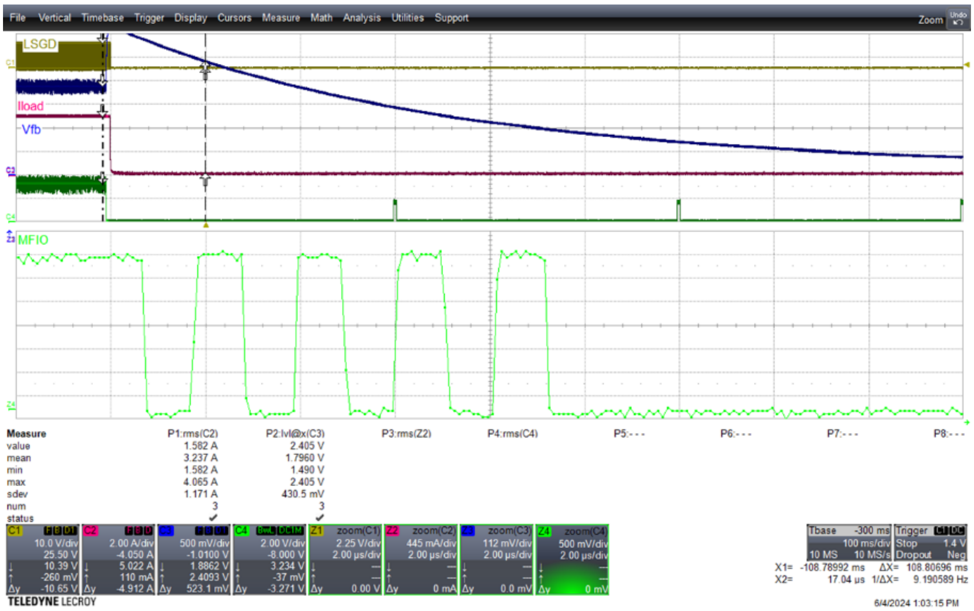
Figure 24 **Burst mode at VBat+ = 42 V, load = 0 A, CCset: 0 V**

5.3 Protection

The XDP™ XDPS2201E digital power controller has various protection features during normal operation. This section shows the output overcurrent protection (OCP) with different levels, input overvoltage protection (V_{in_OVP}) and output undervoltage protection (V_{out_UVP}). Once protection is triggered, the corresponding error code can be read from the MFIO pin. For a detailed description of all protection features, see the datasheet.

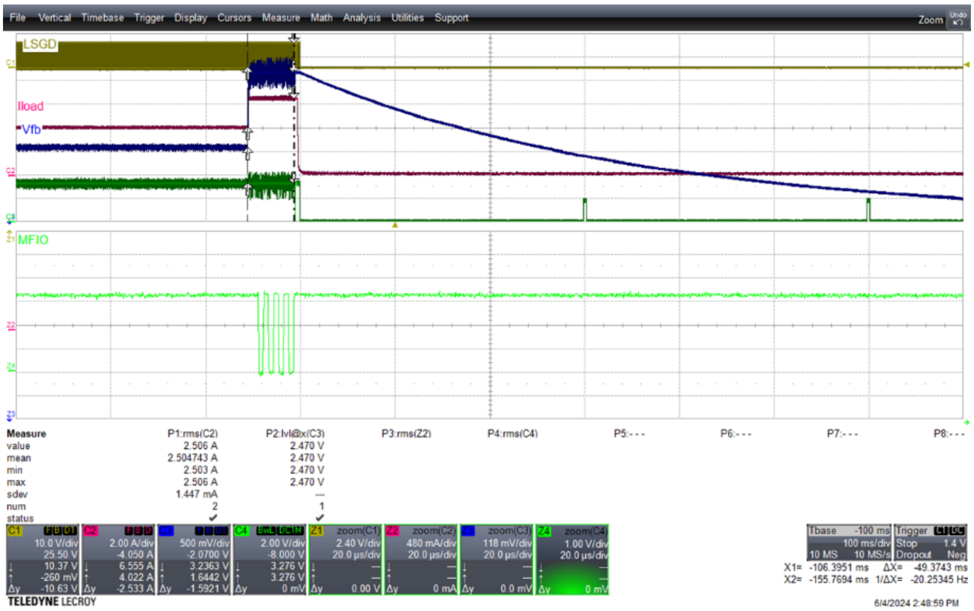
Overcurrent protection

The following figures depict the output overcurrent protection OCP_lev1 and OCPmax at different output loads.



C1: LSGD C2: Iload C3: Vfb C4: MFIO

Figure 25 OCP_lev1 triggering at output load of 5.0 A

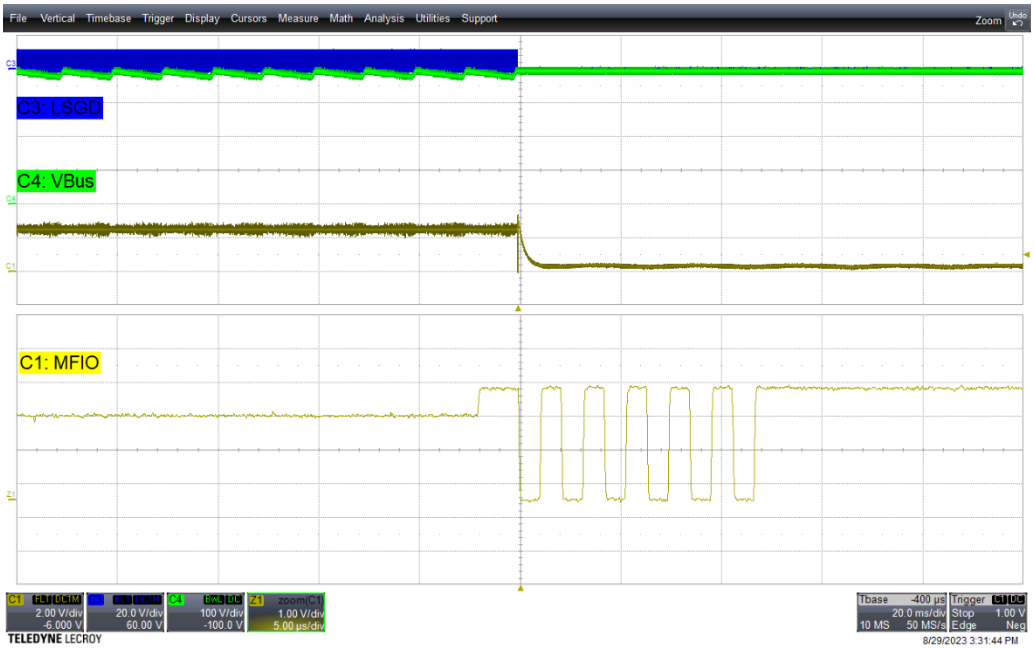


C1: LSGD C2: Iload C3: Vfb C4: MFIO

Figure 26 OCPmax triggering at output load jump from 4 A to 6.5 A

Bus overvoltage protection

For overvoltage at the input, the HFB controller stops switching for certain time and enters auto-restart mode. The behavior is depicted in Figure 27.

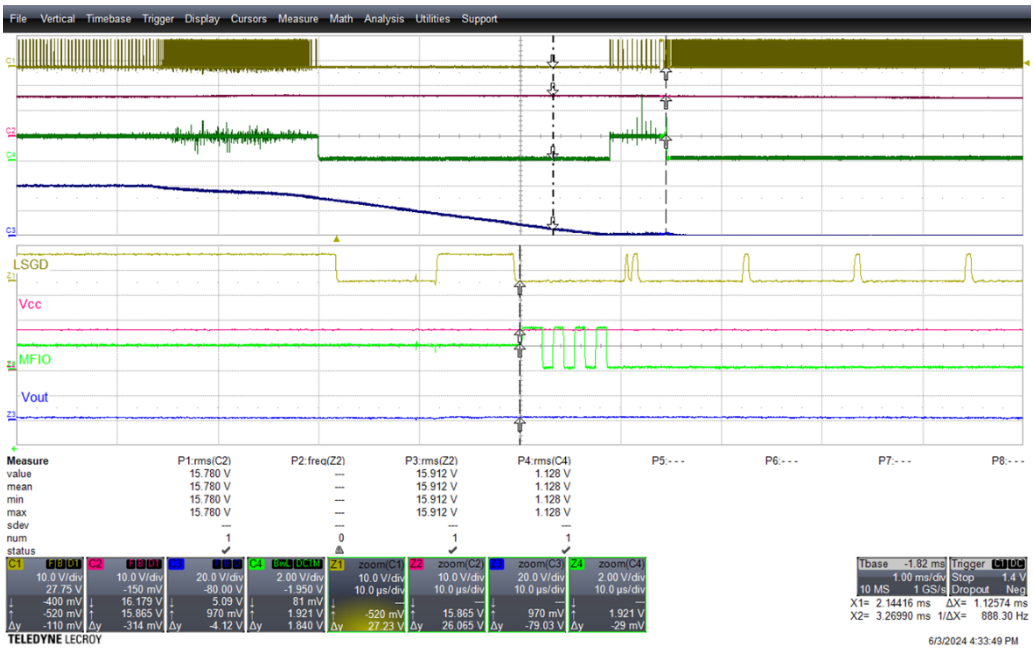


C1: MFIO C3: LSGD C4: V_{BUS}

Figure 27 VbusOVP triggering at input voltage of 278 V AC

Output undervoltage protection

For an overload event at the output the HFB controller stops switching and enters auto-restart mode immediately, as shown in Figure 28.



C1: MFIO C3: LSGD C4: I_{Bat+}

Figure 28 Vout_UVP triggering at short circuit event at the output

6 Bill of materials and specifications

6.1 BOM of XDP™ XDPS2201E digital power 170 W AC-DC wide input

Table 9 BOM of main board

Designator	Description	Manufacturer	Part number
C0	Cap 100 pF/50 V/0603/ C0G/5%	–	–
C1	Cap 1 uF/ 630 V/ THT 22.5/ /10%	TDK Corporation	B32923C3105K189
C2, CVcc1	Cap 1 uF/ 50 V/ 0805/X7R/10%	–	–
C3	Cap 100 nF/ 500 V/1210/ X7R/10%	–	–
C4	Cap 680 nF/ 630 V/THT 22.5 mm/ /10%	Epcos	B32923C3684K189
C5, C6	Cap 390 uF/ 200 V/THT 18 mm x 35.5 mm Leadspace: 7.5 mm/ /20%	Nippon Chemi-Con	EKXJ201ELL391MMP1S
C7, Ccs	Cap 22 pF/50 V/0805/ /5%	–	–
C8	Cap 330 pF/50 V/0603/X7R/10%	–	–
C9	Cap 10 pF/50 V/0805/C0G/50%	–	–
C10, C15, C16, C19	Cap 1nF/50 V/0603/C0G/1%	–	–
C11, C14	Cap 4.7 uF/50 V/0805/ X7R/10%	–	–
C12, C23, C24, Cbs	Cap 100nF/ 50V/0805/ X7R/5%	–	–
C13	Cap 220 uF/25 V/THT/Radial/ /20%	Würth Elektronik	860010473011
C17	Cap 68 nF/50 V/0805/X7R/20%	–	–
C21, C22	Cap 2.2 uF/50 V/0805/X5R/10%	–	–
C26, Cfb	Cap 33 nF/50 V/0805/X7R/5%	–	–
C28	Cap 1 uF/50 V/0805/ X7R/10%	–	–
C30, C31	Cap 330 nF/50 V/0805/ X7R/10%	–	–
C40	Cap 3.2 nF/ /THT 9.5 mm/ /20%	Vishay	440LD32-R
Cbuf3	Cap 10 uF/35 V/ THT/Radial/ /20%	Würth Elektronik	860020572003
Cout	Cap 100 uF/50 V/D10xL17 L/A= 5 mm/ /20%	Kemet	ESX107M050AH2AA
Cout1	Cap 680 uF/50 V/THT/ /20%	Rubycon	50PX680MEFC12.5X20
Cr	Cap 220 nF/400 V/THT 15 mm/ /5%	Epcos	B32652A4224J000
CVcc	Cap 47 uF/35 V/tht/ /20%	Würth Elektronik	860080573003
D0	Dio GBU8K/ /GBU 4L / see component 395212/ /	–	GBU8K
D1	Dio 12V/ /SOD-80/ /	Vishay	TZMB12-GS08
D2, D4, D6, D7, DauxH, DauxL, DgH, DgL	Dio RF05VAM2STR/ /TUMD2M/ /	ROHM Semiconductors	RF05VAM2STR

Designator	Description	Manufacturer	Part number
D3	Dio BAW156/ /SOT23/ /	Infineon Technologies	BAW156
D5	Dio 9.1 V/ /SMD SOD-80/ /	Vishay	TZMB9V1-GS08
Dbs	Dio US1M/ /DO-214AC (SMA)/ /	Vishay	US1M-E3/61T
Ddb	Dio 1N4148WX-TP/ / SOD-323/ /	Micro Commercial Components	1N4148WX-TP
DVcc	Dio 24 V/ / SOD80C/ /	Nexperia	BZV55C24
F1	3.6 mm x 10 mm/250 Vac /4 A	Cooper Bussmann	C310T-SC-4-R-TR1
G1	Pow MCP1799-5002H/DB/ /SOT223-4/ /	Microchip Technology	MCP1799-5002H/DB
JP.debug	Con HTSW-103-07-G-S/ /CON-THT-2.54-3-1-8.38/ /	Samtec	HTSW-103-07-G-S
L2	Ind 7.4 mH/ / THT/ /	Kemet	SCF29XV-080-1R3A026JV
L5, L6	Ind 35 uH/ /tht/ /20%	Würth Elektronik	7447015
MOV	Res 560 V/460 V/ THT/ /	Bourns	MOV-10D561K
Q1	Tra BSC160N15NS5/ /PG-TDSON-8-46, PG-TDSON-8-7/ /	Infineon Technologies	BSC160N15NS5
QH, QL	Tra IPA60R280P7S/ /PG-TO220-3-312/ /	Infineon Technologies	IPA60R280P7S
QVaux, QVcc	Tra BSS169/ /PG-SOT23/ /	Infineon Technologies	BSS169
R0	NTC 47k/ /0603/ /3%	Vishay	NTCS0603E3473HHT
R1	Res 1R/ /THT/Radial/ /20%	TDK Corporation	B57364S0109M000
R2, R21	Res 3MEG/200 V/1206/ /1%	–	–
R3, R4, R5	Res 330k/200 V/1206/ /1%	–	–
R6, R7, R8	Res 10MEG/200 V/1206/ /1%	–	–
R9	Res 220k/150 V/0805/ /1%	–	–
R10	Res 9.1MEG/150 V/0805/ /1%	–	–
R11	Res 24k/200 V/1206/ /1%	–	–
R12	Res 27k/200 V/1206/ /1%	–	–
R13, R30, R47	Res 47k/150 V/0805/ /1%	–	–
R14, R40	Res 20k/150 V/0805/ /1%	–	–
R15	Res 300R/150 V/ 0805/ /1%	–	–
R16	Res 150k/75 V/0603/ /1%	–	–
R18	Res 4.7k/150V/0805/ /1%	–	–
R23	Res 0R/200 V/1206/ /0%	–	–
R26, R29, R36	Res 24k/75 V/0603/ /1%	–	–
R27, R42, R43, R46	Res 0R/150 V/0805/ /	–	–

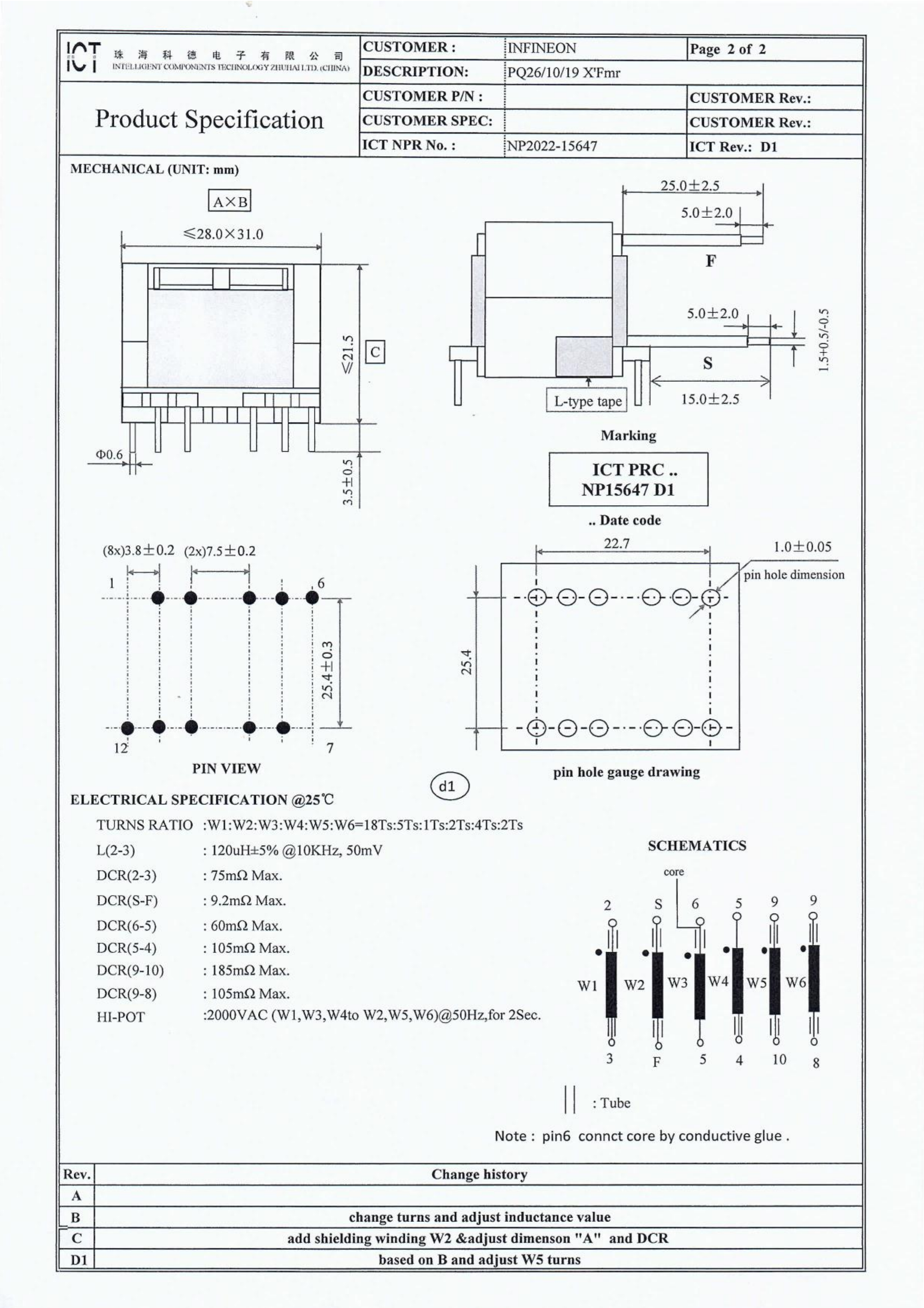
Designator	Description	Manufacturer	Part number
R28	Res 2k/75 V/0603/ /1%	–	–
R31	Res 130k/75 V/0603/ /1%	–	–
R32	Res 3k/75 V/ 0603/ /1%	–	–
R33	Res 8.2k/ /0603/ /1%	–	–
R34	Res 10MEG/75 V/0603/ /1%	–	–
R35, R49	Res 2.2R/150 V/0805/ /1%	–	–
R37	Res 5.1k/75 V/0603/ /1%	–	–
R38	Res 36k/75 V/0603/ /1%	–	–
R41	Res 120k/150 V/0805/ /1%	–	–
Rbs	Res 3.6R/200 V/1206/ /1%	–	–
Rcr	Res 1MEG/200 V/1206/ /1%	–	–
Rcs	Res 1k/150 V/0805/ /1%	–	–
Rg1, Rg2, Rg4, Rg5, RgL	Res 22R/150 V/0805/ /1%	–	–
Rg3	Res 22k/150 V/0805/ /1%	–	–
Rg6	Res 22k/150 V/0805/ /1%	–	–
Rs0	Res 220mR/675 mV/1206/ /1%	Bourns	CRM1206-FX-R220 E LF
Rs1, Rs2	Res 330mR/675 V/1206/ /1%	Bourns	CRM1206-FX-R330 E LF
Rs3, Rs4, Rs5	Res 50mR/ /1206/ /1%	Vishay	WFC1206R0500FE66
TR0	Tra NP2022-15647-D1/ /	ICT	NP2022-15647-D1
U0	Int XDPS2201E/ /PG-DSO-14/ /	Infineon Technologies	XDPS2201E
U1	Pow MP6908AGJ-P/ /TSOT23-6/ /	Monolithic Power Systems	MP6908AGJ-P
U2	Ana TLV9102IDR/ /SOIC-8/ /	Texas Instruments	TLV9102IDR
U3	Opt VOL618A-3X001T/ /LSOP-4/ /	Vishay	VOL618A-3X001T
X1	Con JL-250-25-T/ /JP-THT-JL-250-25-T/ /	Samtec	JL-250-25-T
Xin	Con 691412120003B/ /WR-TBL/ /	Würth Elektronik	691412120003B
Xout1	Con 691322310004/ /WR-TBL/ /	Würth Elektronik	691322310004
Xout2	Con 613007143121/ /THT 7 PIN 2.54 mm pitch/ /	Würth Elektronik	613007143121

6.2 BOM of 170 W AC-DC CoolSET™ daughterboard (optional)

Table 10 BOM of CoolSET™ daughterboard

Designator	Description	Manufacturer	Part number
C12	Capacitor 1 nF/500 V/THT/Radial//20%	Murata	DE1E3RA102MA4BQ01F
C13, C13A	Capacitor 4.7 µF/400 V/THT/Radial//20%	Würth Elektronik	860021374008
C16	Capacitor 10 µF/50 V/1206/X7R//10%	–	–
C17	Capacitor 100 nF/50 V/0603/X7R//10%	–	–
C18	Capacitor 1 nF/50 V/0603/X7R//10%	–	–
C22	Capacitor 820 µF/6.3 V/SMD//20%	Würth Elektronik	875075155009
C24	Capacitor 10 µF/25 V/1206/C0G//10%	–	–
C25	Capacitor 220 nF/10 V/0603/X7R//5%	–	–
C26	Capacitor 1 nF/25 V/0402/C0G//2%	–	–
C111	Capacitor 22 nF/50 V/0603//10%	–	–
D12	RS1DL	Taiwan Semiconductor	RS1DL
D21	Diode PMEG6030EP//SOD-128//	Nexperia	PMEG6030EP
IC11	ICE5AR4770AG//PG-DSO-12//	Infineon Technologies	ICE5AR4770AG
IC21	TL431BMFDT, 215	Nexperia	TL431BMFDT,215
L11	Inductor 100 µH//WE_7447462//10%	Würth Elektronik	7447462101
L21	Inductor 2.2 µH//SMD//20%	Würth Elektronik	74438343022
R12	Resistor 27 R/75 V/0603//1%	–	–
R14	Resistor 3.90 R/200 V/1206//1%	–	–
R16, R16A, R16B, R16C	Resistor 15 MEGR/150 V/0805//0R	–	–
R16D	Resistor 15 MEGR/75 V/0603//1%	–	–
R17	Resistor 750 kR/75 V/0603//1%	–	–
R18, R18A	Resistor 8.2 MEGR/150 V/0805//0R	–	–
R19	Resistor 121 kR/75 V/0603//1%	–	–
R22	Resistor 120 R/75 V/0603//1%	–	–
R23	Resistor 1.2 kR/75 V/0603//1%	–	–
R24, R25, R26	Resistor 10 k/75 V/0603//1%	–	–
R25A	Resistor 0 R/75 V/0603//1%	–	–
TR1	750344058 (Rev. 02)/1.96 mH	Würth Elektronik	750344058
U1	Optocoupler VOL618A-3X001T//LSOP-4//	Vishay	VOL618A-3X001T

6.3 Transformer specifications



ICT 珠海科德电子有限公司 INTELLIGENT COMPONENTS TECHNOLOGY ZHUHAI LTD. (CHINA)	CUSTOMER :	INFINEON	Page 2 of 2
	DESCRIPTION:	PQ26/10/19 X'Fmr	
Product Specification	CUSTOMER P/N :		CUSTOMER Rev.:
	CUSTOMER SPEC:		CUSTOMER Rev.:
	ICT NPR No. :	NP2022-15647	ICT Rev.: D1

MECHANICAL (UNIT: mm)

ELECTRICAL SPECIFICATION @25℃

TURNS RATIO :W1:W2:W3:W4:W5:W6=18Ts:5Ts:1Ts:2Ts:4Ts:2Ts
L(2-3) : 120uH±5% @10KHz, 50mV
DCR(2-3) : 75mΩ Max.
DCR(S-F) : 9.2mΩ Max.
DCR(6-5) : 60mΩ Max.
DCR(5-4) : 105mΩ Max.
DCR(9-10) : 185mΩ Max.
DCR(9-8) : 105mΩ Max.
HI-POT :2000VAC (W1,W3,W4to W2,W5,W6)@50Hz,for 2Sec.

Note : pin6 connct core by conductive glue .

Rev.	Change history
A	
B	change turns and adjust inductance value
C	add shielding winding W2 &adjust dimenson "A" and DCR
D1	based on B and adjust W5 turns

Figure 29 Transformer specifications of NP2022-15647-D1

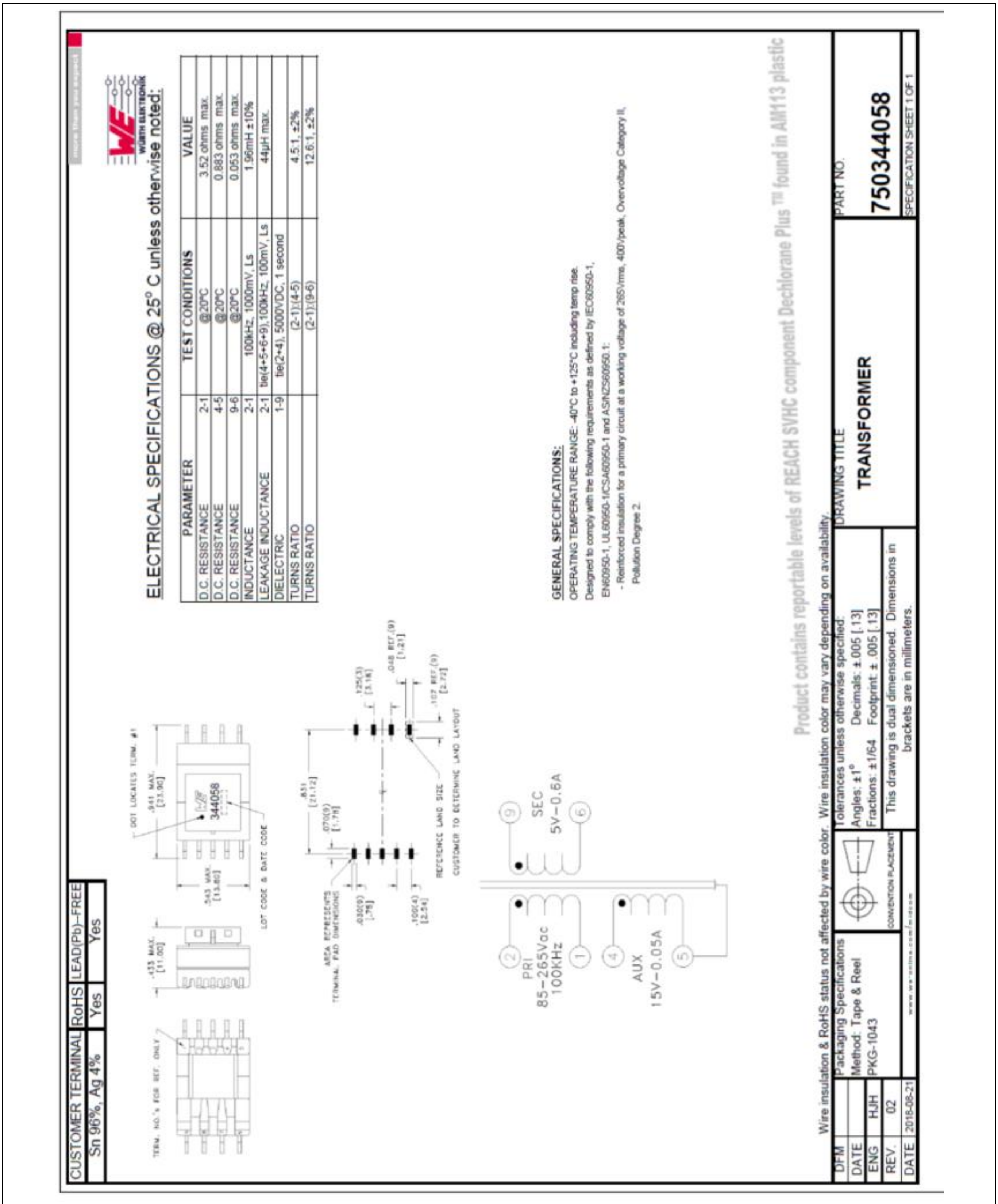


Figure 30 Transformer specifications of 75034405 (optional for daughterboard)

References

Revision history

Document revision	Date	Description of changes
V 1.0	2024-11-29	Initial release

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